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KEYING SYSTEM

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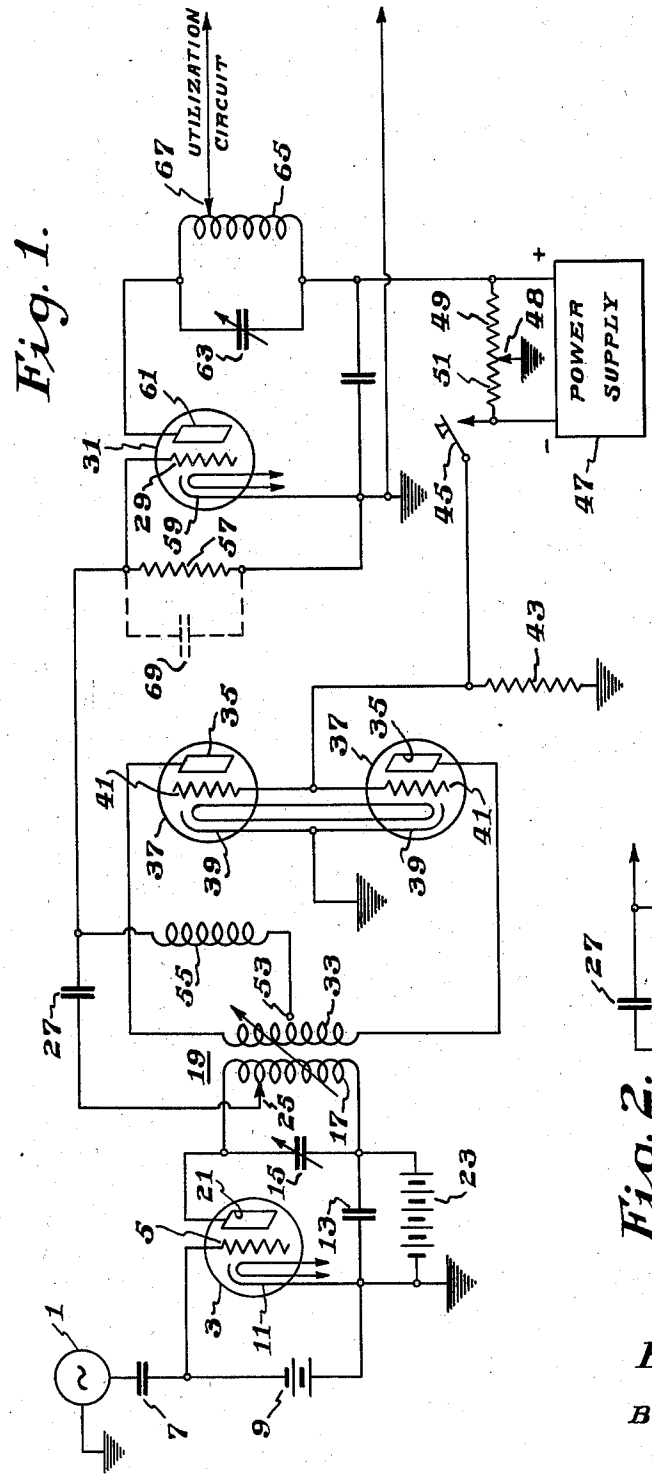


Fig. 1.

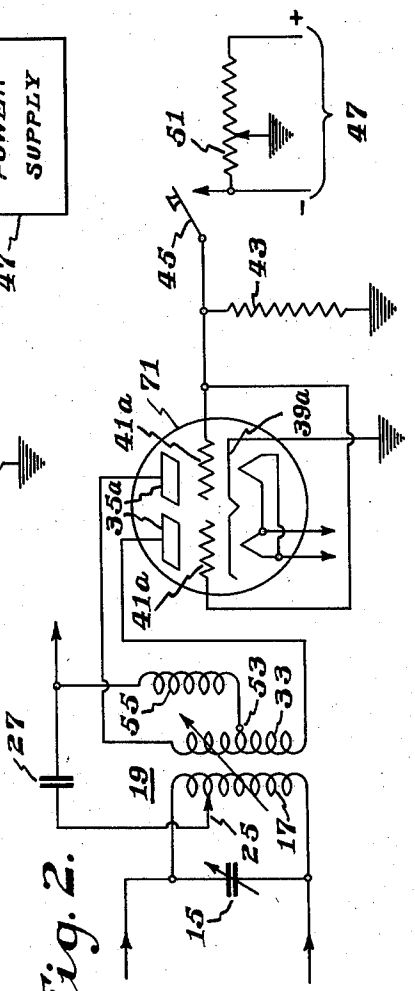


Fig. 2.

