FIP8102 XR 2,187,603 XJ220E SEARCH ROOM

2,187,603

CROSS REFERENCE

RADIO TRANSMITTER

Filed Feb. 5, 1937

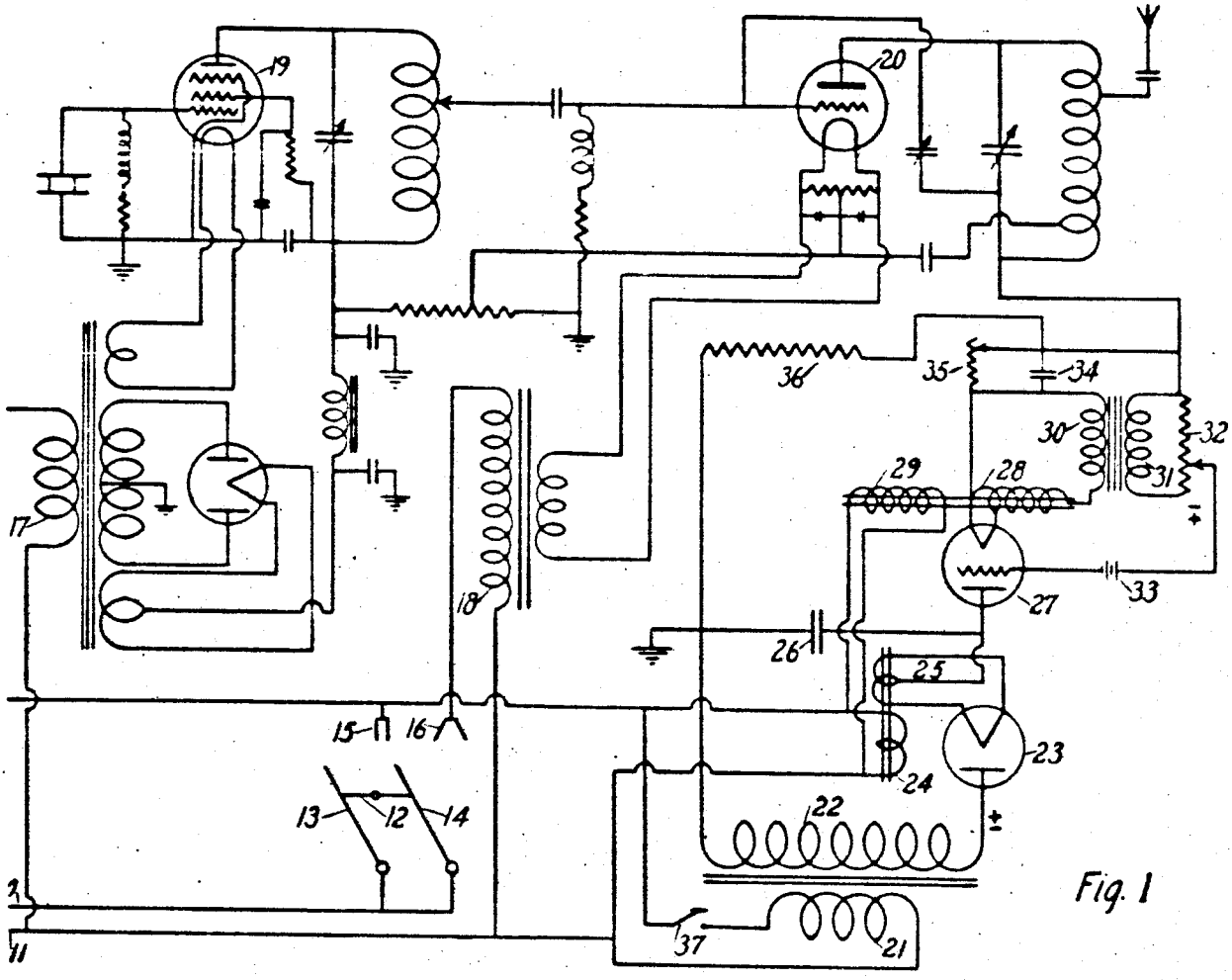
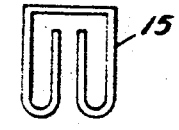


Fig. 1

Fig. 2



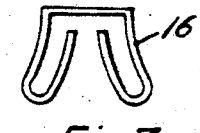


Fig. 3.

