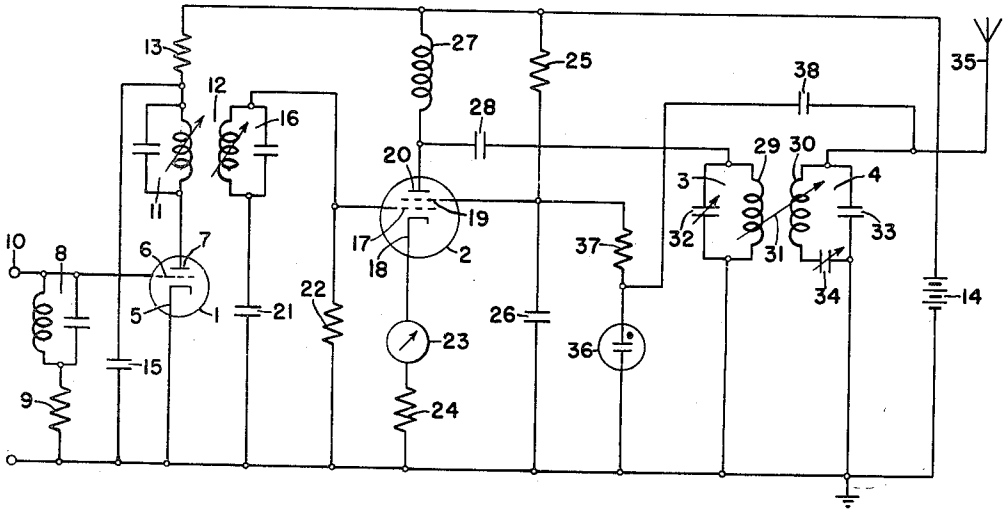
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TRANSMITTER TUNING METHOD AND APPARATUS

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TRANSMITTER TUNING METHOD AND APPARATUS

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The present invention relates to means for tuning transmitters and has as an object thereof to provide means utilizing a glow or a gaseous discharge device for tuning such transmitters. Such provisions enable transmitters to be simply tuned without the need for separate or special apparatus.

Another object of the present invention is to provide a glow discharge tube and circuit for the output portion of a transmitter such that the output portion as well as intermediate portions thereof may be individually and in the aggregate tuned for optimum performance.

A still other object of the present invention is to provide an improved circuit and method comprising a glow discharge tube for simply, yet completely, tuning a communications transmitter.

A still further object of the present invention is to provide means for tuning individually various elements of the output portion of a transmitter by means of a glow discharge device without the need for performing switching operations.

In an illustrative embodiment of a transmitter for carrying out the present invention, an electron discharging device is provided having a cathode, a grid, a screen grid and an anode, a tuned output circuit, and a source of unidirectional operating potential. The anode-cathode discharge path of said device, said output circuit and said source of unidirectional potential are connected in circuit. A tuned antenna circuit is variably coupled to said output circuit and an input circuit is coupled between the grid and cathode of said discharge device. The cathode-screen discharge path of said device is connected in circuit with said source through a resistance. A glow discharge device and another resistance is connected in series between the screen grid and the negative terminal of said source. Means are provided for coupling the output appearing across the said tuned antenna circuit to said glow discharge device.

The novel features which are considered to be characteristic of our invention are set forth in particularity in the appended claims. The invention itself, however, both as to its organization and method of operation together with further objects and advantages thereof may best be understood with reference to the following description taken in connection with the accompanying drawing in which the sole figure shows a schematic diagram of an embodiment of the present invention.

In the drawing is shown the output portion of a communication transmitter comprising an intermediate stage including an electron discharge device 1, a power output stage including an electron discharge device 2, and tuned output circuit 3, variably coupled to a tuned antenna circuit 4. Electron discharge device 1 includes a cathode 5, grid 6 and anode 7. The cathode 5 is connected to ground. The grid 6 is connected through tuned circuit 8 and resistance 9 to ground and also to input terminal 10 to which radio-frequency energization is applied. The anode 7 is connected through a tuned circuit 11, including the primary of the radio-frequency transformer 12, and a decoupling resistance 13 to the positive terminal of source 14, the negative terminal of which is connected to ground. The junction of the tuned circuit 11 and resistance 13 is connected through de-coupling capacitance 15 to ground. The inductance of the primary of the transformer 12 is shown as variable.

