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ULTRAHIGH FREQUENCY DEVICE

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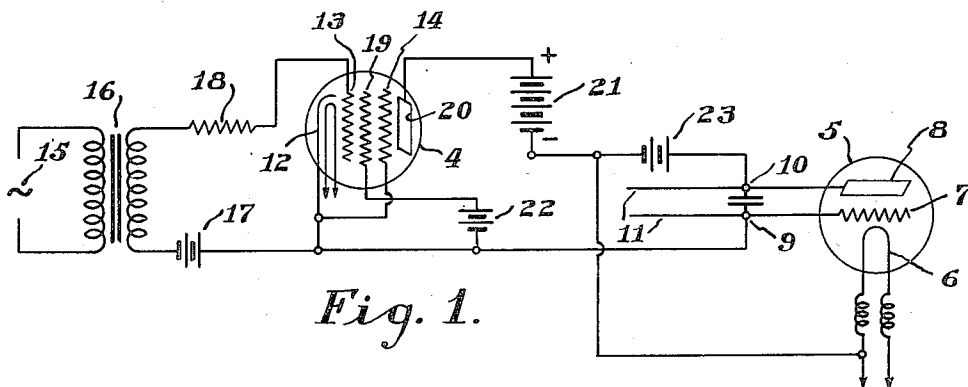


Fig. 1.

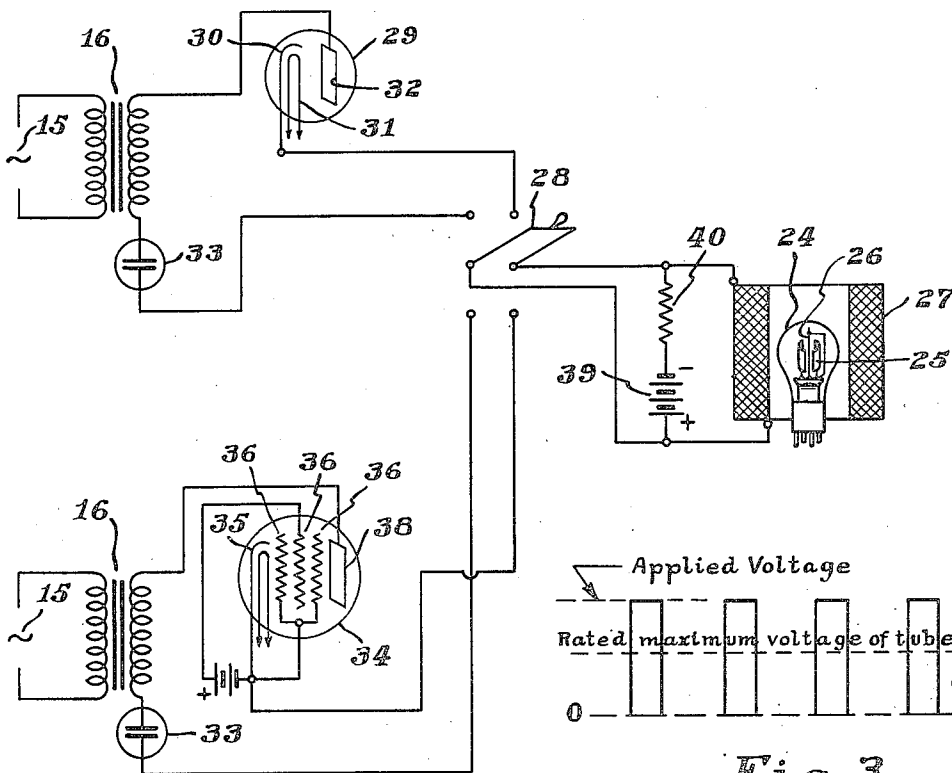


Fig. 2.

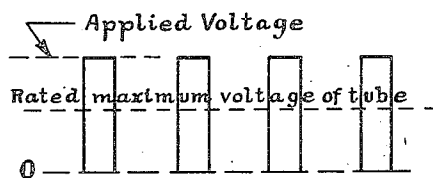


Fig. 3.

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ULTRAHIGH FREQUENCY DEVICE

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This invention relates to ultrahigh frequency apparatus and more particularly to a device and a method of operating the same in which extremely high frequencies of oscillation may be obtained by virtue of the impress of potentials across the electrodes of the electron discharge tubes at higher than the rated voltages of such electron discharge tubes.

In carrying out my invention I have found that these excessive voltages may be applied to the electron discharge tubes without overheating, provided means are employed for periodically interrupting the flow of current for excitation of the tubes. The circuit is preferably interrupted at a supersonic rate so as to give the semblance of continuous operation. The interruptions, while extremely rapid, are of such duration as to enable the tube and its elements to be cooled. In this manner, the tube can be operated either as an oscillator or as a detector at much higher voltages than was heretofore assumed to be possible. Thus, the tubes can be used to secure higher frequencies of oscillation.

