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KEYING SYSTEM

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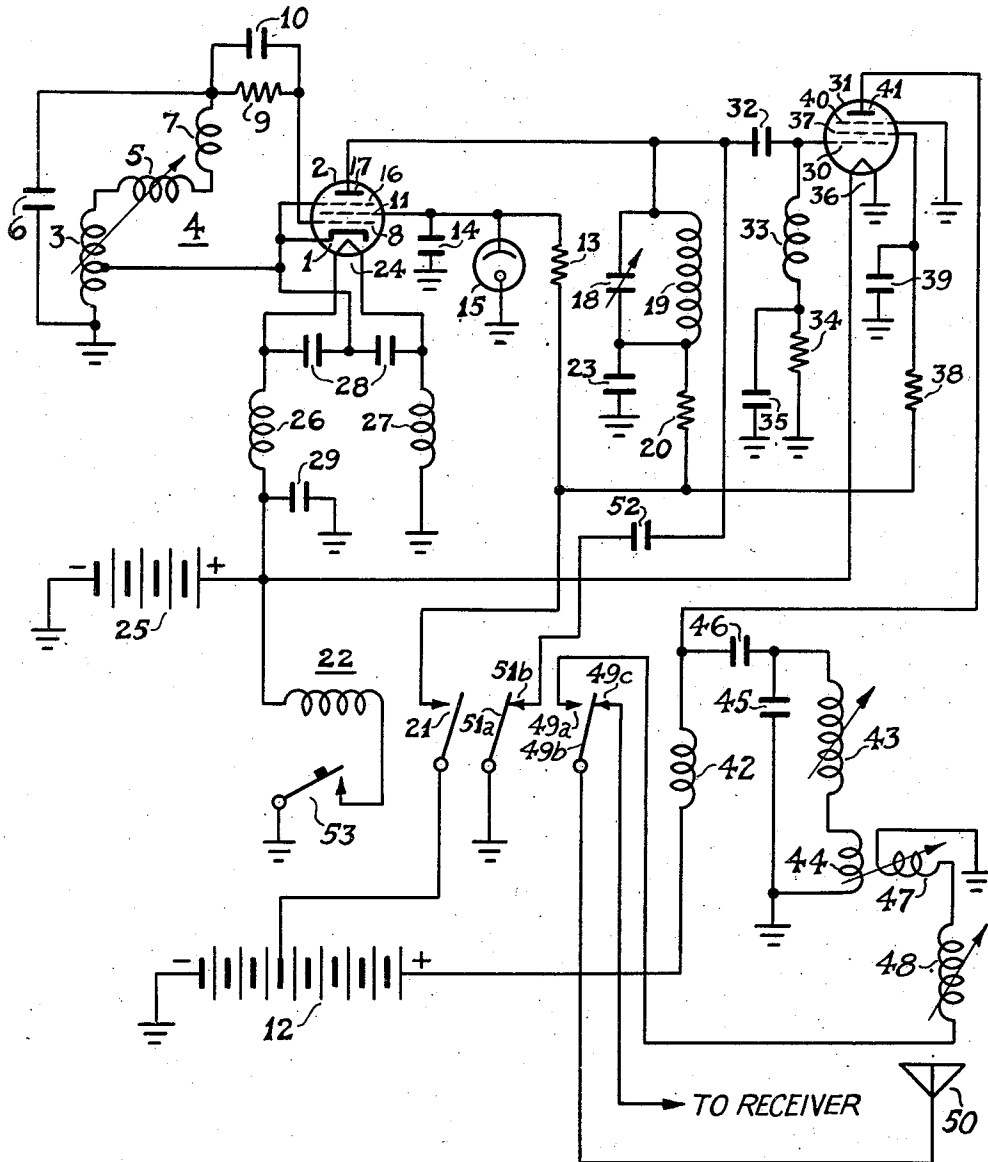


Fig. 1

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KEYING SYSTEM

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This invention relates to radio transmitters emitting keyed signals and more particularly to an improved keying system for use in such transmitters.

