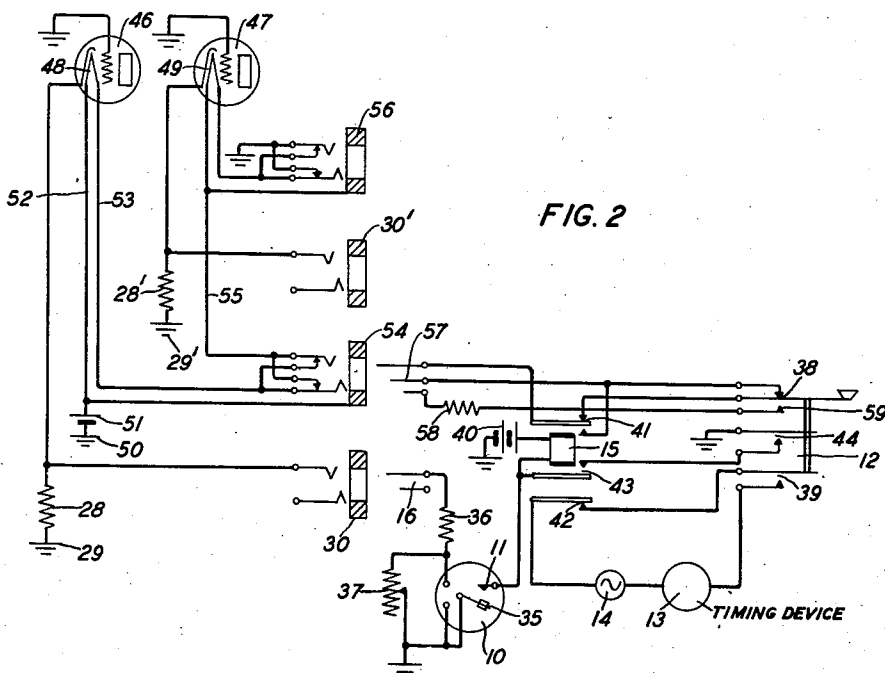
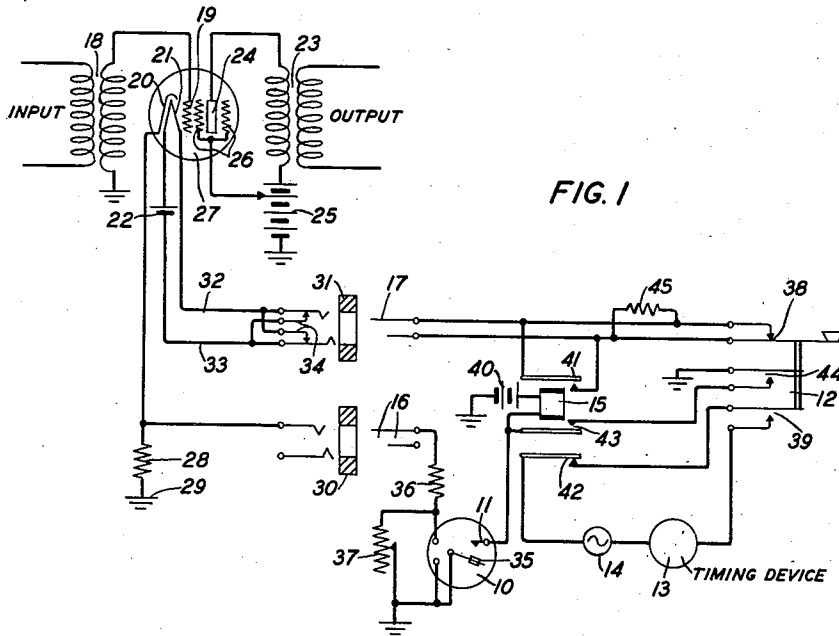


May 31, 1938.