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KEYING SYSTEM

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9 Claims. (Cl. 250—17)

This invention relates to keying systems for radio transmitters, and has particular reference to a device of this character which may find general utility not only in place of manual or mechanical relays, but also in high speed automatic keying systems such as used for perforated tape code signal transmission, photoelectric pickup systems for facsimile signal transmission, and other high speed systems in which the use of vacuum tube relays becomes essential.

In keying a transmitter heretofore it has been the practice to modulate a carrier wave in either of two ways. According to one method, the keying is applied to the plate circuit, and some sort of absorption circuit is resorted to for maintaining constant the load on the oscillator regardless of whether the key is open or closed. This system has the disadvantage that the power available on a transmitter at a given plate voltage is inefficiently utilized.

The second keying system as generally used in the past provided for the application of signals to the grid of one of the vacuum tubes in the amplifier. This method usually involves the provision of an extra high voltage power supply unit.

It is well known, in order to maintain constant the frequency of an oscillator, that certain precautions must be taken either to avoid wide variations in the load carried by the oscillator, or else to so design the circuit that the frequency will be stabilized independently of the load. To accomplish the latter is no easy matter and, accordingly, it is among the objects of our invention to provide a keying system in which, whether a marking or spacing signal is being transmitted, the oscillator has a uniform and invariable load.

Other objects of our invention include the provision of a keying system which is so designed that it is of the simplest possible construction, is operable without undue waste of power, and is adapted for keying the signals on and off at any desired speed.

Among the features of our invention to be hereinafter noted in the detailed description we should here mention that we propose to so apply the signals to an amplifier network that, when the key is closed, a definte load will be sustained by the oscillator, being applied to the grid-cathode impedance of a certain electron discharge tube, whereas, when the key is open, a tube or tubes in an auxiliary stage will be caused to dissipate energy from the oscillator in an equal amount by virtue of a current flow across the cathode and plate electrodes of such tube or tubes.

The novel features which we believe to be characteristic of our invention are set forth with particularly in the appended claims. Our invention itself, however, as to its organization and method of operation will best be understood by reference to the following description taken in connection with the accompanying drawing, in which—

Figure 1 shows diagrammatically one way whereby our invention may be carried into effect, and

Fig. 2 shows a portion of the diagram of Fig. 1 so modified as to substitute in place of two tubes a single electron discharge tube which comprises two independent triode units.

Referring to Fig. 1, we show a portion of a transmitter network in which a source of oscillations 1 is provided. The carrier wave so produced may be successively impressed upon as many stages of amplification as may be desired. The space discharge tube 3 may constitute one of the stages. It is, therefore, controlled by impress of the oscillations upon its grid 5 through a suitable capacitor 7 in the usual manner. The grid 5 may be biased as by means of a source of potential 9, or, if desired, it may be self-biased by means of a suitable resistor, not shown. The output circuit of this tube includes a cathode 11, a by-pass capactor 13, a tank circuit having an adjustable capacitor 15, shunted by an inductance which in this case is shown as the primary 17 of a suitable transformer 19, and finally the anode 21 of the tube 3. Anode potential is supplied between the grounded cathode 11 and the anode 21 by means of a suitable source 23. From a tap 25 on the primary 17 a circuit is established through a capacitor 27 to the grid 29 of a space discharge tube 31. The secondary 33 of the transformer 19 has its terminals connected respectively with the two anodes 35 of an auxiliary push-pull electron discharge tube stage, which stage we make use of for applying the keying signals. The push-pull tubes are numbered 37 and comprise the usual cathodes 39 and grids 41, as well as the anodes 35 aforementioned. The cathodes 39 are preferably grounded, whereas the grids 41 are normally self-biased by grounding the same through a grid leak resistor 43 of suitable value.