Present day radio transmitters employ radio frequency amplifiers operating with very strongly negative control grid bias to secure good efficiency. A variety of methods are utilized to secure the necessary operating bias, such as the use of a separate source for the bias potential, the use of a portion of the anode supply voltage and the use of the grid current resulting from the application of excitation to the control grid of the power amplifier stage passing through a grid resistor to develop the required bias. In transmitters designed for use in aircraft and mobile vehicles the latter method is most frequently employed as it affords the maximum output energy from the amplifier stage for a given anode supply voltage, thereby diminishing the weight of the anode power supply necessary to provide a given radiated energy. The use of this system is characterized by the complete loss of power amplifier control grid bias during those portions of the excitation keying cycle during which no signal is present. This reduction in bias shifts the tube operating point to a region of the characteristic in which the mutual conductance is relatively high, and as a result, a stage which is stable under all other normal operating conditions may oscillate parasitically and emit radiation during the off period of the keying cycle. Because of the weight and space limitations in aircraft transmitters, it is not possible to make use of a separate source of negative grid bias to avoid operation in this portion of the characteristic and it has therefore been the practice to key the high voltage supply to the anode of the power amplifier or to key the connection between the cathode of the power amplifier and the negative terminal of the anode high voltage source. This remedy was reasonably satisfactory except in aircraft operating at altitudes of 30,000 to 40,000 feet where excessive arcing and sparking of the keying contacts was observed leading to their early destruction. At these altitudes, the insulating property of the air is markedly impaired and the anode circuit carrying potentials of 1000 volts or more cannot be readily interrupted.

A principal object of this invention is to provide new and novel means for the suppression of undesired radiation during the no signal intervals of a keyed radio transmitter.

Another object of the invention is to provide

a system for the suppression of spurious radiation from a keyed radio transmitter which operates satisfactorily and without damage to the contact points under the low atmospheric pressures found at high altitudes.

The above objects and advantages are accomplished by tuning the input and output circuits connected to a power amplifier to different resonant frequencies during the off period of power amplifier excitation, and tuning said circuits to the same resonant frequency during the on period of power amplifier excitation.

Other objects and advantages of the invention will in part be described and in part be obvious when the following specification is read in conjunction with the drawing in which the single figure is a schematic diagram of a radio transmitter embodying the invention.

Referring further to the figure, the cathode 1 of the oscillator tube 2, which may be of the type commercially designated as 807, is connected to the tap on the fixed winding 3 of the variometer 4 and one end of the winding 3 is connected to ground. The other end of winding 3 is connected to one end of the movable winding 5 of the variometer 4 and the other end of the winding 5 is in turn connected to the tuning capacitor 6 in series with the loading inductance 7. This terminal of condenser 6 is also connected to the control grid 8 of vacuum tube 2 in series with the parallel combination of grid leak 9 and capacitor 10 and the other terminal of capacitor 6 is connected to ground. The space charge grid 11 is supplied with a positive potential from the 380-volt tap on the 1000-volt direct current source 12 through the dropping resistor 13 and the contact 21 on the keying relay 22, and the grid 11 is maintained at ground potential for radio frequency currents by the capacitor 14 connected between grid 11 and ground. The voltage regulator tube 15 which may be of the type designated as VR-150 is also connected between space charge grid 11 and ground to stabilize the potential of grid 11 and prevent frequency variations with changes in the output voltage of source 12. The suppressor grid 16 of tube 2 is connected to the cathode 1 and the anode 17 of tube 2 is connected to the 380-volt tap of source 12 in series with the parallel resonant circuit including capacitor 18 and inductance 19, the isolating resistor 20 and the contact 21 on the keying relay 22. The decoupling action of resistor 20 is enhanced by the capacitor 23 connected between the anode side of resistor 20 and ground. The cathode 1 is maintained at operat-

ing temperature by the heater 24 connected to the filament voltage source 25 through the isolating chokes 26, 27. The capacitors 28 are connected in series across the terminals of heater 24 and their junction point is in turn connected to the cathode 1 to minimize the radio frequency potential difference between the cathode 1 and associated heater 24. The negative terminal of source 25 is grounded for direct current and the positive terminal of this source is grounded for radio frequency potentials by the capacitor 29 connected between this point and ground. The circuit just described in connection with oscillator tube 2 is a Hartley oscillator circuit and its operation will not be dwelt upon in detail because of its familiarity to those skilled in the art. Suffice it to say that the oscillation involves only the cathode 1, control grid 8 and the space charge grid 11 and that its frequency is controlled by the resonance frequency of the circuit including the variometer 4 and the capacitor 6. This frequency is selected by variation of the relative positions of the coils 3 and 5 in the variometer 4.

