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KEYING SYSTEM

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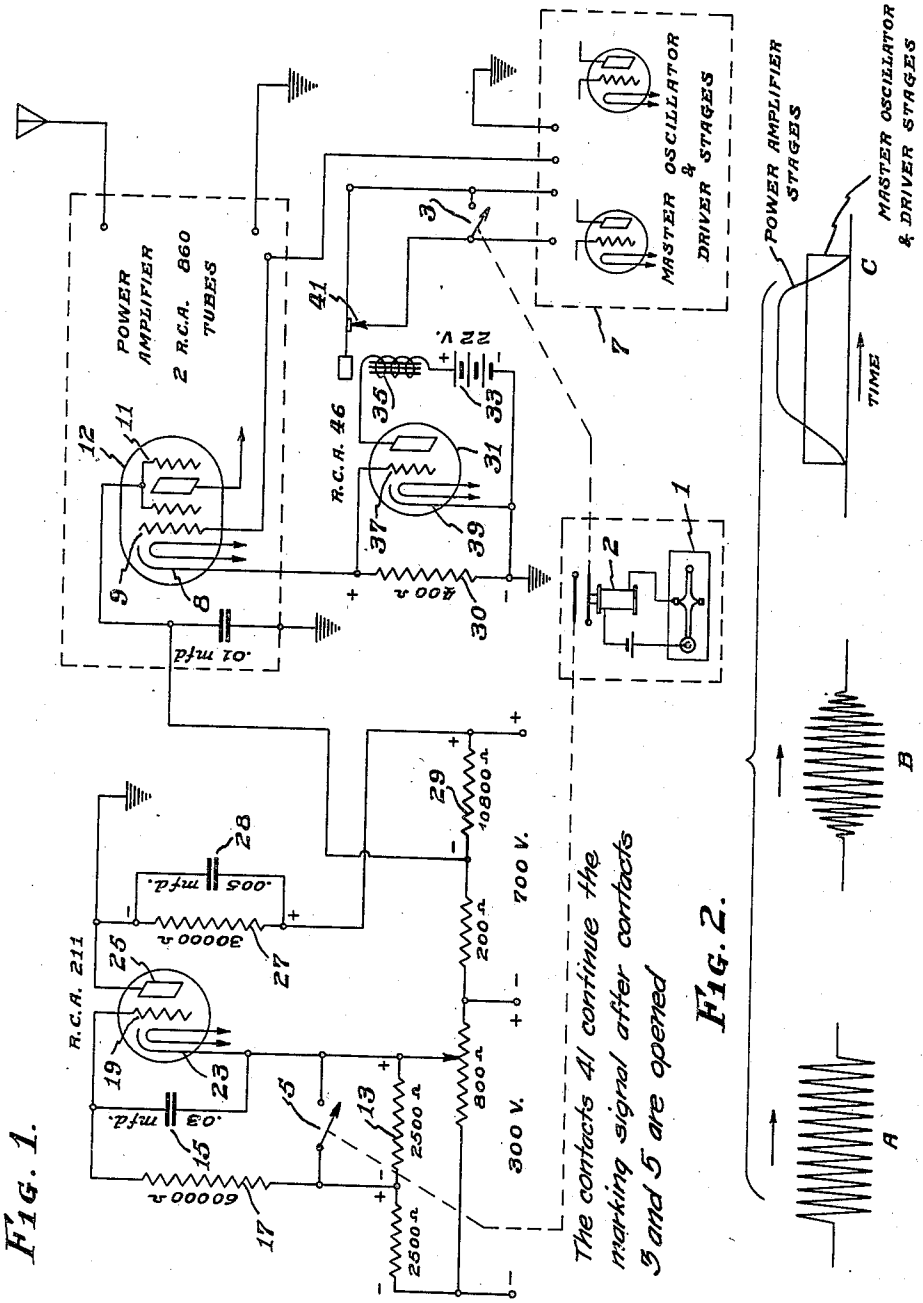


Fig. 1.

Fig. 2.

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KEYING SYSTEM

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My invention broadly relates to keying systems. More specifically my invention is a keying system for high power radio transmitters in which objectionable key clicks are substantially eliminated.

