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MAGNETRON CATHODE STRUCTURE

Filed June 28, 1961

FIG. 1

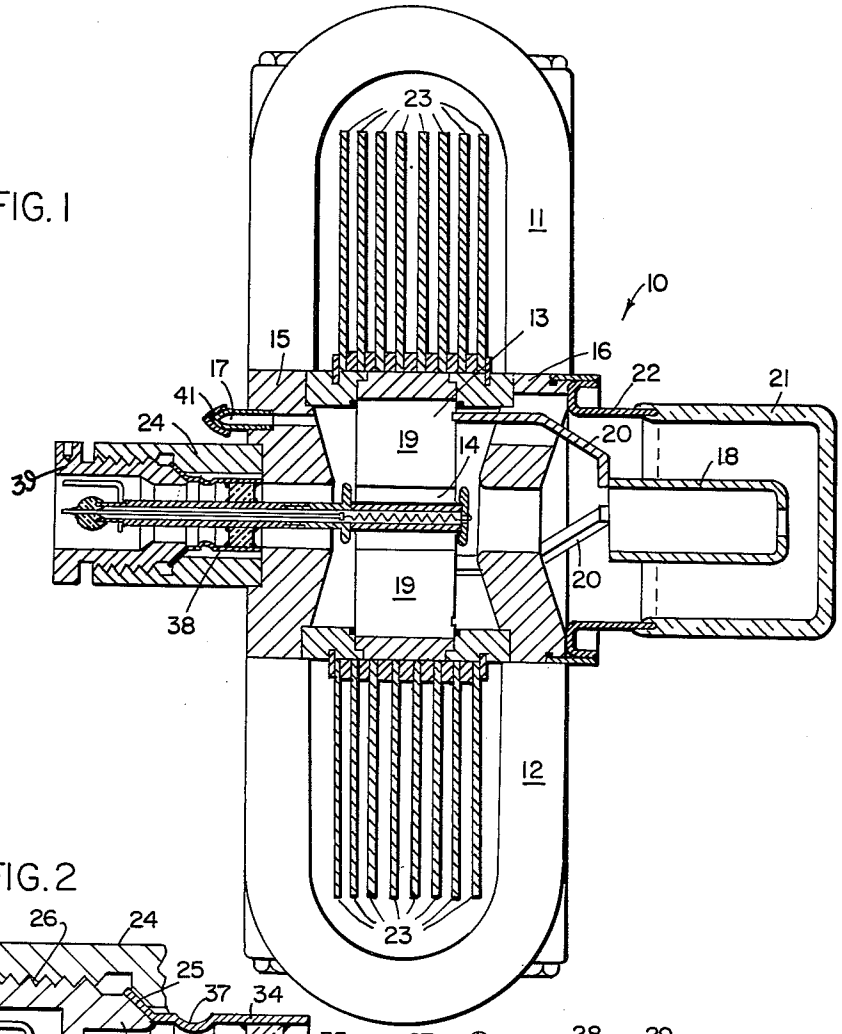
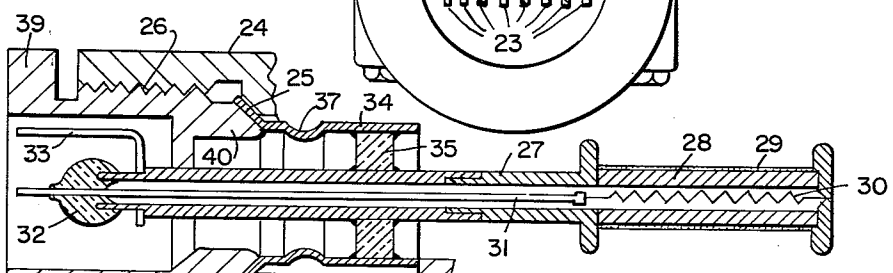


FIG. 2



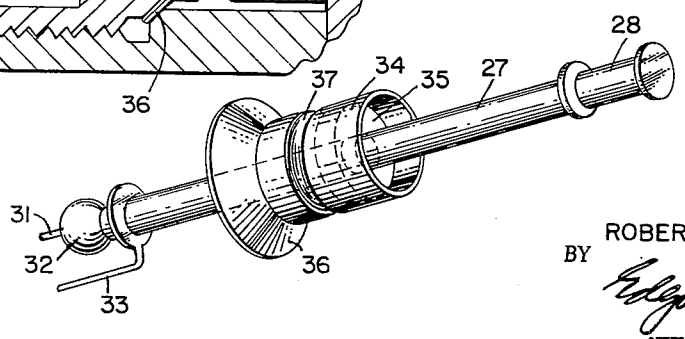


FIG. 3

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MAGNETRON CATHODE STRUCTURE

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The present invention relates generally to magnetron oscillator devices and, in particular, to a new and unique cathode structure.

