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H. E. MENDENHALL
ELECTRON DISCHARGE DEVICE

2,105,924

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FIG. 1

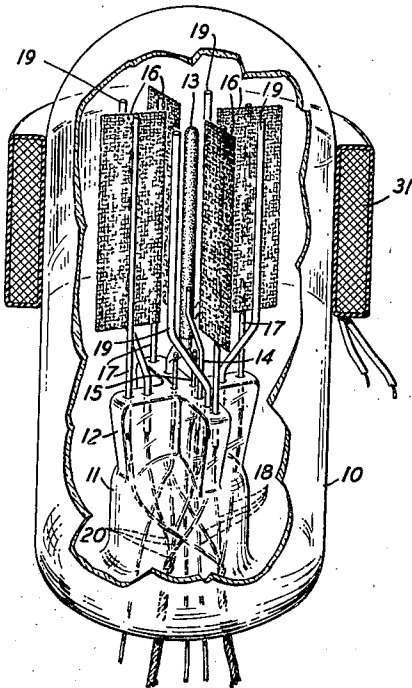


FIG. 2

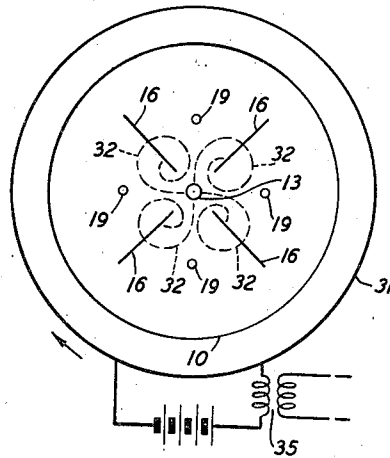


FIG. 3

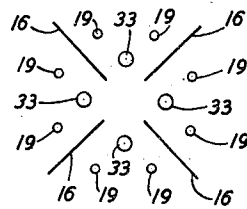
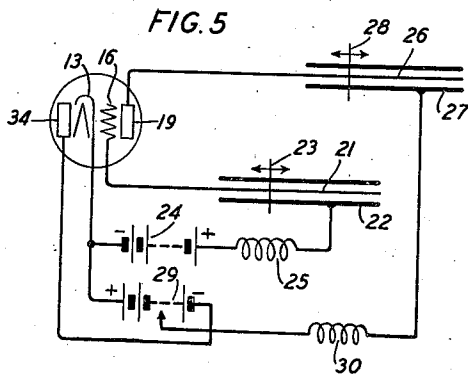
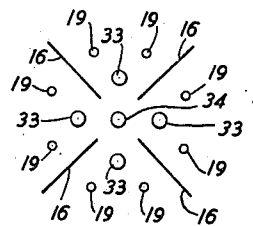


FIG. 4



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ELECTRON DISCHARGE DEVICE

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9 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices and more particularly to such devices adapted for the generation of ultra-high frequency oscillations and commonly known as Barkhausen oscillators.

In Barkhausen oscillators, the output electrode usually is in the form of a grid disposed between a cathode and a reflecting electrode. Because of the extremely small transit times requisite in devices adapted for the generation of ultra-high frequency oscillations, the electrodes must be very closely spaced so that the output electrode necessarily must be of relatively small dimensions. Hence, the output electrode has a small area and can dissipate but a limited amount of heat. Furthermore, in Barkhausen oscillators, but a small percentage of the electrons emanating from the cathode eventuate in or constitute the oscillating current. As a result of the foregoing, the power output obtainable from Barkhausen oscillators is relatively small and the operating efficiency of such oscillators is relatively low.

One object of this invention is to increase the power output and efficiency of ultra-high frequency oscillation generators.

In one illustrative embodiment of this invention, a Barkhausen oscillator comprises a linear cathode, a plurality of flat grids uniformly spaced about and extending radially with respect to the cathode, and a plurality of rod-like reflecting electrodes each disposed parallel to the cathode and between successive grids.

The grids may have a positive potential applied thereto and serve as the output electrode of the oscillator. The reflecting electrodes preferably are maintained at a low negative potential, although they may be operated at a relatively low positive potential or at substantially zero potential. In the operation of the device, some of the electrons will pass into the regions between the grids and the reflecting electrodes and oscillate in these regions before finally passing to the grids. Other of the electrons will traverse spiral orbits through and around the grids before passing to the grids.

In order to increase the oscillating component of the output current, a coil is provided for producing a magnetic field causing a large number of the electrons emanating from the cathode to traverse spiral paths before impinging upon and being absorbed by the grids.

