Sept. 20, 1949. A. H. LAIDIG 2,482,495

MAGNETRON

Filed Nov. 27, 1943

Fig. 1.

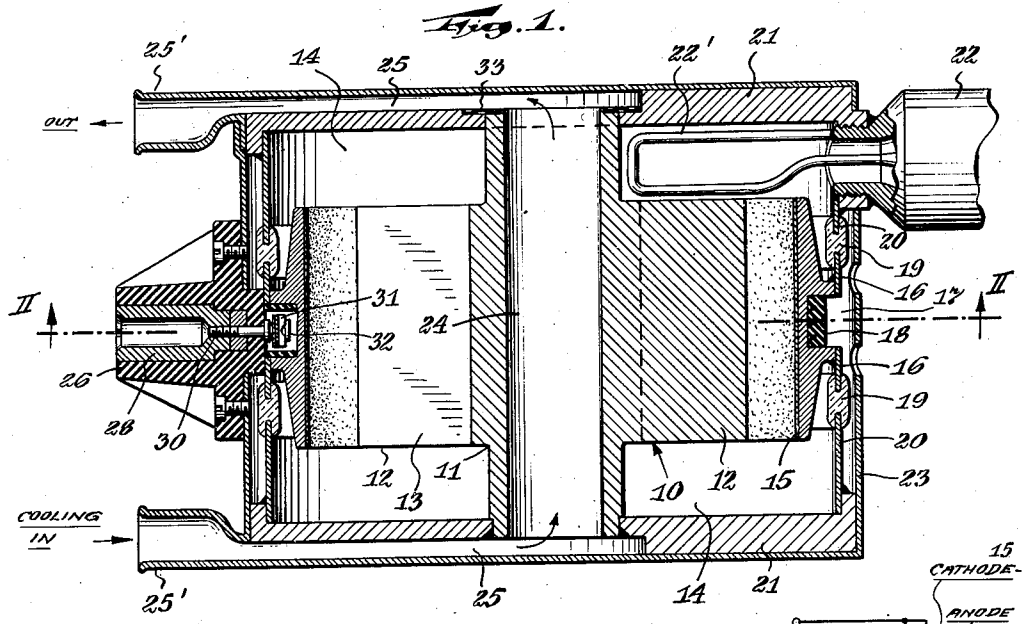


Fig. 3.

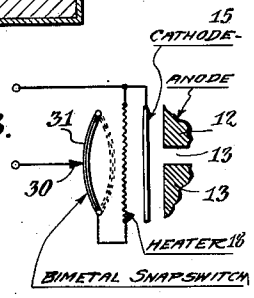
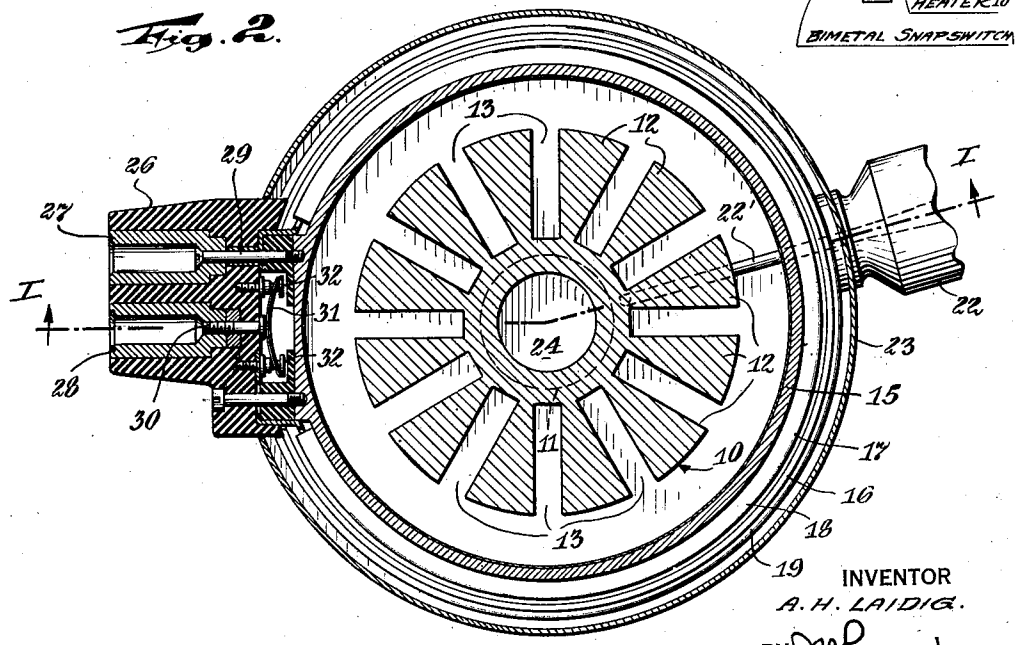


Fig. 2.