D. K. GANNETT
TESTING ARRANGEMENT FOR ELECTRON DISCHARGE
DEVICES AND METHODS OF OPERATING SAME
Filed Aug. 16, 1935

2,118,919

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

FIG. 3

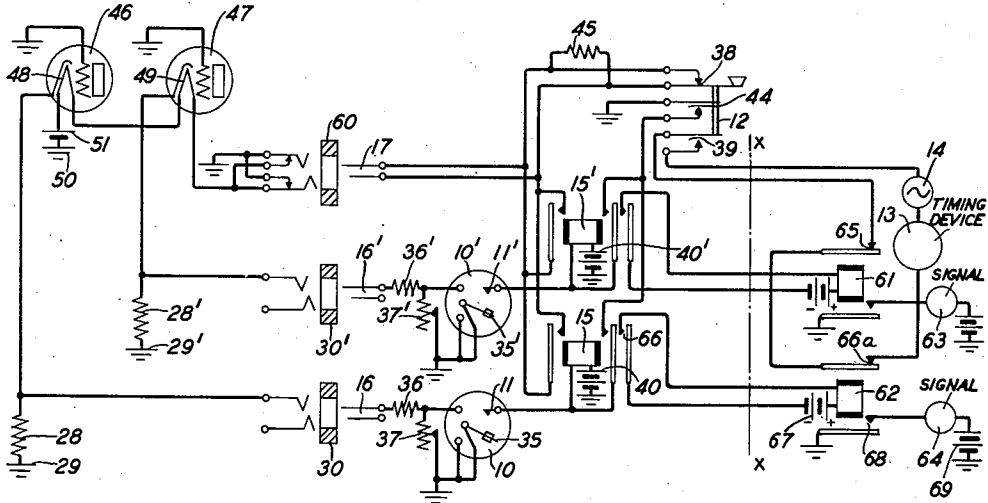
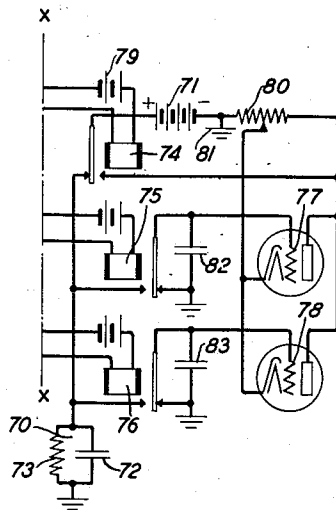


FIG. 4



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TESTING ARRANGEMENT FOR ELECTRON
DISCHARGE DEVICES AND METHODS OF
OPERATING SAME

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Application August 16, 1935, Serial No. 36,463

19 Claims. (Cl. 250—27)

This invention relates to testing arrangements for electron discharge devices and methods of operating same and more particularly for testing the operating efficiency of such devices.

5 In communication translating systems, such as transcontinental or transoceanic telephone or telegraph systems, or in fact any other type of equivalent or continuously operating relatively long system, amplifiers or repeaters are essential
10 in relaying the speech or signal currents in the system and these amplifiers or repeaters employ electron discharge devices as the amplifying medium. In some types of systems, electron discharge devices are also used as modulators, demodulators and oscillators. The efficiency and
15 stability of the particular system is dependent, in a large measure, upon the operating characteristics of the discharge devices and a controlling characteristic is the electron activity of the cathode or the ability of the cathode to emit a sufficiently copious supply of electrons across the discharge space between the cathode and other electrodes associated therewith, such as an input
20 anode or grid and an output electrode or anode.

25 In such a system which is in continuous operation for twenty-four hours a day it is important to ascertain the operating condition of the various discharge devices at regular intervals by suitable testing circuits, to determine whether any of the devices cause the efficiency or stability of the system to depreciate to a critical operating level. Furthermore, it is highly desirable to perform the testing without removing the devices from the
30 the repeater circuit and without interrupting communication service in the system. This is particularly important in multi-channel carrier systems where removal of the device would require interrupting a number of communication channels.

35 One object of this invention is to expedite the determination of the degree of activity of the cathodes in electron discharge devices in communication translating systems whereby the probable failure of the devices may be predicted and interruption of service in the system prevented.

40 Another object of this invention is to enable such determination without the removal of the discharge devices from the system, and, hence, without appreciably affecting service in the system.

45 In accordance with one aspect of the invention, an indicating meter relay is connected in the cathode circuit of a discharge device to reg-

ister the normal voltage drop which is proportional to the space current flowing in the cathode circuit. A switching mechanism is provided for either disrupting the energizing circuit of the cathode or merely reducing the heating current
5 to a lower value to cause the cathode to cool sufficiently for the purposes of the test. Since there is a definite relation between temperature and time in a cooling cathode for any given type of device, it is proposed to measure the elapsed time
10 required to produce a given change in space current. When the cathode heating current is lowered a timing element is energized to record the elapsed time for the space current to decay in the cathode circuit due to the cooling of the
15 cathode. When the cathode has cooled sufficiently to cause the space current to decay to a predetermined point, say 10 to 50 per cent less than the normal operating value, the meter relay automatically controls the reestablishment of
20 the cathode energizing circuit and discontinues the operation of the timing element. The more active the cathode, the further its temperature may fall before the space current will decay to the predetermined value, and the longer will be
25 the elapsed time. The elapsed time is therefore a measure of the activity of the discharge device and if the time is less than a chosen critical value the device is determined to be sufficiently inactive to require replacement.

30 A similar test may be performed on two or more devices in a single amplifier circuit where the energizing circuit of the various cathodes is arranged in series relation. In one form of the invention, a resistance is substituted in the
35 energizing circuit of the device under test to avoid affecting other devices in the same energizing circuit in which the emission may be lower than the device under test and may fall so low, if the energizing circuit were opened for the
40 test period, that service in the system would be interrupted.

