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RADIO TRANSMITTING SYSTEM

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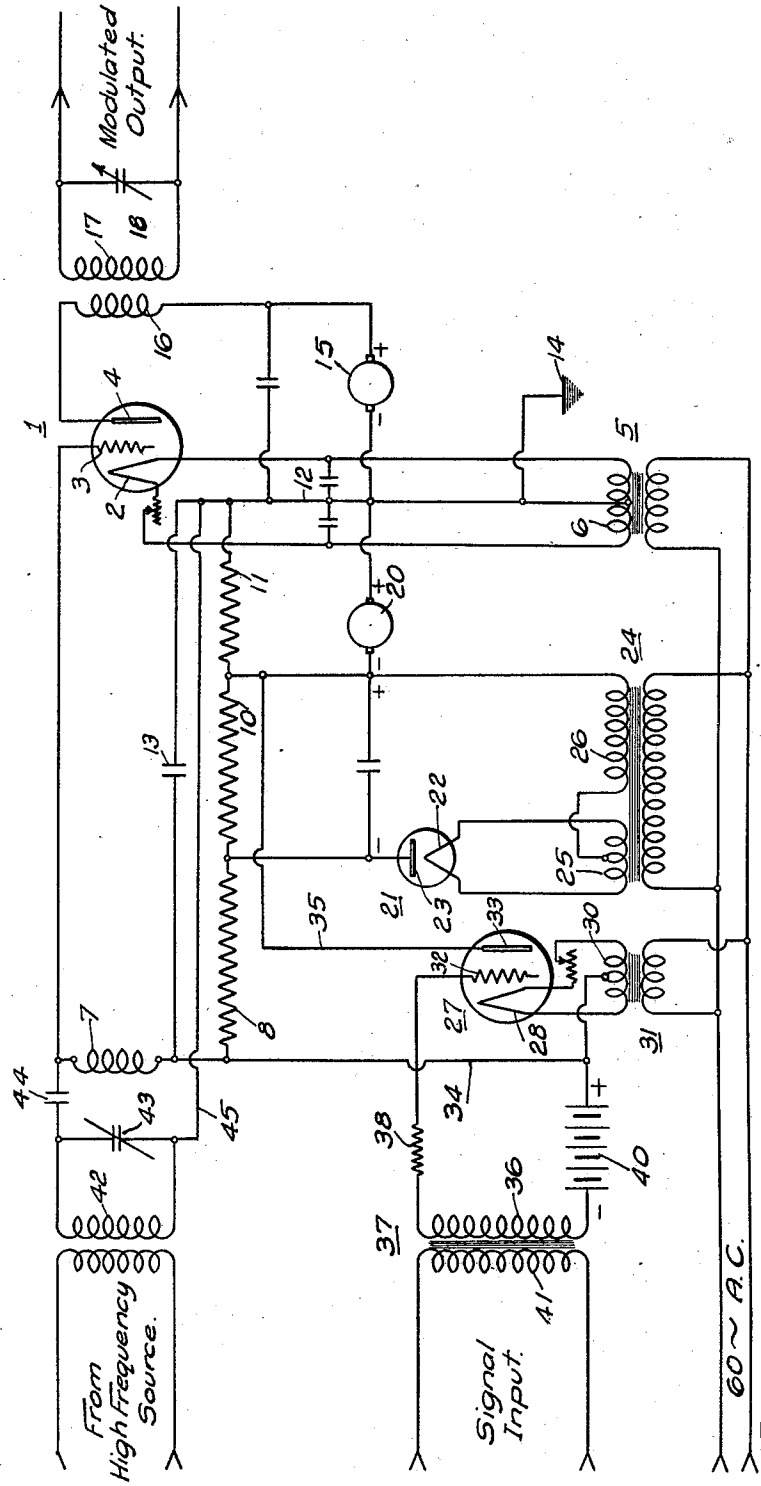

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UNITED STATES PATENT OFFICE

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RADIO TRANSMITTING SYSTEM

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My invention relates to radio-transmitting systems, and it has particular relation to systems of the type wherein signaling is accomplished by interrupting the continuity of a radio-carrier-wave at predetermined intervals representative of a code.

One manner in which the continuity of a carrier wave may be interrupted at signaling frequency is exemplified in the Colpitts Reissue Patent No. 15,538, February 13, 1923, wherein it is disclosed that the oscillations generated by a thermionic tube may be started and stopped at will by altering the grid-biasing potential applied therto. Systems of the general type of that disclosed in the Colpitts patent, however, while operative for transmitters of relatively low power, are not entirely satisfactory when an attempt is made to utilize them in connection with thermionic tubes of the power type, inasmuch as the grid-currents that must be interupted to accomplish signaling are often of such magnitude and voltage as to cause destructive sparking at the machnical-relay contacts. In addition to the limitation as to the amount of power the Colpitts system, and others of the same general type, can satisfactorily handle, they are also incapable of extremely high-speed operation by reason of the inertia of the moving elements of the relay. The latter limitation is a serious one, inasmuch as practically all commercial radio-communication at the present time is handled by machine-transmitters which attain relatively high speeds.

