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# TRANSMITTER TUNING INDICATOR

***Fig. 1***

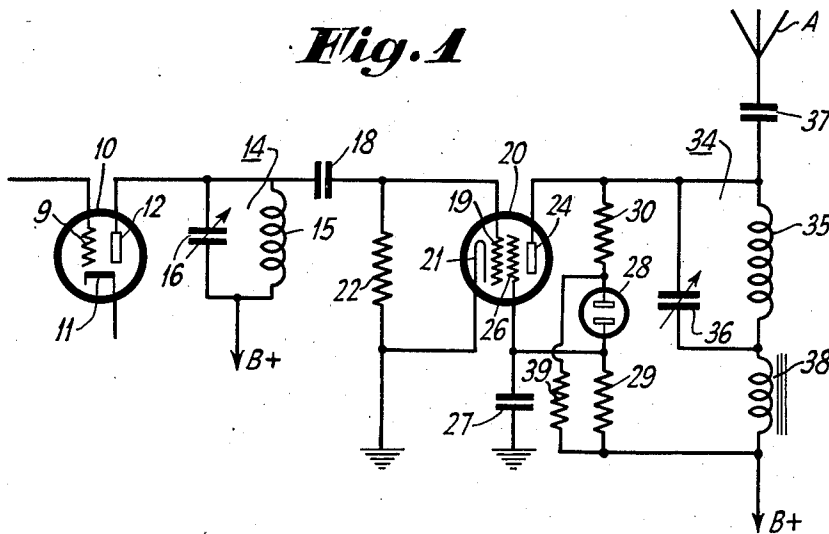
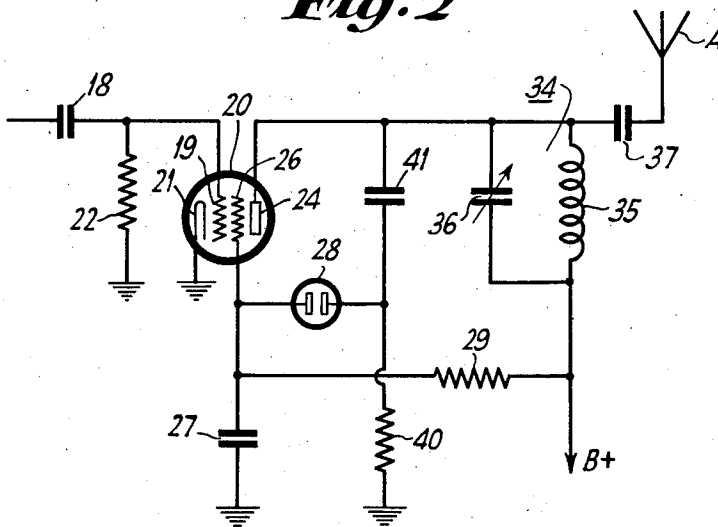


*Fig. 2*



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## UNITED STATES PATENT OFFICE

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## TRANSMITTER TUNING INDICATOR

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The present invention relates to indicator circuits and more particularly to an indicator circuit for denoting proper tuning of a radio transmitter.

An object of the present invention is to provide a tuning indicator for miniature radio transmitters wherein conventional tuning meters cannot be employed because of their size and weight.

Another object of the present invention is to provide a simple, inexpensive tuning indicator for radio transmitters.

Another object of the present invention is to adapt a single gas discharge tube to indicate the proper tuning of a pair of cascade connected circuits in a radio transmitter.

A further object of the present invention is to provide a tuning device which will respond to changes in D. C. and/or changes in radio frequency individually or simultaneously.

Still another object of the present invention is to provide a circuit arrangement whereby a single indicator lamp may be caused to respond in a distinct manner to each of a plurality of variable conditions without requiring selective switching operations.