In another illustrative embodiment of this invention, a Barkhausen oscillator comprises a cathode having a plurality of parallel elements arranged in a cylindrical boundary and a plu-

rality of flat grids each disposed between two adjacent or successive cathode elements and extending radially with respect to the cathode boundary. The radius of the cylindrical boundary preferably is equal to or greater than the radius of the boundary defined by the innermost edges of the grids. A plurality of rod-like reflecting electrodes are provided, each being disposed adjacent one of the cathode elements and one of the grids, and parallel to the cathode.

In order to insure a uniform radial dispersion of electrons, a fourth electrode may be provided within the boundary defined by the cathode elements. This electrode may be a linear rod positioned in the axis of the cathode boundary and preferably is operated at a negative potential. A coil may be provided for producing spiraling of the electrons as described hereinabove.

The invention and the various features thereof will be understood more clearly and fully from the following detailed description with reference to the accompanying drawing, in which:

Fig. 1 is a perspective view of an electron discharge device illustrative of one embodiment of this invention, a portion of the enclosing vessel and external coil being broken away to show the electrodes more clearly;

Fig. 2 is a diagrammatic view showing the relative disposition of the electrodes in the device shown in Fig. 1, and illustrating typical paths traversed by some of the electrons in flowing from the cathode to the output electrode;

Fig. 3 is a plan view of the electrodes in another embodiment of this invention, wherein the cathode includes a plurality of elements lying in a cylindrical boundary;

Fig. 4 is a plan view of the electrodes in a modification of the embodiment of this invention shown in Fig. 3, including a fourth electrode within the boundary of the cathode elements; and

Fig. 5 illustrates a typical oscillator circuit including an electron discharge device constructed in accordance with this invention.

Referring now to the drawing, the electron discharge device shown in Fig. 1 is of the type generally known as a Barkhausen oscillator and comprises an enclosing vessel 10 having an inwardly extending stem 11 at one end which terminates in a multi-armed or cross-shaped press 12. A linear cathode 13, which may be of the equipotential or heater type, or a single linear filament, is mounted on the press 12 by a leading-in conductor 14 for the cathode and by leading-in conductors 15 for the heater element of the cathode.

A plurality of grids 16, which may be of molybdenum, tantalum or tungsten wire mesh, are positioned about the cathode 13, equally spaced from each other, and extend radially with respect to the cathode 13 and parallel thereto. Each of the grids 16 is supported by a rigid metallic upright or rod 17 embedded in one of the arms of the press 12, the several uprights or rods, and hence the grids 16, being electrically connected together by leading-in conductors 18.

A plurality of reflecting electrode elements 19 are provided between the grids, each of the elements being, for example, a metallic wire or rod embedded in one arm of the press 12, equally spaced from two adjacent or successive grids 16, and disposed parallel to the cathode 13. The elements 19 may be electrically connected together by leading-in conductors 20 sealed in the stem 11.

As shown in Fig. 5, the grids 16, which serve as the output electrode of the device, may be operated at a positive potential, being connected to the cathode 13 through a Lecher system including coaxial conductors 21 and 22 short-circuited by a slidable conductor 23, and a source, such as a battery 24. If desired, a suitable inductance 25 may be provided in the cathode-grid circuit. The reflecting electrode elements 19 may be connected to the cathode 13 by a Lecher system including coaxial conductors 26 and 27 short-circuited by a slidable conductor 28, in series with a source, such as a battery 29 and a suitable inductance 30. Preferably, the reflecting electrode elements 19 are negatively biased with respect to the cathode 13, although they may be operated at zero potential or with a small positive bias with respect to the cathode 13.

Some of the electrons emanating from the cathode 13 flow directly to the grids 16 and constitute a substantially constant component of the output current. Other electrons pass through and around the grids 16 before finally impinging upon and being absorbed by the grids, and constitute the oscillating component of the output current. When the reflecting electrode is operated at a positive potential with respect to the cathode, secondary electrons emanating from the grids may also become part of the oscillating current. In order to increase the oscillating component of the output current, in accordance with this invention, a coil 31 is provided about the vessel 10 for subjecting the electrons emanating from the cathode to a magnetic field so that the electrons will be caused to traverse spiral orbits before impinging upon the grids 16. As shown in Fig. 2, under the action of the magnetic field, the electrons will traverse spiral paths as indicated by the dotted lines 32, in passing from the cathode 13 to the grids 16.

It will be apparent also that the grids 16 may be of relatively large area so that they are capable of handling relatively large currents without becoming unduly heated.

