

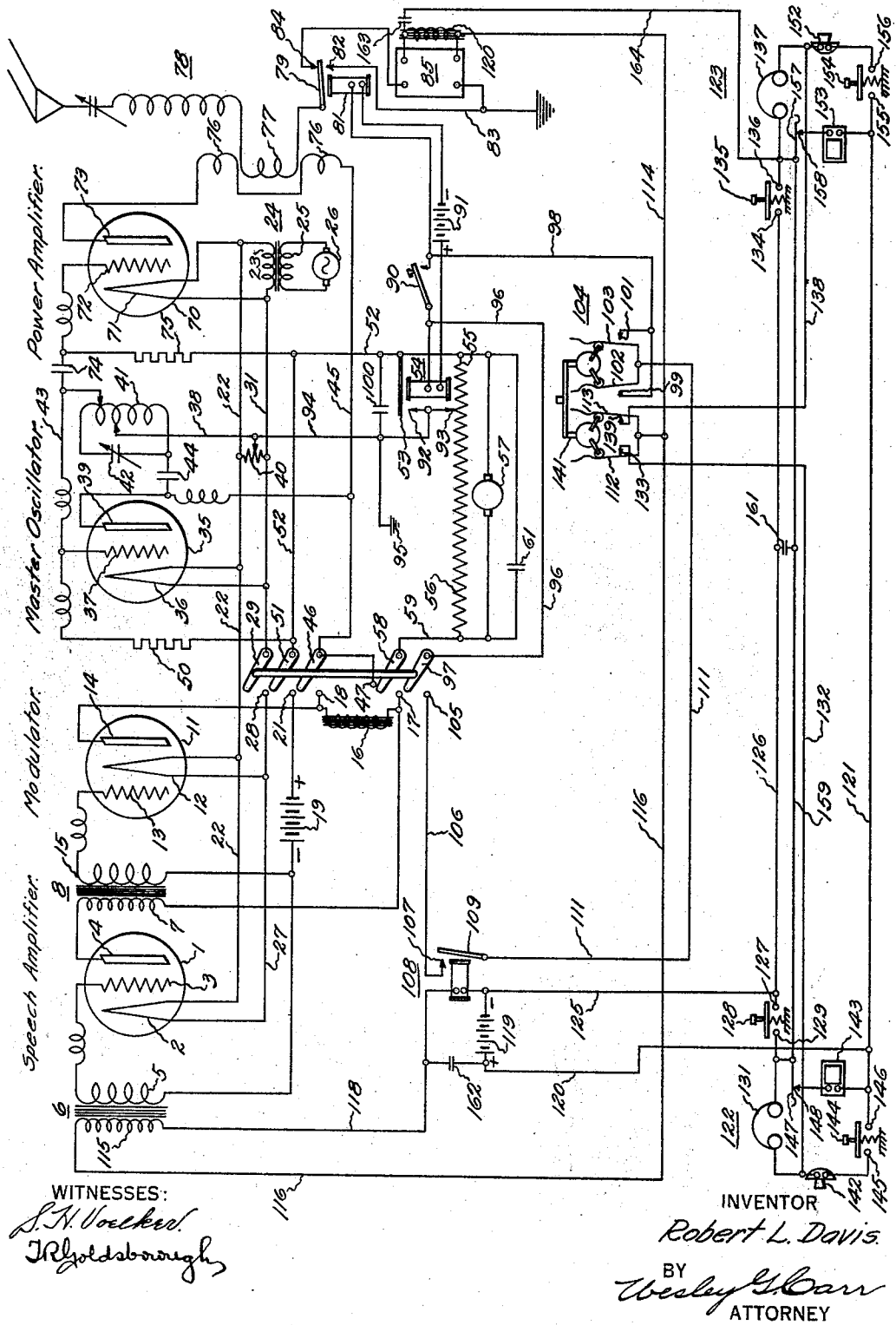
Aug. 9, 1932.

R. L. DAVIS

1,870,795

CONTROL MEANS FOR TRANSMITTING SYSTEMS

Filed Feb. 1, 1927



UNITED STATES PATENT OFFICE

ROBERT L. DAVIS, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE
ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA

CONTROL MEANS FOR TRANSMITTING SYSTEMS

Application filed February 1, 1927. Serial No. 165,135.

My invention relates to radio transmitting systems, and it has particular relation to systems designed for the optional transmitting of telegraphic or telephonic signals.