The keying of a radio transmitter involves numerous difficulties. Among these are the interference problems caused by "key clicks" and "key thumps". Such interference is particularly objectionable when a number of transmitters are operated in close proximity to a number of receivers,—a condition often experienced on shipboard.

When keyed transmitters and receivers are being simultaneously operated in relatively close proximity, the key clicks have been found to set up transient currents in the receivers. These transient currents are caused by the abrupt building-up and sharp decay of a keyed transmitter wave. Numerous considerations make the elimination of key clicks highly desirable.

One of the objects of my invention is the elimination of key click or thump disturbances in a transmitted wave.

Another object is to so shape the envelope of the keyed transmitted energy that the interference caused by such keying is substantially eliminated by an inexpensive and simply arranged apparatus.

A further object is to gradually build up the keyed wave and thereafter gradually reduce the keyed wave to eliminate the disturbing effects of abrupt keying.

An additional object is to make the key click limiting device substantially independent of the transmitted frequency and practical for high keying speeds.

My invention may be best understood by referring to the accompanying drawing in which Fig. 1 is a schematic diagram of one embodiment of my invention, and

Fig. 2 (A, B, C) are illustrations of a conventionally keyed carrier wave, a carrier wave keyed in accordance with my invention, and relative keying characteristics of the several stages of a transmitter keyed in accordance with this invention.

Referring to Fig. 1, a suitable key 1 is connected by relay means 2 to two pairs of relay key contacts 3, 5. The relay is arranged so that one pair of the key contacts 3 close slightly before the other pair of contacts 5. This allows the master oscillator and driver stages 7 to energize the power amplifier grid 9. However, the screen grid 11 of the power amplifier 12 is initially biased negatively to cut off the anode current of the power tube, and the power tube will therefore not be instantaneously energized.

Shortly after the first pair 3 of key contacts are closed the second pair 5 of relay key contacts closes by means of a suitable mechanical connection between the pairs of contacts. This short circuits the biasing resistor 13 and allows the capacitor 15 to discharge through the resistor 17. Before the closing of the second pair 5 of key contacts, the grid electrode 19 of thermionic tube 21 was sufficiently negatively biased by the potential across resistor 13 to cut-off the current tending to flow from the cathode 23 to the anode 25.

The gradual discharge of the capacitor 15 through the resistor 17 gradually decreases the negative bias on the grid 19, thereby permitting gradual building up of current through the cathode, anode and anode circuit resistor 27. The current flowing through the anode resistor 27 establishes a voltage drop across this resistor. This voltage minus the voltage drop across the bias resistor 29 will be applied to the screen grid 11 of the power amplifier tube 12. Thus, the screen grid 11 which was initially negative with respect to ground becomes positive and thereby permits anode current to flow in the power amplifier tube, which now assumes its normal load.

The anode current flowing through the cathode resistor 30 to ground produces a voltage drop across the cathode resistor which positively biases the vacuum tube 31. The anode battery 33 is chosen so that substantially no current flows in the field winding of the latching relay 35 when the grid 37 is at zero voltage with respect to the cathode 39. When the grid 37 becomes positive with respect to cathode 39, current flowing in the field winding of the relay closes the relay contacts 41 which are in parallel with the relay key contacts 3. Since the plate or anode current from the power amplifier 12 varies during keying, it is essential that the latching relay contacts remain closed until the anode current of the power amplifier practically ceases.

When the key 1 is opened and the keying relay is deenergized, i. e. during start of a space, the latching relay 35 contacts 41, in parallel with the relay key contacts 3, remain closed until the power amplifier current nearly ceases. During this last mentioned interval the second pair of relay key contacts 5 open which allows bias voltage to gradually build up across capacitor 15 through resistor 17. The gradually increasing

bias slowly cuts off the anode current in tube 21. Thus, the current through resistor 27, and the shunting capacitor 28, is slowly reduced to zero.

