Oct. 20, 1959 E. C. OKRESS 2,909,701

CATHODE HEATER SYSTEM FOR ELECTRON DISCHARGE DEVICE

Filed July 6, 1955 2 Sheets-Sheet 1

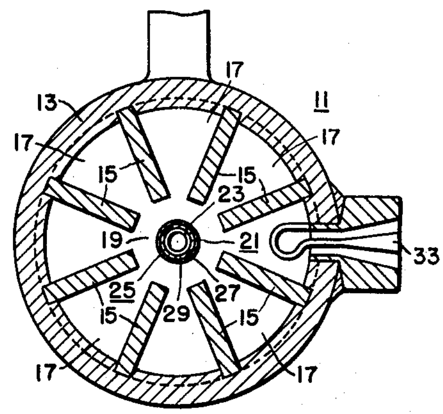


Fig. 1.

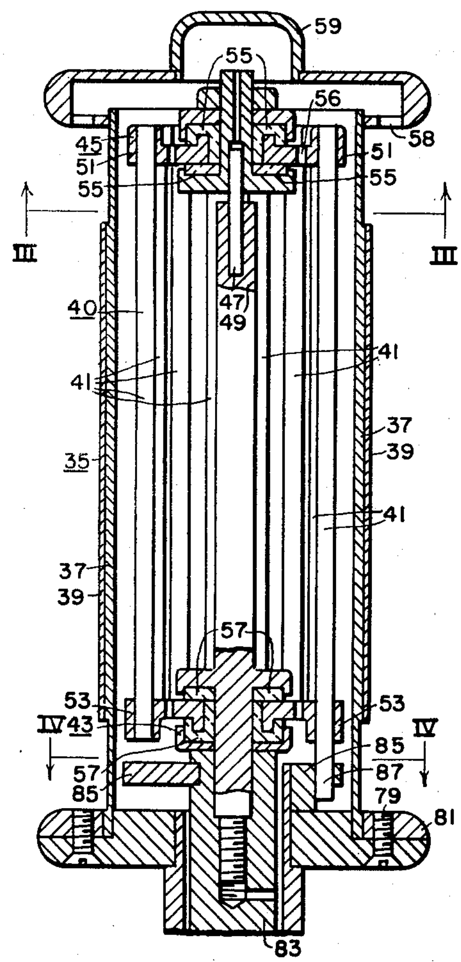


Fig. 2.

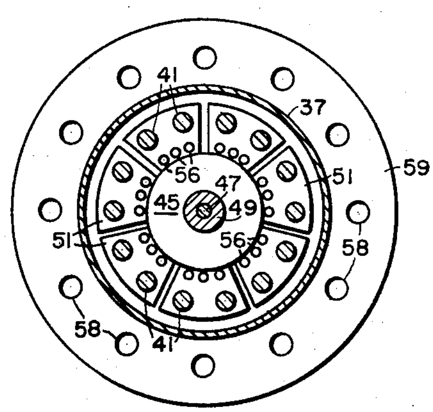


Fig. 3.

WITNESSES

*Leon M. Garman*

*H O Blair*

INVENTOR

Ernest C. Okress

BY *F. E. Browder*

ATTORNEY

Oct. 20, 1959 E. C. OKRESS 2,909,701

CATHODE HEATER SYSTEM FOR ELECTRON DISCHARGE DEVICE

Filed July 6, 1955 2 Sheets-Sheet 2

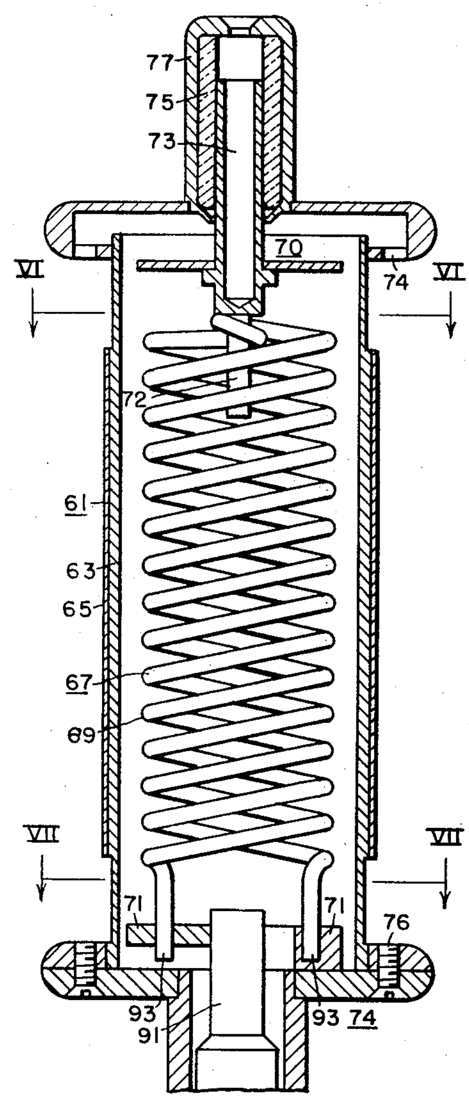


Fig. 5.