The current flowing to the anode 17 flows in pulses of the same frequency as the oscillating potentials appearing on the control grid 8 and develops a voltage across the resonant circuit including capacitor 18 and inductor 19. As the anode load impedance does not control the frequency of oscillation, this circuit may be tuned to the fundamental frequency of oscillation or to any desired harmonic thereof according to the desired output frequency. Voltages appearing across this load circuit are impressed on the control grid 30 of the power amplifier 31 which may be of the commercial type 814, through the coupling capacitor 32. A direct current path from the control grid 30 to ground is established through the choke 33 and resistor 34 connected between this point and ground. The rate of change of the operating bias of amplifier 31 is controlled by the capacitor 35 connected in parallel with the resistor 34 and the choke 33 prevents excessive loss of driving power through this portion of the circuit. Operating emission for the amplifier 31 is provided by the filament 36 having one terminal grounded and the other connected to the positive terminal of source 25. Situated on the other side of the control grid 30 from the filament 36 is the space charge grid 37 maintained at a positive direct current potential by connection to the fixed contact 21 of relay 22 through the dropping resistor 38 and maintained at ground potential for radio frequency currents by the capacitor 39 connected between grid 37 and ground. The suppressor 40 is connected to ground and anode 41 is connected to the 1000-volt terminal of source 12 through the choke 42. Potentials appearing across the choke 42 are impressed on the tank circuit including the variable inductor 43 and variometer winding 44 connected in series across the capacitor 45 through the blocking capacitor 46 connected between the anode 41 and one terminal of capacitor 45, the other terminal of this capacitor being grounded. The tank circuit mentioned is normally tuned to the same frequency as the resonant circuit of capacitance 18 and inductance 19 which is connected in the grid circuit of amplifier 31. The antenna 50 is connected to the movable contact 49b which engages the front contact 49a when relay 22 is energized. Front contact 49a is connected to ground through the loading inductance 48 and the variometer secondary 47 where the coupling

between the tank circuit and the antenna circuit is effected. In operating the equipment, the loading inductor 48 is adjusted to bring the antenna circuit into resonance with the output frequency and the relative position of the coils 44 and 47 in the variometer is adjusted to provide the most satisfactory reflected load impedance for the power amplifier 31. When keying relay 22 is de-energized, the antenna 50 is connected to any desired receiving equipment via the movable contact 49b and the rear contact 49c. The contacts 51a and 51b are also controlled by the keying relay 22 for a purpose to be more fully described. Movable contact 51a is connected to ground while fixed contact 51b is connected to the anode 17 through the capacitor 52 which is thus effectively in parallel with capacitor 18 when contacts 51 are closed, due to the negligible impedance of capacitor 23 at the operating frequency. In a particular transmitter where capacitor 18 had a value of approximately 100 mmfd., the capacitor 52 was made .003 mfd. with very satisfactory results. One end of the operating winding of relay 22 is connected to the positive terminal of the source 25 and the other terminal of this winding is connected to ground in series with the key 53. Closure of key 53 excites the operating winding of relay 22 closing contacts 21, opening contacts 51a and 51b and moving the movable contact 49b into engagement with the corresponding front contact 49a. With the key 53 open, contacts 21 are opened, contacts 51a and 51b are closed, and movable contact 49b engages the corresponding rear contact 49c.

Thus, with the key 53 down, anode and screen voltages are applied to the amplifiers 2 and 31 and the antenna 50 is coupled to the transmitter output. The circuit now operates as a conventional oscillator and power amplifier with the grid current flowing during the positive signal peaks on the control grid 30 supplying operating bias for the power amplifier by virtue of the voltage drop across the resistor 34.

