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MICROWAVE DYNATRON OSCILLATOR

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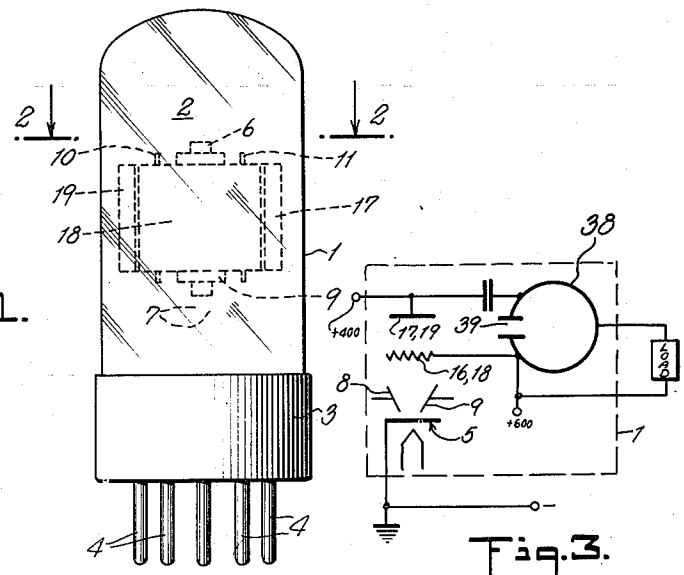


Fig. 1.

Fig. 3.

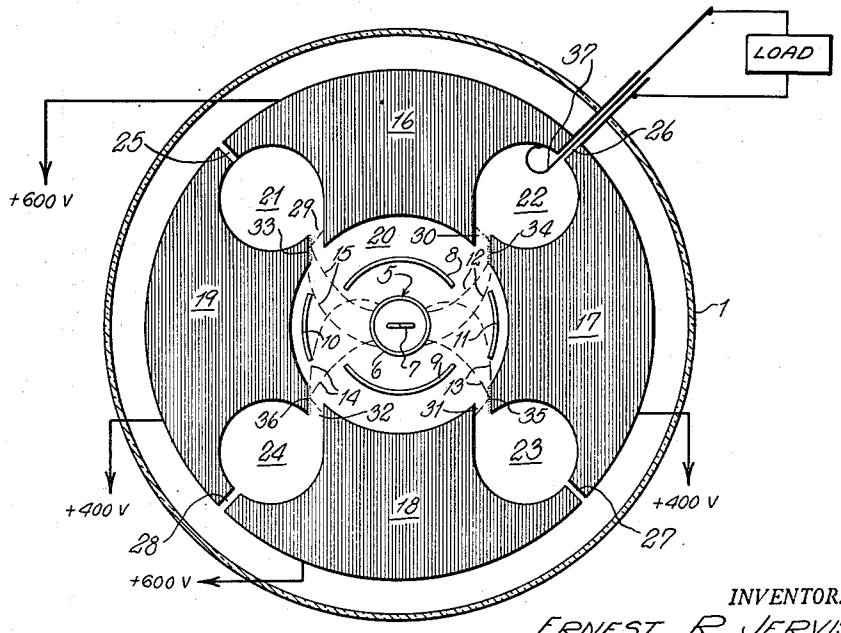


Fig. 2.

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MICROWAVE DYNATRON OSCILLATOR

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8 Claims. (Cl. 315—39)

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This invention relates to electron discharge tubes, and more particularly to such tubes for use at very high or microwave frequencies.

A principal object of the invention is to provide an improved oscillator-generator tube of the dynatron type.

Another object is to provide a novel construction of microwave dynatron oscillator.

A feature of the invention relates to a microwave dynatron tube having a central primary electron-emitting cathode and a plurality of focussing and deflecting electrodes symmetrically mounted around the cathode and cooperating with a series of dynodes and output anodes which also symmetrically surround the cathode; the anodes and dynodes being directly formed with extensions constituting integral cavity resonators.

Another feature relates to a microwave dynatron tube having all the electrodes symmetrically disposed around a common central primary electron-emitting cathode, the dynodes and anodes being in the form of spaced metal blocks with the adjacent spaced faces of the blocks acting respectively as dynodes and anodes, and with the blocks formed with integral cavity resonators which are excited to resonance directly by the associated dynodes and anodes.

A further feature relates to an improved oscillation generator employing dynodes and anodes which are shaped and disposed with relation to each other to effect a more efficient coupling between the secondary electron streams and the output circuits through the intermediary of cavity resonators which are integrally formed with the dynodes and anodes.

A further feature relates to the novel organization, arrangement and relative location and interconnection of parts which cooperate to provide an improved microwave dynatron oscillator.

Other features and advantages not particularly enumerated, will be apparent after a consideration of the following detailed descriptions and the appended claims.

