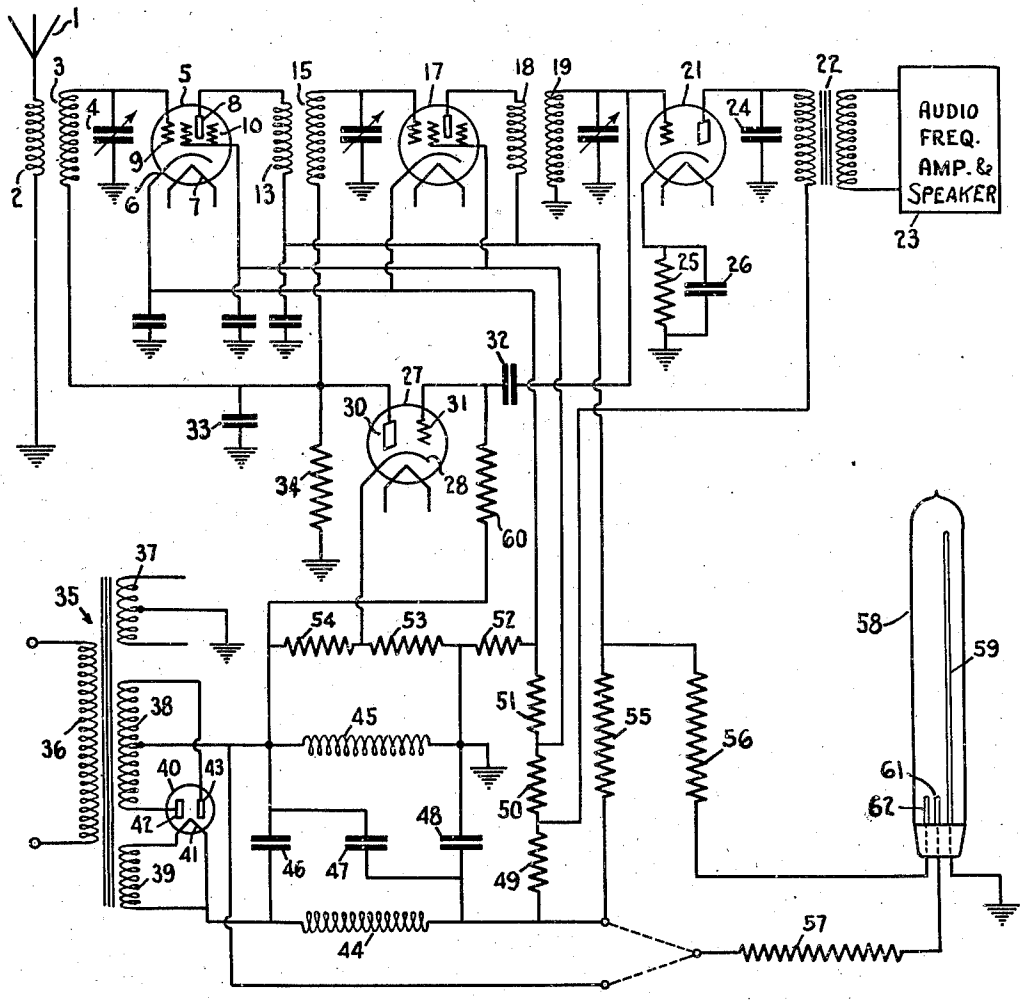
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TUNING INDICATOR SYSTEM FOR RADIORECEIVERS

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TUNING INDICATOR SYSTEM FOR RADIO-RECEIVERS

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5 Claims. (Cl. 250—20)

This invention relates to a tuning indicator system for radio receivers and more particularly to an improvement on the system of my Patent No. 1,839,419, patented January 5, 1932.

In that patent I have disclosed a system particularly adapted for use with radio receivers and arranged to indicate by a lamp when the radio receiver is tuned to resonance with an incoming signal.

In that system a gaseous discharge lamp such as a neon lamp is provided, connected across the power supply circuit in such a manner that the voltage effective upon the lamp is insufficient to cause the lamp to light when no signal is being received, but when an incoming signal is being received and when the receiver is tuned to resonance therewith, the voltage effective across the lamp is increased to a value sufficient to cause the lamp to glow.

