July 31, 1934. W. VAN B. ROBERTS 1,968,105

AMPLIFIER SYSTEM

Filed Oct. 11, 1930

Fig. 1

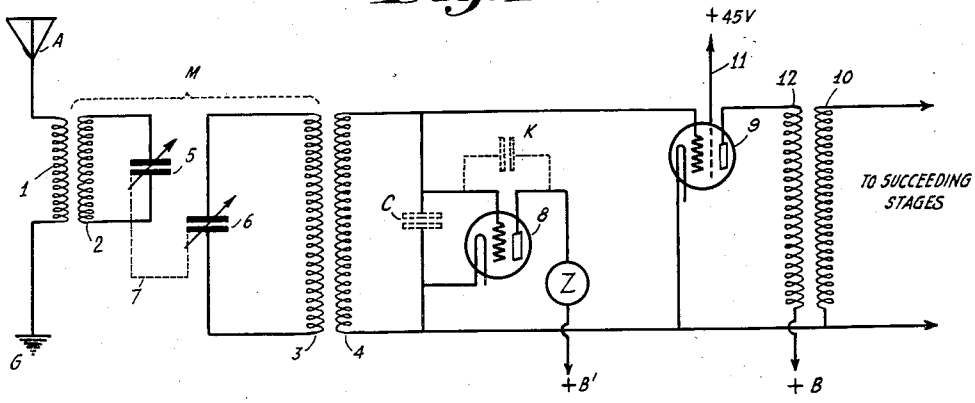


Fig. 2

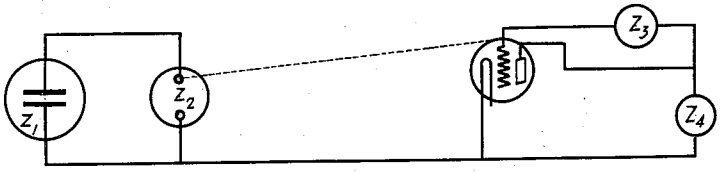
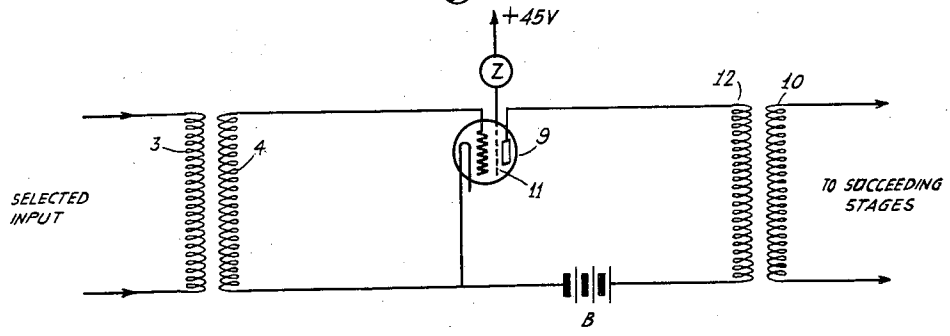


Fig. 3



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1,968,105

AMPLIFIER SYSTEM

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10 Claims. (Cl. 179—171)

My present invention relates to electron discharge tube amplifier systems, and more particularly to novel methods of, and means for, amplifying radio frequencies over a relatively wide frequency range in a non-tunable amplifier system employing electron discharge tubes.

The usual untuned amplifier system having non-adjustable circuit constants does not possess uniformity of amplification. This is due to the fact that the amplification of an untuned amplifier system varies with impressed frequency, maximum results being secured near the resonant frequency of the system. This defect has been avoided by so constructing the system that there is produced a self-tuning amplifier, i. e., one that is automatically or inherently tuned over a wide range of frequencies thereby resulting in uniform high amplification over the said range. Obviously, a radio receiver embodying a plurality of stages of self-tuned radio frequency amplification possesses certain advantages over the well known type of tuned radio frequency receiver.

However, the operation of the self-tuning stages must be dependable. Now, I have discovered a method of, and means for, designing the input circuit of a tube employed in a self-tuning stage so that the said input circuit will resonate uniformly and automatically at frequencies impressed thereon, and which frequencies are encompassed in a given range, such as the present broadcast range, the novel design utilizing a predetermined variation of the apparent input impedance of an auxiliary electron discharge tube added solely for resonating purposes.

Accordingly, it is one of the main objects of the present invention to provide a self-tuning radio frequency amplifier comprising at least one electron discharge tube having an input circuit connected to a source for transmitting thereto from a range of frequencies a selected band of frequencies, and an output circuit connected to succeeding stages, and means in the input circuit of the tube, having fixed constants predetermined in the design, but whose apparent impedance is variable with impressed frequency, for maintaining the input circuit uniformly resonant to any impressed frequencies selected from said range.