The grids 41 are connected in parallel to any suitable keying device such as that conventionally represented at 45. By closing the key 45 the grids 41 are rendered more negative than is possible by virtue of the self-bias which is obtained when the key is open. This is accomplished by connecting one terminal of the key

to the negative side of a power supply 47 and by providing a potentiometer 49 across the poles of the power supply 47 such that an intermediate tap 48 on the potentiometer may be grounded. If that portion of the potentiometer shown at 51 has a resistive value considerably less than the value of the resistor 43, then it is apparent that the tubes 37 may be blocked by rendering their grids 41 strongly negative when the key 45 is closed.

It will be noted that there is no provision of a source of anode voltage to be applied to the anodes 35 other than that which is induced in the secondary 33 by the current flow in the tank circuit 15—17. The tubes 37 will, when the key 45 is open, absorb a certain definite amount of energy from the amplifier 3 according to the space current which is permitted by the normal bias of the grids 41 and by the impedance of the remaining part of the circuit, which includes a center tap 53 on the secondary winding 33, a choke coil 55, and either the grid-to-cathode impedance of the tube 31, or in parallel therewith the grid-leak resistor 57 which is connected to the cathode 59 and to ground.

Due to the presence of the choke coil 55 it is substantially only a rectified current that flows through the circuit just now described. This rectified current tends to bias the grid 29 so negatively that the tube 31 blocks when the key 45 is open.

Assuming now that the key 45 is closed, the grids 41 will become so negatively biased as to block the tubes 37 and hence the secondary winding 33 will be substantially open circuited. Rectified energy will, therefore, be no longer derived from the mid-tap 53 for maintaining the grid 29 negative. Instead, this grid will be restored to its normal bias through the grid leak 57, whereupon it is possible to supply continuous excitation from the oscillator through the amplifier 3 and tank circuit 15—17, the tap 25, capacitor 27, and thence to the grid 29. Under these conditions, the tube 31 will amplify in the usual manner and the carrier wave will be impressed upon the output circuit of the tube 31 which includes, if desired, a tuned network having a capacitor 63 and an inductance 65. A tap 67 on the inductance 65 may be connected to either a further stage of amplification or to an antenna (not shown).

In certain cases it may be desirable to introduce a capacitor 69 in shunt with the grid-leak resistor 57, as is well known in the art.

It will be understood from the foregoing description that proper values may be obtained for each element of the keying circuit such that the load reflected into the tank circuit 15—17 may be held constant despite the keying. The necessary adjustments, when so made, will obviate all difficulties heretofore encountered by way of maintaining a constant frequency of oscillations from the generator 1.

Referring to Fig. 2, we show a modification of so much of the circuit of Fig. 1 as is necessary to illustrate the use of a single electron discharge tube 71 having a twin arrangement of triode elements to be used in place of the push-pull tubes 37. Connections to the anodes 35*a* are made with the terminals of the secondary coil 33 in the same manner as shown in Fig. 1. The grids 41*a* are also connected in parallel to the key 45, the same as shown in Fig. 1. The cathode 39*a* is grounded. The operation of the device when using a tube such as that shown at 71 is, therefore, similar in all respects to that which has been described in the foregoing part of the specification with respect to Fig. 1.

In certain instances it may be found preferable to substitute an alternating current power supply source for the direct current source shown at 47, or to superimpose alternating upon direct potentials while still preserving the proper conditions for self biasing the grids 41 or 41*a* when the key 45 is open and for negatively biasing these grids when the key is closed. Such modifications can be made according to practices well known in the art and with the result that the output signal becomes pulsating in character. If, therefore, the A. C. source used is one of audio frequency, a tone of definite pitch is produced while the key is closed, thus obviating the use of so-called "choppers" of certain other types.

We have found that while a push-pull arrangement of the tubes 37 is generally desirable because it provides full wave rectification of the energy from the oscillator 1, there are instances where it may be desirable to utilize half-wave rectification. Hence it is possible to dispense with one of the tubes 37 and to so connect the choke coil 55 that it will be in series with the entire secondary winding 33 of the transformer 19.

It will be seen that we have provided a system in which the operation of the oscillation generator is made substantially independent of shifts between the transmission by radiation of the carrier wave and the suppression thereof, as when the key 45 is alternately closed and opened. It is obvious that in place of the key 45, as conventionally shown, any suitable means such as, for example, a vacuum tube relay, may be provided for high speed operation of the keying system.