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MAGNETRON

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11 Claims. (Cl. 250—27.5)

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This invention relates to magnetrons, and contemplates an improved organization thereof as well as an improvement of specific parts included in the assembly.

The trend of the prior art relating to magnetrons has hovered around the provision of a centrally located cathode and a surrounding anode having a plurality of resonant cavities opening inwardly toward the cathode. This has immediately imposed certain mechanical and electrical limitations which have confined the devices to the conventional relationship of parts with restricted cathode area and output. One of the most serious difficulties encountered with magnetrons and which has imposed an undesirably short life, has been overheating the cathode from electron bombardment the heat from which supplemented heat supplied by the cathode heater.

In its general aspects, the present invention seeks to overcome the difficulties and deficiencies encountered in the conventional magnetron construction.

Likewise of general nature, an object of the invention is to provide for materially greater cathode area than possible in the conventional magnetron construction.

Of closely related character is the further object of providing a construction wherein concentration of electronic bombardment is less than in conventional magnetron construction.

A specific object of the invention is to provide a cathode which girdles or peripherally surrounds the anode.

Another object of the invention is to fluid-cool the anode.

Yet another object of the invention is to provide a replaceable heater for the cathode and to provide such a heater which is replaceable without disturbing the vacuum of the magnetron.

A further object of the invention is to automatically control the heater current from the temperature of the cathode.

Again, other objects of the invention are to provide a structure which prevents relative vibration between cathode and anode; to provide a structure which may be readily and accurately machined during fabrication; to increase the life of the magnetron as well as rated output thereof; and to provide other economies of manufacture and benefits in use.

Still further objects of the invention will appear to those skilled in the art as the description progresses, both by direct recitation thereof and by inference from the context.

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Referring to the accompanying drawing in which like numerals of reference indicate similar parts throughut the several views;

Figure 1 is a vertical section on an axial plane as indicated by line I—I of Fig. 2 of a magnetron of my improved construction;

Figure 2 is a horizontal cross-section as on line II—II of Fig. 1; and

Figure 3 is a diagrammatic view of the electrical circuit and automatic switching means for the heater.

In the specific embodiment of the invention illustrated in said drawing, the reference numeral 10 designates a generally cylindrical anode formed with a hollow hub portion 11 intermediate the ends of which radially project partitions 12 the side walls of which define outwardly opening cavities 13 shown in this instance as slots. In a direction parallel to the hub axis said partitions are shorter than the hub and thereby provide an end space 14 at each end of the anode. Said cavities extend longitudinally through the anode so as to open into said end spaces. Around the anode girdling the same is a cylindrical cathode 15 said cathode being spaced from the periphery of the anode and being electron emissive on its inner face toward the anode. At the outer periphery of the cathode are provided a pair of metallic rings 16 of equal diameter and spaced longitudinally one from the other. Between these rings the outer face of the cathode provides a peripheral groove 17 which accordingly is outwardly open enabling an arcuate heater element 18 to be sprung into the said groove. More will be said with respect to this heater element hereinafter.

The aforementioned rings 16 are soldered or otherwise secured vacuumtight to the said cathode and are coaxial therewith. They are preferably of material to which glass may be sealed, and may accordingly be advantageously formed from an alloy sold in trade under the name of "Kovar" the constituency of which is described in Patent 2,062,335 of December 1, 1936. A ring 19 of borosilicate or other insulating material is sealed to each said metallic ring on the far edge thereof from the cathode groove, and to the far edge of each glass ring is sealed another metallic ring 20 also preferably of the alloy above mentioned. The grooved portion of the cathode, all of said metallic rings and both said glass rings constitute the peripheral wall of the magnetron. End caps 21 applied at the extreme edges of metallic rings 20 form end closures for the magnetron, these end caps be-

ing soldered or otherwise sealed to said rings and to the extremities of the hub. The interior region of the magnetron between the peripheral wall and hub and between said end caps is accordingly fully enclosed and is evacuated. An output coaxial line **22** is sealed through the peripheral wall into one end space, said coaxial line likewise being under vacuum. The terminal **22'** of the coaxial line is formed as a loop situated within the end space with one leg of the loop contiguous to the end of the anode and extending radially thereof. If so desired, a protective shell **23** may be provided surrounding the glassed peripheral wall of the magnetron, said shell being removable in whole or in part for permitting access to the heater element and replacement of that element when desired.

