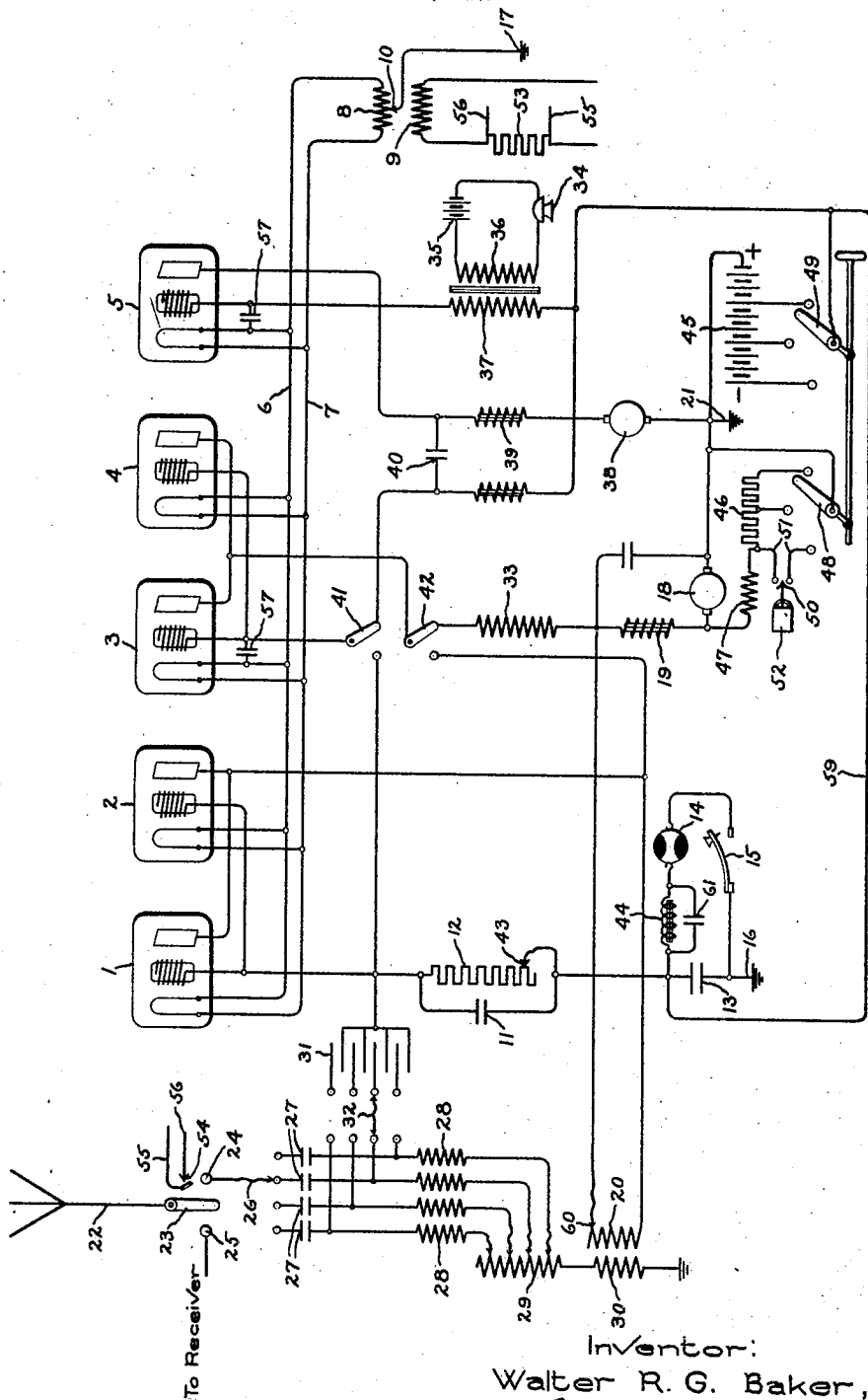


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W. R. G. BAKER.
HIGH FREQUENCY SIGNALING SYSTEM.
FILED SEPT. 17, 1921.



Inventor:
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UNITED STATES PATENT OFFICE.