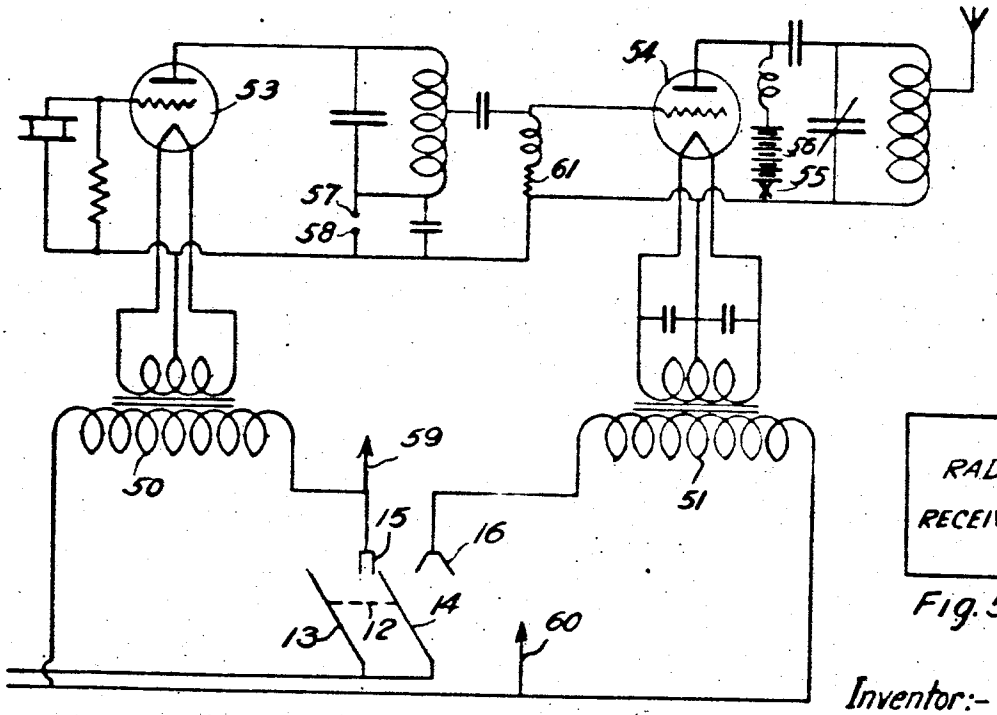


Fig. 4

Fig. 5.

Inventor:-
Nathan Hall

2187603
OR IN 331/75

Patented Jan. 16, 1940

2,187,603

UNITED STATES PATENT OFFICE

2,187,603

RADIO TRANSMITTER

Nathan I. Hall, Elkins, W. Va.

Application February 5, 1937, Serial No. 124,296

24 Claims. (Cl. 250—17)

Although this invention is particularly adapted for high frequency oscillating circuits such as radio transmitters, it in general relates to electrically oscillating circuits and has as its objects the provision of a method for starting radio transmitters, the provision of means whereby said method may be carried out, and the provision of means for producing electrical pulses, the number of which may be varied. Other objects of the invention will appear as this description proceeds.

I have discovered that it is preferable to start a radio transmitter by first energizing the filament of the oscillator tube and after the same has reached its normal operating temperature to energize the filament of the amplifier tube. I have provided a switch which may be partially closed and when thus closed completes a circuit to the oscillator tube. When the switch is fully closed, all tubes are energized. By closing this switch in two steps, pausing in the partially closed position long enough for the oscillator tube to attain maximum filament temperature, abnormal anode currents are eliminated.

