# United States Patent

[11] 3,594,604


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[21] Appl. No. **730,140**
[22] Filed **May 17, 1968**
[45] Patented **July 20, 1971**



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## [54] HIGH-POWER ELECTRON TUBE HAVING TWO LONGITUDINALLY DISPLACED CATHODE SECTIONS

**10 Claims, 2 Drawing Figs.**


[52] **U.S. Cl.** ..... **313/278,** 313/271, 313/35, 313/279, 313/341
[51] **Int. Cl.** ..... **H01j 1/94,** H01j 19/48
[50] **Field of Search** ..... 313/271, 272, 273, 274, 275, 276, 277, 278, 279, 341, 35, 36



[56] **References Cited**

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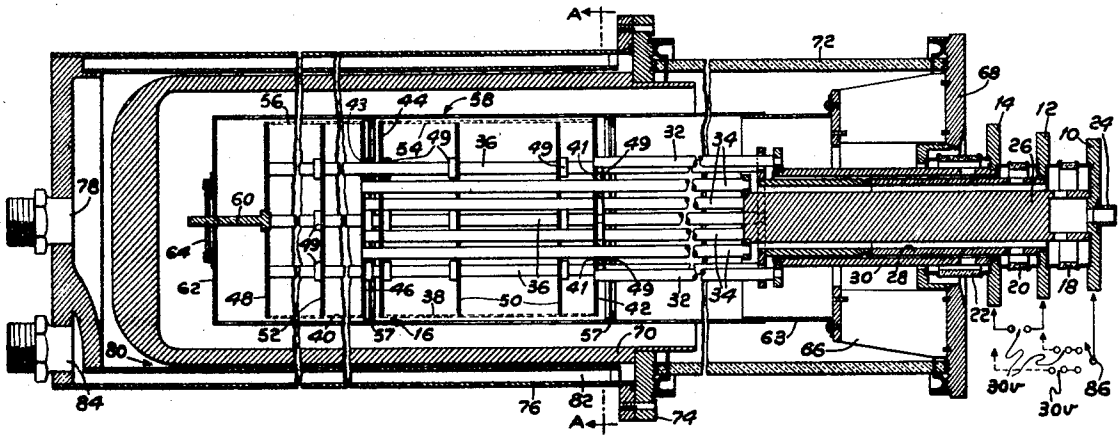
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**ABSTRACT:** A split cathode and support structure for a high-power triode permit operation at increased voltages and relatively low currents. Longitudinal conductive support members maintain dimensional stability of the elements while providing a common connection to both portions of the cathode.

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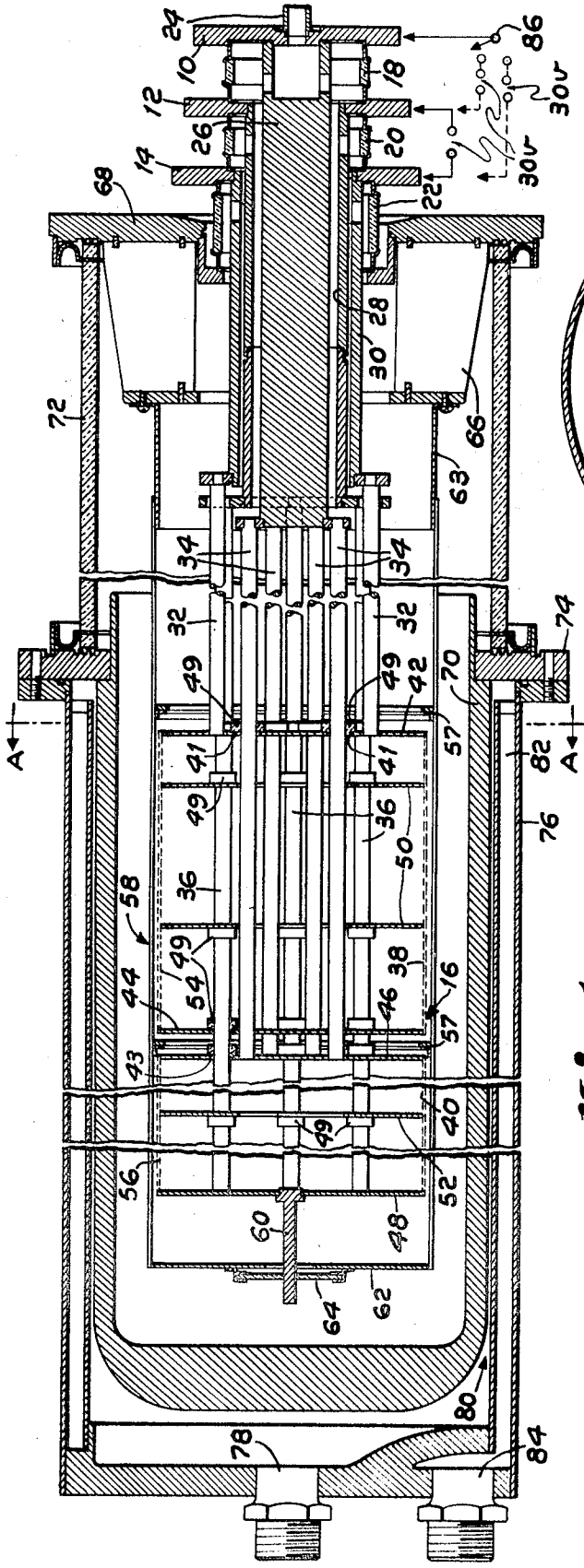


