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ELECTRON TUBE AND SOCKET HAVING OVERLAPPING TERMINALS AND CONTACTS AND INTERENGAGING HOLDING MEANS

Filed March 26, 1962 2 Sheets-Sheet 1

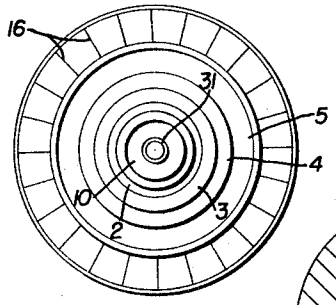


Fig. 2

Fig. 1

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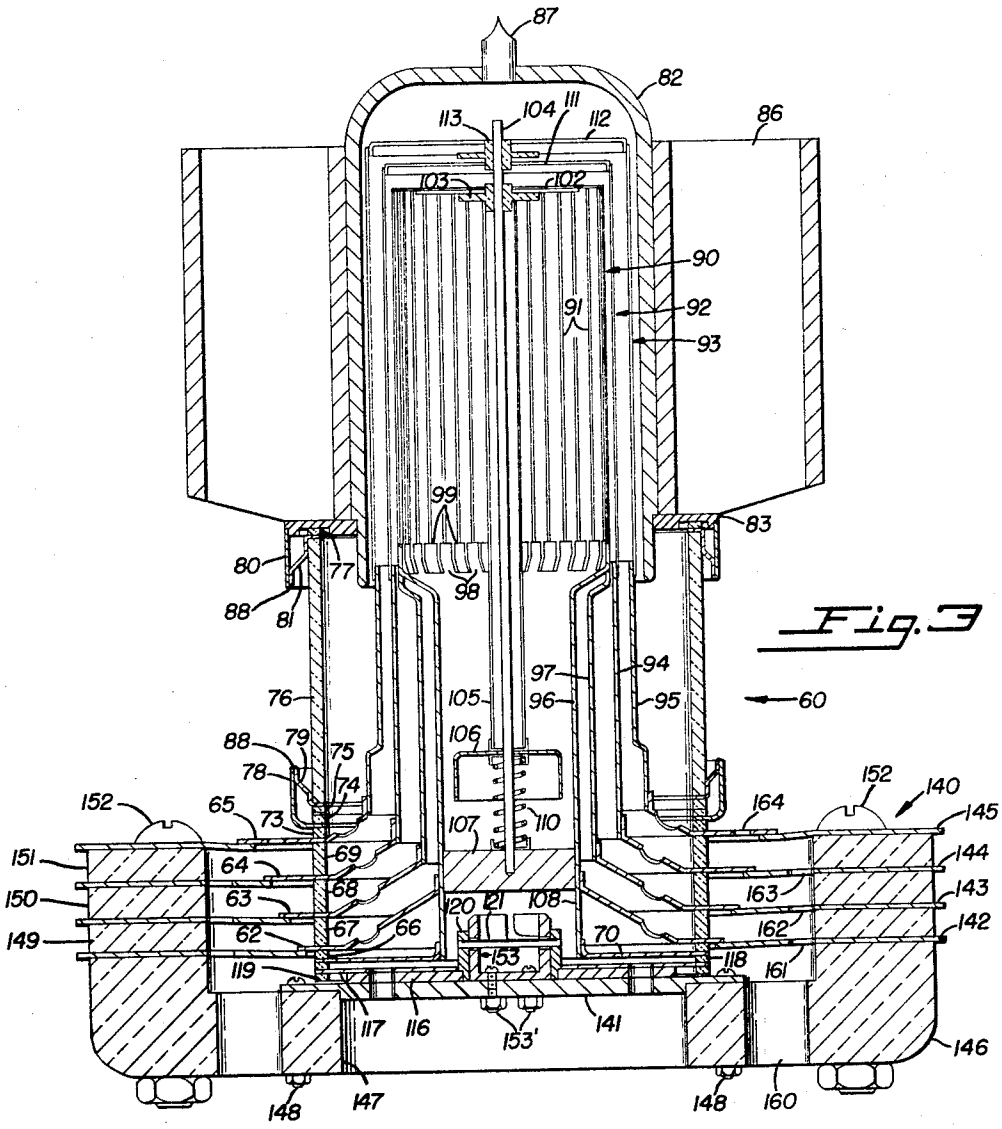


Fig. 3

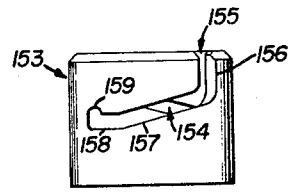


Fig. 4

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ELECTRON TUBE AND SOCKET HAVING OVERLAPPING TERMINALS AND CONTACTS AND INTERENGAGING HOLDING MEANS

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This invention relates to electron tubes and more particularly to an improved terminal arrangement for tubes and cooperating socket structure.

It has been proposed in the past to provide terminals on a tube in the form of axially spaced continuous rings of successively decreasing diameter. One of the reasons for this type of terminal is to provide increased terminal area and therefore increased current carrying capability, as distinguished from pin or tab type terminals. In most cases the socketing structure for such tubes involves ring-type contact fingers engaging the peripheral edges of the terminal rings. Another socketing arrangement suggested in the past has been to provide the socket with continuous rings which overlap the terminal rings and make contact along an annular surface on the face of the terminal rings. Although the latter arrangement has several desirable features it has not been widely adopted because of the difficulty of providing a practical means for inserting and holding the tube in the socket.