I have also provided means for transmitting a series of equally spaced pulses at any of several predetermined rates. This result is accomplished by utilizing a vacuum tube which is energized by a half wave rectified alternating current. The grid of this tube has a condenser connected to its circuit in such a manner that when the condenser is charged to a predetermined potential no current can flow to the transmitter. This condenser is shunted by a variable resistor and accordingly the time interval during which the condenser is charged above said predetermined potential is governed by the value of shunting resistance. After the condenser is charged, the transmitter is inoperative for a predetermined number of cycles until said condenser discharges, at which time current may again flow to the transmitter during the short time interval required to recharge said condenser.

The resistance element which is in parallel with the condenser determines the time interval between successive pulses and therefore determines the audio frequency of the outgoing radio frequency waves. By varying this resistor, the outgoing audio frequency may be varied. It is understood that any mechanical device may control this resistor in which event the frequency of the outgoing pulses will indicate the position or characteristic of said mechanical device. As an example, the resistor may be varied in accordance with the speed of the wind in which event the frequency of the outgoing pulses will vary in a definite relationship with the said speed. The primary use for my invention, however, is with means for determining the velocity of radio waves and for use in connection with ionosphere observations.

In the drawing;

Figure 1 is a diagram illustrative of the preferred form of my invention.

Figure 2 illustrates the details of one female contact of a starting switch which constitutes part of my invention.

Figure 3 illustrates another female contact of the starting switch which is used in my invention.

Figure 4 illustrates another form of my invention and this form utilizes the starting switch of Figures 2 and 3.

Figures 1 to 4 inclusive represent the radio transmitting apparatus constituting my invention and Figure 5 shows a receiving station located nearby the transmitting apparatus and subject to interference therefrom under certain circumstances.

In Figure 1, alternating current having a frequency of say sixty cycles per second is supplied to wires 10 and 11. Tapped into conductor 10 is located the double pole single throw switch 13, 14. Blades 13 and 14 are mechanically interconnected by cross-member 12 and therefore both blades move simultaneously. The female contactors 15 and 16 are of the well known knife switch type (see Figure 3) except that contactor 16 is spread. Due to this fact, it is necessary that in closing the switch the blades 13 and 15 make contact prior to the time at which blades 14 and 16 contact each other. It is furthermore possible to partially close the switch so that blades 13 and 15 will engage each other but blades 14 and 16 will not. This is the procedure that I follow in starting the transmitter. At first, the switch is thus partially closed, and when it is subsequently desired to transmit, the switch is fully closed. In this manner, the oscillator tube is not only energized prior to the amplifier tube, but the expensive amplifier tube is not burning during periods of "listening in." Hence, while "standing-by" the switch remains partially open and not until I desire to actually send out signals do I fully close the switch. This prevents abnormal anode currents from flowing and also preserves the amplifier tube during "listening-in" or "stand-by" periods.

Connected to contactor 15 is the transformer 17, the secondary of which energizes the oscillator tube 18. Furthermore, transformers 21, 24, and

20 are connected to this contact. The energization of transformers 18 is controlled by contactor 16. Transformer 18 energizes the filament of the amplifier tube 20.

The secondary winding 22 is connected in series with the resistor 36 which may be 2000 ohms, and with the mercury vapor rectifier tube 23. This latter tube may be the well known commercial type commonly known as the type '66. Tube 23 has a filament that is energized by the secondary winding 25. The center tap of said winding 25 is connected to the plate of the mercury vapor triode 27 which triode may be the well known commercial type commonly called the FG–17. The filament of this tube is energized by the secondary winding 28 of the transformer 29. The transformer 30 has a primary winding that is energized by the secondary winding 28 and a secondary winding 31 which is shunted by a variable resistor 32. This resistor is in turn shunted across the grid circuit of the tube 27. In addition to the grid potential supplied by resistor 32, electromotive forces are applied to said grid by battery 33 and by condenser 34. Connected between the center tap of the transformer 25 and the end of secondary winding 22 is placed the condenser 26 which preferably has a capacity of 0.05 μfd. Resistor 35 is connected at its left end to the ground and at its right end to the plate of tube 20. The potential drop across this resistor therefore controls the plate input to the final amplifier.