Fig. 1

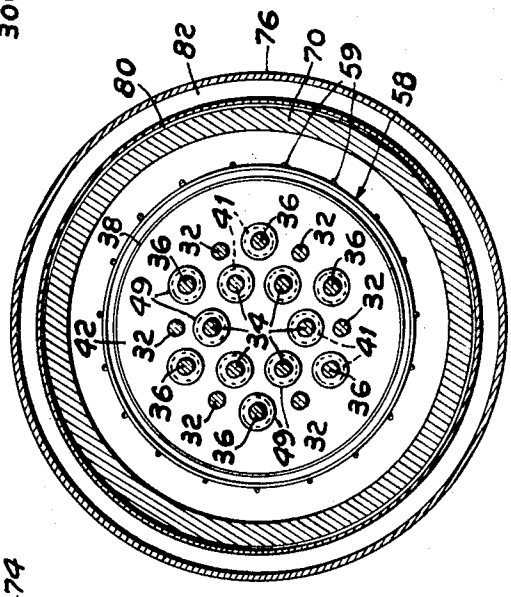


Fig. 2

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# HIGH-POWER ELECTRON TUBE HAVING TWO LONGITUDINALLY DISPLACED CATHODE SECTIONS

## BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an improved high-power electron tube and particularly to a novel cathode and support structure providing more efficient operation and simplified processing.

2. Description of the Prior Art

High-power tubes, such as used for pulse modulation or radar switches, operating in the multimegawatt range, are generally limited in cathode emission capability by large heating losses resulting from large filamentary cathode currents which also cause structural instability and sagging of the elements. In a known presently available power tube for example, the cathode operates at 7—8 v. and about 2,000 amps. While it is more efficient to utilize relatively higher cathode voltages and smaller currents to achieve a desired output, this has been difficult to accomplish since longer tube elements are required which would normally compound the structural and spacing problems.

## SUMMARY OF THE INVENTION

It is therefore the primary object of the present invention to provide an improved structure for a high-power tube which permits the use of relatively higher filamentary cathode voltages and lower currents while maintaining dimensional stability of the elements.

This is accomplished by a novel split cathode and support structure wherein longitudinally conductive support rods extend through a directly heated tubular mesh cathode which is divided into two longitudinal sections. One group of rods are connected in common to two centrally disposed lateral plates supporting adjacent ends of the mesh between the two sections and other groups connect to supporting plates at the top and bottom ends of the cathode. The long cathode and supports permit more efficient operation at higher voltages and lower currents with stable spacing of the elements, while the usual carburization processing of the cathode is facilitated by performing it in separate steps for each cathode section at lower than normal voltages. The details of the invention will be more fully understood and other objects and advantages will become apparent in the following description and accompanying drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a side view of the novel tube structure in partial cross section, and

FIG. 2 shows a plan view of the tube taken at section A–A of FIG. 1.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

As shown in FIG. 1, a coaxial-type high-power electron tube includes a base support having disc-shaped electrode connections **10**, **12**, **14**, preferably of copper, which provide external electrical connections to respective portions of a directly heated tubular wire mesh-type cathode, preferably of thoriated tungsten, shown by dashed lines and generally indicated at **16**. The electrodes are separated by ceramic spacers **18**, **20**, **22** along the tube envelope with kovar rings providing vacuumtight seals between the metal and ceramic elements. A central hollow tube **24** in the end of the base provides a sealed pinch-off used during evacuation. An inner longitudinal solid copper rod **26** and coaxial copper tubes **28**, **30** connect the external disc-shaped electrodes to a plurality of longitudinal cathode support rods **32**, **34**, **36**, preferably of molybdenum. The cathode is divided into two longitudinal sections **38**, **40**, with a first group of rods **32** being connected to a first transverse or lateral support plate **42** at the lower end of cathode section **38**. A second group of rods **34** extend through holes **41** in plate **42** and through section **38** and are connected in common to a second and third centrally positioned support plates **44**, **46** at the adjacent intermediate ends of the tubular mesh between the two cathode sections. The third group of rods **36** extend through both sections and holes **43** in plates **44** and **46** and connect to a fourth support plate **48** at the upper end of cathode section **40**. All of the rods passing through holes **41** and **43** are suitably insulated from the respective plates by insulating bushings **49**. As shown in FIG. **2**, there are a total of 18 rods with six in each group.