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HIGH-FREQUENCY SIGNALING SYSTEM.

Application filed September 17, 1921. Serial No. 501,334.

To all whom it may concern:

Be it known that I, WALTER R. G. BAKER, a citizen of the United States, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in High-Frequency Signaling Systems, of which the following is a specification.

My present invention relates to high frequency signaling systems and more particularly to apparatus of the vacuum tube type for producing and modulating high frequency oscillations for use in a signaling system.

One of the objects of my invention is to provide a system which will be capable of generating high frequency oscillations and supply them to a transmitting circuit. These may be in the form of speech modulated high frequency waves such as are used for radio telephony, interrupted continuous waves for radio telegraphy or continuous waves for radio telegraphy. Still another object of my invention is to provide a system in which vacuum tubes are employed for modulating the high frequency waves produced by other vacuum tubes and in which, when the transmitting equipment is employed for radio telegraphy, modulator tubes may be utilized for producing high frequency oscillations.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims, my 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 in which I have shown diagrammatically a circuit arrangement whereby my invention may be carried into effect.

As indicated in the drawing the transmitting equipment comprises a series of vacuum tubes 1, 2, 3, 4, 5 of the three-electrode or pliotron type. In the description of the various tubes, 1 and 2 are designated as oscillators, tubes 3 and 4 as modulators, and tube 5 as an amplifier. The filaments in all of these tubes are connected to common bus bars 6 and 7 which are supplied with current for lighting the filaments from the secondary 8 of an alternating current transformer 9, the middle point 10 of the sec-

ondary 8 being grounded. The grid electrodes of the oscillator tubes 1 and 2 are connected in parallel and the plate electrodes of these tubes are likewise connected in parallel. The input circuit of the oscillator tubes 1 and 2 comprises a series condenser 11 shunted by the leak resistance 12 and a second series condenser 13 which is shunted by a rotatable make and break device 14 in series with a key 15. The input circuit is completed to the filament by means of the ground connection at 16 and ground connection 17 to the middle point of the transformer secondary 8. The output circuits of the oscillators 1 and 2 are supplied with energy from a direct current source 18 through an audio frequency reactance 19 and an inductance 20, the negative terminal of the direct current source 18 being grounded at 21. The transmitting circuit to which high frequency oscillations are to be supplied in the case illustrated includes an antenna 22 which may be connected by means of the switch 23 either to the transmitting equipment by making contact at 24, or to suitable receiving equipment by contact 25. In order to provide for the generation of and supply to the antenna of different wave lengths the connection between antenna and earth may be made through the variable connector 26 to a series of condensers 27, loading inductances 28, the variable loading inductance 29 and inductance 30, which is coupled to the plate inductance 20. The necessary coupling between the output circuits of the tubes 1 and 2 and their input circuits to permit these tubes to act as generators of high frequency oscillations is obtained by means of the capacity 31. The amount of coupling capacity which is most suitable for the different wave lengths to be generated may be obtained by means of the variable connector 32.

In case the system is to be employed for radio telephony the output circuits of the modulators 3 and 4 are supplied with energy from the source 18 through the iron core impedance 19 and the radio frequency choke 33. The sound waves which are to be transmitted for reproduction at the receiving station are impressed upon the telephone transmitter 34 which is in a local circuit with the battery 35 and primary 36 of a telephone transformer. The

secondary 37 of the telephone transformer is included in the input circuit of the amplifier 5. The output circuit of the amplifier 5 is supplied with current from a direct current source 38 through an impedance 39. The potential variations produced in the output circuit of the amplifier 5 across the impedance 39 by the potential variations of the amplifier grid are impressed through a coupling condenser 40 upon the input circuits of the modulators 3 and 4. The variations of the grid potential of the modulators produce corresponding variations in the output circuit and in the potential variations across the impedance 19. As a result the potential applied to the anodes of the oscillator tubes 1 and 2 varies in accordance with the variations in the current in the output circuit of the modulator tubes 3 and 4 and the amplitude of the high frequency oscillations generated varies in direct accordance with the variations in the current supplied by the microphone 34. When the transmitting equipment is used for radio telephony the condenser 13 is short circuited by a closure of the key 15 and by contact made through the rotatable make and break device 14 or in any other desired manner.