When the key 37 is closed, and the transmitter duly started, the operation of the pulse generating device is as follows: When the right hand terminal of winding 22 is energized positively, current flows through tube 23 and charges condenser 26. On this half of the cycle the lower end of resistor 32 is negative and no current flows through tube 27. Near the peak of the next half cycle the tube 27 becomes conducting and current flows therethrough from condenser 26 (which has retained its charge). If resistor 35 is shorted (no resistance in the circuit) the charge from the condenser 26 will flow directly to the transmitter, generating a signal the duration of which is approximately 0.0001 second. If resistor 35 remains shorted, pulses will be generated at the frequency of the alternating current (in this case sixty times a second). However, if resistor 35 is adjusted to a higher value of resistance, the pulses will be generated at a slower rate inasmuch as the passage of current through this resistor will charge the condenser 34. This condenser will then be in series with the grid circuit of the tube 27 and so long as this condenser remains charged the potential thereof will prevent current from flowing through tube 27. Accordingly, after this condenser is once charged it will block the grid of tube 27 for a predetermined number of cycles during which time the condenser 34 is discharging through resistance 35. If resistor 35 has a relatively low resistance value, the charge on condenser 34 will be rapidly dissipated and only alternate pulses will be "blocked." Consequently, the pulses of the outgoing waves will occur at the rate of 30 times a second. With a higher value of resistance they will occur 15 times per second, etc. It is possible to obtain stable operation at a value of resistance whereby there will be only three pulses per second (when sixty cycle alternating current is used). These pulses energize the radio transmitter and generate a modulated radio frequency wave which is very valuable in ionosphere measurements.

In Figure 4, the master oscillator tube 53 controls the operation of the amplifier tube 54. In actual practice, I employ an intermediate low power buffer amplifier which is energized simultaneously with the oscillator, but such is believed to be immaterial to the invention and accordingly is not shown. The oscillator is energized by a power supply which is of the well known full wave rectifier type, the rectifier being energized by conductors 59 and 60. Wires 57 and 58 represent this power supply. The amplifier tube is also energized from a similar (although higher voltage) plate supply. This plate supply is represented diagrammatically as battery 56. The amplifier plate supply is also energized by conductors 59 and 60. A telegraph key 55 is arranged to control the application of the power amplifier plate voltage. Bias is supplied to the amplifier tube by the resistor 61. The filaments of tubes 53 and 54 are respectively energized by transformers 50 and 51, the primary windings of which are respectively energized by contactors 15 and 16.

The abnormal anode current mentioned in this patent is the current which would flow through the amplifier tube if electron emission starts in that tube with insufficient biasing potential on its control grid. It will be noted that the only potential for biasing the control grid of the amplifier tube 54 is supplied by rectification in the grid of that tube of the output current of the oscillator 53; the rectified current flowing through resistor 61.

The switch 12 is constructed in the same manner as the switch 12 of Figures 1, 2, and 3. This switch is closed by first depressing it part way until blade 13 engages contact 15 but blades 14 and 16 do not touch each other. After an interval of time, the switch is fully depressed to energize all tubes. As a result of tests extending over a period of several years, I believe this method of starting the transmitter increases the life of the amplifier tube. I also found by opening the blades 14 and 16 while "listening in" the transmitter does not interfere with reception of weak or long distance signals on the receiver designated by Figure 5 and I found such interference without this feature.