The magnetron is a well-known device for the generation of radio frequency energy in the microwave spectrum. One of the many problems associated with the usage of these devices in radar transmitters is the overall life which is critically dependent upon the source of continued emission of the electrons. Since the procurement costs of magnetrons is quite high, failure of a relatively small component of the overall structure, such as the cathode-emitter, warrants consideration of a means for reactivation by replacement of the cathode structure. Such replacement, however, is complicated by the fact that all applicable devices are highly evacuated and depend for their operation on the degree of vacuum existent within the tube envelope.

It is, therefore, a primary object of the present invention to provide a new and unique replaceable cathode structure for magnetron oscillator devices.

A further object of the invention is the provision of a replaceable cathode structure which assures maintenance of the high degree of vacuum necessary for the proper functioning of the tube.

A feature of the present invention resides in a wholly integral and separable cathode assembly which when inserted into the tube envelope assures a vacuum-tight seal at the point of contact. This vacuum seal is attained without resort to soldering, brazing or other prior art vacuum sealing techniques. An advantage of the structure is that costly tubes need not be discarded as a result of being inoperative due to heater burn out, short-circuiting of heater elements, cathode poisoning or lack of sufficient emissive material. The faulty cathode structure may be removed and a completely new one installed in a minimum of time without special tools being required and the overall tube may be re-evacuated to the high vacuum desired.

Other objects, features and advantages will be apparent after consideration of the following detailed specification taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a detailed cross-sectional view of an illustrative embodiment of the invention;

FIG. 2 is an enlarged cross-sectional view of the cathode structure of the present invention; and

FIG. 3 is a perspective view of the embodiment prior to insertion into the magnetron tube envelope.

Referring to FIG. 1 the magnetron oscillator **10** illustrated is of the so-called packaged-type incorporating external magnets **11** and **12** to generate microwave energy at a specific fixed frequency. An anode member **13** of the multi-segmented type defines a plurality of resonant cavities surrounding a central passageway **14**. Outer pole pieces **15** and **16** abut opposite ends of the anode member **13** to facilitate the direction of the magnetic field into the interaction space defined by the resonant cavities. The combined pole pieces and anode member define the overall tube envelope which is generally evacuated by means of exhaust tubulation **17** joined to pole piece **15**.

Energy generated by the magnetron tube may be coupled by means of a short section of coaxial line **18** joined to the anode member vanes **19** by means of legs **20**. A dielectric enclosure **21** surrounds the outer end of the coaxial line **18** and is joined to the tube envelope by means of a metallic cup **22** to thereby vacuum seal this end of the

tube envelope. Cooling fins **23** mounted on the tube envelope, permit cooling by means of the direction of forced air on the lateral surfaces thereof.

The opposite end of the tube envelope supports a cathode electrode assembly which is easily inserted and removed in accordance with the teachings of the present invention. This assembly will now be described with attention being directed to FIGS. 2 and 3. A tubular extension **24** is joined to the outer end of pole piece **15**. The inner walls of extension **24** are counterbored to provide a chamfered seat **25**. In addition an inner threaded section **26** is provided adjacent to the outer end of this extension. I next provide an integral and unitary sub-assembly comprising an elongated tubular support member **27** having a substantially spool-shaped configuration disposed at one end thereof. This section, indicated by the numeral **28**, is coated with a layer **29** of an emissive material commonly employed in the art. If desired, this end of the support member may be adapted for one of the dispenser-type cathode-emitters wherein a porous tungsten metal is impregnated with the emissive material. Axially disposed within the support member **27** is a heater element **30** together with the electrical connection means **31**. The outer end of support member **27** is vacuum sealed by means of a glass-to-metal seal **32**. The conventional high voltage connection means include a terminal connector **33** joined at this end of the support member **27**.

A coaxially disposed hollow sleeve member **34** is joined at an intermediate point to support member **27** by means of a dielectric member **35**, such as glass or ceramic bead. Sleeve member **34** is desirably fabricated of a soft deformable metal such as copper, and is provided with a flared flange **36** at one end thereof. In addition, a convoluted section **37** is provided to thereby relieve any strains which might possibly damage dielectric seal **35**.

Whenever replacement of the cathode electrode structure is desired the inoperative cathode may be removed and a completely new assembly inserted into the axial passageway **38** which communicates with the anode central passageway **14**. The cathode electrode assembly may be inserted until the flared flange **36** of sleeve member **34** contacts the chamfered seat **25**. A threaded plug **39** is then introduced into extension **24** with its nose portion **40** contacting flange **36**. Since this portion is tapered to mate with flange **36** and seat **25**, rotation of the plug will result in compression of the soft copper material. This will result in a substantial "cold" metal-to-metal seal which will effectively retain the vacuum condition of the overall tube. The threaded portion **26** as well as the plug threads may be carefully controlled to assure a good fit.