5 One object of my invention is to provide a transmitting system that will consume minimum power when in operation.

Another object of my invention is to provide a transmitting system wherein no power will be radiated during the intervals between keying, or when modulation current is absent.

Another object of my invention is to provide a duplex transmitting system, in which a receiving instrument is automatically disconnected from the antenna during keying intervals, and connected thereto during spacing intervals.

Another object of my invention is to provide in a transmitting system of the type described, a dual system of control, permitting the output of the system to be modulated from a plurality of separate points.

Another object of my invention is to provide a duplex radio transmitting system particularly adapted for use on shipboard, in which the circuit network utilized for the radio output control may also be utilized for communication between separated points.

30 In the operation of transmitting systems which radiate a considerable amount of power, it is highly desirable that every precaution be taken to minimize power waste, and to reduce the wear and tear on the expensive thermionic devices involved. To this end, certain "carrier wave suppression" systems have been designed, in which the unmodulated carrier wave is never radiated, radiation taking place only upon modulation being supplied.

Although carrier-wave suppressing systems are an improvement over systems which permit the radiation of the carrier at all times, yet they do not, in general, provide for the suppression of the direct current component in the plate circuits of the various tubes during non-signalling intervals. In large installations, even though carrier wave suppression is practised, the tubes are subjected

to constant wear, and consequently their deterioration is rapid.

One phase of the present invention, therefore, is concerned in providing means for stopping the plate current in all tubes of a transmitting system during non-signalling periods. This result I accomplish by normally applying to the grids of all the tubes a negative potential sufficiently high to stop all plate current, changing this negative potential to the proper operating potential by means of a manually controllable relay. The relay may be either under the control of a telegraph key, or may be actuated by a push-button located contiguous to the microphone used for voice modulation, suitable additional switching arrangements being also provided whereby the system may be adapted to telegraphy or telephony at the option of the operator.

Inasmuch as duplex, or break-in operation is highly desirable in point-to-point communication, I have also provided a system of relays whereby a radio receiver is placed in circuit with the transmitting antenna during non-keying, or non-signalling intervals. The relay system is arranged to be controlled by the telegraph key, or the push-button above referred to, depending on whether signalling is being carried on by telegraph or telephone.

I have, in addition, provided a system of circuit connections whereby the radio transmitter and receiver may be distantly controlled from a plurality of points. This feature is of distinct value on ship board, enabling either the radio operator, or a distantly situated ship's officer, to operate the transmitter.

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

The single figure of the drawing is a diagrammatic view of a transmitting system in-

corporating a preferred form of my invention.

Referring to the drawing, I have illustrated my invention as applied to a telephone transmitter constructed according to the present trend of the art. Such a transmitter usually comprises a speech amplifier, a modulator, a master oscillator, and a power amplifier, each stage including a plurality of power tubes connected in parallel. In order to avoid a multiplicity of detail, each group of parallel-connected tubes has been represented in the drawing as a single tube, and each group will be referred to as though it comprises but a single tube as shown.

A speech amplifier tube 1, having a filament 2, a grid 3 and a plate 4, is provided with an input circuit comprising the secondary of an audio frequency transformer 6, and an output, or plate circuit, comprising the primary 7 of an audio frequency transformer 8.

A modulator tube 11, having a filament 12, a grid 13 and a plate 14, has an input circuit comprising the secondary 15 of the audio frequency transformer 8, and an output circuit including a modulation choke-coil 16. One end of the modulation choke-coil is connected to the output circuit of the speech amplifier and to a contact element 17, while the end of the choke nearest the modulator plate is connected to a contact element 18.

The grid circuits of the speech amplifier and modulator tubes are connected in parallel through a biasing battery 19 to a contact element 21.

One filament terminal of the speech amplifier tube and one filament terminal of the modulator tube are connected to a conductor 22 which is connected to the secondary winding 23 of a filament heating transformer 24, the primary winding 25 of which is supplied with alternating current from a source 26. The other filament terminals of the speech amplifier tube and the modulator tube are connected to a conductor 27 which leads to a contact element 28, with which element co-operates a switch member 29 connected to the other terminal of the secondary winding 23 through a conductor 31.

A master oscillator tube 35, comprising a filament 36, a grid 37 and a plate 39, has a frequency determining circuit comprising an inductor 41 shunted by a tuning condenser 42, this circuit being connected to the grid 37 through a conductor 43 and to the plate 39 through a condenser 44. A resistor 40 is connected across the filament power supply leads 22 and 31, and a connection 38 is made between a mid-point thereof and a mid-point on the inductor 41. Filament power for the oscillator tube is supplied from the filament transformer 24, while plate potential is supplied through a conductor 45 terminating in a movable switch member 46

and a fixed contact member 47. The grid 37 is connected through a resistor 50 to a conductor 52, one end of which terminates in a movable switch member 51, and the other end of which is connected to the armature 53 of a relay 54 and to the negative end 55 of a resistor 56 connected across a generator 57 arranged to supply high potential for the plates of the various tubes.