Pairs of additional support plates **50**, **52**, only one being shown in section **40**, are also insulatingly mounted on rods **36** to minimize bowing or sagging of the tubular wire mesh portions **54**, **56** between the ends of the respective cathode sections and maintain spacing with respect to the helically wound wires of the surrounding coaxial control grid **58**, shown generally in solid lines in FIG. **1**. Annular flanged grid support members **57** reinforce the grid along the midsection to aid in maintaining proper spacing. The grid is formed of molybdenum wire preferably treated with a coating to inhibit primary and secondary electron emission and is pressed into lateral slits in a plurality of thin vertical wire rods **59**, as shown in FIG. **2**. A further molybdenum rod **60** is mounted on the upper cathode support plate **48** to provide support and maintain centering and spacing of the grid with respect to the cathode. Rod **60** passes through a hole in a molybdenum plate **62** at the top of the grid, with a quartz insulating disc **64** aligning the rod and plate. The quartz disc is secured to and extends laterally across the plate **62** which provides a partial heat shield for the disc. The lower end of grid **58** is welded to a tubular grid support **63** which is in turn mounted on radial copper slabs **66** extending around the base of the tube, with copper disc **68** providing electric connections thereto.

A tubular copper anode **70** surrounds the grid and is supported on a cylindrical ceramic spacer **72** forming a portion of the envelope extending from the grid electrode connection **68**. The ceramic spacer **72** is designed to withstand high voltages. External electric connections to the anode are made to copper rings **74** sealed to the ceramic. An external water cooling jacket **76** surrounds the anode, with water entering at an orifice **78** at one end of the anode, flowing through inner passage **80** past anode ring **74**, through outer passage **82** and out of opening **84**. The entire tube may also be immersed in oil, if necessary, to avoid external voltage breakdown or arcing. In operation, the anode voltage may be in the order of 60,000 v., with peak pulse power in excess of 50 megawatts being available. The overall length of the tube is about 3—4 feet.

The split cathode arrangement permits use of relatively higher cathode voltages and lower currents, which are in the order of 30 v. and 1,000 amps DC to provide improved efficiency and dimensional stability. The two cathode sections, which are heated to about 2000° K., are designed to allow for expansion without distortion and are considerably stronger than a single cathode structure of double length. The cathode voltage is preferably applied between disc electrodes **12** and **14** which connect respectively to the upper and lower ends of the cathode so that the two sections are in a series arrangement. Disc electrode **10** may be used as a center tap connection in some applications and, if desired, the cathode sections may be operated in parallel. A typical grid bias of −4,000 v. DC is applied to the grid with a positive pulse of +5,000 v. required to permit conduction. In addition, during processing of the tube, by using the center tap connection **10** and a suitable switch **86**, the two cathode sections may be operated separately at different times to simplify cathode carburization. This is usually performed in a partial vacuum of 1 mm. of hydrocarbon gas to convert the thoriated tungsten cathode to tungsten carbide which has a much longer emission life. Only half the usual voltage is applied selectively to each section, thus eliminating long path discharge across filament members during the carburizing procedure. A current of about 1500 amps and 30 v. DC are applied to each section to heat the

cathode to about 2500° K. for a sufficient time to cause carburization. A small warmup potential may also be applied to the second cathode section during processing of the first in order to prevent difficulties which may be caused by wide temperature differentials between the two sections.

It may thus be seen that the present invention provides an improved high power electron tube with greater efficiency and stability. While only a single embodiment has been illustrated, the invention is not to be considered as limited to the exact form or use shown and many variations may be made in the particular design and configuration without departing from the scope of the invention as set forth in the appended claims.

We claim:

1. An electron discharge device comprising an evacuated envelope including a directly heated tubular wire mesh cathode, a coaxially arranged grid surrounding said cathode in spaced insulating relation thereto, and an anode surrounding said grid, said cathode having two longitudinally displaced tubular mesh sections, a plurality of longitudinal conductive support members for each said section extending within said cathode, one group of said support members forming a common connection between said two cathode sections, and electrical connection means for said anode, grid and cathode support members passing through said envelope.

2. The device of claim 1 wherein said longitudinal support members are metallic rods and said cathode includes lateral supporting plates at upper, lower and intermediate ends of said two sections, groups of said longitudinal support rods being connected to each said lateral plate, said one group passing through and insulated from said plate at said lower end and connecting together two intermediate end plates of said two cathode sections.

3. The device of claim 2 wherein said electrical connection means includes electrodes at the base of said envelope connected to said two cathode sections and to said common connection respectively.

4. The device of claim 3 wherein two electrodes are connected to said upper and lower ends of said cathode sections to provide a series arrangement for said cathodes.

5. The device of claim 4 including longitudinal support means insulatingly connected between said plate at said upper end of said cathode and said control grid.

6. The device of claim 5 wherein two electrodes are connected respectively between said common connection and one end of said cathode.

7. The device of claim 5 wherein said control grid comprises a plurality of vertical wire rods, a wire helically wound around said vertical rods, and annular support members along the length of said grid.

8. The device of claim 6 including means selectively applying a source of potential to said two electrodes connected between said common connection and one end of said cathode for each cathode section.

9. The device of claim 7 including anode cooling means surrounding said anode.

10. The device of claim 7 wherein said envelope includes ceramic spacers and means sealing said spacers between said electric connection means for said anode, grid and cathode members to withstand high-voltage breakdown.