45 In accordance with another aspect of the invention the tests may be performed by matching two or more devices in a communicating system
50 having their energizing circuits in series. In this embodiment an indicating meter relay is connected to each cathode circuit of the multi-tube system with a single switching mechanism for controlling the timing element and the energizing
55 circuits of the tubes. The rate of cooling of the cathodes will be registered on the relays and the relay associated with the cathode of lesser activity will close its contacts when the space current falls a predetermined amount, where-

upon the energizing circuit will be reestablished and the timing element stopped, to indicate the elapsed time of the space current decay in the least active tube. In addition to this arrangement, a signaling device is associated with each relay and is operated upon the closing of the contacts thereof, to indicate the tube which is at fault and that tube should be replaced if the emission is below a specified standard determined by the elapsed time registered on the timing element.

In accordance with a modification of the invention relating to the multi-tube testing arrangement, the timing element has a fixed time constant and the signaling device associated with each relay is a gas-filled trigger tube which flashes to indicate the defective device if the relay operates prior to the termination of the time interval established for the timing element. The various arrangements and the several features of the invention will be understood more clearly by referring to the following detailed description taken in connection with the accompanying drawings, in which:

Fig. 1 is a diagrammatic view of the simplest form of the invention and shows the testing circuit including the indicating relay, timing device and switching mechanism to the right of the drawings, while the discharge device to be tested in a typical amplifier circuit, modified in accordance with this invention, is shown to the left of the drawings;

Fig. 2 shows the same testing circuit slightly modified for testing a group of discharge devices having their energizing circuits in series;

Fig. 3 is a diagrammatic view of another arrangement for simultaneously testing a group of discharge devices and determining the least active device in the group; and

Fig. 4 shows a modified circuit to be substituted for the apparatus situated to the right of vertical lines X—X in Fig. 3 and in which flashing gas discharge tubes indicate the defective device in the system under test.

Referring to Fig. 1 specifically, the testing arrangement of this invention consists essentially of an indicating or registering means 10, such as a meter relay having an adjustable contact 11, a switching mechanism or key 12, a timing element 13, such as an electric clock with its associated energizing source 14, an electromagnet or relay 15 controlled by the contacts of the indicating relay 10 and two connecting plugs 16 and 17. The discharge device which is to be tested for its operating efficiency is shown in a typical amplifier circuit having an input transformer 18, one side of the secondary being connected to a control electrode or grid 19 of the discharge device and the other side being connected to ground. A cathode 20, of the equi-potential type is connected to ground 29 through a resistance 28. The cathode 20 has associated therewith a heater element 21 which is energized by a battery or other energizing source 22. An output transformer 23 is shown on the other side of the device with one end of the primary winding connected to an output or plate electrode or anode 24 while the other end of the primary winding is connected to the positive side of a battery 25 having its negative side grounded. A pair of dual screen electrodes 26 surround the anode and are connected to the battery 25 at a lower positive value than the anode 24. The respective electrodes of the discharge device are enclosed in an evacuated vessel 27 and are so spaced with respect to each other

that the cathode, when it attains a stable temperature under operating conditions, emits a copious supply of electrons across the discharge space between the electrodes, the electrons being drawn toward the plate electrode 24 and the flow of electrons being governed by the control electrode 19. The resistance 28 in the cathode circuit is of such value that the potential drop across it is a measure of the flow of space current in the tube 27. One of the contacts of a jack 30 is connected to one side of the resistance 28 and another jack 31 is provided with its main contacts connected to conductors 32 and 33 forming the supply circuit for the heating element 21, the jack 31 having transposed inner contacts 34 to form a closed circuit for energizing the heater element 21 through the battery 22. This arrangement forms a typical set-up for an amplifier in a communication translating system in which the discharge device is continuously operated. The only additional equipment added to the amplifier circuit are the jacks 30 and 31.

The method of making an activity test on the discharge device in the amplifier circuit heretofore described consists of two simple operations, namely, inserting the plugs 16 and 17 in the respective jacks 30 and 31 and then depressing key 12 whereupon the remaining operations are performed automatically by the associate apparatus in the testing circuit.

The detailed operations of the testing circuit will now be described. When the plug 16 is inserted in jack 30 the meter relay 10 is connected across resistance 28 and the pointer 35 of the relay indicates the voltage drop across the resistance 28, this voltage drop being proportional to the space current flowing in the cathode 20 so that the meter indicates the normal space current of the discharge device. The meter relay 10 is a microammeter having a high resistance 36 connected between the tip contact of plug 16 and one side of the meter, while the other side is connected to ground so that the meter operates as a voltmeter. A variable resistance 37 is connected in shunt to the terminals of the meter 10 to provide a full scale deflection of the pointer 35. A suitable meter relay for the purpose of this invention is commercially known as a "Sensitrol Relay, Model 705". It is a microammeter relay having a scale of 10 microamperes for indicating the current measurement. The adjustable contact 11 is a small permanent magnet while the movable contact is an iron "rider" mounted on the pointer 35 which travels over the scale. The operating torque moves the iron "rider" into the magnetic field of the adjustable contact and the "rider" is drawn firmly against it. This insures perfect contact, prevents chattering and permits a considerable amount of energy to be safely controlled. The adjustable contact may be moved to any desirable operating value. The contact 11 and an index are fastened to a common arm which may be moved to a desirable operating point by means of a knob on the front of the dial casing of the relay. After the space current is indicated on the meter relay 10, and resistance 37 has been adjusted so as to obtain a full-scale deflection of pointer 35, the plug 17 is inserted in jack 31 and the key 12 is depressed, to disrupt the energizing circuit including battery 22 of the heater element 21 of the discharge device through the open contact 38 of key 12. In accordance with this method of operation the bridging resistance 45 may be omitted. Simultaneously with the opening of contact 38 of key 12 the lower