In the drawing,

Fig. 1 is an elevational view of a tube according to the invention.

Fig. 2 is an enlarged sectional view of Fig. 1, taken along the line 2—2 thereof.

Fig. 3 is a typical schematic wiring diagram of the tube and its circuit for generating sustained microwave oscillations.

Referring to the drawing, the tube may comprise any suitable evacuated enclosing bulb or envelope 1, within which is supported the electrode assembly or mount 2. The tube 1 may be attached to any conventional base 3 which carries the usual plug-in contact prongs 4. The various electrodes of the mount 2 are connected to the respective prongs 4 in the usual manner.

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The electrode assembly or mount comprises a central electron-emitting cathode 5 which is preferably of the unipotential indirectly-heated type, such as is well-known in radio tube constructions. For example, it may consist of a tubular metal sleeve 6, the exterior surface of which is coated with any of the materials which emit primary electrons when raised to a sufficiently high temperature. Suitably located within the sleeve 6 and insulated therefrom is any well-known heater wire for raising the cathode to emitting temperature. Disposed symmetrically on opposite sides of the cathode and partially surrounding the same, are two curved metal electrodes 8, 9, whose spaced edges form diametrically opposite windows for the passage of the primary electron beams from the cathode. The electrodes 8 and 9, instead of being formed of separate metal members, may for example be constituted of a single cylindrical metal member having two of its opposite sides provided with windows for the emergence of the primary electrons. Mounted in alignment with each of these windows, is a pair of diametrically opposite curved plates 10, 11. These curved plates preferably are formed of cylindrical sectors and are located in outwardly radially spaced relation with respect to the above-mentioned windows. The electrodes 8, 9, 10, 11, are arranged to be connected to ground or to a suitable negative potential, so that each pair of electrodes, for example electrodes 8 and 11, acts as deflector and focussing electrodes for the primary electrons, causing them to follow a curved trajectory and to be focussed into a beam represented by the lines 12. Likewise, the electrodes 9 and 11 form the primary electrons into another focussed beam 13. Similarly, the electrodes 9 and 10 form the primary electrons into a third focussed beam 14, and the electrodes 10 and 8 form the electrons into a similar fourth focussed beam 15.

Surrounding all of the foregoing electrodes are four metal blocks 16, 17, 18, 19. These blocks may be cut from a single cylindrical metal block having a central bore 20, and with four symmetrically-spaced lateral bores 21, 22, 23, 24. This single metal block is then provided with four slits 25, 26, 27, 28, each slit being in radial alignment with a respective one of the bores 21—24. Likewise, the inner wall of each of the

bores 21—24 is provided with a slot or passage 29, 30, 31, 32 in such a way that these slots or passages extend substantially tangential to the curved walls of the respective bores. In effect, therefore, the single block is formed into four separate and similar blocks which are electrically insulated from each other, so far as direct current is concerned, and these four sections of the block are mounted for example on individual supports, not shown, so that the flat walls 33, 34, 35, 36, of the blocks 17 and 19 are located respectively at the regions where the respective primary electron beams 12—15 are focussed. It will be observed, therefore, that the primary electrons strike these flat walls 33—36 at somewhat glancing angles of less than 90 degrees. In accordance with one feature of the invention, the walls 33—36 are treated or coated with any suitable material which acts as a copious source of secondary electrons when bombarded by the primary electrons. The blocks 17 and 19 which carry the secondary emission coatings on their flat walls 33—36, are connected to a suitable positive high voltage direct current potential, for example positive 400 volts, and the blocks 16 and 18 are connected to a somewhat higher positive direct current potential, for example 600 volts. Consequently, each of the surfaces 33—36 acts as a dynode, and the cooperating spaced flat face of the associated anode block acts as a secondary electron collector or anode. In accordance with well-known theory, when the surfaces 33—36 emit secondary electrons, there exists a negative resistance characteristic in each of the passages 29—32. Each of these negative resistance passages is in direct communication with the corresponding bore 21—24. These bores can be designed of such physical dimension and shape, as is well-known in the cavity resonator art, so as to resonate at a particular frequency for which the tube is to act as an oscillation generator.