I claim to have invented:

1. The method of starting a radio transmitter of the master oscillator power amplifier type which includes heating the cathode of the oscillator tube to its normal electron emission temperature and rectifying the output of the oscillator tube and effecting biasing of the amplifier tube principally by such rectified output before the cathode of the amplifier tube is heated to its normal electron emission temperature.

2. In combination, a first electron discharge device, means including a second electron discharge device for controlling said first electron discharge device, each of said electron discharge devices having an anode and a cathode, said first electron discharge device being subject to an abnormal anode current in the absence of the controlling action of said control means, and means for heating the cathodes of said discharge devices, said last-named means including means to heat the cathode of said second discharge device to its normal electron emission temperature before the cathode of said first electron discharge device reaches its electron emission temperature thereby to establish normal operation of said control means before said first electron discharge device attains its normal operating condition.

3. In combination, a radio transmitter and a power supply therefor comprising, in combination, a half wave rectifying device means, a source of alternating current in series with said means, a condenser shunted across the series circuit of said source and said means, an electron discharge device having a grid, a second condenser controlling the charge on said grid, a series circuit including said source, said devices, said second condenser and said transmitter, and a variable resistor shunting said second condenser.

4. In combination, a source of alternating current, a half wave rectifying device in series therewith, a condenser shunted across said source and rectifier, a discharge device having a grid, means for varying the grid potential thereof in accordance with the variations of said alternating current, and a condenser in series with said grid, said second condenser and said devices being in series with said source.

5. In a master-oscillator-power-amplifier transmitter, an amplifier, an oscillator driving the same, and a switch having two current paths therethrough which respectively control circuits in said oscillator and said amplifier, said switch being so constructed and arranged that it may be partially closed to energize the oscillator current path but not said amplifier current path and may be fully closed to close said circuits in both the oscillator and the amplifier.

6. In a radio transmitter, a first radio tube; circuit connections including means whereby said tube acts as a master oscillator; a second radio tube having a filament, a grid, and a plate; circuit connections including means for operating said second tube as an amplifier driven by said oscillator; a pulse generator for modulating said second tube comprising a transformer with primary and secondary windings, a half wave rectifier having an anode and a cathode, the anode being connected to one side of the secondary of said transformer, a condenser connected between the cathode of said rectifier and the remaining side of the secondary of said transformer, means connecting to ground both the remaining side of said secondary and the filament of said second radio tube, and a triode having a filament, grid, and plate, the plate of said triode being connected to the cathode of said rectifier; a condenser connected between the filament of said triode and the plate of said second radio tube, said grid of said triode being controlled by the electromotive force across said condenser to effect a series of sub-multiple pulses to said second radio tube plate; a variable resistor across said second condenser; and starting means for operating the above-mentioned devices which may be operated during a warm-up period to energize said oscillator, said transformer, and said pulse generating modulator, and may be operated in a running position to energize also the second radio tube filament, the second radio tube filament not being energized during the warm-up period.

7. A pulse generator comprising a source of alternating current electromotive force, means which is charged by alternate alternations of said electromotive force and includes means for preventing it to discharge into said source on other alternations of said electromotive force, and a discharge circuit for said first-means comprising a device having an anode, a cathode, and a control means for regulating the flow between said anode and said cathode to permit such flow during intervals of at least a part of said other alternations and to prevent said flow during those intervals when said source is charging said first-means, and a load, said load, anode, and cathode being connected in series with said first-means, whereby pulses of energy will be supplied from said first-means to said load.

8. In a radio transmitting system, the combination with a radio transmitter having two wires and means for controlling the outgoing waves in accordance with the potential across said two wires of a pulse generating modulator comprising a source of alternating current electromotive force, a condenser, means for charging said condenser by alternate alternations of said source, and a discharge circuit for said condenser to transmit energy therefrom to said two wires, said discharge circuit comprising a triode having an anode, a cathode, and means for controlling the current from said anode to said cathode in accordance with the electromotive force of said source to permit current flow from said condenser to said wires during the alternate alternations when said condenser is not being charged by said source and to prevent said flow during said alternate alternations when said condenser is being charged by said source.

