July 29, 1947. W. W. EITEL ET AL 2,424,683

ELECTRON TUBE

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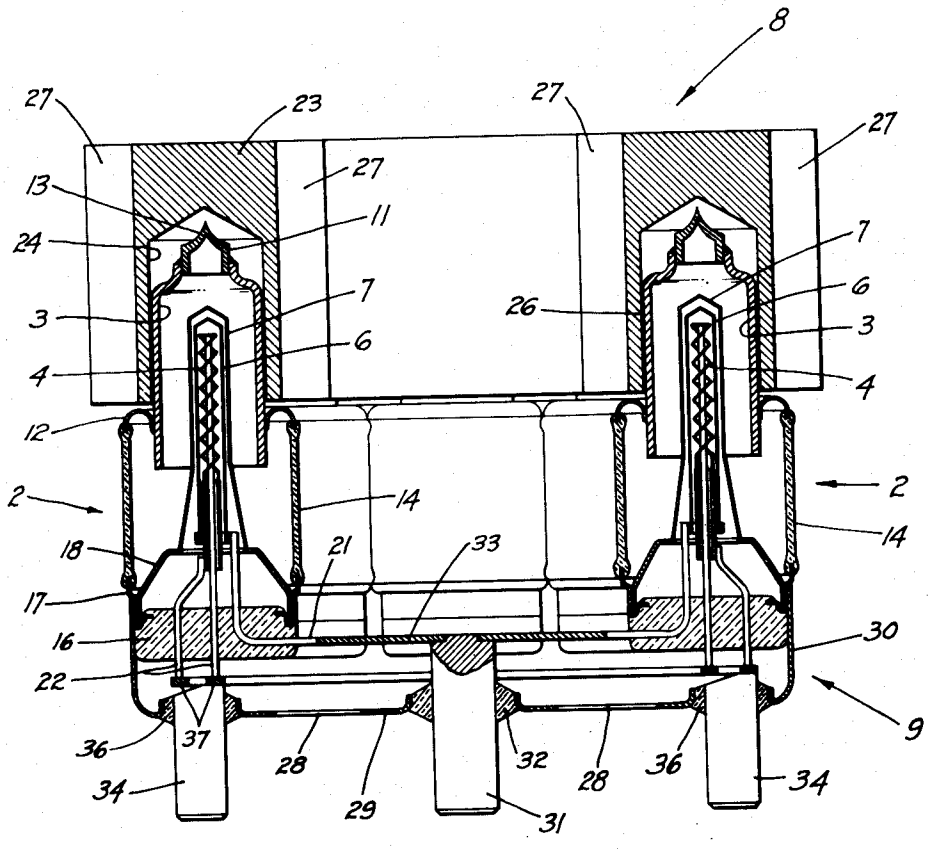


Fig. 1

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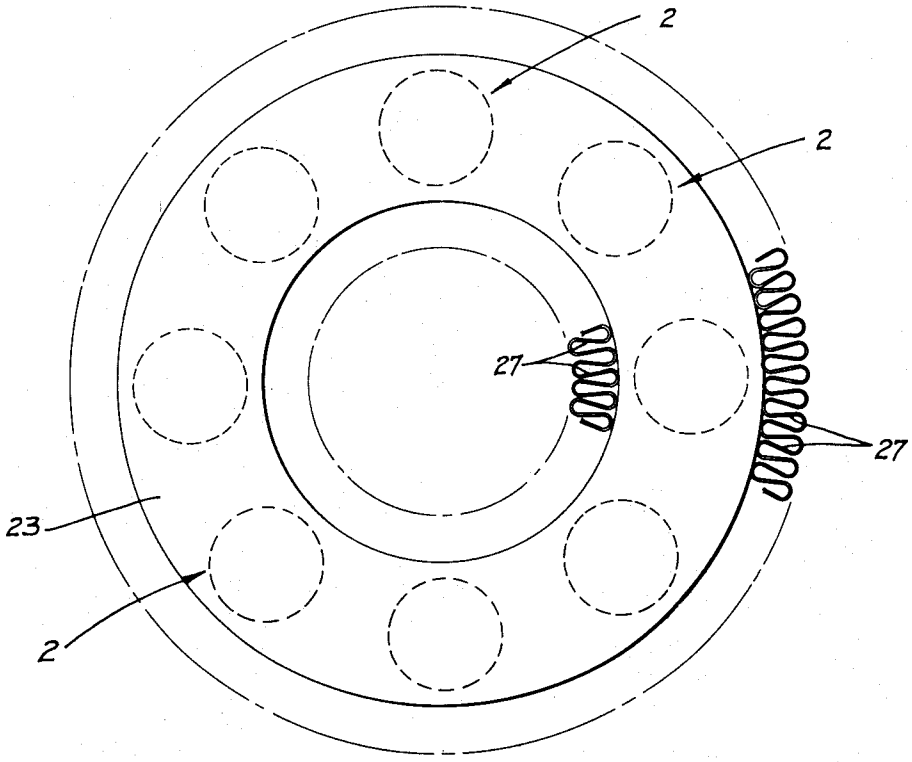


Fig. 2

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ELECTRON TUBE

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11 Claims. (Cl. 250—27.5)

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Our invention relates to electron tubes of the power or transmitting tube type.