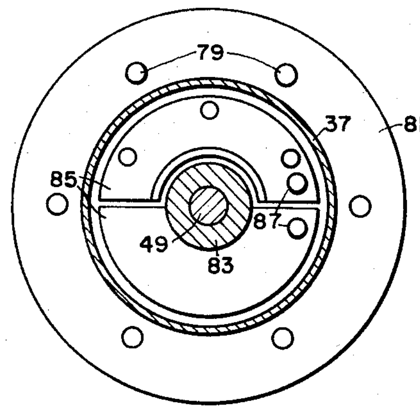


Fig. 4.

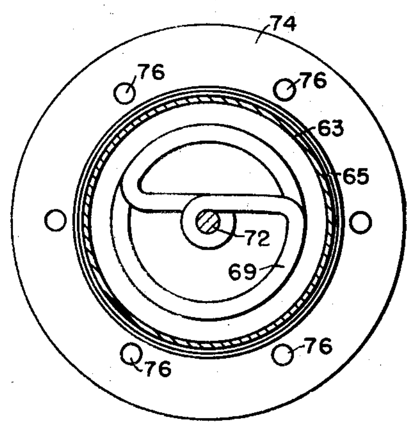


Fig. 6.

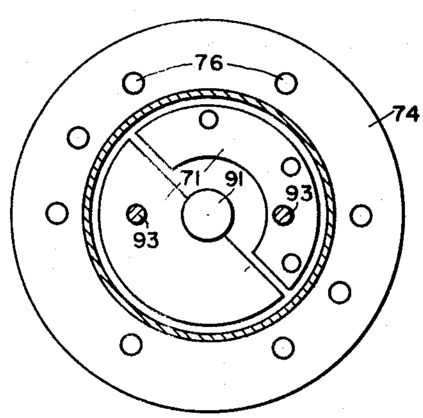


Fig. 7.

United States Patent Office

2,909,701

Patented Oct. 20, 1959

1

2,909,701

# CATHODE HEATER SYSTEM FOR ELECTRON DISCHARGE DEVICE

Ernest C. Okress, Elmira, N.Y., assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Application July 6, 1955, Serial No. 520,188

5 Claims. (Cl. 313—278)

This invention relates to electron discharge devices and, more particularly, to a cathode heater assembly for an electron discharge device.

It is an object of this invention to provide an electron discharge device having an improved cathode heater system.

Another object is to provide an electron discharge device having an improved cathode heater filament structure.

A further object is to provide an electron discharge device with an improved cathode heater which is compensated for variations in temperature.

An additional object is to provide an electron discharge device having a non-inductive cathode heater system.

It is a different object to provide an improved cathode heater system having a substantial thermal drop from the cathode heater filament to the refractory insulators.

Still another object is to provide an improved cathode heater system suitable for use in a magnetron.

These and other objects of the invention will be apparent from the following description taken in accordance with the accompanying drawings, which form a part of this application, and in which:

Figure 1 is a top sectional view of a typical prior art magnetron in which type of electron discharge device my invention may be employed;

Fig. 2 is a sectional view of a cathode assembly embodying a first form of my invention;

Fig. 3 is a cross-sectional view along line III—III of Fig. 2;

Fig. 4 is a cross-sectional view along line IV—IV of Fig. 2;

Fig. 5 is a sectional view of a cathode assembly embodying a second form of my invention;

Fig. 6 is a cross-sectional view along line VI—VI of Fig. 5; and

Fig. 7 is a cross-sectional view along line VII—VII of Fig. 5.

In Fig. 1 there is shown a magnetron **11** including a housing body or anode portion **13** and plates or vanes **15**. The plates or vanes **15**, in cooperation with the anode portion **13**, generally define triangular, trapezoidal or sector-shaped pockets **17**, all of said pockets **17** being connected with a central chamber or pocket **19** where a cathode **21** is positioned. The cathode **21** in the present embodiment is shown as enclosing a helical filament **23** made preferably of tungsten. An electron emitting housing **25** includes an oxide coating **27**, such as thorium oxide, on a cylindrical sleeve **29** which may be composed of a metal such as molybdenum or tantalum. Also shown is the coaxial terminal or output lead **33**. Other coupling means than the coaxial terminal or output lead **33** may be used.