The present invention contemplates including a single potential responsive device between the screen grid and anode circuits of the output tube of a radio transmitter so that the potential responsive device is responsive to the amplitude of direct current potential applied to the screen grid of the amplifier tube and also responsive to the amplitude of radio frequency energy developed across the output tank circuit. Thus, as the preceding stage in the transmitter is tuned through resonance, the amount of bias developed on the control electrode of the final amplifier stage passes through a peak value and the amount of current drawn by the screen electrode of the tube passes through a minimum. The drop through the screen decoupling resistor is therefore a minimum, the potential difference between the anode and screen grid is a minimum and the potential responsive device indicates a minimum. Then, as the output tank circuit is tuned to resonance, the developed radio frequency voltage across the tank circuit reaches a maximum value, and a maximum response is obtained from the potential responsive device. Thus, a single potential responsive device such as neon tube or gas indicator bulb may be used to indicate proper tuning of two cascaded amplifier stages of a transmitter without involving any switching operations whatsoever. The structure is simple

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and compact and therefore is extremely well adapted for use in miniature radio transmitter arrangements.

The present invention will be more fully understood by reference to the following detailed description which is accompanied by a drawing in which:

Figure 1 illustrates in diagrammatic form an embodiment of the present invention, while

Figure 2 illustrates in diagrammatic form a modification of the embodiment of Figure 1.

Referring now to Figure 1 there is shown a thermionic discharge tube 10 having a control grid 9, cathode 11 and anode or output electrode 12. This tube may be a crystal oscillator tube, a buffer amplifier tube or a frequency multiplier tube of a miniature portable radio transmitter. The anode 12 of tube 10 is connected to tank circuit 14. The tank circuit includes an inductance 15 tuned by variable condenser 16. However, it is within the scope of the present invention to use a fixed tuning capacitor and variable inductance tuning, if desired. The connections to grid 9 and cathode 11 are not shown in this figure since these connections vary in accordance with the function served by tube 10, depending upon whether it is a crystal oscillator, buffer amplifier or frequency multiplier. The specific mode of operation of tube 10 is, however, not a part of the present invention, and it is not believed necessary to describe its operation further in any detail. It is only necessary to consider that radio frequency energy appears on anode 12 and that tank circuit 14 may be tuned to resonate with said radio frequency energy by suitable varying of the circuit parameters of the tank circuit as, for example, by varying the capacity of condenser 16. Condenser 18 couples energy from tank circuit 14 to grid 19 of an output or power amplifier tube 20. A bias potential for grid 19 is developed in known manner across resistor 22 by grid-cathode circuit rectification of the radio frequency energy coupled thereto from tank circuit 14. The developed bias potential will be in direct proportion to the amplitude of the output of tube 10. Tube 20 has an output electrode or anode 24 connected through tank circuit 34 and a winding of modulation transformer 38 to a source of potential designated by the legend B+. Screen electrode 26 is supplied with operating potential through dropping resistor 29 from the same source of potential. Screen grid 26 is by-passed to ground or some other point of zero reference potential by a by-pass condenser 27. It may be seen that

the current drawn by anode 24 and screen grid 26 is dependent upon the amount of bias potential developed on grid 19 by the rectification of radio frequency energy applied thereto.

Output tank circuit 34 may be coupled to a suitable radio frequency load or antenna A through a coupling condenser 37. However, the present invention is not limited to this form of output coupling since inductive coupling may as well be used.

A neon glow tube 28 or other similar gas discharge device has one terminal connected to screen 26 and the other connected through resistor 30 to anode 24. Thus, the indicator neon tube 28 glows in accordance with the amplitude of radio frequency voltage developed on the plate 24 of tube 20 or in proportion to the direct current voltage drop across screen grid resistor 29 or as a result of a combination of both effects. In practice the amount of illumination due to direct current component is utilized for a tuning indication of tank circuit 14 while the illumination due to the radio frequency component is used for a tuning indication of tank circuit 34. Resistor 30 acts as a current limiting resistor to prevent the neon tube 28 from drawing excessive current. In some cases, where the anode supply potential is so low that reliable operation of tube 28 may not in all cases be obtained, a resistor 39 may be inserted between tube 28 and the source of anode potential. This connection is desirable when battery operation is contemplated, since the anode potential, during operation may drop to such an extent that otherwise tube 28 may go out, while the battery still has considerable operating life left. The series connection of resistors 30 and 39 form a potential divider across coil 35 and the winding of transformer 38, increasing the potential applied to tube 28 by a suitable fraction of the drop across said elements.