The positive pole of the generator 57, and the shunting resistor 56 are connected to a movable switch member 58 by means of a conductor 59. A condenser 61 is connected across the terminals of the generator 57, this condenser being of relatively large size, preferably about five microfarads.

A power amplifier tube 70, having a filament 71, a grid 72 and a plate 73 has its grid coupled to the output circuit of the master oscillator through a coupling condenser 74. The grid circuit of the power amplifier tube includes a resistor 75 which is connected to the relay armature 53. The purpose of the connections between the grids of the various tubes and the relay armature will be later explained in detail.

The filament of the power amplifier is connected across the secondary winding 23 of the filament transformer 24, while the plate is connected through a coupling inductor 76 to the conductor 45. It will be noted that the power amplifier and master oscillator tubes are connected in parallel, insofar as the plate potential is concerned, and that the output of both will therefore be modulated when the system is used for telephony. This rather unusual method of connection seems to permit of more complete modulation than is possible with the systems of the customary type.

The coupling inductor 76 is placed in inductive relationship with an inductor 77 included in an antenna system 78. The armature 79 of a relay 81 is included in the antenna system 78, and associated therewith is a lower contact element 82 connected to ground through a conductor 83, and an upper contact element 84 connected to ground by way of a radio receiving device 85.

The relays 54 and 81 are connected in series with a telegraph keying device 90, which may be of any desired type, automatic, or manual, and operating current for these relays is provided from a battery 91.

The contact element 92 associated with the armature 53 of the relay 54 is connected to a point 93 near the negative end of the resistor, and is also connected to the mid-point of the resistor 40 by a conductor 94. In order that the potential of the mid-point of the resistor 40 may be fixed, it is provided with a ground connection 95. A large condenser 100, preferably of about one microfarad capacity, is connected across the armature 53 and the contact element 92. This

condenser prevents sparking at the opening and closing of the contacts.

The keying device 90 is shunted by a circuit comprising a conductor 96 terminating in a movable switch arm 97, and a second conductor 98 terminating in two contact members 99 and 101 associated with the movable members 102 and 103 of an interphone switching device 104.

The movable switch arm 97 is associated with a contact element 105 which is connected through a conductor 106 to the contact element 107 of a relay 108, the movable armature 109 of which is connected by a conductor 111 to the movable members 102 and 103 of the interphone switching device 104. This switching device also comprises two additional movable members, 112 and 113, these members being connected by a conductor 114 to an audio-frequency choke-coil 120 in the output circuit of the radio receiving device 85, and by a conductor 116 to one terminal of the primary winding 115 of the speech amplifier input transformer 6. The other terminal of the winding 115 is connected by a conductor 118 through the actuating winding of the relay 108 and a source of potential 119, to a conductor 121 connected between telephone substations 122 and 123. The actuating winding of relay 108 is also connected by a conductor 125 to a conductor 126 extending between the stations 122 and 123. At station 122 the conductor 126 terminates in a contact element 127 associated with a circuit closing device 128 and a second contact element 129. The contact element 129 is connected through a telephone head-set 131 and a conductor 132 to a contact element 133 associated with the movable member 112 of the switching device 104.

At station 123 the conductor 126 terminates in a contact element 134 associated with a circuit closing device 135 which cooperates with a contact element 136, from which element a circuit may be traced through a telephone head-set 137, and a conductor 138, to a contact element 139 associated with the movable member 113 of the switching device 104.

An actuating device 141 is arranged to permit simultaneous control of the movable members 102, 103, 112 and 113, of the interphone switch 104.

In addition to the telephone head set, telephone station 122 comprises a microphone 142, a calling buzzer or bell 143, and a circuit closing device comprising a movable element 144 having contact elements 145 and 146 associated therewith. A hook-switch 147 is also provided, with which cooperates a contact element 148 connected to the buzzer 143.

The telephone station 123 comprises in addition to the telephone headset 137, a microphone 152, a calling buzzer or bell 153, and

a circuit closing device comprising a movable element 154 having fixed contact elements 155 and 156 associated therewith. There is also at station 123 a hook-switch 157 cooperating with a contact element 158 connected to the buzzer 153.