It is an object of this invention to provide a system of the class described having generally improved operating characteristics.

It is still a further object of my invention to provide a system of the class described which is more flexible and lends itself more readily to the various radio receiver circuits to which it may be applied.

It is still a further object of my invention to provide a system of the class described which shall have a more nearly linear response on the part of the lamp to impressed voltage and in which the excessive voltage required to cause the tube to strike, is for all practical purposes eliminated.

It is still a further object of my invention to provide a system of the class described in which the lamp indicator has a column of light which rises and falls in a manner like that of a column of mercury in a thermometer as the resonance point of the incoming signal is reached and passed.

Still other objects and advantages of my invention will be apparent from the specifications.

The features of novelty which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its fundamental principles and as to its particular embodiments, will best be understood by reference to the specification and accompanying drawing, in which

The figure is a circuit diagram of radio receiver according to my invention.

Referring now more particularly to the drawing, I have shown a so-called automatic volume control radio receiver arranged for operation from a suitable source of alternating current. While I have shown a radio receiver of the so-called tuned radio frequency amplifier type, it will be understood that this is not essential and that the principles herein disclosed may be applied to other types of circuits such, for example, as the superheterodyne circuit.

In the drawing 1 represents an antenna connected to ground through coupling coil 2, which coupling coil is arranged to supply energy to the coil 3 connected in the input circuit of the first radio frequency amplifier tube 5.

The coil has one terminal connected to the grid or control electrode 9 and its other terminal is grounded through condenser 33 and also through resistance 34. Condenser 4 is connected between the grid terminal of coil 3 and ground, and in the tuned radio frequency type of receiver is made variable for the purpose of tuning, and usually all of the variable tuning condensers are connected together in a so-called gang.

The first radio frequency amplifier 5 is shown as a screen grid heater tube and comprises a cathode 6 arranged to be heated to electron-emitting temperature by a heater filament 7. The tube is also provided with an anode 8, a control grid 9 and a screen grid 10. Since the construction of such tubes is well known to those skilled in the art and forms per se no part of the present invention, the same is not described in detail, and it will be understood that other types of tubes may be substituted for that shown.

The anode 8 is connected to the primary 13 of the interstage coupling transformer, the secondary 15 of which is connected to the input of the second radio frequency amplifier tube 17, and since the construction and arrangement of this stage is for all practical purposes the same as that of the stage already described, it is not described in detail.

The output of the second radio frequency amplifier tube 17 is fed to a detector tube 21 through the medium of the primary and secondary 18 and 19 respectively of the inter-stage coupling transformer and the tuning condenser is provided as before.

The detector tube 21 is herein shown as a heater tube of conventional type, arranged for so-called power detection by means of biasing resistance 25 shunted by condenser 26. The output of the detector tube is supplied to any suitable type of audio frequency amplifier and indicator such as 23 by means of the transformer or equivalent coupling 22. Condenser 24 may be

connected between the anode of tube 21 and ground as shown.

Automatic volume control is achieved by the use of tube 27 which may be the conventional type of heater tube as shown. The anode 30 of the volume control tube is connected to ground through resistance 34 and the grid or control electrode 31 is connected through condenser 32 to the grid of the detector tube 21.

The system is energized from a suitable type of alternating current such as the house lighting current by means of a power transformer 35 having a series of windings including a primary winding 36 and secondary windings 37, 38 and 39. The secondary winding 37 feeds the filaments of the various tubes of the radio frequency and audio frequency amplifier and also the volume control tube and for purposes of simplicity such connections are not shown, being well understood in the art. The winding 39 serves to heat the filament of a rectifier tube 40 which may comprise filament 41 and plates 42 and 43.