In another embodiment of this invention, shown in Fig. 3, the cathode comprises a plurality of linear elements 33, which may be of the heater type, or filaments, arranged in a cylindrical boundary. If the elements 33 are filaments, they may be connected in series or parallel. Each of the cathode elements 33 is disposed between two linear reflecting electrode elements 19 which in turn are disposed between and equally spaced from a plurality of grids 16 extending radially with respect to the cathode boundary and disposed parallel to the cathode

elements 33 and the reflecting electrode elements 19. Preferably the radius of the boundary of the cathode elements 33 is equal to or greater than the radius of a circle including the innermost edges of the grids 16. The elements 19 may be electrically connected to each other and the grids 16 similarly may be connected to each other, and the several electrodes may be associated in a circuit as illustrated in Fig. 5.

In a modification of the embodiment of this invention shown in Fig. 3, a fourth electrode 34 is provided. This electrode 34, as illustrated in Fig. 4, may be a linear metallic rod disposed centrally of the cathode boundary, and preferably is operated at a relatively high negative potential, as indicated in Fig. 5, to insure uniform radial dispersion of the electrons from the cathode.

It will be understood, of course, that a magnetic coil, such as shown in Fig. 1, may be utilized in connection with devices of the construction illustrated in Figs. 3 and 4, to produce spiraling of the electrons through and about the grids 16. An alternating voltage at a lower frequency such as audio-frequency may be introduced by means of a modulating transformer 35 to modulate the radio frequency output.

It will be understood, also, that various modifications may be made in the specific embodiments of the invention illustrated and described without departing from the scope and spirit of this invention as defined in the appended claims.

What is claimed is:

1. An electron discharge device comprising a cathode, an output electrode including a plurality of reticulated output grids extending radially with respect to said cathode, an auxiliary electrode including a plurality of rod members disposed between said grids, and means for producing a magnetic field adjacent said cathode.
2. A Barkhausen oscillator comprising a linear cathode, an output electrode including a plurality of flat perforate grids disposed edgewise to said cathode and extending radially with respect thereto, a reflecting electrode including a plurality of rod members disposed parallel to said cathode and between said grids, and means for producing a magnetic field in the vicinity of and parallel to said cathode.
3. An electron discharge device comprising a cathode including a plurality of elements mounted in a substantially cylindrical boundary, an output electrode including a plurality of grids disposed radially with respect to said boundary, an electrode including a plurality of members disposed in cooperative relation with said cathode and grids, and an auxiliary electrode mounted within said boundary and in the longitudinal axis thereof.
4. A Barkhausen oscillator comprising a cathode including a plurality of linear elements mounted in a cylindrical boundary, an output electrode including a plurality of flat grids extending radially with respect to said boundary, each of said grids being disposed between two of said cathode elements, a reflecting electrode including a plurality of rod members disposed parallel to said cathode elements, and a linear auxiliary electrode within said boundary and in the longitudinal axis thereof.
5. A Barkhausen oscillator comprising a cathode, a reflecting electrode, an output electrode, said reflecting electrode being mounted adjacent and intermediate the lateral ends of said output electrode, and means for causing electrons eman-

ating from said cathode to traverse spiral paths in passing to said output electrode.

5 6. A Barkhausen oscillator comprising a cathode, a reflecting electrode, an output electrode including a reticulated grid member extending radially with respect to said cathode, and means for producing a magnetic field in the vicinity of said cathode and output electrode whereby electrons emanating from said cathode are caused to traverse spiral orbits in passing to said out-
10 put electrode.

15 7. A Barkhausen oscillator comprising a linear cathode, an output electrode including a plurality of grids disposed about and extending radially with respect to said cathode, a reflecting electrode including a plurality of rod members disposed in cooperative relation to said cathode and grids and parallel to said cathode, and a magnetic coil encompassing said grids for causing electrons emanating from said cathode to traverse spiral
20 orbits in passing to said grids.

8. A Barkhausen oscillator comprising a cathode, an output electrode having perforated ele-

ments disposed about said cathode and extending radially with respect thereto, a reflecting electrode, an auxiliary electrode adjacent said cathode for producing radial dispersion of electrons therefrom, and means for producing a magnetic
5 field in the vicinity of said cathode and said elements whereby electrons emanating from said cathode are caused to traverse spiral orbits in passing to said output electrode.

9. A Barkhausen oscillator comprising a cathode including a plurality of elements disposed in a cylindrical boundary, an output electrode including a plurality of grids extending radially with respect to said boundary, a reflecting electrode including a plurality of rod members disposed between said grids and parallel to said elements, an electrode within said boundary, and means for producing a magnetic field in the vicinity of said elements and grids so that electrons emanating from said cathode are caused to
10 traverse spiral orbits in passing to said grids.
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