The proper tuning procedure for utilizing these effects is to set condenser 36 of tank circuit 34 so that the radio frequency component on anode 24 of tube 20 is low, a condition which exists at all tuning points for tank circuit 34 except the desired final tuning and those immediately adjacent the final point. Then, condenser 16 of tank circuit 14 may be adjusted for maximum output from tube 10. As previously explained, the larger the output from tube 10, the higher the developed rectified voltage across resistor 22, thus decreasing both screen and plate currents drawn by tube 20. The decreased screen current means a lower drop through resistor 29 and consequently less illumination of the indicator tube 28. Thus, the first tuned circuit 14 is tuned to its proper operating conditions by watching tube 28 for minimum illumination. After this has been accomplished, the final amplifier tank circuit 34 is tuned to the desired operating frequency by tuning condenser 36 so as to obtain maximum illumination of tube 28 due to a maximum in the developed radio frequency component across tank circuit 34.

An alternate circuit for tuning indication is shown in Figure 2 wherein only the final amplifier circuit and indicator arrangement are shown. The first amplifier or buffer amplifier arrangement constituted by tube 10 of Figure 1 is to be considered as feeding through condenser 18 to tube 20 in Figure 2, the same as it does in Figure 1. In Figure 2, however, indicator tube 28 is connected from screen grid 26 through a current limiting resistor 40 to ground. A radio

frequency coupling condenser 41 is connected from the plate 24 of tube 20 to the high potential end of resistor 40.

In the procedure for operation of the circuit arrangement of Fig. 2, as for that of Fig. 1, condenser 36 of tank circuit 34 is set off resonance so that the radio frequency component appearing on anode 24 of tube 20 is low. Then, condenser 16 of tank circuit 14 may be adjusted for maximum output from tube 10. As the output from 10 increases, the developed rectified voltage across resistor 22 increases and both screen and plate currents drawn by tube 20 accordingly decrease. The decreased screen current means a lower drop through resistor 29 and consequently a greater D.-C. potential across indicator tube 28 and resistor 40. Thus, the first tuned circuit 14 is tuned to its proper operating conditions in this case by watching tube 28 for a maximum illumination. After this has been accomplished, the final amplifier tank circuit 34 is tuned to the desired operating frequency by adjusting condenser 36 to obtain a second maximum illumination of tube 28 due to a maximum in the developed radio frequency component across tank circuit 34.

As in the arrangement described above with reference to Figure 1 both alternating and direct voltage components contribute to the amount of illumination supplied by indicator tube 28. However, in the case of Figure 2 proper tuning of the first condenser circuit 14 produces a greater illumination by way of a greater direct voltage component. This is due to the increase of direct screen grid potential on screen grid 26 due to a decreased current flow through tube 20 with increased bias potential developed on control electrode 19. Thus, for optimum tuning both tank circuits may be tuned individually to produce maximum illumination of indicator tube 28.

While we have illustrated a particular embodiment of the present invention, it should be clearly understood that it is not limited thereto since many modifications may be made in the several elements employed and in their arrangement and it is therefore contemplated by the appended claims to cover any such modifications as fall within the spirit and scope of the invention.

What is claimed is:

1. An indicator circuit adapted to be associated with a pair of cascade connected amplifier tubes, the second of said tubes having at least a control electrode, an anode and a screen electrode, means for connecting said anode and said screen electrode to a source of potential, connections to said control electrode whereby bias potentials are developed thereon proportional to the excitation supplied thereto from the first of said tubes, means for coupling an output circuit to said anode, and a potential responsive device connected between said screen electrode and said output circuit to provide an indication is directly proportional to the developed control electrode potential and directly proportional to the potential developed across said output circuit.