contact 39 is closed to start the timing device which is an electric clock energized by the 60 cycle source 14. When the contact 38 of key 12 is opened to disrupt the energizing circuit, the cathode 20 begins to cool, due to the absence of conduction heat from the heater element 21. This results in a decay of the space current in the cathode due to the diminishing of the emission of electrons and consequently the same effect is produced in the resistance 28. The cooling of the cathode and the decay of current in the resistance 28 necessarily causes the pointer 35 on meter relay 10 to indicate the decreasing voltage drop in the resistance 28. The iron "rider" on the pointer 35 then engages the contact 11 which may be adjusted to a position such as 20 per cent below the normal value of space current in the discharge device so that the discharge device is not completely inactive during the test and may continue to amplify the signal and speech currents passing through the amplifier circuit.

When the falling space current as indicated on the meter relay 10 causes the "rider" on the pointer 35 to engage the contact 11 a circuit is completed for relay 15 and this relay is energized by battery 40 through the contacts of meter relay 10 and the ground connection of the meter. Relay 15 in energizing automatically closes the energizing circuit of heater element 21 through the upper spring and contact 41, to restore the discharge device to normal operation. At the same time the relay 15 opens the circuit of the timing device 13 through the lowermost spring and contact 42 and establishes a holding circuit for relay 15 through the lower inner spring and contact 43 and the contact and spring 44 of key 12 to ground. The holding circuit is provided to prevent any unavoidable deenergizing of relay 15 through the opening of the contacts of meter relay 10. Instead of completely disrupting the energizing circuit of heater element 21, as previously described, it may be preferable to merely lower the heating current 25 to 50 per cent instead of reducing it to zero during the test. In this case a resistance 45 may be connected across the conductors connected to the tip and ring of plug 17, to produce the required reduction in the heating current. As previously described, the operation of relay 15 causes the timing circuit to be disrupted and the interval of time recorded on the electric clock 13 will be a measure of the activity of the cathode 20 of the discharge device. If the elapsed time is less than a chosen critical value, the discharge device is determined to be sufficiently inactive to require replacement. The testing circuit is returned to normal by releasing key 12 and removing plugs 16 and 17 from the jacks 30 and 31, respectively.

Fig. 2 shows an arrangement for testing a group of discharge devices individually, the devices being shown without the associated circuit apparatus to simplify the description. This figure shows the arrangement for two discharge devices, but the same arrangement may obviously be used for any number of discharge devices whose heaters are associated together in the same energizing circuit. The two discharge devices shown, 46 and 47, may be two separate amplifiers, two stages of a multi-stage amplifier or a single stage in push-pull relation with the heating elements 48 and 49 arranged in series through an energizing circuit which may be traced from ground 50, battery 51, conductor 52, heating element 48, conductor 53, upper contact and spring of jack 54, conductor 55, heating element 49 of discharge device 47 and

upper contact and spring of jack 56 to ground. It will be noted that the sleeves of both jacks 54 and 56 are connected to the energizing circuit of the heater elements of the discharge devices to cooperate with the three-conductor plug 57 which is substituted for the plug 17, as described in connection with Fig. 1. When the heater elements of two or more discharge devices are in series, it is obvious that if the test is performed on one device and it is allowed to control the time that the heater circuit is open, the electron emission or activity of another discharge device, which may be less active than the one under test, may fall as far during the open period as to interrupt service in the amplifier. In order to avoid this difficulty a resistance 58 is connected to the sleeve contact of plug 57 so that when the plug 57 is inserted in jack 54 the resistance 58 is substituted in the energizing circuit for the heater element 48 of the discharge device 46 during the open period, thereby maintaining at approximately its normal value the current in heater 49 of the other discharge device 47 which is in the same circuit. When the plug 57 is inserted in jack 54 and the key 12 is depressed by the operator, the energizing circuit of heater element 48 is disrupted through the tip and ring contacts of plug 57, upper spring and closed contact of relay 15 and the spring and open contact 38 of depressed key 12. The resistance 58 is substituted for the heater element 48 in the energizing circuit of discharge device 47 so that the heater element 49 will be subjected to the same heating current which it normally receives when heater element 48 is in series with it. This circuit may be traced from ground 50, battery 51, sleeve of jack 54, sleeve contact of plug 57, resistance 58, closed contact 59 and spring of key 12 in its depressed condition, closed contact and upper spring 41 of relay 15 to the tip contact of plug 57, upper main spring of jack 54, conductor 55, heater 49 and upper contact and spring of jack 56 to ground.