The operation of a magnetron of this type is more fully described in the United States Patent No. 2,520,-955, entitled "Trapezoidal Cavity Magnetron," Okress et al., issued September 5, 1950, and assigned to the same assignee as this application.

2

Fig. 2 is an embodiment of one form of my invention including a cathode **35** comprising a cylindrical sleeve **37**, which is coated with an electron emissive layer **39**. The cathode heater **40** includes heater filament members **41** which are substantially straight and comparatively heavy, e.g., 0.120 inch diameter. The heater **40** is rigidly supported at one end by the filament base assembly **43** and at the other end by the filament support assembly **45**. The filament support assembly **45** is longitudinally movable on an axial pin member **47** which is attached to an axial pin support member **49**. The filament support assembly **45** will move in either direction along the axis of the axial pin member **47**, because of the relative expansion and contraction of the filament members **41** and the axial pin support member **49** due to temperature variations. The filament support assembly **45** and the filament base assembly **43** include filament support members **51** and **53** in physical contact with the filament members **41**. Electrical insulator members **55** and **57** are in physical contact with the filament support members **51** and **53**, respectively, but are not in such contact with the filament members **41**. The filament support members **51** and **53** are made of a material with a high melting point, e.g., tantalum. In this way, a substantial thermal drop from the filament members **41** to the electrical insulator members **55** and **57** is provided by means of the filament support members **51** and **53** and the safe operating temperature of the respective electrical insulator members **55** and **57** is not exceeded. A top housing member **59** encloses the top of the cathode assembly. The cathode **35** is supported by a bottom housing member **81**. The flange portions of the bottom housing member **81** are secured together by screw members **79** or other suitable fasteners. Heater filament member lead portions **87** are supported by lead support members **85**.

In order to form a non-inductive filament system, an even number of filament members **41** are connected in series thereby reducing the creation of stray magnetic fields to a negligible amount. A non-inductive filament system is preferable because the associated magnetic field leakage due to high heater current would otherwise interfere with the operation of the electron discharge device.

Fig. 3 is a view of Fig. 2 along line III—III showing a cylindrical cathode sleeve **37**, the heater filament members **41**, the axial pin support member **49**, the axial pin member **47**, the filament support members **51**, the top housing member **59**, and a part of the filament support assembly **45**.

Fig. 4 is a view of Fig. 2 along line IV—IV showing a cylindrical cathode sleeve **37**, the heater filament member lead portions **87**, the bottom housing member **81**, the axial pin support member **49**, the filament base assembly support member **83**, the lead support members **85** and screw members **79**.

The elements of Figs. 2, 3 and 4 may be composed of, but are not limited to, the following materials: cylindrical sleeve **37**, molybdenum or tantalum; electron emissive layer **39**, thorium oxide; heater filament members **41**, tungsten; filament support members **51** and **53**, tantalum; electrical insulator members **55** and **57**, a refractory material such as aluminum oxide or beryllium oxide; axial pin member **47**, tungsten; bottom housing member **81**, molybdenum; filament base support member **83**, molybdenum; the lead support members **85**, molybdenum; axial pin support member **49**, molybdenum; and top housing member **59**, molybdenum.

Fig. 5 is an embodiment of another form of my invention including a cathode **61** comprised of a cylindrical sleeve **63** coated with an electron emissive layer **65**. The heater **67** includes a double helical filament member **69**, and is rigidly supported by heater support members 71 at one end. The other end of the heater 67 is movable along its axis and is attached to and guide by an axial pin system 70. The helical filament member 69 longitudinally moves the axial pin member 72. The longitudinal motion of the helical filament member 69, due to changes in temperature, will move the axial pin support member 73 in either direction along the axis of the guide member 75. In this way, no internal stress is caused in the helical filament member 69, because of thermal expansion or contraction, as would be the case if both ends of the helical filament member 69 were rigidly anchored. The guide member 75 is set in a top housing member 77, and the cathode 61 is supported by a bottom housing member 74. The flange portions of the bottom housing member 74 are secured together by screw members 76 or other suitable fasteners. Heater filament member lead portions 93 are supported by heater support members 71.

Fig. 6 is a view of Fig. 5 along line VI—VI showing the cylindrical sleeve 63, the helical filament member 69, the bottom housing member 74, the screw members 76 and the axial pin member 72.