It is well known that in the use of oscillator tubes of the Barkhausen-Kurz type, or of the magnetron type, the frequency obtainable is very largely dependent upon the difference of potential which can be applied across the electrodes. An excessively high grid voltage continuously applied to a Barkhausen-Kurz tube would cause overheating of the grid. Likewise, in a magnetron type of tube excessive voltages continuously applied would cause overheating of the anodes and possibly other elements. By magnetically and intermittently deflecting the electron stream between the cathode and the anodes of a magnetron tube, the overheating due to electronic bombardment may be prevented.

Accordingly, it is an object of my invention to provide a device and a method for operating ultrahigh frequency oscillators and detectors without overheating.

Another object of my invention is to provide a method for applying excessive voltages to electron discharge tubes whereby the frequency of oscillation may be increased beyond previously obtainable limits and to accomplish this result without destroying the tubes.

The features of my invention which I believe to be novel are set forth in the appended claims. The apparatus and method, however, as to the specific details by which I propose to carry out my invention, may be best understood from the following description taken in connection with the accompanying drawing in which

Figure 1 shows diagrammatically the combination of a detector or oscillator of the Barkhausen-Kurz type and an impulse generator including apparatus for amplifying and shaping the impulses;

Fig. 2 shows, also diagrammatically, the combination of a magnetron type detector or oscillator with either one of two circuits for providing an impulse generator, amplifier and wave-shaping device the output of which may be applied to the electro-magnetic unit commonly used to control such a magnetron; and

Fig. 3 shows diagrammatically the wave form of voltage to be applied to an ultrahigh frequency apparatus according to my invention.

I have shown in Fig. 1, a Barkhausen-Kurz oscillator tube 5 which may be employed for producing ultrahigh frequency oscillations. This tube comprises a filament cathode 6, a grid 7, and an anode 8. An extremely high potential may be impressed upon the input circuit across the points of connection 9—10 therewith where a voltage node would be formed. The frequency of oscillation is determined partly by the voltage applied and partly by the resonant characteristics of the input and output circuits. Portions of the circuits are shown as antennae 11. The impulse generator for supplying an interrupted flow of current for exciting the oscillator tube may be of any well known type. It is preferable, however, that the impulses be produced at a supersonic rate.

It is also important that the pulsating current applied to the oscillator tube be shaped so as to be as nearly rectangular as possible. A flat topped wave peak is essential to the production of oscillations of uniform frequency. It will be seen from Fig. 3, however, that these wave peaks may be applied at far greater voltages than would be possible if the tube were to be operated continuously. In Fig. 3, the maximum voltage rating for these tubes is indicated by the horizontal broken line in contrast with the flat topped wave peaks of much higher applied voltage.

In Figs. 1 and 2, are shown by way of illustration, three different types of wave shaping devices any one of which may be employed in connection with an ultrahigh frequency electron discharge tube, whether it be a Barkhausen-Kurz tube like that of Fig. 1, or a magnetron tube as shown in Fig. 2.

If it is desired to employ a pentode tube 4 as in Fig. 1 then such a tube would have impressed upon its input circuit, including the cathode 12 and control grid 13 a potential which is derived from any suitable alternating current source 15, the energy of which is transformed as by the transformer 16. The control grid may be suitably biased as by the battery 17 and may be further prevented from becoming positive by use of a resistor 18. This pentode tube has a suppressor grid 14, connected with the cathode, a screen grid 19 and an anode 20. The battery 21 supplies anode potential in the output circuit of tube

4 and also puts a high positive bias on the grid 7 of the tube 5.

A battery 22 may be employed as usual in the screen grid circuit of tube 4, between the cathode 5 12 and the screen grid 19. Another battery 23 provides a suitable difference of potential between the cathode 6 and the anode 8 of the tube 5.

The device shown in Fig. 1 provides for impressing the output energy of the transformer 16 upon the input circuit of the tube 4. This creates a large voltage swing on the grid 13, with the result that the plate current flows in pulses. The cut-off points are such as to provide substantially rectangular waves of energy to be impressed across the grid-cathode circuit of the tube 5. During intervals of discharge a voltage much greater than the maximum rated voltage of the tube 5 may be used because these intervals are separated by moments of no discharge when the elements of the tube are allowed to cool. The tube 5 may therefore serve to generate oscillations of ultrahigh frequency not heretofore obtainable because the voltage limitations for continuous operation had been reached.