After insertion of the new cathode electrode assembly the overall magnetron tube may be re-activated by conventional vacuum pumping techniques and exhaust tubulation **17** will be tipped-off and sealed as at **41**.

As a result of the teachings of this invention a simple and efficient means is provided for the continued operation of the high cost magnetron tubes. Prior art magnetrons not embodying the tubular extension **24** may be easily converted and adapted with such a member at a minimum of cost. Replacement cathode assemblies can always be maintained readily available and can be inserted with a minimum of skilled labor required. While a specific embodiment of the invention has been described herein, various modifications or alterations will occur to persons skilled in the art without departing from the scope thereof. It is intended, therefore, that all matter contained in the above specification or shown in the accompanying drawings shall be interpreted in a manner consonant with the definition of the invention in the appended claims.

What is claimed is:

1. A magnetron oscillator comprising a multi-segmented anode resonator defining a central passageway, pole piece members of a magnetic material abutting opposite ends of said resonator, a tubular extension member joined to the outer end of one of said pole piece members, said tubular extension member defining a passageway communicating with said central passageway and wall structure defining a seat disposed therein, a unitary cathode electrode assembly removably disposed within said tubular extension member, said cathode electrode assembly comprising a tubular support member having disposed at one end thereof an emissive material, a hollow sleeve member coaxially disposed about an intermediate point of said support member and being joined thereto by a vacuum-tight seal, said sleeve member defining a flange portion adapted to mate with said seat when the latter is contacted and means for retaining under compression the contacting surfaces of said flange and seat to thereby effect a cold metal-to-metal vacuum seal.

2. A magnetron oscillator comprising a cylindrical multisegmented anode resonator defining a central passageway, a plurality of magnetic metallic pole piece member joined to opposite ends of said resonator, a metallic tubular extension member joined to the outer end of one of said pole piece members, said tubular extension member defining a passageway communicating with said central passageway and wall structure defining a chamfered seat disposed therein, a unitary cathode electrode assembly adapted to be inserted within said passageway, said cathode electrode assembly comprising an elongated metallic tubular support member having disposed at one end thereof a coating of an emissive material, a hollow metallic sleeve member coaxially disposed about an intermediate point of said support member and being joined thereto by a dielectric seal, said sleeve member defining a flared flange portion adapted to mate with said seat when the latter is contacted and means for retaining under compression the contacting metallic surfaces of said flange and seat to thereby effect a cold metal-to-metal vacuum seal.

3. A magnetron oscillator according to claim 2 wherein said sleeve member defines a convoluted section adjacent to the flange portion.

4. A magnetron oscillator according to claim 2 wherein wall structure adjacent to the outer end of said extension member passageway defines an internal threaded section.

5. A magnetron oscillator according to claim 2 wherein said retaining means comprise a threaded plug member extending into said extension member passageway with its inner end contacting said flange and seat.

6. A cathode electrode assembly for electron discharge devices of the magnetron type comprising an elongated hollow tubular member defining at one end thereof an area of an emissive material, a heater element disposed within said tubular member and being joined thereto by a vacuum retaining seal, a hollow sleeve member of a soft deformable metal coaxially disposed about an intermediate point of said tubular member and being joined thereto by a vacuum retaining seal, said sleeve member defining a tapered flange portion and an intermediate convoluted section, and high voltage electrical connection means disposed at the non-emissive end of said tubular member.

7. In a magnetron oscillator device having a cylindrical metallic envelope with a hollow tubular extension member joined at one end thereof to provide a passageway communicating with the interior of said envelope, a cathode electrode assembly adapted to be inserted into said passageway, said cathode electrode assembly comprising an elongated hollow tubular member having disposed at one end thereof a coating of an emissive material, a heater element disposed within said tubular member and being joined thereto by a dielectric-to-metal seal, a hollow sleeve member of a soft deformable metal coaxially disposed about an intermediate point of said tubular member and being joined thereto by a dielectric-to-metal seal, said sleeve member defining a tapered flange portion and in intermediate convoluted section and means for retaining said cathode assembly within said extension member passageway.

8. In a magnetron oscillator device according to claim 7 wherein said retaining means comprise a threaded plug member having its inner end tapered to mate with said flange portion to thereby compress same against wall structure defined within said passageway to provide a cold metal-to-metal vacuum joint at the point of contact.

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