The output from the tuned circuit 11 is coupled to the tuned circuit 16 which includes the secondary of the transformer 12, the inductance of which is also variable. One end of the tuned circuit 16 is directly connected to the grid 17 of electron discharge device 2 which also includes a cathode 18, a screen grid 19, and an anode 20. The other end of the tuned circuit 16 is connected through a blocking capacitance 21 to ground. The grid 17 is also connected through grid leak resistance 22 to ground. The cathode 18 is connected through a current indicating device 23 and cathode resistance 24 to ground. The screen grid 19 is connected through screen load resistance 25 to the positive terminal of source 14 and also connected through by-pass capacitor 26 to ground. The anode 20 is connected through radio-frequency choke 27 to the positive terminal of source 14. The anode 20 is connected through capacitance 28 to one side of the tuned output circuit 3, the other side of which is connected to ground.

Tuned output circuit 3 comprises the primary winding 29 of a radio-frequency transformer, the coupling of which is variable to the secondary winding 30 by the means schematically designated 31. Variable capacitance 32 is connected in shunt with the primary winding 29. The secondary winding 30, with capacitance 33 and variable capacitance 34 connected in shunt with the secondary winding 30, forms the antenna tuned circuit. The junction of capacitances 33 and 34 is connected to ground and the junction of capacitance 33 and the secondary winding 30 is connected to the antenna 35.

An indication of tuning of various tunable elements in the output portion of the transmitter is indicated by the gaseous discharge device or glow discharge tube 36 which has one electrode connected to ground and the other electrode connected through a series current limiting resistance 37 to screen grid electrode 19. Also coupled to the glow discharge tube 36 is the antenna tuned circuit 30 through a coupling capacitor 38 between the antenna 35 and the junction of resistance 37 and glow discharge tube 36. This portion of the circuit functions to produce an indication of the tuning of the output portion of the transmitter as well as an indication of tuning of the prior stages of the transmitter, i. e., the tuned circuits 11 and 16.

By glow discharge device is meant a device of the kind used in the radio art comprising a pair of cold electrodes spaced in an inert atmosphere such as neon gas. Application of a potential across the electrodes above a predetermined potential called the ignition potential causes a glow discharge to appear around and between the electrodes. The intensity of the glow varies with the magnitude of the applied potential. When the applied voltage is alternating, both electrodes glow and when the applied voltage is unidirectional, only one electrode glows.

In accordance with the technique of the present invention, initially radio-frequency energization is applied at the input terminal 10 with the tuned antenna circuit 4 substantially de-coupled from the tuned output circuit 3. The bias on the screen grid electrode 19 and the value of the current limiting resistance 37 are selected such that some luminosity is produced in the glow discharge tube 36. The tuning of tuned output circuit 3 by means of variable capacitor 32 will cause a larger radio-frequency voltage to appear at the anode 20 and also will produce a

decrease in the potential of the screen grid electrode **19** when the tuned output circuit **3** is in tune. This condition will be manifested by minimal luminosity in the glow discharge tube **36**. Concurrently with the tuning of the tuned output circuit **3**, it may be desirable to tune, or retune if they have been previously roughly tuned, the preceding tuned circuits **11** and **16** to produce a minimal indication in the device **36**.

The next step in tuning the output portion of the transmitter involves tuning the tuned antenna circuit **4** by adjustment of the variable capacitor **34**. When the tuned antenna circuit **4** is in tune, voltage is maximized across capacitance **33**. The output across capacitance **33**, being coupled through coupling capacitance **38** to the glow discharge tube **36**, will cause an increase in the luminosity of the glow discharge tube **36** to an optimum, thereby indicating that the tuned antenna circuit **4** is properly tuned on frequency.

Proceeding further in the tuning operation, the coupling **31** between the primary winding **29** and secondary winding **30** of the output transformer is varied to obtain maximum output which is indicated by maximal luminosity of both electrodes of the glow discharge tube **36**.

In the past, techniques utilizing only a cathode or anode circuit meter were not entirely reliable in giving an indication of proper coupling. Increasing the coupling increased the voltage across the secondary winding **30** of the transformer. Over-coupling changed the impedance of the secondary winding **30** as reflected into the primary winding **29** in such a direction as to change the anode loading of the electron discharge device **2** to increase anode current. Thus, maximum anode or cathode current did not coincide with optimum coupling.

In the final step of adjusting the coupling, current indicating device **23** is used as follows. The coupling is adjusted until either maximum brilliance on both electrodes is obtained in the glow discharge tube **36** or maximum rated anode-cathode current is reached in the electron discharge device **2**, whichever comes first. The effect of this adjustment, in terms of a load line on the anode current-anode voltage characteristic of the electron discharge device **2** and coupling, is to assure that a load line and coupling are arrived at at which the rate of change of power output from the electron discharge device **2** with respect to coupling, and indirectly impedance, is zero.

Accordingly, it is seen that a simple yet effective circuit has been provided for determining the tuning of the various tuned elements in the output portion of a transmitter. This is done by simple circuit provisions which are integrally incorporated in the transmitter circuits and which do not require special switching operations to obtain the various indications.