The trend in electron tube design is toward tubes capable of operation at the higher frequencies. It is not difficult to achieve the desired electrical properties for good operation at high frequencies with tubes of small physical size because small tubes have certain inherent advantages from the standpoint of tube structure and geometry, such as maintaining closer electrode spacings and lower inductance leads. The disadvantage of small structures for power tube uses is the limitation on power output due to lack of heat dissipation from the electrodes, particularly from the anode. In other words, large physical size is incompatible with electrical properties required for higher frequency operation, and this would appear to put a ceiling on power output for high frequency tubes.

The broad object of our invention is to provide a tube capable of large power output without sacrifice of those electrical properties required for high frequency operation.

Another important object is to provide a tube structure which simplifies the manufacture of power tubes, and which enables a variety of tubes of different power ratings to be built, all from basic tube units made alike.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth in the following description of our invention. It is to be understood that we do not limit ourselves to this disclosure of species of our invention, as we may adopt variant embodiments thereof within the scope of the claims.

Referring to the drawings:

Figure 1 is a vertical sectional view of a tube embodying the improvements of our invention; and

Figure 2 is a top view of the same.

In terms of broad inclusion, our electron tube comprises a plurality of tube units, each unit comprising an envelope having a portion forming an anode. A cooler structure is provided on the tube, common to the anodes of the units. In our preferred tube construction the units are disposed in a circle and the cooler is a ring-shaped structure having recesses receiving the anodes. The tube units contain other electrodes, such as cathodes and grids, which electrodes are preferably connected to terminals arranged on a common base.

In greater detail, and referring to the drawings, our preferred tube comprises a plurality of

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cartridge-like tube units 2 having axes disposed parallel with the main axis of the tube. We show eight units, arranged in a circle, but a greater or less number of units may be incorporated in the tube. Each of the units shown is a tetrode-unit embodying an anode 3, cathode 4, control grid 6 and screen grid 7; it being understood, of course, that these units may be of other tube types, such as diodes or triodes.

Units 2 are each complete tube units, independently constructed and evacuated. Anodes 3 are of the external anode type adapted for cooling by forced air or the like, and are connected to a common cooler structure 8. This cooler structure is ring-shaped to accommodate the circular arrangement of tube units. A common base structure 9 spaced below cooler 8 is provided to embrace the projecting portions of tube units 2, this base being annular in shape to correspond with the circular outline defined by the tube units.

Anodes 3 are formed as portions of the envelopes of the individual units. Each anode preferably comprises a tubular body of metal, such as copper, carrying an exhaust tubulation 11 at the top and a sealing flange 12 adjacent the bottom. Tubulation 11 is brazed to the anode and, after evacuation of the envelope, is pinched off at tip 13. Flange 12 is sealed to a cylindrically-shaped envelope section 14 of vitreous material such as glass.

The internal electrodes of each tube unit are preferably supported from the lower portion of the envelope. As illustrated, a vitreous disk 16 sealed to a metallic ring 17 provides a closure for the lower end of the envelope, ring 17 being sealed to envelope section 14. Screen grid 7 is supported by a bracket 18 secured to ring 17 so that this ring functions as a lead-in conductor for the screen grid. The control grid 6 is supported on a rod sealed to disk 16 and having a bent portion providing a lead-in conductor 21 terminating at a side of the envelope below the screen grid conductor. The cathode illustrated is a double spiral filament secured to lead-in conductors 22 also sealed to disk 16, these conductors terminating below the envelope.

As shown in Figures 1 and 2 the plurality of tube units 2 are arranged in a circle about the tube axis and project downwardly from the common cooler structure 8. In our preferred tube, which is adapted for forced air cooling, the cooler comprises a ring-shaped core 23 of metal, such as copper, having recesses 24 for receiving anodes 3 of the units. The anodes are secured to core

23 by a fusible bonding material 26 of cadmium solder or the like. Radially extending fins 27 are provided on core 23 to further enhance removal of heat from anodes 3, these fins being preferably arranged on both inner and outer surfaces of the cooler core. For convenience in manufacture we preferably form the fins by corrugating a continuous strip of metal and brazing it to the core. Only part of the fin construction is shown in Figure 2 to simplify the drawing.

In operation of our tube an air stream is directed downwardly on the cooler. This air divides and passes down through the center of the tube as well as along the outside, thus flowing past both sets of fins 27. The central column of air also functions to cool the tube parts confined by base structure 9, suitable openings 28 being provided for exhaust of the air. This air flow may, of course, be reversed so as to be directed upwardly instead of downwardly through the tube.

Base structure 9 preferably comprises a cup-shaped metal piece 29 embracing the projecting portions of units 2 and having a flange 30 secured to rings 17. The base piece flange thus forms a common terminal for the screen grids of the several units. A common terminal 31 is also provided for the control grids of the units. As shown in Figure 1, the control grid terminal is disposed centrally of the tube and is mounted on base piece 29 by an insulating spacer 32. A spider 33 connects terminal 31 with inwardly projecting control grid conductors 21. A pair of cathode terminals 34 mounted on base piece 29 by insulating spacers 36 carry a pair of rings 37 secured to conductors 22, thus connecting the filaments in parallel.