2. An indicator circuit adapted to be associated with a thermionic amplifier tube, said tube having at least a control electrode, an anode and a screen electrode, means for connecting said anode and said screen electrode to a source of potential, connections to said control electrode whereby bias potentials are developed thereon proportional to the excitation supplied thereto,

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and a single potential-responsive device coupled to said screen electrode and said anode to provide an indication proportional to the developed control electrode potential and to the output potentials developed on said anode.

3. An indicator circuit adapted to be associated with a pair of cascade connected amplifier tubes, the second of said tubes having at least a control electrode, an anode and a screen electrode, means for connecting said anode and said screen electrode to a source of potential, connections to said control electrode whereby bias potentials are developed thereon proportional to the excitation supplied thereto from the first of said tubes, means for coupling an output circuit to said anode, and a potential responsive device connected between said screen electrode and said output circuit to provide an evaluation inversely proportional to the developed control electrode potential and directly proportional to the potential developed across said output circuit.

4. An indicator circuit adapted to be associated with a pair of cascade connected amplifier tubes, the second of said tubes having at least a control electrode, an anode and a screen electrode, means for connecting said anode and said screen electrode to a source of potential, connections to said control electrode whereby bias potentials are developed thereon proportional to the excitation supplied thereto from the first of said tubes, means for coupling an output circuit to said anode, and a gas discharge tube connected between said screen electrode and said output circuit, said gas discharge tube providing illumination inversely proportional to the developed control electrode potential and directly proportional to the potential developed across said output circuit.

5. An indicator circuit adapted to be associated with a pair of cascade connected amplifier tubes, the second of said tubes having at least a control electrode, an anode and a screen electrode, means for connecting said anode and said screen electrode to a source of potential, connections to said control electrode whereby bias potentials are developed thereon proportional to the excitation supplied thereto from the first of said tubes, means for coupling an output circuit to said anode and a gas discharge tube connected between said screen electrode and ground to provide illumination varying directly proportional to the developed control electrode potential, a further connection from said gas discharge tube to said anode to vary said illumination directly proportional to the potential developed across said output circuit.

6. An indicator circuit adapted to be associated with a thermionic amplifier tube, said tube having at least a control electrode, an anode and a screen electrode, means for connecting said anode and said screen electrode to a source of potential, connections to said control electrode whereby bias potentials are developed thereon proportional to the excitation supplied thereto, means for coupling an output circuit to said anode and a single potential-responsive device connected between said screen electrode and said output circuit to effect a response inversely proportional to the developed control electrode potential and directly proportional to the potential developed across said output circuit.

7. An indicator circuit adapted to be associated with a thermionic amplifier tube, said tube having at least a control electrode, an anode and a screen electrode, means for connecting said

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anode and said screen electrode to a source of potential, connections to said control electrode whereby bias potentials are developed thereon proportional to the excitation supplied thereto, means for coupling an output circuit to said anode and a gas discharge tube connected between said screen electrode and ground to obtain an indication directly proportional to the developed control electrode potential and a condenser coupled from said gas discharge tube to said anode to obtain an indication directly proportional to the potential developed across said output circuit.

8. An indicator circuit adapted to be associated with an amplifier circuit arrangement comprising an electron discharge tube having at least a control grid, a screen grid and an anode, said electron discharge tube having an adjustable resonant circuit coupled to the control grid thereof and a tunable output circuit coupled to the anode thereof, means to connect said screen grid and said anode to a source of operating potential, means to apply radio frequency oscillations to said tunable resonant circuit, connections to said control grid to develop thereon bias potentials proportional to the amplitude of the oscillations across said adjustable resonant circuit, and a single potential-responsive device connected to said screen grid to provide an indication of resonance in response to changes in direct current drawn by said electron discharge tube as said adjustable resonant circuit is tuned, and means to couple said potential-responsive device to said anode to provide an indication of resonance in response to the change in amplitude of the amplified radio frequency potential developed on said anode as said output circuit is tuned.