While a particular embodiment of our invention has been shown and described, it is apparent that changes may be made without departing from the invention in its broader aspects and, therefore, the aim in the appended claims is to cover all such changes and modifications which fall within the true spirit and scope of our invention.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. In combination, in a transmitter comprising an electron discharging device having a cathode, a grid, a screen grid and an anode, a tuned output circuit, a source of unidirectional operating potential, the anode-cathode discharge path of said device, said output circuit and said source of unidirectional potential being connected in circuit, a tuned antenna circuit variably coupled to said output circuit, an input circuit coupled between the grid and cathode of said discharge device, the cathode-screen grid discharge path of said device being connected in circuit with said source through a resistance, and another resistance and a glow discharge device connected in series between said screen grid and the negative terminal of said source, and means for coupling the output appearing across said tuned antenna circuit to said glow discharge device.

2. In combination, in a transmitter comprising an electron discharging device having a cathode, a grid, a screen grid and an anode, a tuned output circuit, a source of unidirectional operating potential, the anode-cathode discharge path of said device, said output circuit and said source of unidirectional potential being connected in circuit, a tuned antenna circuit variably coupled to said output circuit, an input circuit coupled between the grid and cathode of said discharge device, the cathode-screen grid discharge path of said device being connected in circuit with said source through a resistance, and another resistance and a glow discharge device connected in the order named in series between said screen grid and the negative terminal of said source, and means for capacity coupling the output appearing across said tuned antenna circuit in shunt with said glow discharge device.

3. A transmitter comprising an electron discharge device having a cathode, a grid, a screen grid and an anode, a tuned output circuit, a source of unidirectional operating potential, the anode-cathode discharge path of said device, said output circuit and said source of unidirectional potential being connected in circuit, a tuned antenna circuit variably coupled to said output circuit, an input circuit coupled between the grid and cathode of said discharge device, the cathode-screen grid discharge path of said device being connected in circuit with said source through a resistance, and another resistance and a glow discharge device connected in the order named in series between said screen grid and the negative terminal of said source, said resistances and the ignition potential of said glow discharge device being selected to produce a glow of varying intensity over the range of screen potentials to which said glow discharge device is subject during all conditions of operation of the glow discharge device, and means for coupling the output appearing across said tuned antenna circuit in shunt with said glow discharge device, whereby said transmitter is tuned by de-coupling said tuned antenna circuit from said output circuit, energizing the input circuit of said electron discharge device, tuning said output circuit for minimal luminosity of said glow discharge device, adjusting the tuning of the antenna circuit for maximum luminosity of said glow discharge device, and varying the coupling between said output circuit and said tuned antenna circuit for maximum luminosity of said glow discharge device.

4. A transmitter comprising an electron discharge device having a cathode, a grid, a screen grid and an anode, a tuned output circuit, a source of unidirectional operating potential, an anode-cathode current indicator, the anode-cathode discharge path of said device, said anode-cathode current indicator, said output circuit and said source of unidirectional potential being connected in circuit, a tuned antenna circuit variably coupled to said output circuit, an input circuit coupled between the grid and cathode of said electron discharge device, the cathode-screen grid discharge path of said electron discharge device being connected in circuit with said source through a resistance, and another resistance and a glow discharge device connected in the order named in series between said screen grid and the negative terminal of said source, said resistances and the ignition potential of said glow discharge device being selected to produce a glow of varying intensity over the range of screen potentials to which said glow discharge device is subject during all conditions of operation of the glow discharge device, means for coupling the output appearing across said tuned antenna circuit in shunt with said glow discharge device, whereby said transmitter is tuned by de-coupling said tuned antenna circuit from said output circuit, energizing the input circuit of said electron discharge device, tuning said output circuit for minimal luminosity of said glow discharge device, adjusting the tuning of the antenna circuit for maximum luminosity of said glow discharge device, varying the coupling between said out-

put circuit and said tuned antenna circuit for maximum luminosity of said glow discharge device, and varying the coupling between said circuits until either maximum luminosity of said glow discharge device or maximum-rated current through said anode-cathode discharge path is reached.

5. An indicator circuit in combination with a transmitter comprising an output stage including an electron discharge device having a screen grid electrode, the potential of which varies inversely with optimum tuning of the tuned output circuit connected in circuit with the anode-cathode discharge path of said device, and a tuned antenna circuit variably coupled to said output circuit, means for obtaining an indication of the tuning of said tuned output circuit, including a gas discharge device and a resistance connected in series, means for supplying said screen potential in shunt with said resistance and said gas discharge device, means for obtaining an indication of the tuning of said tuned antenna circuit and the coupling of said tuned antenna circuit to said output circuit comprising means for coupling said tuned antenna circuit in shunt with said gaseous discharge device.

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