Another important object of the invention is to provide means for changing an untuned amplifier into an automatically tunable amplifier by utilizing the input capacity of an auxiliary space discharge device to control the resonance in the input circuit of the amplifier.

Another object of the invention is to provide in a radio receiver simple means for selecting a desired band of frequencies from a range of frequencies, and a self-tuning amplifier for amplifying the selected band, said amplifier comprising at least one stage including a four electrode screen grid electron discharge device, and means associated with at least one electrode for maintaining the stage uniformly resonant throughout said range.

Still another object of the invention is to provide in a radio broadcast receiver a simple, highly selective, band selector unit, and a plurality of self-tuning radio frequency amplifier circuits, each circuit embodying a screen grid tube, and means associated with the screen element for rendering its associated circuit automatically resonant to impressed, selected frequencies.

Still other objects of the invention are to improve generally the compactness and design of radio frequency amplifiers, and to provide a receiver employing self-tuning amplifier units which is reliable in operation, and economical in design and assembly.

The novel features which I believe to be characteristic of my invention are set forth in particularity in the appended claims, the invention itself, however, as to both its organization and method of operation will best be understood by reference to the following description taken in connection with the drawing in which I have indicated diagrammatically several circuit organizations whereby my invention may be carried into effect.

In the drawing,

Fig. 1 shows diagrammatically a radio receiver embodying the invention,

Fig. 2 is an electrical analysis of the invention,

Fig. 3 is a circuit showing a modified form of the invention.

Referring to the accompanying drawing in which like characters of reference indicate the same parts in the different views, Fig. 1 shows a receiving circuit wherein an antenna A, grounded as at G, is coupled by any well known means, such as an inductance coil 1 to an inductance coil 2, the latter being shunted by a variable condenser 5. The coil 2 is coupled, as at M, to a second tunable circuit comprising an inductance coil 3 and a shunting variable condenser 6, the condensers 5 and 6 being controlled by a common means 7, shown by dotted lines.

The two resonant circuits coupled by the untuned common reactance, the mutual inductance M of the coils 2 and 3, represent a band pass

selector unit capable of selecting a band of desired frequencies from a range of frequencies such as the broadcast range. It will be understood in what follows that by varying the common control means 7, the band pass selector unit will impress upon the subsequent amplifier the desired band of frequencies, at present 10 kilocycles wide.

The subsequent radio frequency amplifier comprises a plurality of self-tuning stages of amplification, of which plurality of stages, I have only shown one in detail for the sake of simplicity of showing, it being clearly understood that the output circuit of the stage to be described is coupled by an inductance coil 10 to any desired number of succeeding stages of self-tuning radio frequency stages, detector and subsequent audio amplifier stages and loud speaker. Specifically, a self-tunable radio frequency amplifier stage, according to this invention, comprises an electron discharge tube 9 of the screen grid type, the control electrode of the tube and the cathode being connected to an inductance coil 4. The coil 4 is coupled to the inductance coil 3 of the band pass selector unit. The screen element 11 of the tube has impressed thereon the desired positive potential, about 45 volts in present practice, while the anode of the tube is supplied with energy from a source B through an inductance coil 12, which inductance coil is coupled to the coil 10.

In the input circuit of the tube 9, and in association with the input electrodes of the tube, there is disposed a means for automatically resonating the stage of amplification to the selected band of frequencies impressed upon the inductance coil 4. This automatic means comprises an auxiliary electron discharge tube 8, shown as of the triode type, the input electrodes, the control electrode and the cathode, being connected across the inductance coil 4. The anode of the tube 8 is energized from a source B' through an impedance conventionally represented by the symbol Z. It will be noted that in effect there is a capacity shunted across the inductance coil 4 which capacity represents the inherent capacity between the control electrode and the cathode, and which is denoted by dotted lines and the reference letter C. Likewise, the capacity between the control electrode and anode of the tube 8 is denoted by the symbol K, and the significance of these two capacities will be later explained.

In Fig. 2, there is shown an electrical and graphical analysis of the action of the tube 8, and its asociated capacities C, K and impedance Z. The symbolic representation Z_1 includes the input capacity of the amplifier, the effect of the plate circuit of the preceding amplifier and the capacity C of the tube 8. The symbol Z_2 represents the input impedance due to the impedance of Z_3. Z_4 is an impedance of predetermined character located in the plate circuit of tube 8, and Z_3 is likewise the impedance of an arbitrarily chosen network connecting plate and grid of tube 8, although frequently this network may be chosen to consist merely of the natural grid and plate capacity of the tube as shown at K of Fig. 1.