When it is desired to employ the apparatus for radio telegraphy the grids and anodes of the modulators 3 and 4 may be connected by means of switches 41 and 42, respectively in parallel with the grids and anodes of oscillators 1 and 2. The number of oscillating tubes being thus doubled the output of the equipment will also be substantially doubled. If desired, the amplifier 5 may also by suitable connection be employed in parallel with the other tubes as an oscillator. In order that the apparatus may be operated most efficiently for the production of high frequency oscillations it is desirable that the average potential of the grids should be negative. The grid condenser 11 with the grid leak resistance 12 furnishes the necessary adjustment for this purpose and when the modulator tubes are switched over in parallel with the oscillator tubes the value of this resistance may be adjusted by means of the variable connection 43 to give the desired negative potential for the operation of the four tubes in parallel.

When it is desired to transmit interrupted continuous waves the device 14 is rotated. When the shunt circuit around condenser 13 is broken by means of this device the grids of the tubes immediately assume such a high negative charge that the production of high frequency oscillations is stopped. When this shunt circuit is made the negative charge on the grids is permitted to leak off through the leak resistance 12 and the connection around condenser 13 and the production of oscillations immediately starts. If the device 14 is rotated at such a speed as

to produce interruptions at an audible frequency, then when the key 15 is closed high frequency oscillations will be supplied to the antenna in groups succeeding each other at an audible frequency. When it is desired to transmit continuous waves the make and break device 14 is short circuited or stopped at such a point that contact is made there-through and the generation of high frequency waves is interrupted only when the key 15 is opened. A choke coil 44 should be inserted in series with the make and break device 14 and the key 15 to prevent high frequency current from flowing in this shunt circuit. In case the radio choke coil 44 in series with the interrupter is insufficient to prevent radio currents from taking this path, a trap circuit may be formed by shunting this choke with a condenser 61. This trap circuit is tuned to the transmitting wave length.

In the operation of the vacuum tubes 3, 4 and 5, it will usually be desirable to maintain the grids normally at a negative potential with respect to the filaments, and for this purpose a biasing battery 45 may be employed. This same battery may also, if desired, be employed for furnishing a biasing potential for the grids of the oscillators by means of the connection 59. In order that the equipment may be operated to supply different amounts of power, the resistance 46 may be inserted in series with the field 47 of the generator 18 by means of a switch 48. The amount of this resistance in the field of the generator may be varied as desired; and the amount of power supplied from the generator to the oscillating system thereby varied at will. Whenever the voltage supplied to the output circuits of the tubes is varied it is also usually desirable that the potential of the grids of the tubes should be varied. This may be accomplished by means of the switch 49, which may be operated simultaneously with the switch 48.

It is frequently desirable that the transmitting set should be so arranged that it cannot be operated by inexperienced persons, or without permission of their superior officers. One convenient way of preventing such operation at the full power output of the equipment is indicated in the drawing in connection with the means for supplying power to the set. A switch 50 is inserted in the lead 51 by means of which all of the resistance 46 is cut out and this switch is held open by means of a lock 52. Until the lock 52 is removed it will therefore be impossible to operate the equipment at its full output.

When the equipment is to be employed for telephone operation it is desirable in order to lengthen the life of the tubes as well as for other reasons, that the generation of the oscillations should not take place dur-

ing the reception period. This may be accomplished by interrupting the supply of current to the plate circuits. If, however, the current supplied to the filaments is completely interrupted during the reception period a short time interval will elapse between the time when the current is supplied to the filaments and plate circuits and the time when oscillations start. To prevent this delay, or at least reduce it to a minimum, means may be provided whereby the current supplied to the filaments of the vacuum tubes will be reduced to such a value during the reception period that the life of the tubes will be greatly increased over their life in case the filament current should be kept at its normal value during reception. If the filament current is restored to its normal value as soon as it is desired to transmit, oscillations will start sooner than they would if the filament current and the consequent heating of the filament had to be built up from a low value or temperature. I have indicated in the drawing one way in which this result may be accomplished. In series with the primary of transformer 9 there is inserted a resistance 53. An auxiliary contact 54 is provided which closes a circuit through conductors 55 and 56 when the switch 23 is operated to connect the antenna to the transmitting position. The conductors 55 and 56 form a short circuit around the resistance 53 so that this resistance is automatically short circuited when the transmitting equipment is connected to the antenna. When the switch 23 is thrown over to the receiving position contact 54 is broken and resistance 53 is effective in reducing the amount of current supplied to the filaments.