9. A pulse generator comprising a source of half wave rectified alternating current electromotive force, a condenser shunted across said source, a rectifying device having an anode, a cathode, and a control means for controlling the flow of current from said anode to said cathode, a load, a second condenser, a circuit for supplying current from said first condenser through said anode and cathode to said load, said second condenser cooperating with said circuit so as to be charged by flow of current therethrough, means for actuating said control means to effect high impedance through said rectifying device when said source is charging said first condenser and low impedance at other intervals, said last-named means including means for affecting said control means by the charge on said second condenser to effect high impedance in said rectifying device when said second condenser is charged above a certain point and low impedance during said other intervals and being constructed and arranged so that its action on said control means will create a series of pulses through said supply circuit the rate of which pulses is a sub-multiple of the frequency of said alternating current electromotive force.

10. The device defined by claim 9 in which said second condenser is shunted by a resistor.

11. In an oscillator-amplifier type radio transmitter, a first radio tube having a cathode, means for operating said tube as an oscillator, a second radio tube, circuit connections including means for operating said second radio tube as an amplifier driven by said oscillator, a starting switch having a plurality of positions of closure which is so constructed and arranged that said switch must pass a certain-point of closure before it reaches another-point of closure, means for energizing said first tube cathode when said switch is at or beyond said certain-point of closure, the said other-point of closure controlling one of said circuit connections to disable said amplifier prior to the time that said switch reaches said other-point of closure and to close the particular circuit connection which it controls when said switch reaches said other-point of closure, whereby the circuit to the oscillator cathode must be completed before the amplifier stage can operate.

12. The device defined by claim 2 including in

addition, a third electron discharge device having a cathode, and circuit connections including means to operate said third discharge device as an audio frequency modulator for said first electron discharge device.

13. In a pulse generator, a condenser, means for producing a uni-directional electromotive force which rises from a low value to a high value periodically and includes means for charging said condenser uni-directionally as well as for preventing discharge of said condenser to said first means, a load, and a circuit for feeding the discharge current of said condenser to said load, said circuit including means for preventing discharge into said load when said potential is high and permitting such discharge for a short interval when said potential is low.

14. In a radio transmitter of the type wherein one tube drives another, a driving stage including a first electron discharge device having a cathode, a driven stage including a second electron discharge device having a cathode, circuit connections for heating said cathodes from their cold conditions to their hot conditions, and a starting switching means including a part exposed for manual operation which part constitutes the sole manually operable part of said switch which operates said cathodes; said circuit connections including means such that when said part is moved in a predetermined manner to an "on" position the cathode of said first electron discharge device is heated from cold condition at a faster initial rate than the cathode of said second electron discharge device and such that a higher initial percentage of rated electromotive force is applied to said cathode of said first electron discharge device than is applied to the cathode of said second electron discharge device and such that the cathode of said first electron discharge device reaches its normal electron emission temperature before the cathode of said second device reaches its normal electron emission temperature.

15. In combination; an electrical circuit including an electron discharge device having a grid, a plate, and a cathode; means responsive to the output of said device; said circuit including means whereby said device is subject to an abnormal plate current when the cathode is heated in absence of biasing potential on said grid; a device comprising a cathode with an anode spaced from said cathode, whereby a space is defined between the anode and cathode of said second device; means for biasing said grid primarily by power which was transmitted through said space; and means which during the starting period of the devices temporarily applies a higher percentage of rated electromotive force to the cathode of said second device than to the cathode of said first device.

16. In an electrical system of the type wherein one stage drives another, a driving stage, a stage driven thereby, a modulating stage, each of said stages having an electron discharge device with a cathode, said modulating stage including means whereby said driven stage is modulated at an audio frequency, and means for supplying energizing potentials to said stages to effect outputs therefrom, said last-named means being operable by movement of a single hand in a single direction to effect normal electron emission temperature of said cathode of said driving stage as well as of said modulating stage prior to the time that the cathode of the driven stage reaches its normal electron emission temperature.