The opposite terminals of secondary 38 are connected to the plates 42 and 43 respectively of rectifier tube 40 and the mid-point of winding 38 is connected to a filter choke 45. A similar filter choke 44 is provided connected to the filament of rectifier tube 40 and condensers 46, 47 and 48 may be provided as shown. The function of the power supply apparatus, as will be understood, is to provide relatively non-fluctuating potentials of the proper value to energize the various tubes and, as will be understood, the left hand terminal of choke 44 represents the highest positive point of potential of the system, whereas the left hand terminal on choke 45 represents the most negative point of the system.

In order to provide the various operating potentials a series of resistances 49, 50, 51, 52, 53 and 54 may be connected between the right hand terminal of choke 44 and the left hand terminal of choke 45. These resistances may be actually separate resistors connected in series, or if desired, they may be in the form of a single resistance with taps at appropriate points. The plates of the radio frequency amplifier tubes may be connected together and through resistances 55 to the common terminal of resistance 49 and choke 44, the plate of the detector tube may be connected to the point between resistances 49 and 50 while the screen grids of the radio frequency amplifier tubes may be connected together and to a point between resistances 50 and 51.

The cathodes of the radio frequency amplifier tubes may be connected together and to a point between resistances 51, and 52, while the common point of resistances 52 and 53 is connected to the right hand terminal of choke 45 and also to ground. The cathode 28 of the volume control tube 27 may be connected to the point between resistances 53 and 54. Thus it will be seen that while the grids are maintained at ground potential the cathodes of the radio frequency amplifier tubes are maintained at a point positive with respect to ground, thereby providing a negative bias upon the radio frequency amplifier grids.

The amount of this negative bias (when no signal is being received) is determined by the voltage drop through resistance 52, the right hand terminal of which is connected to the cathodes of the radio frequency amplifier type and the left hand terminal of which is connected to ground and thus to the grids of the radio frequency amplifier tubes.

The negative bias upon the radio frequency amplifier tube is, however, controlled by the volume control tube in the following manner. The grid 31 of the volume control tube is normally maintained sufficiently negative with respect to cathode 28 so that no plate current is drawn by the tube. This result is obtained by the connection of the grid 31 through resistance 60 to the left hand terminal of resistance 54 while the cathode 28 is connected to the right hand terminal of said resistance.

The potential difference between the cathode and grid of this tube is maintained at a value sufficiently large so that when radio frequency voltage is supplied to the grid 31 there is a net increase in plate current due to the fact that when the grid goes more negative there is very little change in the plate current while when the grid goes more positive there is a considerable increase in plate current.

When plate current flows in the tube 27 there is a voltage developed in resistance 34 tending to make the upper terminal thereof more negative with respect to the lower terminal by an amount dependent upon the strength of signal voltage impressed upon the grid 31. This voltage, as will be seen, is impressed between the cathode and the grid of the radio frequency amplifier tubes and therefore controls the negative bias upon the said amplifier tubes.

The negative bias normally existing on said tubes when no signal is being received is chosen to be such that the tubes are at maximum sensitivity, or are operating at such a point on their characteristic that an increase in the negative bias in a negative direction decreases the gain of the amplifier.

Thus it will be seen that when a strong signal is being received a strong radio frequency voltage is applied to the grid 31 of the volume control tube 27 and this in turn increases the negative bias on the radio frequency amplifier tubes, causing a decrease in the gain of the receiver. This decrease in the gain causes a decrease in the strength of the signal voltage applied to the grid of the volume control tubes and thereby a decrease in the voltage drop through resistance 34 which tends to cause an increase in the gain of the radio frequency amplifier. Thus a condition of equilibrium is reached for any particular strength of signal, depending upon the various adjustments which have been made, tending to maintain the signal at constant strength.

From the foregoing, it will be understood that the plate current drawn by the radio frequency amplifier tubes is greatest when no signal is being received and is at its minimum when the strongest signal is being received.

The construction and operation of the lamp indicator will now be described. The indicator is designated generally by reference number 58 and consists of an evacuated tube containing a cathode 59 and a pair of auxiliary electrodes 61 and 62. The cathode 59 is preferably in the form of a relatively long rod or wire, whereas the anodes 61 and 62 are relatively short rods or wires, and the three electrodes are sealed within an evacuated envelope into which there has been admitted a small amount of suitable gas such as neon. Since the production of such tubes follows well known lamp practice, it is not described in detail, but reference may be had

to my co-pending application, Serial No. 527,673 entitled "Tuning indicator", filed April 4, 1931, of which this application is a continuation in part. In general, the amount of gas introduced is of the order of 10 millimeters, but the best amount for any given condition should be determined by trial.