The hook-switch 147 at station 122 is connected to one terminal of the head-set 131, to the contact element 129, and to a conductor 159 which extends to the hook-switch 157 located at station 123. At station 123 the hook-switch 157 is connected to one terminal of the telephone head set 137 and to the contact element 136.

A condenser 161, preferably of approximately five microfarads capacity, is connected between conductors 126 and 159, while a similar condenser 162 is shunted around the relay 108 and the battery 119.

The output circuit of the radio receiving device 85 is connected through a stopping condenser 163 and a conductor 164 to the contact element 136, which element is in turn connected to the headset 137 and, through the conductor 159, to the headset 131.

In order that the operation of my invention may be made clear, it is first assumed that unmodulated telegraphic signals are to be transmitted. In such event, there is no necessity for energizing the speech amplifier and the modulator, and the switch-arms 29, 51, 46, 58 and 97 are removed from the contact elements 28, 21, 18, 17 and 105, thus opening the circuits through which the speech amplifier and modulator are supplied with filament power, plate potential and grid bias. A further movement of the switch arm 58 causes it to make contact with the contact-element 47, thus connecting the positive pole of the generator 57 to the bus 45, supplying plate potential to the master oscillator and power amplifier. The five switch arms referred to may obviously be interconnected for simultaneous actuation, and this manner of connection is preferably employed in an actual embodiment of my invention.

The filaments of the master oscillator and of the power amplifier tubes may now be energized from the source 26 and, by reason of the connections from the frequency determining circuit 41, 42 to the plate and grid of the oscillator tube, oscillations will be generated provided the grid bias potential of the oscillator tube is of the proper value. The generated oscillations will be amplified in the power amplifier, and may be radiated as a radio-frequency wave from the antenna.

It is believed obvious that signalling may be accomplished by interposing a telegraph key in the plate circuit of either the master oscillator tube or the power amplifier tube, or in the antenna-ground system. In these positions, however, the key would necessarily be forced to handle a large amount of power, and would be subjected to destructive spark-

ing. I prefer, therefore, to interrupt the generated train of oscillations by periodically making the grid potential of the master oscillator so negative that oscillations cannot be generated, and by also simultaneously making the grid of the power amplifier so negative that oscillations, even though generated, cannot be amplified therein. The manner in which I accomplish the alteration of the grid potentials at signal frequency will now be explained.

Assume that the interphone switching device 104 is in the position shown in the drawing, in which position the contact elements 99 and 101 are disassociated from the cooperating movable members 102 and 103, and the circuit shunting the telegraph key 90 is open. As long as the key 90 is open, the grids 37 and 72 are negatively biased by the drop in potential from the point 93 on the resistor 56 to the negative terminal of the source 57, the point 93 being grounded and being connected to the resistor shunting the filament leads 22 and 31. The total value of the resistor 56, in an actual installation, is 40,000 ohms, the value between the points 93 and 55 is 10,000 ohms, and the applied potential approximately 1,200 volts, which places the point 55 approximately 300 volts negative with respect to the filaments. Such bias is amply sufficient to block both the oscillator and power amplifier tubes.

Upon closing the key 90, relays 54 and 81 are energized, armature 53 and contact 92 cooperating to short circuit that portion of the resistor 56 which lies between the points 93 and 55. The negative bias is consequently removed from the grids 37 and 72, thus permitting the generation and radiation of oscillations whenever the key is depressed.

Upon energizing the relay 81, armature 79 makes contact with element 82, thus completing the circuit to ground for the radiating structure. In its up, or normal, position, armature 79 makes contact with element 84, completing the antenna circuit to ground through the radio receiver 85.

It is thus apparent that the system does not generate or radiate oscillations during spacing intervals and, that also during such spacing intervals the radio receiving set is in operative condition.

The circuit for the received signals may be traced through condenser 163 over conductor 164 through the head set 137, conductor 138, contact 139, movable member 113 and conductor 114. Another receiving circuit may be traced through condenser 163, conductor 164, conductor 159, head set 131, conductor 132, contact 133, movable element 112 and conductor 114 back to the receiving set output choke. The head set 137 is assumed to be that used by the radio operator while the other head set 131 may be located

at any convenient situation such as the chart-room or the bridge.

The operation of my system, when using voice modulation will now be explained.