It is accordingly, an object of my invention to provide, in a radio-transmitting system, instrumentalities that shall function to permit the efficient control of higher power than has heretofore been possible.

Another object of my invention is to provide a keying system for a radio-transmitter that shall be capable of handling the heavy grid currents involved in the operation of thermionic tubes of the power type.

Another object of my invention is to provide a grid-biasing-potential-control system that shall be particularly suitable for use in connection with thermionic amplifier and oscillator tubes of the power type.

Another object of my invention is to provide a keying system for radio transmitters that shall be capable of substantially unlimited speed.

Another object of my invention is to provide a radio-transmitting system analogous to the system disclosed in the aforementioned patent to Colpitts, wherein the necessity for utilizing a mechanical relay shall be eliminated.

Another and more specific object of my invention is to provide, in a radio-transmitting system of the aforementioned type, a relay device for keying purposes that shall be without moving parts and, consequently, free from inertia.

According to one embodiment of my invention, I provide two separate sources of biasing potential for the grid of one of he high-power thermionic tubes comprised in the amplifying portion of a radio-transmitting system of the type known to those skilled in the art as a "master-oscillator, power-amplifier" transmitter. One of the sources, preferably a direct-current generator, supplies sufficient biasing potential, when utilized alone, to maintain the grid of the thermionic tube at the normal operating potential, while the other source, which is preferably a rectifier energized from alternating-current mains, supplies enough additional potential to prevent the tube from functioning, even though supplied with grid excitation. I further provide a control network in shunt to the bias-rectifier, and include therein the plate-filament path of a second thermionic tube, which tube will hereinafter be designated the "keying tube". The input circuit of the keying tube comprises the secondary winding of a specially constructed keying-transformer, the primary winding of which is connected to a source of signals.

I find it preferable to utilize a machine-controlled telegraph key, or an analogous device, as the source of signals, inasmuch as a keying system constructed according to my invention responds more efficiently to high-speed signals than to signals at low speeds.

The novel features that I consider characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with further objects and advantages thereof, will best be understood by reference to the following description of a specific embodiment, taken in connection with the accompanying drawing.

The single figure of the drawing is a schematic circuit diagram exemplifying the application of a preferred embodiment of my invention to an amplifier stage of a radio transmitting system of the "master-oscillator, power-amplifier" type.

Referring to the drawing, an amplifier stage, arranged according to my invention, comprises a thermionic device 1, preferably, though not absolutely necessary, of the high-power type, having a filament 2, a grid 3, and a plate 4. The filament may conveniently be energized from any source of commercial-frequency alternating current by means of a transformer 5, the secondary winding 6 of which is connected to the filament terminals. The grid of the device 1 is connected to an intermediate point on the secondary winding of the transformer through a radio-frequency choke coil 7, a plurality of impedance devices 8, 10 and 11, and a conductor 12. A condenser 13 is preferably connected in shunt to the impedance devices, which are shown in the drawing as resistors, in order to by-pass currents at radio frequency therearound.

A ground connection 14 is provided for the conductor 12, in order to assist in stabilizing the operation of the amplifier.

Plate potential for the thermionic device 1 is supplied from a source 15, preferably a direct-current generator, over a circuit which includes an output inductor 16. The output inductor may be coupled to a succeeding amplifier stage by way of an oscillatory circuit comprising an inductor 17 and a tuning condenser 18, or coupled thereto in any one of the many ways known to those skilled in the art. If desirable, instead of utilizing additional stages of amplification between the output circuit and an antenna, the said output circuit may be directly coupled thereto.

A source 20 of biasing potential is arranged in shunt to the impedance device 11, the positive terminal of the source being connected to the conductor 12 which extends to the intermediate point on the secondary winding of the filament-supply transformer.

A second source 21 of biasing potential, preferably a rectifier having a filament 22 and a plate 23, is arranged in shunt to the impedance device 10, the plate 23 of the rectifier being connected to the end of the impedance device nearest the grid of the thermionic tube 1. The rectifier is supplied with energizing potential from a transformer 24 having two secondary windings 25 and 26, the winding 25 serving to heat the filament and the winding 26 being connected between an intermediate point on the winding 25 and the plate to supply high potential to the latter over the resistor 10.