The remainder of the circuit is substantially the same as Fig. 1 and the operations of the testing circuit are the same as described in connection with Fig. 1 in which the plug 16 is inserted in the jack 30 to obtain the space current flowing in resistance 28 which is recorded on the meter relay 10 and the plug 57 is inserted in jack 54 to prepare the energizing circuit of heater element 48 to be disrupted by the operation of key 12. The decay of space current in the discharge device 46, as recorded on the meter relay 10, causes the pointer 35 to engage the contact 11, to automatically operate relay 15, to reestablish the energizing circuit of the heater element 48 of discharge device 46 and disconnect the timing device 13 which indicates the elapsed time of the current decay which is a measure of the activity of the device under test. The same operation is performed on discharge device 47 by inserting plug 16 in jack 30' and plug 57 in jack 56, the cathode of discharge device 47 being connected to a grounded resistance 28' through the ground 29' so that the insertion of plug 16 in jack 30' provides a connection for bridging the meter relay 10 across the resistance 28' to obtain the space current flowing in the cathode. It will be obvious that during this test the discharge device 46 is unaffected by the disruption of the energizing circuit of the heater element of discharge device 47 since a complete circuit is provided for discharge device 46 to perform its normal functions.

Another arrangement for testing multi-tube amplifiers is shown in Fig. 3 in which one device

is matched against the other and the device of lesser activity controls the operation of the testing circuit. The elapsed time of the lesser activity tube may then be checked with a standard critical value to determine whether the device should be replaced in the amplifier. In this arrangement the heater elements 48 and 49, respectively, of the discharge devices 46 and 47 of the multi-stage amplifier are connected together in a series energizing circuit from ground 50, battery 51 to ground connected to the upper main spring and closed contact of jack 60. In order to perform the test according to this invention, separate jacks 30 and 30' are connected across cathode resistances 28 and 28' and two meter relays 10 and 10' are respectively connected to plugs 16 and 16' for recording the normal space currents flowing in the cathodes of the respective discharge devices 46 and 47. Upon the insertion of plugs 16 and 16' in the respective jacks 30 and 30' the normal space current flowing in the cathodes of discharge devices 46 and 47 will cause a deflection of the pointers 35 and 35', respectively, of the meter relays 10 and 10'. Shunt resistances 37 and 37' are then adjusted so as to make the deflections of pointers 35 and 35' correspond to the full scale readings of meter relays 10 and 10'. The next operation is to insert plug 17 in jack 60. The depression of key 12 causes a disruption of the series energizing circuit of the heater elements 48 and 49 or causes a specified reduction in the heating effect of the energizing circuit due to the bridging resistance 45. At the same time the electric timing element 13 is connected in circuit through the lower spring and closed contact 39 of key 12, the circuit of the timing element being slightly changed in this arrangement due to the inclusion of associate relays 61 and 62 and signaling devices 63 and 64. The energizing circuit for the timing element 13 may be traced from energizing source 14, closed contact 39 and lower spring of key 12, closed contact and upper spring 65 of relay 61, closed contact 66a and upper spring of relay 62, timing element 13 to source 14.

With the insertion of the plugs in the respective jacks and the operation of the key 12, let us assume that the cathode of discharge device 46 is of lesser activity than the cathode of discharge device 47. In that event, as the cathodes cool, the space current of discharge device 46 will decay faster than the space current of discharge device 47, and pointer 35 of meter relay 10 will engage its contact 11 before pointer 35' of meter relay 10' is ready to engage its contact 11'. It will be realized that the timing device is operating during this interval due to the operation of key 12 and when the pointer 35 engages the contact 11 of meter relay 10, relay 15 is operated to reestablish the energizing circuit through the left-hand spring and contact and establishes a holding circuit for relay 15 through the inner right-hand spring and contact of relay 15, closed contact 44 of key 12 to ground. Relay 15 also energizes relay 62 through the outer right-hand spring and contact 66 and the closed circuit including battery 67. The energization of relay 62 disrupts the timing circuit through the contact 66a to stop the timing clock 13 and closes a circuit through the lower spring and contact 68 to energize the signaling device 64 through a circuit including battery 69. The signaling device 64 may be a glow lamp or an incandescent lamp or possibly a bell or alarm to indicate the particular discharge device of lower activity. The

elapsed time indicated on the timing device will determine whether the operating discharge device is satisfactory for future service or should be replaced due to a loss of activity which might endanger the efficiency of the communicating system in which it is incorporated.