When the tubes 3 and 4 are being operated as modulators and the tube 5 as amplifier, high frequency potentials are sometimes induced upon the grids of these tubes of such a value as to seriously interfere with their normal operation. This difficulty may be overcome by use of condensers 57 which short circuit the high frequency currents which may be impressed upon the input circuits of these tubes and are connected in the circuit only when the tubes are employed as modulators and amplifiers.

The apparatus should preferably be so arranged and switching means provided whereby all of the adjustments of the system for changing the wave length transmitted may be made simultaneously by the operation of one switch handle. These adjustments in the system illustrated comprise the variable connections 26 and 32 and also preferably the variable connection 60 to the plate inductance 20.

As an alternative method of operation to transmit interrupted continuous waves with the apparatus illustrated and described, the

telephone transmitter 34 may be replaced by an interrupter such as the interrupter 14 or a buzzer. If, for example, a buzzer is employed in place of the microphone 34 then when the tubes 1 and 2 are employed as oscillators, tubes 3 and 4 will act as modulators and tube 5 as an amplifier. The keying of the system may then be accomplished either by means of the key 15 in shunt to condenser 13, or by inserting a key in the primary circuit of the microphone transformer. The first method of operation mentioned is preferable, but has one disadvantage in that plate current will be taken by tubes 3, 4 and 5 whether the key 15 is up or down. In order to prevent this the positive terminal of the biasing battery 45 instead of being connected directly to ground, as shown, may be connected through the connection 59 to ground through the condenser 13, the negative terminal of the battery 45 being connected to the grids of tubes 3, 4 and 5 by means of the switch 49. These grids will then when the key 15 is open, receive a negative potential sufficient to cut off the plate current.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. The combination in a high frequency transmitting apparatus of a plurality of vacuum tubes adapted to act as oscillation generators and modulators when the apparatus is used for high frequency telephone transmission and means whereby the modulator tubes may also be employed to serve as oscillation generators when the apparatus is employed for telegraph transmission.

2. The combination in a high frequency transmitting apparatus of a plurality of vacuum tubes having input and output circuits, the input circuit of at least one of said tubes being coupled by capacity to the output circuit whereby the tube will act as a high frequency oscillation generator, means whereby one of said tubes will act as a modulator of the high frequency oscillations generated and means whereby the modulator tube circuits may also be connected in parallel with the oscillator tube circuits and thereby assist in the generation of high frequency oscillations.

3. The combination in a high frequency transmitting system of a transmitting circuit, a plurality of vacuum tubes adapted to act as oscillation generators and modulators for generating and modulating high frequency oscillations and supplying them to the transmitting circuit and means whereby the modulator tubes may be connected in parallel with the oscillator tubes to assist in the generation of high frequency oscillations.

4. The combination in a high frequency transmitting system of a transmitting circuit, a plurality of vacuum tubes having in-

put and output circuits, the output circuit of at least one of said tubes being coupled to the transmitting circuit and the input circuit of said tube being coupled by capacity to the transmitting circuit whereby the tube will act as a generator of high frequency oscillations which will be supplied to the transmitting circuit, means whereby another of said tubes will act as a modulator of the high frequency oscillations supplied to the transmitting circuit, and means whereby the modulator tube circuits may also be connected in parallel with the oscillator tube circuits and thereby assist in the generation of high frequency oscillations.

5. The combination in a high frequency transmitting system of a transmitting circuit, means for varying the tuning of said transmitting circuit, a plurality of vacuum tubes having input and output circuits, the output circuit of at least one of said tubes being coupled to the transmitting circuit and the input circuit of said tube being coupled by capacity to the transmitting circuit whereby the tube will act as a generator of high frequency oscillations which will be supplied to the transmitting circuit, means for varying the amount of capacity coupling, means whereby another of said tubes will act as a modulator of the high frequency oscillations supplied to the transmitting circuit and means whereby the modulator tube circuits may also be connected in parallel with the oscillator tube circuits and thereby assist in the generation of high frequency oscillations.