A keying tube 27, having a filament 28 energized from the secondary winding 30 of a power transformer 31, a grid 32, and a plate 33, is connected in shunt to the impedance devices 8 and 10 by means of a conductor 34 which extends from an intermediate point on the secondary winding 30 to the junction between the device 8 and the choke-coil 7, and a second conductor 35 which extends from the plate 33 to the junction between the devices 10 and 11. The space-current path of the keying tube is, therefore, in shunt to the said impedance devices 8 and 10, and is also in shunt to a portion of the output circuit of the rectifier 21.

The input circuit of the keying tube comprises the secondary 36 of a keying transformer 37, a stabilizing resistor 38, and a source 40 of biasing potential, the positive terminal of the latter being connected to the intermediate point on the secondary winding of the filament-supply transformer. The primary winding 41 of the keying transformer 37 must have a time constant such that the inductive voltage of the transformer will not, during the time necessary to transmit the longest single code-symbol at the minimum rate at which the system is to operate, fall below that value necessary to so counteract the biasing source 40 that the keying tube is rendered conductive. The minimum rate I contemplate employing is of the order of from ten to fifteen words per minute, speeds less than that being commercially impracticable.

The source of the signals is not shown, it being within the scope of my invention to utilize any well-known device for delivering direct-current impulses to the primary winding 41 at predetermined intervals and durations in accordance with a telegraphic or other code.

An oscillatory circuit, comprising an inductor 42 and a tuning condenser 43 connected in shunt thereto, is arranged to supply high-frequency excitation to the power tube 1, being coupled thereto through a grid condenser 44 and a conductor 45. The oscillatory circuit may be energized from a crystal, or tuning-fork-controlled master oscillator, or from any other energy source which is capable of supplying oscillations at the desired radiation frequency.

In the operation of a radio transmitter comprising my invention as herein described, the potentials of the sources 20 and 21 are so chosen that, when both sources are effective,

the aggregate negative potential applied therefrom between the grid and filament of the power tube is sufficient to bias the grid to beyond the cut-off point, thus preventing the tube from functioning as an amplifier, in spite of the continuous operation of the exciting source. The potential of the source 40 which supplies biasing potential to the grid of the keying tube is also so adjusted that, in the no-signal condition of the transmitters, the keying tube is biased to the cut-off point, thus preventing a flow of current therethrough from the rectifier 21.

Code signaling is accomplished by periodically impressing on the grid of the keying tube, through the transformer 37, positive impulses of sufficient magnitude to overcome the biasing potential supplied from the source 40, thus permitting the space-current path in the said tube to become sufficiently conductive to act as a shunt to the bias rectifier 21, and also to carry the grid current from the power tube.

The shunt-path to the bias rectifier, thus established through the keying tube, includes, in addition to the resistance of the space-current path in the said tube, the resistance of the impedance device 8. The said device serves to limit the current drawn from the rectifier by the keying tube, and it is preferably given such resistance that the grid current, plus the current from the rectifier, when flowing through the keying-tube space-current path, causes a potential drop therein just sufficiently additional to the potential supplied by the bias generator to bias the grid of the power tube to its best operating value.

In one embodiment of my invention, the power tube is of the type known as WT—25, rated at 250 watts, and the keying tube of the type designated "203—A," rated at 50 watts, both of the said tubes being made by the Westinghouse Electric & Manufacturing Company. When the power tube is excited from a source of oscillatory current of sufficient amplitude, if the grid thereof is maintained at a potential 400 volts negative with respect to the filament, efficient amplification is obtained, and the grid-current flowing through the keying tube is of the order of 100 milliamperes.

The impedance devices 8, 10 and 11 are given values of 50,000, 10,000 and 2,000 ohms, respectively, the internal resistance of the bias rectifier is determined to be of the order of 2,000 ohms, and the internal resistance of the keying tube is approximately 1,666 ohms during signal intervals. The potential developed across the bias rectifier is in the neighborhood of 1,200 volts, while the bias generator applies a potential of 200 volts across the terminals of the impedance device 11.

The cut-off potential applied to the grid of the power tube, when the keying tube is blocked from the source 40, is substantially 1,200 volts, which is amply sufficient to prevent any excitation of the said power tube from the master oscillator. The current flowing in the keying tube during signal intervals is approximately 120 milliamperes, producing a potential-drop thereacross of approximately 200 volts.

My invention is mainly advantageous in that the keying speed obtainable by its use is in no manner limited by the inertia of mechanical relay devices. The response of the keying tube, and the consequent starting and stopping of the amplification in the power tube, is substantially instantaneous, thus giving rise to radiated signals that are clean cut and easily readable.

The current carried by the keying tube, 120 milliamperes in the specific arrangement herein described, is well within the limits of safety for the device, and it is believed obvious that, for the handling of higher currents, keying tubes of much larger capacity could be utilized.