The switch arm 29, 51, 46, 58 and 97 are so moved as to make contact with elements 28, 21, 18, 17 and 105. Filament potential for the speech amplifier and modulator tubes is accordingly applied thereto through conductors 22 and 27. At the same time, by reason of the contact of arm 58 with element 17, positive potential is applied to plates 4 and 14 from the generator 57. The plate 14 is connected through contact 18, switch arm 46 and conductor 45 to the plates of the master oscillator and the power amplifier, the modulation choke coil 16 being interposed in its usual and well-known position.

The grids 3 and 13 of the speech amplifier and modulator respectively are connected through a biasing battery 19, contact 21, and switch arm 51 to the grid bias bus 52, the further connections of which have been previously explained.

Assuming that the radio operator desires to control the modulation of the transmitted oscillations by means of microphone 152, the arm 141 of the interphone switch 104 is thrown to the right which causes contacts 112 and 133 to open, contacts 99 and 102 to close, while contacts 113 and 139 remain closed. Before speaking into the microphone 152, the button 154 is pressed, completing the circuit between contacts 155 and 156. A circuit may be now traced from the positive pole of battery 119 through conductor 120, conductor 121, contacts 155 and 156, microphone 152, contacts 139 and 113, conductor 116, primary winding 115, relay 108, back to the negative pole of battery 119. The relay 108 thus being energized causes armature 109 to make contact with element 107, placing a shunting circuit around the telegraph key 90. This circuit may be traced as follows: battery 91, relay 54, switch arm 97, contact 105, conductor 106, contact 107, armature 109, conductor 111, contacts 102 and 99, conductor 98, relay 81 and back to the negative pole of the battery.

As previously explained, the energizing of relay 54 removes the blocking bias from the master oscillator and the power amplifier tubes. In view of the fact that the grids of the speech-amplifier and modulator tubes are also connected to the same conductor 52 through which bias potential is applied to grids 37 and 72, both the speech amplifier and the modulator will be blocked at the same time that the oscillator and amplifier are blocked. When this blocking bias is removed by the action of relay 54, the speech amplifier and modulator still have sufficient bias from the battery 19 to maintain them at the best operative point.

It is thus apparent that the operator, by

completing the circuit across contacts 155 and 156, has supplied the microphone with talking current and has, at the same time, by the action of relay 54, removed the blocking bias from the entire system.

If, therefore, the microphone 152 is energized by speech while the button 154 is depressed, the speech currents will be amplified and the radiated wave will be modulated thereby. Upon pressure being removed from the button 154, blocking bias is again restored to all the tubes by reason of the release of relay 108 and the consequent de-energization of relay 54. The operator, therefore maintains the button 154 depressed as long as he desires to transmit and upon release of the pressure the oscillations cease and the transmitting antenna is connected by the action of the relay 81 to the receiving set.

If it is desired that the microphone at station 122 be used for modulating the output of the transmitter, the operating arm 141 of the interphone switching device 104 is thrown to the left, thus opening contacts 139 and 113 and closing contacts 103 and 101. By applying pressure to the button 144 the circuit between contact element 145 and 146 is closed and a circuit may be traced from the positive pole of the battery 119 through contacts 146, 145, microphone 142, conductor 132, contact elements 112 and 133, conductor 116, primary winding 115, conductor 118, relay 108 and the negative pole of the battery 119. The relay 108 is, accordingly, energized and the cycle of operations previously described may be repeated.

If it is desired to communicate between stations 122 and 123 without modulating the transmitting system, the arm 141 of the interphone switch 104 is set in its central position as shown in the drawing. When the switch is in this position it will be noted that inasmuch as contacts 99 and 102 and contacts 101 and 103 are disassociated, the shunting circuit comprising armature 109 and contact 107 cannot be completed, with the result that even though relay 108 be energized the blocking potential will not be removed from the tubes. If the radio operator at station 123 desired to communicate with station 122 he removes the head set 137 from the switch hook 157 and presses the button 135. Ringing current is then supplied from the positive pole of battery 119 through conductor 120 to the buzzer 143, through contact 148, switch hook 147, conductor 159, contact 136, contact 134, conductor 126, conductor 125 and back to the negative pole of the battery 119 to energize the buzzer 143. The party at station 122 then removes the head set 131 from the switch hook 147 and presses the talking button 144 in order to energize the microphone 142. The direct current supply for the microphone 142 may be traced over a circuit as follows; from the positive pole of

the battery 119 through conductor 120, contacts 146 and 145, microphone 142, contact element 133, movable arm 112, conductor 116, primary winding 115, relay 108 and back to the negative pole of battery 119.