If we assume that the discharge device 47 is of subnormal activity instead of discharge device 46, then the meter relay 10' will control the testing operation by the pointer 35' closing a circuit through the adjustable contact 11' to operate relay 15' through the battery 40'. Then relay 15' will close its left-hand spring and contact to reestablish the energizing circuit of the heater elements of both tubes, establish a holding circuit through the contact 44 of key 12 and the inner right-hand spring and contact of relay 15' and also energize relay 61 through the outer right-hand spring and contact of relay 15', whereupon the timing circuit of timing device 13 is disrupted through the spring and contact 65 of relay 61 and signaling device 63 is operated to indicate that discharge device 47 is of lesser activity than discharge device 46. Again, the elapsed time recorded on the timing device will determine whether the discharge device 47 should be replaced in the amplifying circuit.

While the timing device heretofore described has been specified as an electric clock, it is not essential for the purposes of this invention to confine the operation of the testing circuit to the specific use of an electric clock. Another arrangement including a timing circuit and two gaseous trigger tubes as the signaling elements of the testing circuit is shown in Fig. 4 and the circuit arrangement as illustrated may be substituted for the association of apparatus shown in Fig. 3 to the right of the vertical line X—X. In this arrangement a condenser-resistance discharge circuit is employed as the timing element which is normally connected to the positive side of a 130-volt battery 71. In order to evaluate the time constants of the timing circuit 70, say for about 10 seconds, as a measure of time in which a cathode of satisfactory emission is cooled when the energizing circuit is disrupted, the values of condenser 72 and resistance 73 may be 10 microfarads and 1 megohm, respectively. Instead of the timing circuit including the timing device 13 and energizing source 14 being connected across the lower spring and contact of key 12, a relay 74 is substituted as shown in Fig. 4. Relays 75 and 76 are substituted for relays 61 and 62 in the circuit of Fig. 3 and these relays control the gaseous trigger tubes 77 and 78, respectively.

The operation of the testing circuit as modified with the substitution of the circuit shown in Fig. 4 is as follows: As previously described, the various plugs 16, 16' and 17 are assumed to be inserted in their respective jacks for indicating on the meter relays 10 and 10' the normal space current flowing in the discharge devices 46 and 47 of the amplifier circuit. When the key 12 is operated the lower contact 39 and spring are closed to energize relay 74 through battery 79. This operation transfers the 130-volt battery 71 from the timing circuit 70 to the anodes or plates of the trigger tubes 77 and 78. With the removal of the 130-volt battery from the timing circuit 70 through the opening of the spring and outer contact of relay 74, the charged condenser 72 starts to discharge through the resistance 73 at such a rate that the residual potential across the condenser will decline to a value of about 50 volts in an interval of 10 seconds, due to the con-

stants of the elements forming the timing circuit. The cathodes in the gaseous trigger tubes 77 and 78 are energized by their associated heater elements, but in view of the connection of

these cathodes to the intermediate point of resistance 80 which is in shunt to the battery 71 through the inner closed contact and spring of relay 74 this places a positive potential on the cathodes of approximately 50 volts with respect to ground 81 and the grids of the trigger discharge tubes are normally at ground potential through the springs of relays 75 and 76 and are many volts negative with respect to their cathodes so that no current flows in the tubes. The operation of either relay 75 or 76 through the operation of relay 15' or 15 due to the closing of the contacts of meter relay 10' or 10, respectively, transfers either grid of trigger tubes 77 or 78 from ground potential to the potential of condenser 72 at the moment. The grid of either tube, which is rendered positive with respect to its cathode, instantly causes a breakdown in the discharge path between the cathode and anode and the tube flashes to indicate which discharge device is at fault in the amplifying circuit. In order to prevent premature operation of the trigger tubes while the springs of relays 75 or 76 are in mid-air, condensers 82 and 83 are connected to the grid circuits of the respective tubes and have a relatively small value, say .001 microfarad, so as not to discharge condenser 72 in the timing circuit appreciably. It is evident that if either relay 75 or 76 operates before condenser 72 discharges to a potential appreciably lower than that of the cathodes of the trigger tubes 77 and 78, respectively, one of the trigger tubes immediately flashes to indicate the discharge device of lesser activity. However, if the relay operation does not occur until later the condenser 72 will have discharged enough so that the grids of trigger tubes 77 and 78, respectively, are sufficiently negative to prevent the tube from flashing. The flashing of either gaseous tube therefore gives a visual indication that the corresponding discharge device under test is inactive and should be replaced. At the conclusion of the test the release of key 12 interrupts the plate supply of trigger tubes 77 and 78 through the deenergization of relay 74 whereupon the timing circuit 70 is recharged for the next test. The choice of the time constants of the timing circuit 70 and the potential difference to ground furnished the trigger tube cathodes by the resistance 80 determines the critical time which will serve to indicate when a discharge device is sufficiently inactive to need replacing. It will be noted that the testing circuit is not critical with respect to the trigger-off point of the trigger tubes. A variation of one volt in the trigger-off point of the gaseous tubes 77 and 78 affects the time by only about 0.2 second.