6. The combination in a high frequency transmitting system of a transmitting circuit, a plurality of vacuum tubes adapted to act as oscillation generators and modulators for generating and modulating high frequency oscillations and supplying them to the transmitting circuit, means whereby the modulator tubes may be connected in parallel with the oscillator tubes to assist in the generation of high frequency oscillations, and means for interrupting in a regular and predetermined manner the generation of oscillations when all of the tubes are employed as oscillators.

7. The combination in a high frequency transmitting system of a transmitting circuit, a plurality of vacuum tubes having input and output circuits, the output circuit of at least one of said tubes being coupled to the transmitting circuit and the input circuit of said tube being coupled by capacity to the transmitting circuit whereby the tube will act as a generator of high frequency oscillations which will be supplied to the transmitting circuit, means whereby another of said tubes will act as a modulator of the high frequency oscillations supplied to the transmitting circuit, means whereby the modulator tube circuits may also be con-

nected in parallel with the oscillator tube circuits and thereby assist in the generation of high frequency oscillations, and means for interrupting in a regular and predetermined manner the generation of oscillations when all of the tubes are employed as oscillators.

8. The combination in a high frequency transmitting system of a transmitting circuit, means for varying the tuning of said transmitting circuit, a plurality of vacuum tubes having input and output circuits, the output circuit of at least one of said tubes being coupled to the transmitting circuit and the input circuit of said tube being coupled by capacity to the transmitting circuit whereby the tube will act as a generator of high frequency oscillations which will be supplied to the transmitting circuit, means for varying the amount of capacity coupling, means whereby another of said tubes will act as a modulator of the high frequency oscillations supplied to the transmitting circuit, means whereby the modulator tube circuits may also be connected in parallel with the oscillator tube circuits and thereby assist in the generation of high frequency oscillations, and means for interrupting in a regular and predetermined manner the generation of oscillations when all of the tubes are employed as oscillators.

9. The combination in a high frequency transmitting apparatus of a plurality of vacuum tubes having input and output circuits, the input circuit of at least one of said tubes being coupled by capacity to the output circuit whereby the tube will act as a high frequency oscillation generator, means whereby one of said tubes will act as a modulator of the high frequency oscillations generated, means whereby the modulator tube circuits may also be connected in parallel with the oscillator tube circuits and thereby assist in the generation of high frequency oscillations and means for maintaining normally a negative potential upon the input electrode of the oscillator tube, said means being adapted to be adjusted to maintain substantially the same negative potential upon the input electrodes of all of the tubes when the modulator tube is employed to generate oscillations.

10. The combination in a high frequency transmitting system of a transmitting circuit, a plurality of vacuum tubes having input and output circuits, the output circuit of at least one of said tubes being coupled to the transmitting circuit and the input circuit of said tube being coupled by capacity to the transmitting circuit whereby the tube will act as a generator of high frequency oscillations which will be supplied to the transmitting circuit, means whereby another of said tubes will act as a modulator of the high frequency oscillations supplied to the

transmitting circuit, means whereby the modulator tube circuits may also be connected in parallel with the oscillator tube circuits and thereby assist in the generation of high frequency oscillations, and means for maintaining normally a negative potential upon the input electrode of the oscillator tube said means being adapted to be adjusted to maintain substantially the same negative potential upon the input electrodes of all of the tubes when the modulator tube is employed to generate oscillations.

11. The combination in a high frequency transmitting apparatus of a plurality of vacuum tubes having input and output circuits the input circuit of at least one tube being coupled to the output circuit so that the tube will act as a high frequency oscillation generator, means whereby at least one of said tubes will act as a modulator of the high frequency oscillations generated, means whereby the input circuit of the modulator tube may be connected in parallel with the input circuit of the oscillator tube, and means common to the input circuits of all of the tubes for interrupting in a regular and predetermined manner the generation of oscillations.