While we have shown and described two preferred embodiments of our invention, it will be apparent that other embodiments may be employed without departing from the spirit and scope of the invention itself, as set forth in the appended claims.

We claim as our invention:

1. In a keying system, a source of oscillations, an electron discharge tube amplifying network for said oscillations; a direct current source for said network; means for rectifying and absorbing energy from said oscillation source, including an electron discharge device having an anode circuit coupled to said source of oscillations and a grid circuit normally biased to allow current to flow in said anode circuit; and means, including a keying device for applying a cut-off bias potential from said direct current power source to said grid circuit, so arranged that energy from said oscillation source is transferred to said amplifying network, during said marking signal, and utilized as signal energy instead of being absorbed as rectified energy.

2. A keying system in accordance with claim 1 including means for adjusting the electrical constants of said network and of said energy absorbing means so that a uniform load is sustained by said oscillation source regardless of said keying operations.

3. In a keying system, a carrier wave amplifier having a plurality of electron discharge tube stages, a biased grid input circuit and a tuned output circuit in each of said stages, a push-pull electron discharge tube rectifier coupled to the

output circuit of one of said stages, a grid leak resistor connected to said rectifier and included in the grid-input circuit of a succeeding tube stage and thereby arranged to control the grid bias on said succeeding stage, means including a keying device for so varying the impedance of said rectifier and thereby varying the flow of current in said rectifier and resistor as to produce variations in the grid bias potential applied to said succeeding stage so arranged as to effect keyed modulation of the output energy from said succeeding stage, and means for maintaining the amplitude of output energy from the stage to which said rectifier is coupled substantially constant.

4. A device in accordance with claim 3 including a self biasing means in the input circuit of said push-pull rectifier to normally slightly self-bias said rectifier when said keying device is open, and means for biasing said rectifier to cut-off when said keying device is closed.

5. A device in accordance with claim 3 further characterized in that the output circuit of said push-pull rectifier has connected thereto a center-tapped secondary winding of a transformer by which it is coupled to one of said amplifier stages and said secondary is connected through its center-tap with the grid of said succeeding amplifier stage.

6. In a carrier wave amplifier and modulator, means for generating a carrier wave, a plurality of electron discharge tube stages, each stage having a suitably biased grid input circuit and a resonant output circuit, an electron discharge tube rectifier of the full-wave type, means including a transformer having taps on the primary and on the secondary thereof for inter-coupling the output circuits of said rectifier and of one of said amplifier stages, means including a reactive path connecting the center tap of said secondary to the grid of a succeeding amplifier stage and to ground thereby to afford an energy absorption medium for said carrier wave when the impedance of said rectifier is low, and means including a coupling device between the tap of said primary and the grid of said succeeding amplifier stage for delivering carrier-wave excitation energy to said grid when the impedance of said rectifier is high.

7. A device in accordance with claim 6 further characterized in that said rectifier is provided with a pair of parallel connected control grids and means including a keying device is provided in connection with said control grids for causing the same to be biased above cut-off when the keying device is open and below cut-off when said keying device is closed.

8. The method of controlling the oscillatory energy from an oscillation generator so that said oscillatory energy is caused at times to be utilized in an amplifier for effecting the transmission of a marking signal and so that said oscillatory energy of like amplitude may be otherwise absorbed during the period of a spacing signal, which method comprises applying said oscillatory energy to said amplifier during the transmission of said marking signal, and causing said energy to be rectified and simultaneously dissipated during the period of a spacing signal.

9. In a keying system, a carrier wave amplifier having a plurality of electron discharge tube stages, a biased grid input circuit and a tuned output circuit in each of said stages, a push-pull electron discharge tube rectifier coupled to the output circuit of one of said stages, a grid leak resistor connected to said rectifier and included in the grid input circuits of succeeding tube stages and thereby arranged to control the grid bias on succeeding stages, means including a keying device for so varying the impedance of said rectifier and thereby varying the flow of current in said rectifier and said resistor as to produce variations in the grid bias potential applied to said succeeding stages and arranged to effect keyed modulation of the output energy from said succeeding stages, and means for maintaining the amplitude of output energy from the stage to which said rectifier is coupled substantially constant.

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