Since the bias voltage on the screen grid 11 depends upon the difference in voltage across the anode resistor 27 and across the resistor 29, it will be apparent that with zero voltage across the bias resistor 27, the bias voltage on the screen grid 11 will be that across resistor 27 and will be negative with respect to its cathode 8. With the screen grid 11 negatively biased, the anode current in tube 12 will become zero, the bias voltage between the grid 37 and the cathode 39 of tube 31 will be zero, the latching relay will therefore open, and the master oscillator and driver stages thus de-energized.

Thus, I have described how the master oscillator and driver stages of a transmitter may be abruptly keyed and substantially no disturbance will follow the keying because the power amplifier is gradually energized after the first mentioned keying and gradually de-energized before the keyed master oscillator and driver stages are de-energized. The normal keying of a continuous wave transmitter is represented by Fig. 2A. The sharp building up and rapid break establish the interfering radiation. The characteristic marking signal, represented by Fig. 2B, shows the gradually building up and gradual reduction of a signal or carrier current keyed in accordance with my invention. Fig. 2C is a graph representing the relative keying, with respect to time, of the master oscillator and driver, and power amplifier stages.

The actual tube equipment, voltages, resistor and capacitor values will be determined by the type and power of the transmitter to be keyed. If a sensitive relay of the proper characteristics is employed, the vacuum tube 31 may obviously be omitted and the relay connected directly across the biasing resistor, or in series therewith. The manufacturer's normal ratings of the several parts may be followed. By way of example, one suitable set of tubes, constants and voltages have been indicated on the accompanying drawing.

I claim as my invention:

1. A keying system for a source of oscillations and a power amplifier connected to said source, comprising means for keying said source, a pair of thermionic tubes connected to said power amplifier, means connected to said pair of tubes for biasing each of said tubes to cut-off during spacing intervals, means connected to said power amplifier and to the first of said pair of tubes for biasing said power amplifier to cut-off during spacing signals, means including the first of said pair of tubes for overcoming the cut-off bias of said power amplifier, means including said power amplifier for reducing the cut-off bias of the second of said tubes, means including said second tube for temporarily continuing the keying of said source, and keying means connected to said source and to the first of said pair of tubes whereby a marking signal first keys said source, then removes the bias on the first of said pair of tubes thereby permitting anode currents to flow, which currents remove the cut-off bias on said power amplifier, thereby biasing the second of said pair of tubes to maintain the keying of said oscillator, and further arranged to restore the aforesaid cut-off biases during spacing before de-energizing said source of oscillation.

2. A keying system for a source of oscillations and a power amplifier connected to said source, comprising means for keying connected to said source and to the first of said pair of tubes, a pair of thermionic tubes, the first of said tubes having its output circuit connected to said power amplifier, and the second of said tubes having its input circuit connected to said power amplifier, means connected to said pair of tubes and to said power amplifier for biasing each of said tubes to cut-off during spacing intervals, means including said power amplifier for reducing the cut-off bias of the second of said tubes, means including said second tube for temporarily continuing the keying of said source, means connected to said power amplifier for biasing said power amplifier to cut-off during spacing signals, and means including the first of said tubes for opposing the cut-off bias of said power amplifier, whereby said keying means is so constructed and arranged that a marking signal first keys said source, then removes the bias on the first of said pair of tubes thereby permitting anode currents to flow, which currents remove the cut-off bias on said power amplifier, thereby biasing the second of said pair of tubes to maintain the keying of said oscillator, and further arranged to restore the aforesaid cut-off biases during spacing before de-energizing said source of oscillations.

3. A device of the character of claim 1 further characterized by the inclusion of means for gradually energizing and gradually de-energizing said power amplifier.

4. A keying system for a source of oscillatory currents and a power amplifier, including a screen grid, connected thereto which comprises a thermionic tube, means for biasing said tube during spacing signals to substantially cut-off, means for biasing said screen grid to de-energize said power amplifier, a connection from said tube to said screen grid biasing means whereby anode currents in said tube oppose the screen bias means, means for keying said source, means for removing the bias on said tube and thereby positively biasing said screen grid after said source is keyed, and means including said power amplifier for continuing the energization of said source until a spacing signal substantially de-energizes said power amplifier.

5. A device of the character of claim 4 including means for gradually removing the bias on said screen grid during marking signals and gradually restoring said bias during spacing signals.

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