17. In an electrical device of the type wherein one tube drives another, a driving stage including a first electron discharge device having an anode and a cathode, means supplying anode potential thereto, a driven stage including an electron discharge device having an anode and a cathode, means for supplying anode potential to said driven stage, and a starting switch having a plurality of positions of closure constructed and arranged such that it must pass a certain-point of closure before it reaches another-point of closure and when both at and beyond said certain-point of closure energizes the cathode of said driving stage and when it reaches said another-point of closure it initiates normal energization of said cathode of said driven stage.

18. In a radio transmitter of the type wherein one stage drives another, a driving stage including an electron discharge device having a cathode, a driven stage including an electron discharge device having an anode, a cathode, and a grid, means for applying bias to said grid solely by the output of said driving stage, and a starting switch so constructed and arranged that it must pass a certain-point of closure before it reaches another-point of closure and connected so as to energize the cathode of said driving stage when at or beyond the certain-point of closure, to effect generation of radio frequency electromotive forces at said driving stage prior to reaching said another-point of closure, and to initiate energization of the cathode of said driven stage upon reaching said another-point of closure.

19. The method of starting a radio transmitter of the type wherein a first tube is biased principally by the output of a second tube which includes heating the cathode of the second tube to its normal electron emission temperature before the cathode of the first tube reaches its normal electron emission temperature.

20. In a radio transmitter, in combination; a driving stage having a tube with an anode and a cathode; a driven stage having a tube with an anode, a cathode and a grid; a condenser having two leads therefrom one of which is operatively connected to said anode of said driving stage; a resistor one end of which connects to both the remaining lead of said condenser and the grid of the driven stage and the other end of which connects to said cathodes; said resistor constituting the sole biasing means for said driven stage; and means for heating, during the starting period, the cathode of the driving stage at a faster initial rate than the cathode of the driven stage is heated.

21. In a pulse generator, a source of alternating current electromotive force, a half wave rectifier, means electrically connecting one side of said rectifier to one side of said source, a condenser connected between the other side of said rectifier and the other side of said source, said half wave rectifier constituting the sole means for supplying charge to said condenser whereby one side of said condenser is charged positively by a half wave rectified current and the other side of the condenser charged negatively by such half wave rectified current, a triode which has an anode connected to the positively charged side of said condenser, said triode also having a cathode and a grid operatively cooperating with said anode, an electrical resistor a first end of which is connected to the cathode of said triode, a condenser shunted across said resistor, means con-

necting the second end of said resistor to the negative end of said first recited condenser, means connecting said second end of said resistor to said grid comprising means for introducing a potential between said second end and said grid which potential varies proportionally with variations in said alternating current electromotive force and has such polarity with respect to said resistor and grid as to block flow through said triode during the intervals that said source is charging said first-recited condenser; said last-named means, said triode, second-recited condenser, and said resistor being so constructed and arranged that the action of the potentials applied to said grid will produce a series of pulses from said anode each of which pulses have short duration and have spaces therebetween which spaces have a time duration that is a multiple of the time required for said alternating current electromotive force to pass through a complete cycle.

22. The method recited by claim 1 which also includes applying anode potentials to both of said tubes before the cathode of said amplifier tube reaches its normal electron emission temperature.

23. The method recited by claim 19 which includes applying anode potentials to both of said tubes prior to the time that the first named tube attains electron emitting condition.

24. The device defined by claim 13 which includes means for controlling the last-recited means of said claim to render said last-recited means non-conducting intermittently for periods that are multiples of the periods of variation of said electromotive force, whereby the pulses occur at a sub-multiple of the occurrence of said variations.

NATHAN I. HALL.