Several methods of connection may be utilized, but for some purposes I prefer to connect the cathode 59 to ground and to connect the anode 62, which I term the controlling anode, through resistance 56 to the upper terminal of resistance 55. The supplementary electrode 61 is connected through resistance 57 to the lower terminal of resistance 55 as shown or, if desired, to the mid-point of winding 38. Thus it will be seen that there exists between the cathode 59 and the electrode 61 a constant difference of potential which is independent of incoming signals and the connections are so chosen that this voltage is sufficient to more or less ionize the gas within the tube 58 and to maintain it in a condition where when an additional voltage is impressed between the cathode and the controlling anode 62, a luminous discharge will begin to climb up the cathode 59.

The voltage between controlling anode 62 and cathode 59 is the algebraic sum of the voltage drops through resistances 49, 50, 51 and 52 and 55. The voltage drop through the first four resistances is, of course, substantially independent of plate current, while that through resistance 55 is strictly dependent upon the plate current flowing in the radio frequency amplifier tubes, and as will be observed, the direction of the voltage drop in resistance 55 is such as to oppose the voltage drop through resistances 49, 50, 51 and 52. Since the plate current is at a minimum for the strongest signal, the voltage drop through resistance 55 will be at a minimum for the strongest signal, and consequently the voltage effective between the cathode and controlling anode 62 will be at a maximum for the strongest signal, and will increase as the tuning approaches resonance.

The resistance 57 is provided to prevent excessive current being drawn between the cathode 59 and the supplementary anode 61 and may have a value of about one-quarter to one megohm.

If the left hand terminal of resistance 57 is connected to the point between resistances 55 and 49 the ionizing discharge takes place between the cathode and the auxiliary electrode 61. If, however, the left hand terminal of resistance 57 is connected to the mid-point of winding 38, the ionizing discharge takes place between the controlling anode 62 and the auxiliary electrode 61, but in any event the space adjacent the lower end of the cathode 59 is maintained in a sufficiently ionized condition so that there is no substantial increase of voltage required to cause the discharge to strike on cathode 59. If this ionized condition were not maintained it would be found that a relatively much greater voltage would have to be applied between the controlling anode and the cathode in order to cause the discharge to strike than would be necessary to maintain it after it struck. It would also be found that there would be difficulty in obtaining linear movement of the discharge upon the cathode for the same reason.

The function of resistance 56 is to provide for control of the climbing characteristic of the tube with respect to voltage and by variation of the value of this resistance, a variation of the rate and amount of climb with voltage can be obtained. It will be understood, however, that the resistance 56 is not essential and may be omitted in certain cases where the desired rate and amount of climb with voltage increase can be obtained without its use.

In these arrangements, an ionizing discharge is maintained between two of the three electrodes, which is produced by a voltage not subject to fluctuation under incoming signal control, while the actual control of the climbing discharge is produced by a signal controlled voltage between cathode 59 and one of the other electrodes.

While I have not shown any form of cabinet or escutcheon plate, it will be understood that the lamp may be mounted behind the panel and an opening may be provided therein through which the cathode 59 may be observed. This opening may be properly proportioned so that only the upper part of the cathode 59 above the range of the controlling and auxiliary electrode is visible, or if desired, an additional opening may be provided at this point as more fully explained in my co-pending application Serial No. 527,673 already referred to.

In operation, as will be understood, the listener will operate the tuning control to select the desired signal. As the frequency of currents traversing the tuned circuits approaches the resonant frequency thereof, the space current of the radio frequency amplifier tube decreases, reaching a minimum at resonance, at which point the voltage between the cathode and controlling anode is a maximum, and the glow reaches the maximum point of its climb in the indicator, thereby advising the listener that the best setting for reception of that particular signal has been reached.