Referring now to Fig. 2, I have shown conventionally a magnetron detector or oscillator of well known type. The electron discharge tube 24 may comprise a pair of semi-cylindrically shaped anodes 25 arranged coaxially about a straight filament 26. These electrodes may be energized by any suitable or convenient source of energy, not shown. The tube, itself, is surrounded by a solenoid 27 for producing a magnetic field the lines of force of which are somewhat longitudinal of, but at a slight angle to the axis of the electrode system. It is well known that by controlling the field excitation in such a device the path of electrons from the cathode to the split anodes may be deflected more or less to cause cyclic oscillations first toward one section of the anode and then towards the other. In this manner the tube may be caused to oscillate at a desired ultrahigh frequency.

In the application of my invention to a magnetron type of ultrahigh frequency oscillator or detector, it is possible to disable the tube by increasing the current through the solenoid coil 27.

According to the circuit arrangement shown in Fig. 2, it is necessary to increase the flux from the coil 27 in order to stop the electron flow in the tube. Hence, it may be desired that the current through the coil be held at a high enough level to normally stop all electron flow in the tube. This is accomplished by means of the battery 39 and resistor 40 except when the impulse reduces the current through the coil to the value for best operation. It is possible, however, to change this operation by having the battery and resistor normally hold the current through the coil at the best operating voltage, except when the impulse increases the current to a value high enough to stop the electron flow in the tube. In this case the impulse would have to be much longer, so as to last for a period of time greater than that between impulses. The shape, in this case, would not have to be rectangular, but could be any shape that was steep-sided and of large amplitude. Any desired type of circuit interrupter may be used in this connection together with an amplifier and wave-shaping network, either as shown in Fig. 2, (which includes two alternative modifications) or, if preferred, as illustrated in Fig. 1.

The alternative use of different wave shaping networks is illustrated in Fig. 2 by showing them

connected to a double-pole-double-throw switch 28. In one of the modifications a saturated diode 29 is used. This tube employs a cathode 30, indirectly heated by the filament 31, and an anode 32. The cathode-to-anode circuit includes the solenoid coil 27 of the magnetron oscillator, also a gaseous discharge tube 33 and the secondary winding of a transformer 16. When the energy derived from the source 15 is induced in the circuit of the tube 29 in one direction, current flows as soon as the flash-over voltage of the tube 33 is reached. Due to the rectifier action of the tube 29 and also to the cut-off point in the characteristic of the tube 33, the circuit will be sharply interrupted between the peaks of the unidirectional pulses desired for energization of the solenoid 27.

In another form of wave shaping network, shown in Fig. 2, a pentode tube 34 may be used. This tube has the usual indirectly heated cathode 35, three grids 36 and anode 38. Such a tube, as well as the saturated diode tube 29, has a characteristic enabling it to rectify at constant current when controlled by the wave peaks derived from the current induced in the secondary of the transformer 16. The rectifying action ceases instantly when the impressed voltage falls below the low limit of operation of the gaseous discharge tube 33. Hence a substantially rectangular wave shape will be supplied intermittently for energizing the solenoid coil 27.

A certain degree of magnetic flux is maintained in the coil 27 by means of a battery 39 in series with a resistor 40. The resistor 40 offers a high impedance to the impulses generated intermittently.

It will be understood from the foregoing that I may employ the novel method of my invention equally well in connection with ultrahigh frequency detectors the same as with oscillators. As a detector the Barkhausen-Kurz tube will, of course, operate more efficiently at whatever frequency is desired if it is excited by potentials corresponding to those for producing oscillations of the received frequency. Whether the tubes are used for oscillators or detectors, therefore, it is equally important that the excess heat generated incidentally to the application of these high voltages be dissipated without danger of destroying the tubes. The greater the heat generated during operation of the tube, the more time must be allowed for dissipating that heat. Hence, it is of the essence of my invention to interrupt the operation of the ultra-high frequency tubes for a sufficient time to limit the generation of heat by the amount which can be radiated continuously, and at the same time to intermittently employ much higher voltages for tube excitation.

The advantages to be gained in the carrying out of my invention may well be appreciated when it is seen that I am enabled to produce higher frequencies in an oscillator than were heretofore obtainable. Likewise I can operate a detector for receiving these ultrahigh carrier frequencies and the operation thereof is found to be more efficient than was heretofore obtainable.

Although certain specific embodiments of my invention have been herein disclosed and described, it is to be understood that they are merely illustrative of my invention and modifications may, of course, be made without departing from the spirit and scope of the invention as defined in the appended claims.