Fig. 7 is a view of Fig. 5 along line VII—VII showing the bottom housing member 74, screw member 76, filament member lead portions 93, heater support members 71, base member 91.

The elements of Figs. 5, 6 and 7 may be composed of, but are not limited to, the following materials: cylindrical metal sleeve 63, molybdenum; electron emissive layer 65, thorium oxide; helical filament member 69, tungsten; axial pin member 72, tungsten; axial pin support member 73, molybdenum; guide member 75, beryllium oxide; top housing member 77, molybdenum; bottom housing member 74, molybdenum; base member 91, tungsten; and heater support members 71, molybdenum.

The cathode in all embodiments shown should be of the refractory type in order to withstand the high temperature which may be too high for a non-refractory cathode. The straight filament type of embodiment of the present invention as pictured in Figs. 2, 3 and 4 has certain advantages over the helical filament type embodiment as shown in Figs. 5, 6 and 7, and over the helical filament type that was common in prior art. If tungsten, the preferred material, is used, difficulties are encountered in forming and shaping a large diameter wire. Even if the wire does not break, it may be fragile after it is formed. Thermal expansion compensation, as in the helical structure disclosed in Fig. 5, and in the straight filament structure, as disclosed in Fig. 2 and the straight filament structure itself, as disclosed in Fig. 2, minimize this difficulty. It a thin helical filament were used, it would require continuous support by refractory insulators, which is not practical because, at the high filament temperatures necessary for operation, activation and degassing, there would be a reaction between the filament and the refractory insulator, thus gassing the device and destroying the filament. As disclosed previously relative to Fig. 2, a substantial thermal drop is provided between the filaments 41 and the refractory electrical insulators 55 and 57 by the filament support members 51 and 53, and, therefore, the safe operating temperature of the refractory electrical insulators 55 and 57 is not exceeded.

The same principles apply to the structure of Fig. 5 wherein a substantial thermal drop occurs between helical filament member 69 and the guide member 75.

While the present invention has been shown in certain embodiments only, it will be obvious to those skilled in the art that it is not so limited but is susceptible of various changes and modifications without departing from the spirit thereof.



I claim as my invention:

1. In an electron discharge device, the combination of a cathode assembly including a cathode and a non-inductive internal cathode heater, said cathode heater having an axis and a first and a second end, said first end being rigidly supported and said second end being slidably supported and being movable along said axis to compensate for changes in the axial length of said cathode heater due to temperature variations, said cathode heater being supported at said ends only, and electrical insulator means electrically insulating said second end from the rest of said discharge device.

2. In an electron discharge device, the combination of a cathode assembly including a cathode and an internal cathode heater, said cathode heater having an axis and a first and a second end, said cathode heater including an even number of straight filament members, said first end of said cathode heater being rigidly supported and said second end of said cathode heater being movable along said axis to compensate for changes in axial length of said cathode heater due to temperature variations.

3. In an electron discharge device, the combination of a cathode assembly including a cylindrical cathode and an internal cathode heater, said cathode heater having an axis and a first and a second end, said cathode heater including a plurality of cylindrically arranged straight filament members positioned co-axially relative to the axis of said cathode, said first end of said heater being rigidly supported and said second end of said cathode heater being attached to a filament support member, an axial pin, said filament support member being movable along the axis on said axial pin.

4. In an electron discharge device, the combination of a cathode assembly including a cathode and a non-inductive internal cathode heater, said cathode heater having an axis and a first and a second end, said cathode heater including a helical filament member, an axial pin system, said first end of said cathode heater being rigidly supported and said second end of said cathode heater being movable along said axis to compensate for changes in the axial length of said cathode heater due to temperature variations, said second end of said cathode heater being slidably attached to and guided by said axial pin system, said cathode heater being supported at said ends only, and electrical insulator means electrically insulating said second end from the rest of said discharge device.

5. In an electron discharge device, a cathode assembly including a cathode and a non-inductive internal cathode heater member, said cathode heater member having an axis and a first and a second end, said first end being rigidly supported and electrically connected to a source of electrical energy, said second end being slidably supported and being movable along said axis to compensate for changes in the axial length of said cathode heater member due to temperature variations, said cathode heater being supported at said ends only, an electrical insulator means electrically insulating said second end from the rest of said discharge device, said electrical insulator means being at least partially thermally insulated from said second end of said cathode heater.

**References Cited** in the file of this patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| 1,774,698 | Braselton | Sept. 2, 1930 |
| 1,989,819 | Parrott | Feb. 5, 1935 |
| 2,404,363 | Chevigny | July 23, 1946 |
| 2,466,922 | Wax | Apr. 12, 1949 |