In order that the microphone at station 123 may be supplied with direct current it is necessary that the talking button 154 be held depressed, closing the circuit between contact elements 155 and 156. The direct current supply for the microphone 152 then comprises a circuit as follows: positive pole of the battery 119, conductor 121, contact elements 155 and 156, microphone 152, conductor 138, contact element 139, movable arm 113, conductor 116, primary winding 115, conductor 118, relay 108 and back to the negative pole of battery 119.

Insofar as the voice, or alternating, component of the microphone current is concerned, the headsets 131 and 137 are effectively in parallel with both microphones. A common terminal of the headset 137 and the microphone 152 is connected to the corresponding common terminal of the headset 131 and the microphone 142 through a circuit which may be traced over conductor 138, contact elements 139, 113, 112, 133 and conductor 132. The remaining terminals of the headsets are connected directly together by the conductor 159, and an audio frequency path from this conductor may be traced to the lower terminal of each microphone through the condenser 161, battery 119, conductor 121 and the contacts of either talking button 144 or 154.

Irrespective of which microphone is energized by the closing of the circuit through the corresponding talking button, both headsets will be energized by the alternating component of the voice currents, but this double energization is not disadvantageous.

It is thus apparent that a transmitting system constructed according to my invention is extremely versatile. It is easily adapted to either speech modulation or to telegraphy, the change from one to the other being accomplished by merely throwing a single switch. It is also apparent that a transmitting system, according to my invention, is economical in operation, inasmuch as all the thermionic devices involved consume energy only during actual signalling periods and not during spacing periods, or periods when voice modulation is not impressed upon the system. It is also apparent that by reason of the circuit connections illustrated and described I have provided a system whereby a radio transmitter may be satisfactorily controlled from a plurality of distant points.

My system has a further advantage in that it permits communication between the separate radio controlling stations over the same conductors that are utilized to control the radio transmitter, while preventing the cur-

rents used in such station-to-station communication from influencing the output of the radio transmitter, even though the transmitter may be energized.

5 I am aware that break-in systems analogous to the system herein described have been previously proposed. It is my belief, however, that no previous break-in system de-energizes the transmitter completely at such
10 times as the antenna is connected to the radio receiving device. The combination of break-in relays and complete de-energization is one that I believe to be distinctly new and original with me.

15 Although I have illustrated and described a specific embodiment of my invention, many modifications thereof will be suggested to those skilled in the art. My invention is not to be limited, therefore, except insofar as is
20 necessitated by the prior art and by the spirit of the appended claims.

I claim as my invention:

1. In a radio transmitting system, thermionic means for generating radio frequency
25 oscillations, modulating means therefor comprising a microphone and a plurality of thermionic devices, a source of energizing current for said microphone, and means whereby all of said thermionic devices are placed in an
30 inoperative state upon deenergization of said microphone.

2. In a radio transmitting system, a plurality of thermionic devices adapted to generate and transmit radio frequency energy,
35 modulating means therefor comprising a plurality of thermionic devices, a radiating structure, a radio receiver, an antenna, a microphone arranged to control said modulating means, a source of energizing current for said
40 microphone and means whereby the energizing of said microphone controls instrumentalities for placing all of said thermionic devices in an operative state, for permitting the energization of said antenna, and for disconnecting said receiver from said antenna.

3. In a radio transmitting system, a plurality of thermionic devices adapted to generate and transmit signal-modified radio-frequency energy, means comprising a microphone
50 and a source of current therefor for modifying said energy, means for normally biasing said thermionic devices to an inoperative state, and means whereby the connection of said microphone to said current source causes
55 the removal of said bias.

4. In combination, a thermionic device so arranged as to be capable of generating oscillations, means for normally biasing said
60 device to the inoperative state, means comprising a microphone for modulating said oscillations, a current source for said microphone, and means whereby the energization of said microphone from said current source causes the removal of the bias from the thermionic device.

5. In a signalling system, an antenna, a radio receiving means associated therewith, a plurality of thermionic devices for generating and transmitting currents of high frequency to said antenna, means for controlling the grid biasing potentials on said thermionic devices, independent means for selectively dissociating said receiving means from said antenna and keying means for simultaneously controlling the operation of said grid-bias-control means and said dissociating means whereby said radio receiving means is dissociated from said antenna during signalling intervals and associated with said antenna during non-signalling intervals, said keying means and associated system constituting a means for transmitting code signals.

In testimony whereof, I have hereunto subscribed my name this 26th day of January, 1927.

ROBERT L. DAVIS.