I claim as my invention:

1. In an ultra-high frequency oscillator, an

electron discharge device having a plurality of electrodes including cathode, anode- and control-electrodes, means for impressing across said cathode- and control-electrodes a difference of potential of such value as would destroy the device if it were to be applied continuously, and means for periodically interrupting the electron discharge in said device at a supersonic rate such that the device may be caused to generate ultra-high frequency oscillations during intervals of impress of potential across said electrodes and also that the electrodes may be permitted to cool during interruptions of said discharge.

2. In an ultra-high frequency apparatus, an electron discharge device having electrodes including cathode-, anode- and control-electrodes, means including a source of current for impressing across said cathode- and control-electrodes a potential of such value as to be destructive to said device if it were to be applied continuously, and means including a circuit interrupter for applying said potential intermittently and at a supersonic rate, thereby to avoid destruction of said device.

3. Ultrahigh frequency apparatus comprising an electron discharge tube and oscillatory circuit connections therefor, said tube and circuit providing an oscillation generator of the type wherein the frequency of oscillation is largely dependent upon the voltage applied thereto, means to energize said generator including a source of current at a potential greater than that required to obtain the normal maximum frequency of oscillation from said tube, and means including a circuit interruptor for rendering intermittent at a supersonic rate the impression of said potential from said source upon said generator so that said generator is caused to generate substantially continuous oscillations of a higher frequency than the said normal maximum frequency of said tube.

4. In a system for generating high frequency oscillations in which the frequency is largely dependent upon the difference of potential to be applied across two electrodes of an electron discharge device, the method of deriving oscillations of otherwise unattainably high frequency which comprises impressing between said electrodes a uni-directional potential which if continuously applied would generate a destructive heat, and periodically interrupting the operation of said system at a supersonic rate for intervals of time sufficient to dissipate the excess heat.

5. In a communicating system employing ultra high frequency electron discharge devices, the method of operating the same which comprises applying voltages higher than the rated voltage of said device thereto for generating oscillations at a transmitting station and simultaneously for detecting said oscillations at a receiving station, said oscillations being of a desired frequency greater than would be obtainable when operating said devices continuously at their maximum rated voltage, permeating each of said devices with an electrically excited magnetic field, cyclically varying the excitation of said fields at a rapid rate so as to render said devices alternately operable and inoperable and controlling the ratio between the operable and the inoperable intervals so as to provide the semblance of continuous operation of said devices without overheating.

6. Apparatus of the class described comprising an electron discharge tube system of the type which requires for its operation an extremely

high positive grid potential with respect to the cathode, means including a source of alternating current for supplying the grid excitation and means including a thermionic device in combination with a gaseous discharge tube for selecting the wave peaks of one polarity, and for substantially flattening said wave peaks while impressing the same intermittently across the grid and cathode of said apparatus.

7. Apparatus in accordance with claim 6 in which the thermionic device of the last said means is a saturated diode.

8. Apparatus in accordance with claim 6 in which the thermionic device of the last said means is a pentode tube.

9. Apparatus of the class described, comprising an electron discharge tube system of the type which operates by virtue of a magnetic field permeating the region in which the electron discharge takes place, means including a source of alternating current for polarizing said field and means including a wave-shaping device having an electronic rectifier tube for supplying a substantially flat topped wave peak of potential with approximately perpendicular cut-off characteristics for causing the polarization of said field to be unidirectional and intermittent.

10. Apparatus in accordance with claim 9 in which said wave-shaping device includes further means having a gaseous discharge tube for interrupting the action of said rectifier tube.

11. High frequency apparatus comprising an electron discharge tube and circuit adapted for oscillatory excitation at a frequency dependent upon the excitation potential, means including an energy source for supplying said potential, an electron discharge tube interposed in the circuit for supplying uni-directional current from said source to the first said tube, and means including a gaseous discharge tube for at times interrupting the action of the first said electron discharge tube according to voltage variations across said gaseous discharge tube above and below its flash-over point.

12. Apparatus in accordance with claim 11 comprising means, including the electron discharge tube first mentioned, for generating ultra high frequency oscillations.

13. Apparatus in accordance with claim 11 comprising means, including the electron discharge tube first mentioned, for detecting ultra high frequency oscillations.

14. In a communication system employing an electron discharge device having a cathode and a sectionalized anode, the method of producing oscillations therein which comprises applying voltages higher than the rated voltage of said device thereto and permeating said device with an electrically excited magnetic field for causing cyclic oscillation of the electron discharge first toward one section of said anode and then toward another section thereof of a frequency greater than would be obtainable when operating said device continuously at its maximum rated voltage, cyclically varying the excitation of said magnetic field at a rapid rate so as to render said device alternately operable and inoperable, and controlling the ratio between the operable and inoperable intervals so as to provide the semblance of continuous operation of said device without overheating.

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