Although I have described my invention as being particularly adapted to be incorporated into a power-amplifier stage of a radio transmitting system of the master-oscillator, power-amplifier type, it is not, in reality, restricted thereto. It lies within the province of my invention to apply my improved keying system to the master oscillator itself, or to apply it to any oscillation generator or amplifier when it is desirable to interrupt the continuity of the generated oscillations or their amplification.

Inasmuch as numerous modifications of my invention will be apparent to those skilled in the art, it is my desire that its scope shall not be restricted except insofar as is necessitated by the prior art or by the spirit of the appended claims.

I claim as my invention:

1. In a signaling system, an electronic device having a control electrode, a circuit network associated with said control electrode and including a plurality of means for applying a blocking potential thereto, electronic means for rendering ineffective a portion of said potential-applying means, and signal-actuated means for altering the conductivity of said second-mentioned electronic means, said electronic means being connected in shunt to a portion of said circuit.

2. In a signaling system, an electronic device having a control electrode, a circuit network associated with said control electrode and including a plurality of means for applying a blocking potential thereto, a second network connected in shunt to a portion of said potential-applying means, an electronic device included in said second network, and signal-actuated means for altering the con-

ductivity of said second-mentioned electronic device.

3. In a signaling system, an electronic device having a control electrode, a circuit network associated with said electrode and including a plurality of sources of biasing potential, and an electronic device connected in shunt relation to at least one of said sources for altering the effectiveness thereof.

4. In a signaling system, an electronic device having a control electrode, a circuit network associated with said electrode and including a plurality of sources of biasing potential having a total magnitude sufficient to render the said electronic device inoperative if applied to the said control electrode, and an electronic device connected in shunt to at least one of said sources for altering the effectiveness thereof.

5. In a signaling system, an electronic device having a control electrode, means comprising a source of potential and a resistor for applying a biasing potential to said electrode, and electronic means connected in shunt relation to said source and in series relation to said resistor.

6. In a signaling system, an electronic device having a control electrode and a source of electrons, means comprising a source of potential and a resistor connected serially between said electrode and said source of electrons for applying a biasing potential to said electrode, and electronic means connected in shunt relation to said source and in series relation to said resistor.

7. In a signaling system, a thermionic device having a grid and a filament, grid-biasing means comprising a potential source and a resistor serially connected between said grid and said filament, a second thermionic device connected in shunt relation to said source and in series relation to said resistor, and signal-actuated means for altering the conductivity of said second-mentioned thermionic device.

8. In a signaling system, a thermionic device having a grid and a filament, a network including a plurality of sources of biasing potential and a plurality of impedance devices connected between said grid and said filament, and a second thermionic device so interposed in said network that its space-current path is connected in shunt relation to at least one of said sources and in series relation to at least one of said impedance devices.

9. In a signaling system, a thermionic device having a grid and a filament, a network including a plurality of sources of biasing potential and a plurality of impedance devices connected between said grid and said filament, a second thermionic device so interposed in said network that its space-current path is connected in shunt relation to at least one of said sources and in series relation to at least one of said impedance devices, and signal-actuated means for altering the conductivity of said second-mentioned thermionic device.

10. In a signaling system, a thermionic device having a grid and a filament and being of the type wherein a substantial grid current flows during the operation thereof, means for applying a negative potential between said grid and said filament, and a second thermionic device connected in shunt to a portion of said means for rendering more positive said potential and for carrying the grid current when the potential is made sufficiently positive to permit said grid current to flow, whereby the operation of said first mentioned thermionic device may be controlled without the destructive sparking incident to the control thereof through the intermediary of mechanical relays.

11. In a signaling system, a thermionic device having a grid and a filament, means comprising a plurality of voltage sources for negatively biasing the grid with reference to the filament, said sources having impedance devices connected in shunt thereto, a thermionic tube so associated with certain of said impedance devices that the space-current path in said tube is connected in parallel with at least one of said sources, and means for controlling the conductivity of said tube whereby, when the conductivity of said thermionic tube is lowered below that of the impendance devices with which it is associated, the last mentioned source becomes less effective to negatively bias said grid.

12. In combination, a thermionic device having a grid and a filament, means for negatively biasing said grid with respect to said filament to a potential proper for efficient operation of said device, means for applying enough additional biasing potential to render the device inoperative, said several biasing means being serially interposed between said grid and said filament, and means, including a thermionic tube, for establishing a shunt path around said second-mentioned biasing means.

13. In a signaling system, a thermionic device having a control-electrode, a circuit network associated with said control-electrode and including a potential source for applying a blocking potential thereto, thermionic by-pass means connected in shunt relation to a portion of said network through which flows current from said source, and means for controlling the conductivity of said by-pass means.

In testimony whereof, I have hereunto subscribed my name this 22nd day of March, 1928.

ROBERT L. DAVIS.