9. An indicator circuit adapted to be associated with an amplifier circuit arrangement comprising an electron discharge tube having at least a control grid, a screen grid and an anode, said electron discharge tube having an adjustable resonant circuit coupled to the grid thereof and a tunable output circuit coupled to the anode thereof, means to connect said screen grid and said anode to a source of operating potential, means to apply radio frequency oscillations to said tunable resonant circuit, connections to said control grid to develop thereon bias potentials proportional to the amplitude of the oscillations across said adjustable resonant circuit, and a single potential-responsive device connected to said screen grid to provide an indication of resonance of said adjustable resonant circuit in inverse proportion to the potential developed on the control grid of said electron discharge tube as said adjustable resonant circuit is tuned, and means to couple said potential-responsive device to said anode to provide an indication of resonance in direct proportion to the amplitude of the amplified radio frequency potential developed on said anode as said output circuit is tuned.

10. An indicator circuit adapted to be associated with an amplifier circuit arrangement comprising an electron discharge tube having at least a control grid, a screen grid and anode, said electron discharge tube having an adjustable resonant circuit coupled to the control grid thereof and a tunable output circuit coupled to the anode thereof, means to connect said screen grid and said anode to a source of operating potential, means to apply radio frequency oscillations of said tunable resonant circuit, connections to said control grid to develop thereon bias potentials proportional to the amplitude of the

oscillations across said adjustable resonant circuit, and a single potential-responsive device connected to said screen grid to provide an indication of resonance of said adjustable resonant circuit in direct proportion to the potential developed on the control grid of said electron discharge tube as said adjustable resonant circuit is tuned, and means to couple said potential-responsive device to said anode to provide an indication of resonance in direct proportion to the amplitude of the amplified radio frequency potential developed on said anode as said output circuit is tuned.

11. An indicator circuit adapted to be associated with an amplifier circuit arrangement comprising an electron discharge tube having at least a control grid, a screen grid and an anode, said electron discharge tube having an adjustable resonant circuit coupled to the control grid thereof and a tunable output circuit coupled to the anode thereof, means to connect said screen grid and said anode to a source of operating potential, means to apply radio frequency oscillations to said tunable resonant circuit, a grid-leak connected to said control grid to develop thereon bias potentials proportional to the amplitude of the oscillations across said adjustable resonant circuit, and a gas discharge device having one terminal thereof connected to said screen grid and the other terminal thereof coupled by means of a resistor to said anode to provide an indication of resonance of said adjustable circuit in inverse proportion to the direct potential developed in the control grid of said electron discharge tube as said adjustable resonant circuit is tuned, and to provide an indication of resonance of said output circuit in direct proportion to the amplitude of the amplified radio frequency potential developed on said anode as said output circuit is tuned.

12. An indicator circuit adapted to be associated with an amplifier circuit arrangement comprising an electron discharge tube having at least a control grid, a screen grid and an anode, said electron discharge tube having an adjustable resonant circuit coupled to the control grid thereof and a tunable output circuit coupled to the anode thereof, means to connect said screen grid and said anode to a source of operating potential, means to apply radio frequency oscillations to said tunable resonant circuit, a grid-leak connected to said control grid to develop thereon bias potentials proportional to the amplitude of the oscillations across said adjustable resonant circuit, and a gas discharge device having one terminal thereof connected to said screen grid and the other terminal thereof connected to ground to provide an indication of resonance of said adjustable resonant circuit in direct proportion to the potential developed on the control grid of said electron discharge tube as said adjustable resonant circuit is tuned, and a capacitor coupling said other terminal of said gas discharge device to said anode to provide an indication of resonance of said output circuit in direct proportion to the amplitude of the amplified radio frequency potential developed on said anode as said output circuit is tuned.

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