While I have shown and described arrangements in which the column of light increases in length as the difference between the frequency of incoming signals and the resonant frequency of the selecting circuit or circuits decreases, it will be understood that it is within the scope of my invention to invert this characteristic; that is to say, to provide arrangements in which the column of light decreases instead of increasing under the same conditions.

For example, the tube 58 may be put in shunt with resistance 55. In this case the cathode 59 would be connected to the top terminal of resistance 55, and the electrodes 62 would be connected directly to the bottom terminal of resistance 55. The electrode 61 in this arrangement may be left connected through resistance 57 to the mid-point of winding 38. The value of resistance 55 may be selected so as to cause any desired part of the total plate current of the radio frequency tubes to pass through tube 58, the limiting case being, of course, when the value of resistance 55 is infinite, in which case all of the plate current flows through tube 58.

It will be understood that while I have described several systems of connections which operate very satisfactorily to produce the desired result, other connections may be utilized for the purpose, without departing from the spirit and scope of my invention, as will be apparent to those skilled in the art.

I claim:

1. The combination with a radio receiver having at least one tuned circuit for selecting

signals, and a resonance indicator comprising a gaseous discharge lamp having a plurality of electrodes sealed within a container having therein gas at relatively low pressure, said container comprising a relatively long cathode, a relatively short cathode, and a relatively short anode, connections between said relatively short cathode and said anode and points in said radio receiver between which there exists a relatively constant difference of potential just sufficient to maintain ionization between said anode and said short cathode, and a connection between said relatively long cathode and said radio receiver to a point such that there exists between said relatively long cathode and said anode a voltage which increases when the radio receiver is tuned to resonance with incoming signals.

2. The combination with a radio receiver having at least one resonant circuit for selecting incoming signals, of an amplifier tube for amplifying selected signals, a power supply unit for supplying operating potentials to said amplifier, and a resonance indicator comprising a gaseous discharge lamp having at least two electrodes, one of said electrodes being relatively long, and connected between points on said receiver and associated circuits between which there exists a difference of potential increasing with the approach of the frequency of currents traversing said resonant circuit to the resonant frequency thereof, and means comprising a third electrode and connections between said third electrode and one of said first two electrodes and including the gaseous space of said lamp for maintaining the gaseous atmosphere of said tube on the threshold of ionization.

3. Radio receiving apparatus, comprising, in combination, a tuned circuit for selecting desired signals, at least one thermionic relay for amplifying received signals, a power supply circuit for energizing said relay, and including an impedance having a voltage drop therein, means for selecting the frequency of signals to be received, and a signal indicator comprising a gaseous discharge lamp having three electrodes, one of said electrodes connected to a point on said power supply circuit, a second electrode connected to a second point on said power supply circuit, the potential between said two points being independent of incoming signals, and said third electrode connected to a point such that the potential difference between the first mentioned electrode and said third electrode increases when the frequency of incoming signals approaches the resonant frequency of said tuned circuits.

4. Radio receiving apparatus comprising, in combination, at least one tuned circuit for selecting incoming signals, a vacuum tube relay associated with said tuned circuit for repeating incoming signals, a power supply circuit for energizing said relay, and comprising a pair of impedances across one of which there exists a voltage drop independent of incoming signals, and across the other of which there exists a voltage drop which increases with the approach of the frequency of currents traversing said tuned circuit to the resonant frequency thereof, and a gaseous discharge indicator having three electrodes, connections between two of said electrodes and one of said impedances, and connections between one of said two electrodes and the third electrode and said second impedance.

5. Radio apparatus comprising, in combination, an amplifier, a tuned circuit associated therewith, power supply apparatus for energizing said amplifier, operator controlled means for varying the relation between the resonant frequency of said tuned circuit and the frequency of currents supplied thereto, a resonance indicator comprising a gaseous discharge tube having three electrodes, and connections between two of said electrodes and points on said power supply apparatus between which there exists a voltage which increases as the resonant frequency of said tuned circuit and the currents supplied thereto approach, and connections between one of said electrodes and said third electrode, and points on said power supply apparatus between which there exists a relatively constant voltage.

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