By preference, hub **11** of anode **10** is hollow providing a passageway **24** therethrough from end to end. A part of the shell **23** is shown extending across end caps **21** overlying the ends of said hub but spaced therefrom. Radial channels **25** in the outer faces of the end caps communicate with the ends of passageway **24** and are also covered by said shell which may conveniently be formed with connecting nipples **25'** at the periphery of the shell body for appropriate hose or other connection to a circulating fluid supply. This forms a means for cooling the anode.

At one side of the magnetron is provided an insulated receptacle structure for making electrical connection with the heater element. This structure includes an insulating body **26** attached to the outside of the anode at a part thereof overlying a portion of the groove **17** thereof. In the body **26** are embedded two metallic sockets **27, 28** one of which has a screw **29** in the bottom thereof extending into the cathode, said screw receiving one end of the heater wire thereon for electrical connection from the socket to the heater wire. The other socket **28** has a screw **30** in its bottom the head of which is toward the cathode and constitutes a contact point. The mid part of a bimetallic member **31** is opposite this contact screw **30**. The ends of the bimetallic member are forked and engage in and are retained by grooved studs **32**. At least one of these studs has connection with the other end of the heater element. Normal position of the bimetal member is as shown in Fig. 2 with contact being made with screw or contact **30** thereby effecting a closed heating circuit from socket **28**, through contact screw **30** to bimetal member **31** to stud **32** thence through the heater element around the cathode and finally to the other socket **27** through its screw **29**. When the cathode attains a predetermined torrid state, the bimetal member becomes oppositely bowed and thereby disengages contact **29** and opens the circuit.

Experience has taught that in magnetrons a large proportion of electrons return to the cathode and bombard the cathode to such extent that the bombardment supplies adequate heating effect for the cathode to maintain continuing emission thereof. By the present invention, therefore, the heater current is discontinued automatically when bombardment adds its heat and thus the cathode does not suffer overheating by the heater and bombardment continuing simultaneously when proper emitting temperature is attained and while that temperature lasts. However, if the bombardment fails to maintain sufficient temperature of the cathode, the bimetallic switch again closes and the heater once more functions to augment the heat supply. It is to be

further noted, that since the cathode is outside the anode, it presents a far more extensive area and will not only produce a more copious supply of electrons but also avoids concentration of bombarding electrons returning thereto. Proximity of the cathode to the exterior aids in keeping the temperature from becoming excessive.

Attention is also called to the anode structure which provides its resonant cavities opening at the periphery by virtue of which they are more easily and accurately machined than when opening inwardly. Provision of central passage constitutes a most convenient and effective structure for cooling purposes. To assure a tight seal notwithstanding difference in expansion, a washer-like flexible diaphragm **33** may overlap the joint of one end cap **21** and hub **11**, said diaphragm having its inner periphery sealed to the hub and its outer periphery to the said cap.

Replacement of the cathode heater is readily accomplished in the field, as it will be noted it does not require any disturbance of the vacuum seal of the magnetron. The heater element **18** is sufficiently pliable to be fed around the groove or sprung to slide laterally into place as found most convenient.

I claim:

1. A magnetron comprising an evacuated hollow enclosure providing a circumferential wall, a cathode having a body portion forming a part of said circumferential wall, said cathode having a circumferential surface exposed at the exterior of said enclosure, and having an emitting surface within said enclosure facing radially inward thereof, an anode in said enclosure and girdled by said cathode, said anode having a plurality of radial slots opening through the outer periphery of the anode toward the inwardly facing emitting surface of the cathode and constituting cavity resonators, and a heater for said cathode outside of said enclosure next said body portion of the cathode.

2. A magnetron comprising an evacuated hollow enclosure having an exterior circumferential wall, an annular cathode of which a part thereof constitutes an annular part of the circumferential wall of the magnetron, said cathode having a circumferential surface exposed at the exterior of said enclosure, an anode within the magnetron and within said cathode, said anode having a plurality of radial slots opening through the outer periphery of the anode toward the inwardly facing emitting surface of the cathode and constituting cavity resonators, and a heater for the cathode next the said exterior surface of the annular part of the exterior wall of the cathode and at the outside of said magnetron.