When the tube is in operation, the primary electrons from the four beams 12—15 strike the respective secondary emitting surfaces 34, 35, 32 and 33, which release therefrom a copious supply of secondary electrons which travel across the respective passages 30, 31, 32, 29, thus imparting by well-known dynatron action, a negative resistance characteristic across these passages. By reason of the dimensional configuration of the bores 21—24 which causes them to resonate at a particular frequency, this negative resistance characteristic of the respective passages will cause the associated cavity resonator bores to be subjected to charging oscil'ations at a particular frequency. Each cavity therefore continues to oscillate at its resonant frequency so long as the corresponding primary electron beam strikes its respective secondary em'ssion surface. In accordance with known design formula, each cavity 21—24 will have a certain shunt resistance which is a function of the cavity shape and size, and the spacing between the walls of the associated passages 29—32. Ordinarily, this shunt resistance of a cavity resonator, would have a positive value. However, by setting up a negative resistance characteristic across each of the passages 29—32 as above described, and by having different direct current potentials applied to the opposite walls of each passage, the negative resistance overcomes the conventional positive shunt resistance of the associated cavity, thus inducing the generation of sustained ultra-high-frequency oscillations in each cavity. If desired, one of the cavities can be provided with a small inductive loop 37 or probe which can be connected by way of a concentric wave transmission line to a suitable load.

Fig. 3 shows schematically one typical circuit connection of the electrodes and the manner of connecting the tube to the output or load circuit. In this figure, the parts which correspond to those of Fig. 2, bear the same designation numerals. However, for purposes of schematic illustration, the several cavities are represented by a single equivalent single-turn inductance 38 and with a single equivalent inherent capacitance 39.

In addition to the advantages of the construction as above pointed out, there is the additional advantage that the slots or passages 29—32 can be positioned so that the secondary emission surfaces 33—36 are oriented with respect to the impinging primary electrons so that the said primary electrons strike said secondary emission surfaces at the optimum of less than 90° grazing angle for maximum secondary emission. Furthermore, the blocks 16—19 being integral with the secondary emission surfaces act as highly efficient heat dissipators thus maintaining the said secondary emission surfaces at the required relatively low temperature.

While one particular embodiment has been described herein, it will be understood that various changes and modifications may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. An electron tube of the dynatron type comprising an evacuated enclosing envelope, a central primary electron emitting cathode, means defining a plurality of cavity resonators symmetrically surrounding said cathode each of said resonators being formed of a pair of spaced adjacent grooved blocks with one set of adjacent edges of each pair of blocks forming a respective passageway extending parallel to the length of said cathode, one wall of each passageway being an emitter of secondary electrons, and electrostatic electron deflector means located between the cathode and said blocks to form the primary electrons from the cathode into a series of discrete beams having curved trajectories which terminate at said one wall of a respective passageway.

2. An electron tube of the dynatron type, comprising an enclosing evacuated envelope, a central primary electron emitting cathode, electron deflecting and focussing electrodes surrounding the cathode for forming the primary electrons into a series of electron beams, a plurality of dynode surfaces surrounding the cathode one for each of said beams and upon which the corresponding beam impinges, an anode surface for each dynode surface and spaced therefrom to form a dynode gap, and means integral with each pair of dynode and anode surfaces defining a cavity resonator local thereto to be excited by the secondary electron emission in said gap.

3. An electron tube of the dynatron type, comprising an enclosing evacuated envelope, a central electron emitting cathode, a plurality of metal blocks surrounding said cathode said blocks being mounted in spaced adjacent pairs insulated from each other for direct current and with the adjacent walls forming a cavity resonator, said blocks having a common central well within which said cathode is mounted, electron deflecting and focussing electrodes located in said well around said cathode for forming the primary electrons into a series of discrete beams, and a pas-

sageway extending from each cavity resonator to said central well, one wall of each passageway being an emitter of secondary electrons and upon which a corresponding one of said beams may impinge.

4. An electron tube according to claim 3, in which one block of each pair is connected as a dynode block and the other block of each pair is connected as an anode block.

5. An electron tube of the dynatron type, particularly suitable for generating microwave oscillations, comprising a central electron emitting cathode, a set of four curved metal plates surrounding said cathode for forming the primary electrons therefrom into four separate substantially focussed electron beams, a plurality of pairs of metal members surrounding said plates and forming respective passageways, each passageway having one of its side walls coated with secondary electron emissive material, and means defining a cavity resonator in communication with each of said passageways.

6. An electron tube of the dynatron type, comprising, a central primary electron emitting cathode, means defining a plurality of cavity resonators symmetrically located around said cathode, each of said resonators having an individual passageway with one wall of each passageway constituting a secondary electron emitter, and a plurality of electron deflecting and focussing electrodes symmetrically surrounding said cathode for causing the primary electrons from the cathode to be formed into a plurality of separate beams one for each of said passageways and for causing each beam to strike only the coated wall thereof.

7. An electron tube according to claim 5, in which the coated side wall of each of said passageways is located at an optimum grazing angle of less than 90° with respect to the said primary electrons impinging thereon to produce maximum secondary emission.

8. An electron tube according to claim 5, in which the last-mentioned means comprises a series of relatively massive metal blocks integral with respective ones of said side walls to provide heat dissipating means for said side walls.

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