The various arrangements heretofore described and embodying features of this invention provide an accurate and speedy test of the activity of discharge devices without removing them from service and without interrupting the service in the communicating system. The invention is sufficiently flexible to apply the testing arrangement to various types of discharge devices having different values of space current during normal operation. Furthermore, tests made with this invention indicate that a sufficient margin of discrimination is obtained to reject discharge devices on the basis of cathode activity. The time interval for the space current to decrease, for example, to half its value after the time the heater current is interrupted, is approximately in the ratio of 2 to 1, comparing a satisfactory tube with an inactive tube.

While the greatest utility of the invention is realized in testing discharge devices which are continuously operating in a communicating or translating system, it is, of course, understood that the invention is in no way limited to this field. The invention may also be applied to other types of systems where the discharge devices are not necessarily continuously translating speech and signaling currents, for example, in voice operated repeaters, or in carrier current systems. The invention may also be practised in other fields of use where discharge devices are employed, such as radio transmitters and receivers, where it is desired to maintain a high level of transmission efficiency in the system. Moreover, although in the illustrative multi-device circuits shown in Figs. 2 and 3, the heater elements are connected in series, it will be clear that the invention may be utilized in circuits wherein the heater elements of a plurality of electron discharge devices are in parallel or certain of the heater elements are in parallel with one another and in series with other heater elements.

Furthermore, the various embodiments of the invention herein disclosed may be elaborated and modified as to the specific elements described and all such modifications are presumed to be within the scope of the invention as defined in the appended claims.

What is claimed is:

1. A testing circuit for electronic discharge devices having a cathode, comprising an indicating means connected to said cathode, timing means associated with said indicating means, means for altering the heating source of said cathode to register the decay period of said cathode on said indicating means, means for initiating said timing means at the start of the decay period, and means for restoring the heating source to normal operation and discontinuing the operation of said timing means.

2. A testing circuit for electronic discharge devices having a cathode, comprising an indicating means connected to said cathode, timing means associated with said indicating means, means for altering the heating source of said cathode to register the decay period of said cathode on said indicating means, means for initiating said timing means at the start of the decay period, and means under the control of said indicating means for restoring the heating source to normal operation and discontinuing the operation of said timing means.

3. A testing circuit for determining the activity of an electron discharge device having a cathode and a heater element for said cathode, comprising a relay connected in circuit with the space current path of said device, indicating means controlled by said relay, a timing device associated with said relay, and switching means for simultaneously controlling said timing device and the heating current through said heater element.

4. In a system for testing the activity of any one or more of a plurality of discharge devices, indicating means responsive to the space current of any one of said devices, switching means for altering the heating circuit of the cathode of said one device to cause a decay of space current in said device, timing means actuated at the instant of the altering of the heating circuit, and means actuated by said indicating means for re-

storing the heating circuit to normal operation and stopping said timing means.

5 5. A testing circuit for electronic discharge devices having a cathode, comprising a resistance
 10 bridging said resistance to indicate the voltage drop therein, a timing device, means simultaneously disconnecting the heating source of said
 15 cathode and connecting said timing device to said bridging means, and means associated with said
 20 bridging means for reestablishing the heating source to normal operation and stopping said timing device.

15 6. A testing circuit for determining the characteristics of an electron discharge device having a cathode, comprising a resistance in series
 20 with said cathode, energizing means for said cathode, deflecting means connected across said resistance, timing means associated with said
 25 deflecting means, switching means for altering the effect of said energizing means and starting said timing means, and means for restoring said
 30 energizing means to normal operation and terminating the operation of said timing means.

25 7. A testing circuit for electronic discharge devices having a cathode, a heater element for said
 30 cathode, and energizing means for said heater element, comprising an impedance in circuit with said cathode, means having an adjustable
 35 contact for indicating the voltage drop across said impedance, means for connecting said indicating means in circuit with said impedance, a time
 40 indicator circuit, switching means connected to said energizing means for simultaneously disconnecting said energizing means and energizing said
 45 time indicator circuit, and means controlled by said adjustable contact for simultaneously restoring said energizing means to normal and disconnecting said time indicator circuit.

40 8. The method of testing the activity of discharge devices which comprises measuring the space current in the discharge device, reducing
 45 the cathode temperature, recording the elapsed time for the cathode to cool to the point where it reaches a certain degree of inactivity, restoring
 50 the cathode temperature to normal, and terminating the time recording simultaneously with the restoration of the cathode temperature to normal.