With key 53 up, however, the screen and anode of oscillator 2, and the screen of the power amplifier 31 are disconnected from the high voltage source, and the antenna 50 is connected to whatever receiving equipment is used in the installation. When only these modifications are performed when the key is up, it has been found that, despite the absence of potential on screen grid 37, both parasitic and tuned-grid tuned-plate modes of oscillation occur in the power amplifier stage as the grid bias on grid 30 vanishes due to the removal of excitation. This is because of the very high anode potential which causes the continuance of anode current flow in the absence of screen potential. In the arrangement of the invention, however, contacts 51 ground one terminal of the capacitor 52, thereby detuning the resonant circuit 18, 19 in the grid circuit of the power amplifier 31 from the frequency of the resonant circuit 43, 44, 45 in the anode circuit of the power amplifier 31, and no oscillations appear due to the removal of the conditions necessary for their existence. The contacts 51 which perform this function are not subjected to the high potentials existing across similar elements in previously known systems for the suppression of such oscillations and their life expectancy under high altitude operating conditions has been found considerably greater than that of contacts required to break circuits in which operating potentials are 1000 volts and more.

It will be obvious that many changes and modi-

fications may be made in the invention without departing from the spirit thereof as expressed in the foregoing description and in the appended claims.

I claim:

1. In a radio transmitter, an electric discharge device having a cathode, a control grid and anode, a resonant circuit tuned to a predetermined frequency connected between said cathode and said control grid, means for intermittently impressing alternating current potentials on said control grid, means actuated by the current flowing to said control grid for developing control grid bias, a second resonant circuit tuned to said predetermined frequency connected to said anode, and means connecting a capacitor across said input resonant circuit during the absence of alternating current potentials from said control grid.

2. In a radio transmitter, means for converting direct current energy to alternating current energy having a predetermined frequency, a resonant circuit tuned to said predetermined frequency connected in the output circuit of said conversion means, an electric discharge device having a cathode, a control grid, a space charge grid, and an anode, means connecting said resonant circuit to said control grid, a source of direct current energy, a second resonant circuit tuned to said predetermined frequency connected between said anode and said direct current source, a detuning capacitor, and switch controlled electromagnetic relay means intermittently connecting said conversion means and said space charge grid to said direct current source and connecting said detuning capacitor across said first mentioned resonant circuit during the time that said conversion means and said space charge grid are disconnected from said direct current source.

3. In a radio transmitter, an electric discharge device having input and output circuits, a resonant circuit tuned to a predetermined frequency connected in said input circuit, a second resonant

circuit tuned to said predetermined frequency connected in said output circuit, means for supplying keyed excitation to said input circuit, and means detuning said input resonant circuit from said predetermined frequency during the absence of said excitation.

4. In a radio transmitter, an electric discharge device having input and output circuits, a resonant circuit tuned to a predetermined frequency connected in said input circuit, a second resonant circuit tuned to said predetermined frequency connected in said output circuit, means for intermittently impressing alternating current potentials on said input circuit, and means changing the resonant frequency of one of said resonant circuits during the absence of said alternating current potentials from said input circuit.

5. In a radio transmitter, an electric discharge device having input and output circuits, a resonant circuit tuned to a predetermined frequency connected in said input circuit, a second resonant circuit tuned to said predetermined frequency connected in said output circuit, means for intermittently impressing alternating current potentials on said input circuit, and means connecting a capacitor across said input resonant circuit during the absence of said alternating current potentials from said input circuit.

6. In a radio transmitter, an electric discharge device having a cathode, a control grid and an anode, a resonant circuit tuned to a predetermined frequency connected between said cathode and said control grid, means for intermittently supplying alternating current potentials to said control grid, means actuated by the current flowing to said control grid for developing control grid bias, a second resonant circuit tuned to said predetermined frequency connected to said anode, and means changing the resonant frequency of one of said resonant circuits during the absence of said alternating current potentials from said control grid.

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