To explain the operation of the self-tuning amplifier stage, it must be pointed out that one of the essential requirements for securing the desired results depends upon having the apparent input capacity of tube 8 vary sufficiently with frequency to make the total circuit capacity correct for all frequencies. The minimum total value of apparent capacity may be calculated by summing up the capacity between the grid and cathode of tubes 8 and 9, and between grid and screen of the tube 9; and the equivalent capacity across the secondary due to the capacity across the primary, thus making a total of about 35 cms., plus coil capacity, plus the apparent capacity produced by Z_3 and Z_4. The maximum value is equal to the minimum value times the square of the wave length range desired (expressed as a ratio). Therefore, the network Z must be suitably determined to cause this variation in total apparent capacity.

With a suitable network Z inserted in the anode circuit of tube 8, the operation of the self-tunable circuit is as follows: the lower the frequency of signals impressed, the greater the apparent total capacity across coil 4, thus, whatever the signal frequency, the apparent capacity across coil 4 is of approximately the correct value to "tune" coil 4 to the signal being received. The simplest structure for Z of Fig. 1 is a variable resistance, uni-controlled with the signal selector so that its value runs from zero at the highest frequency setting of the selector, to a value sufficiently large to tune in the lowest frequencies at the lowest frequency setting of the selector. However, networks of fixed constants having approximately the same resistance characteristic are preferred where possible, to avoid the necessity for adjustment.

It is possible to replace the coil 4 by a network which at any frequency is equal in impedance, but 180 degrees out of phase, with the input impedance of the tube 8. In such a case the input impedance of the auxiliary tube 8 must have a negative resistance, in order that the passive network, replacing the coil 4, and the fixed capacities may be 180 degrees out of phase.

A modified form of the invention is shown in Fig. 3, the screen element 11 being employed to perform the function of the auxiliary tube 8 in Fig. 1. This is accomplished by inserting in the screen circuit an impedance Z for the purpose of determining in a desired fashion the variation of apparent input capacity of the tube.

While I have indicated and described several systems for carrying my invention into effect, it will be apparent to one skilled in the art that my invention is by no means limited to the particular organizations shown and described, but that many modifications may be made without departing from the scope of my invention as set forth in the appended claims.

What I claim is:

1. An amplifier embodying a tube having input and output circuits, and means in the input circuit for causing a predetermined variation in the input capacity of the tube with a change in frequency, said means including an auxiliary electron discharge device.

2. An amplifier embodying a tube having input and output circuits, and means in the input circuit for causing a predetermined uni-directional variation in the input capacity of the tube with a change in frequency, said means including an electron discharge device connected in parallel with said input capacity.

3. Means for selecting and amplifying high frequency oscillations comprising a tunable band pass selector unit, and an untuned screen grid tube amplifier having means in its input circuit for automatically maintaining resonance in said

amplifier input over a frequency range in accordance with tuning of said unit.

4. Means for selecting and amplifying high frequency oscillations comprising a tunable band pass selector unit, and an untuned screen grid tube amplifier having an auxiliary tube in its input circuit for maintaining resonance in said amplifier input over a frequency range in accordance with tuning of said unit.

5. In combination, an amplifier tube having a normally untuned inductive input circuit, and a tube having its input electrodes connected across the amplifier input providing sufficient capacity to uniformly tune the inductive circuit to desired frequencies throughout a frequency range.

6. In combination, an amplifier tube having a normally untuned inductive input circuit, and a tube having its input electrodes connected across the amplifier input providing sufficient capacity to uniformly tune the inductive circuit to desired frequencies throughout a frequency range, said second tube having a predetermined amount of impedance in its output circuit.

7. In combination, an amplifier tube having a normally untuned inductive input circuit, and a tube having its input electrodes connected across the amplifier input providing sufficient capacity to uniformly tune the inductive circuit to desired frequencies throughout a frequency range and an adjustable frequency selector preceding said inductive circuit.

8. In combination with a resonant circuit including a coil and a tube having its input electrodes connected across said coil, means for selecting signal frequencies of a desired frequency range to be impressed on said coil, a second tube connected to said coil, and an impedance in one of the cold electrode circuits of said second tube of a magnitude such that the input capacity of said first tube is caused to vary with impressed selected frequencies to tune the circuit to such frequencies.

9. In combination with a resonant circuit including a coil and a tube having its input electrodes connected across said coil, means for selecting signal frequencies of a desired frequency range to be impressed on said coil, and a resistor in the anode circuit of said tube of a magnitude such that the input capacity of said tube is caused to vary with impressed selected frequencies to tune the circuit to such frequencies.

10. In combination with a resonant circuit including a coil and a tube having its input electrodes connected across said coil, means for selecting signal frequencies of a desired frequency range to be impressed on said coil, and a resistor in one of the cold electrode circuits of said tube whose magnitude is variable with said selecting means in such a manner that the input capacity of said tube is caused to vary with impressed selected frequencies to tune the circuit to such frequencies.

WALTER VAN B. ROBERTS.