3. A magnetron comprising an evacuated enclosure, a hollow cathode having an electron emitting part thereof facing radially inward within said enclosure and having a circumferential part exposed at the exterior of the enclosure facing radially outward, said circumferential part having a groove in its outer side exposed radially outward at the exterior of the enclosure, a heater for said cathode in said groove exterior to the enclosure, and an anode situated within said enclosure and radially within the cathode.

4. A magnetron comprising an evacuated enclosure, a cathode forming a part of said enclosure with one portion exterior to the enclosure and another portion interior to the enclosure, said interior portion of the cathode having an emitting area thereon within said enclosure, said emitting area within the enclosure being of great-

er extent than the entire area of the portion of the cathode at the exterior of said enclosure.

5. A magnetron comprising an evacuated enclosure containing a cathode and anode with the cathode engirdling the anode and said cathode having an exterior circumferential recess therein, a substantially circular heater for and around said cathode and within said recess and having ends spaced from each other in the recess of said cathode, and a bimetallic switch in the said recess and between the said spaced ends of the heater, said switch being in series with said heater.

6. An electron discharge device comprising an anode, a cathode having a non-emissive face and an emissive face, the emissive face being directed toward said anode for discharge of electrons to the anode, heat-actuated switch means next a mid-part of the cathode at the non-emissive face thereof, and an electric heater in proximity to the cathode at the said non-emissive face thereof for heating the cathode, said heater being in series with said switch means for automatic control of said heater by the heat condition of the mid-part of the cathode.

7. An electron discharge device comprising an anode, a cylindrical cathode around said anode, said cathode having an external non-emissive face and an internal emissive face toward said anode for discharge of electrons to the anode, a heater for said cathode substantially encircling said cathode intermediate the ends of the cathode at the non-emissive face thereof, and a bi-metal snap switch in series with said heater next the non-emissive face of said cathode and substantially as close to and at the same distance intermediate the ends of the cathode as the heater.

8. An electron discharge device comprising an anode, a cylindrical cathode opposed to said anode for discharge of electrons to the anode, said cylindrical cathode having a circumferential region thereof intermediate its ends constituted as a thin wall for prompt conduction of heat therethrough, the portions of said cathode between said ends and thin-wall region providing walls of greater thickness than said thin wall for heat retention and distribution, a heater next said thin-wall region of the cathode for heating the cathode, and a heat-actuated switch in series with said heater and in proximity to said thin-wall region of the cathode for automatic control of said heater by heat condition of the cathode.

9. An electron discharge device comprising an anode, a cylindrical cathode opposed to said anode for discharge of electrons to the anode, said cylindrical cathode having a region circumferentially thereof and intermediate the ends of the cathode constituted as a thin wall for prompt conduction of heat therethrough, the portions of said cathode between said ends and thin-wall region providing walls of greater thickness than said thin wall for heat retention and distribution, a heater circumferentially of and next said thin-wall region of the cathode at the outside of and

for heating said cathode, and a heat-actuated switch also at the outside of said cathode and in series with said heater and in proximity to the thin wall region of the cathode for automatic control of said heater by heat condition of said thin-wall region of the cathode.

10. An electron discharge device comprising a hollow evacuated cylindrical structure, having an outer surface exposed to the atmosphere at the exterior thereof, an anode coaxial to and within said hollow evacuated cylindrical structure, a cylindrical cathode having an electron emitting surface within said hollow evacuated cylindrical structure and having an outer cylindrical region constituting a part of said outer surface exposed to the atmosphere at the exterior of said hollow evacuated cylindrical structure, and a heater for said cathode substantially encircling said outer exposed cylindrical region of the cathode exterior to the evacuated hollow cylindrical structure thereby enabling said heater to be applied and replaced without disturbing the evacuated condition of the said hollow evacuated cylindrical structure.

11. An electron discharge device comprising a hollow evacuated cylindrical structure having an outer surface exposed to the atmosphere at the exterior thereof, an anode coaxial to and within said hollow evacuated cylindrical structure, a cylindrical cathode having an electron emitting surface within said hollow evacuated cylindrical structure and having an outer cylindrical region constituting a part of said outer surface exposed to the atmosphere at the exterior of said hollow evacuated cylindrical structure, a substantially circular heater for said cathode, said heater being less than a complete circle thereby providing ends enabling said heater to be applied to and removed from said outer cylindrical region of the cathode, and an automatic heat-responsive switch in series with said heater and interposed between the ends of the same.

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