It will be noted that control grid terminal 31 is concentric with screen grid terminal 30, and that both of these grid terminals are coaxial with cooler structure 9 which functions as a terminal member for the several anodes. This terminal arrangement is suited for external circuits involving coaxial lines.

Our improved tube is capable of high power output because of the large amount of heat that may be effectively dissipated from the group of anodes, the ring-like cooler structure with inner and outer fins being particularly efficient in that respect. The desired power output capabilities are achieved in our tube without sacrifice of the required electrical properties for high frequency operation because the relatively small individual tube units can be designed with close electrode spacings and short leads.

Another advantage of our improved tube structure is that it enables a variety of tubes of different power ratings to be built, all from basic tube units made alike. Thus, a tube type having four units, another having six units, etc., can be built in accordance with the teachings of our invention. Such a line of power tubes can be manufactured at a minimum cost because the basic units are identical.

Still another advantage of our tube structure is that, in event of failure of an individual tube unit, the worn out unit may be replaced without loss of the tube as a whole. An old unit may be removed from core 23 and a new unit resoldered in place whenever desired.

While we have shown tube units embodying substantially full external anodes, it is understood that the anodes may be of the internal-external type wherein the outwardly projecting portion of the anode functions largely as a heat conducting

member. In that event the outwardly projecting portions of the anodes would be soldered in the core recesses or apertures 24 in the same manner as illustrated with the full external anode type units, the extent to which the anodes project into the envelopes being immaterial from the standpoint of our invention.

We claim:

1. A multi-unit electron tube comprising a plurality of tube units rigidly connected together as a single structural body, each unit comprising an individual envelope having a portion forming an external anode, and a cooler structure carried by the anodes of said units.

2. A multi-unit electron tube comprising a plurality of tube units rigidly connected together as a single structural body, each unit comprising an individual envelope having a portion forming an external anode, a cooler structure carried by the anodes of said units, a cathode and grid in the envelope of each unit, and a grid terminal common to the grids of said units.

3. A multi-unit electron tube comprising a plurality of tube units rigidly connected together as a single structural body, each unit comprising an individual envelope having a portion forming an external anode, a cooler structure carried by the anodes of said units, a cathode and control grid and screen grid in the envelope of each unit, a grid terminal common to the control grids of said units, and a second grid terminal common to the screen grids of said units.

4. A multi-unit electron tube comprising a plurality of tube units rigidly connected together as a single structural body, each unit comprising an individual envelope having a portion forming an external anode, a cooler structure including a core having apertures receiving the anodes of said units, and a fusible bonding material interposed between the anodes and said core.

5. A multi-unit electron tube comprising a plurality of tube units disposed in a circle rigidly connected together as a single structural body, each unit comprising an envelope having a portion forming an external anode, and a circular cooler structure carried by the anodes and coaxial with said circle of units.

6. A multi-unit electron tube comprising a plurality of tube units, each unit having a plurality of electrodes and an individual envelope, and a rigid member tying the tube units together, said member affording a supporting connection between the tube units and providing a direct electrical connection between corresponding electrodes of each of said tube units.

7. A multi-unit electron tube comprising a plurality of tube units, each unit having a plurality of electrodes and an individual envelope, the upper part of the envelope constituting an external anode, and a cooler structure embracing the anodes of the several tube units and providing a direct electrical connection between said anodes, said cooler structure affording a supporting connection between the tube units.

8. A multi-unit electron tube comprising a plurality of tube units, each unit having a plurality of electrodes and an individual envelope, the upper part of the envelope constituting an external anode, a cooler structure embracing the anodes of the several tube units and providing a direct electrical connection between said anodes, a base structure engaging the lower portions of the envelopes of the several tube units and providing a direct electrical connection between corresponding electrodes of each of said tube units, said

cooler and base structures affording supporting connections between the tube units.

9. A multi-unit electron tube comprising a plurality of tube units disposed with their axes parallel to a common central axis, each unit having a plurality of electrodes and an individual envelope, and a rigid circular member concentric with said central axis tying the units together, said member affording a supporting connection between the tube units and providing a direct electrical connection between corresponding electrodes of each of said tube units.

10. A multi-unit electron tube comprising a plurality of tube units disposed with their axes parallel to a common central axis, each unit having a plurality of electrodes and an individual envelope, the upper part of the envelope constituting an external anode, a circular cooler structure concentric with said central axis embracing the anodes of the several tube units and providing a direct electrical connection between said anodes, and a circular base structure concentric with said axis engaging the lower portions of the envelopes of the several tube units and providing a direct electrical connection between corresponding electrodes of each of said tube units, said cooler and base structures affording supporting connections between the tube units.

11. A multi-unit electron tube comprising a plurality of connected tube units disposed about a vertical axis, each unit comprising an individual envelope with an external electrode, and cooler means carried by said electrodes and forming a vertical passage, said cooler means having fins projecting into said passage.

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