50 9. The method of measuring the elapsed time required to produce a given change in space current in an electron discharge device without
 55 disrupting service in a translating system which comprises measuring the normal space current flowing in the cathode circuit, cooling the cathode
 60 to reduce the space current to a definite value, recording the elapsed time during the cooling period, and automatically restoring the cathode
 65 temperature to normal when the given change in space current is reached.

65 10. The method of measuring the elapsed time required to produce a given change in space current in an electron discharge device without
 70 disrupting service in a translating system which comprises measuring the normal space current flowing in the cathode circuit, cooling the cathode
 75 so that the space current falls to 10 to 50 per cent less than the normal value thereof, initiating a time record at the instant of cathode cooling, continuing said time record until the space current reaches a given lower value, and discontinuing the time record while simultaneously restoring the cathode to normal temperature operation, the elapsed time being a measure of the activity of

the discharge device as compared to a chosen critical value.

11. The method of detecting loss of activity in an electron discharge device which comprises measuring the space current in a resistance in
 5 the cathode circuit, disconnecting the energizing source of the cathode, recording the elapsed time for the current to decay in said resistance after
 10 the termination of the energizing source, and reestablishing said energizing source when the decaying current reaches a critical value.

12. The method of determining the degree of activity of electronic discharge devices which comprises measuring the space current of the device,
 15 reducing the heating current of the cathode to a subnormal value, timing the space current decay during the cooling of the cathode, and simultaneously restoring the heating current to normal and discontinuing the timing to indicate
 20 the time interval elapsed during the decay period.

13. A test circuit for determining the activity of heater type cathodes of electron discharge devices which comprises means for measuring the
 25 voltage drop in the cathode circuit of the device, means for reducing the heating circuit of the cathode to a subnormal value, means for initiating a timing element at the instant of the reduction of the heating circuit, signaling means associated with said timing element, and means associated with the measuring means for restoring
 30 the heating circuit to normal operation, disconnecting said timing element and operating said signaling means.

14. A testing circuit for differentiating between active and inactive electron discharge devices
 35 having a heater type cathode which comprises means for measuring the normal space current in the cathode circuits of the individual devices, a timing element, switching means for changing the value of the heating current in the cathode
 40 circuits to cool the cathodes to a subnormal value and simultaneously operating a timing element during the cooling interval of the cathodes, flashing devices individually associated with the respective measuring means, and means operated
 45 by each measuring means to operate the flashing device associated therewith when the cooling rate in one of the cathode circuits is greater than in another circuit, said means simultaneously restoring the heating circuits to normal operation and discontinuing the operation of said timing element.

15. A testing device for measuring the activity of multi-tube circuits having heater type cathodes and a common energizing circuit for said
 55 cathodes, which comprises means for measuring the voltage drop in the cathode circuit of either tube, an adjustable contact associated with the measuring means, means for connecting a series resistance in place of the heating circuit of the tube under test, an electric timing device, switching means for opening the heating circuit of the tube under test and simultaneously operating said timing device, and a relay operated by said adjustable contact to automatically restore the
 60 heating circuit to normal operation and terminate the operation of said timing device.

16. A testing circuit for a plurality of electron discharge devices having individual cathodes, a resistance in series with each cathode and energizing heater circuits in series, comprising an indicator for each device, means for connecting each indicator across each cathode resistance, a time recorder circuit, switching means for reducing the heating effect of said energizing circuit
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and initiating said time recorder circuit, means controlled by said indicators for restoring said heater circuits to normal and discontinuing the operation of said time recorder circuit, and signal responsive means for indicating the less active device under test.

17. A testing circuit for a plurality of electron discharge devices having individual cathodes, a resistance in series with each cathode and energizing heater circuits, comprising an indicator for each device, means for connecting each indicator across each cathode resistance, a time recorder circuit, switching means for reducing the heating effect of said energizing circuits and initiating said time recorder circuit, means controlled by said indicators for restoring said heater circuits to normal operation and discontinuing the operation of said time recorder circuit, and individual signal responsive means under the control of each indicator to designate the device of sub-normal operation.

18. A testing circuit for a plurality of electron discharge devices having individual cathodes, a resistance in series with each cathode and energizing heater circuits in series, comprising an indicator for each device, means for connecting

each indicator across each cathode resistance, a time recorder circuit, switching means for reducing the heating effect of said energizing circuits and initiating the operation of said time recorder circuit, means controlled by said indicators for restoring said heater circuits to normal operation and discontinuing the operation of said time recorder circuit, a signal device associated with each indicator, and a relay controlling each signal device and actuatable by said indicator to designate the discharge device of lesser activity.

19. An activity testing arrangement for a group of discharge devices having equipotential cathodes, a heater circuit for each cathode, and energizing means connected in series with said heater circuits, comprising a resistance connected to each cathode, a voltage indicator for each device connected across each resistance, timing means, switching means for reducing the effects of said energizing means and applying said timing means to said devices simultaneously with the reduction of the energizing means, and signal responsive means under the control of the individual indicators to determine the least active device in the group.

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