12. The combination in a high frequency transmitting apparatus of a plurality of vacuum tubes having input and output circuits, the input circuit of at least one tube being coupled to the output circuit so that the tube will act as a high frequency oscillation generator, means whereby at least one of said tubes will act as a modulator of the high frequency oscillations generated, means whereby the input circuit of the modulator tube may be connected in parallel with the input circuit of the oscillator tube and a rotatable make and break device connected in common to the input circuits of all of the tubes for interrupting in a regular and predetermined manner the generation of oscillations.

13. The combination in a high frequency transmitting apparatus of a plurality of vacuum tubes having input and output circuits, the input circuit of at least one tube being coupled to the output circuit so that the tube will act as a high frequency oscillation generator, means whereby at least one of said tubes will act as a modulator of the high frequency oscillations generated, means whereby the input circuit of the modulator tube may be connected in parallel with the input circuit of the oscillator tube, a rotatable make and break device connected in common to the input circuits of all of the tubes, said make and break device being arranged in such a way that when the connection is broken thereby a sufficiently high negative potential will automatically be impressed upon the input electrodes to interrupt the generation of oscillations.

14. The combination in a high frequency transmitting apparatus of a plurality of vacuum tubes having input and output circuits the input circuit of at least one tube being coupled to the output circuit so that the tube will act as a high frequency oscillation generator, means whereby at least one of said tubes will act as a modulator of the high frequency oscillations generated, means whereby the input circuit of the modulator tube may be connected in parallel with the input circuit of the oscillator tube, a common portion of all of the input circuits thus connected including a series condenser shunted by a resistance which may be varied in accordance with variations in the number of tubes whose input circuits are connected in parallel and a second series condenser which is shunted by a rotatable make and break device with a key in series therewith.

15. The combination in a high frequency transmitting system of a transmitting circuit, a plurality of vacuum tubes having input and output circuits, the output circuit of at least one of said tubes being coupled to the transmitting circuit and the input circuit of said tube being coupled by capacity to the transmitting circuit whereby the tube will act as a generator of high frequency oscillations which will be supplied to the transmitting circuit, means whereby another of said tubes will act as a modulator of the high frequency oscillations supplied to the transmitting circuit, means whereby the modulator tube circuits may also be connected in parallel with the oscillator tube circuits and thereby assist in the generation of high frequency oscillations, a common portion of all of the input circuits thus connected including a series condenser shunted by a resistance which may be varied in accordance with variations in the number of tubes whose input circuits are connected in parallel, and a second series condenser which is shunted by a rotatable make and break device with a key in series therewith.

16. The combination in a radio signaling system of an antenna, a vacuum tube transmitting set adapted to supply high frequency oscillations to said antenna, switching means for connecting said antenna to said transmitting set or to a receiving set, and means adapted to be operated simultaneously with said switching means for reducing the amount of current supplied to the filaments of the vacuum tubes of the transmitting set when the antenna is connected to the receiving set.

17. The combination in a radio signaling system of an antenna, a vacuum tube transmitting set adapted to supply high frequency oscillations to said antenna, a source of current for supplying heating current to the filaments of the vacuum tubes of said transmitting set, a resistance in series with said

source, switching means for connecting said antenna to said transmitting set or to a receiving set, and means adapted to be operated simultaneously with said switching means for short circuiting said resistance when the antenna is connected to the transmitting set and removing the short circuit from said resistance when the antenna is connected to the receiving set.

18. The combination in a high frequency signaling system of a vacuum tube generating equipment for supplying high frequency oscillations, a source of energy for said equipment, means for varying the amount of energy supplied by said source to said equipment, and means associated with the means for

varying the energy supply for preventing the unauthorized use of the generating equipment.

19. The combination in a high frequency signaling system, of a vacuum tube generating equipment for supplying high frequency oscillations, a source of energy for said equipment, means for varying the amount of energy supplied by said source to said equipment, and means associated with the means for varying the energy supply for preventing the unauthorized use of the generating equipment with its maximum output.

In witness whereof, I have hereunto set my hand this 16th day of September, 1921.

WALTER R. G. BAKER.