It is an object of this invention to provide an electron tube which obtains the benefit of ring-type terminals and yet has a simple and effective means for inserting and holding the tube in a socket.

Another object of the invention is to provide an electron tube of the type described in which the means for inserting and holding the tube in a socket does not materially add to the outside dimensions of the tube.

A further object of the invention is to provide electron tubes of the type described in which the means for inserting and holding the tube in a socket is easily adaptable to various types of tubes.

An additional object of the invention is to provide an improved electron tube socket which cooperates with improved tubes which meet the preceding objectives.

Another object of the invention is to provide an improved tube and socket assembly of the type described in which efficient cooling of the tube is possible.

By way of brief description an improved tube according to the invention comprises a terminal end having a side wall formed by continuous terminal rings separated by insulating cylinders. The terminal rings project outwardly of the insulating cylinders and are of successively increasing diameter, starting with the smallest diameter adjacent the end of said terminal end. The means for inserting and holding the tube in the socket comprises a locking arrangement at said terminal end. The socket comprises contact rings which cooperate with the terminal rings on the tube and a locking arrangement which cooperates with the locking arrangement on the tube, all as will be hereinafter described in detail.

Other and further objects and features of advantage will be apparent from the following detailed description which makes reference to the accompanying drawings in which:

FIGURE 1 is a cross-sectional view of a tube and socket embodying the features of the invention,

FIGURE 2 is a bottom view of the tube in FIGURE 1, on a greatly reduced scale,

FIGURE 3 is a cross-sectional view similar to FIGURE 1 but showing the invention embodied in a different tube, and

FIGURE 4 is a side view of the locking member on the socket of FIGURE 3.

Referring in more detail to the drawings, FIGURE 1 discloses a generally cylindrical tube **1**. The lower end of the tube is the terminal end and has a side wall formed by metal terminal rings **2–5** separated by short ceramic cylinders **6–9**. The terminal rings are of successively increasing diameter starting with the smallest ring **2** up to the largest ring **5**. The end wall at the terminal end of the tube is formed by a metal disk **10** which is attached to ceramic cylinder **6**. It will be noted that disk **10** is cone-shaped or recessed toward the anode for reasons to be hereinafter described.

Above ring **5** the tube envelope is formed by a ceramic cylinder **11** and an inverted cup-shaped metal anode **12**. Thin metal sealing rings **13** and **14** are attached to the members **11** and **12** and the final seal is formed by welding or brazing at **15**. Conventional cooling fins **16** are attached to the side of the anode, and a conventional pinch-off tubulation **17** is attached to the top of the anode. As is common in the art, the ends of all of the ceramic cylinders are metalized and brazed to the adjacent metal parts.

The tube contains a conventional cylindrical cathode can **20** surrounded by a conventional wire cage type control grid **21** and a similar screen grid **22**. Metal support cylinders **23**, **24** and **25** connect the cathode and grids to the terminal rings **3**, **4**, and **5**, respectively. The cathode is heated by a wire coil **27** which is connected at one end to a support pin **28** mounted on terminal ring **2** by means of the support portion **29**. The other end of the heater **27** is mounted on a support post **30** which is brazed in a central aperture in the end wall **10**.

Post **30** extends below wall **10** to provide a downwardly projecting threaded portion **31** which can be integral with post **30** or a separate piece brazed to the post. In either case, portion **31** has its rim **32** brazed to wall **10**. Thus it will be seen that post **30** and portion **31** are connected to wall **10** at two axially spaced positions to provide a very rigid structure. Threaded portion **31** provides the tube element which cooperates with the socket to pull the tube into the socket and hold it there. Since threaded portion **31** is located at the end and on the axis of the tube it does not increase the outside diameter of the tube at all, nor can it possibly interfere with flow of cooling air along the side wall of the tube. Also, since a part of threaded portion **31** fits within the recess formed by the end wall **10**, it adds only a relatively small amount to the length of the tube.

FIGURE 1 shows tube **1** mounted in a generally cylindrical socket **40** comprising a metal base portion **41** and four metal contact rings **42–45**. These metals parts are spaced apart by four insulating parts of dielectric material such as ceramic. The base insulating part is a cup-shaped member **46** having a countersunk central bore **47** providing a shoulder **48**. Base member **41** is shaped to match the countersunk bore **47**, and is brazed or otherwise secured therein. The other three insulating parts are short cylinders **49–51** which separate the contact rings **42–45**. Electrical contact can be made to rings **42–45** where they project outwardly of the insulting cylinders **49–51**. The metal rings **42–45** and the insulating members **46**, **49–51** can be conveniently assembled by a plurality of circumferentially spaced bolts **52**.

In order to obtain insertion of the tube in the socket and hold it there, the base portion **41** is provided with internal threads **53** which match the external threads on the tube member **31**. Cooling is made possible by means of circumferentially spaced holes **54–58** in members **46**, **42**, **43**, **4**, and **5**, respectively. Thus, cooling air forced against the bottom of the socket will flow along the side wall of the tube through the holes **54–58**.

FIGURE 1 discloses a tube of relatively small size such that the external rim around cooling fins **16** can be grasped by the fingers of one hand. Thus it is a simple matter to insert the tube in the socket until its threaded member **31** engages the base portion **41** of the socket and then rotate the tube so that the interengaging threads will draw the tube into the socket until end wall **10** of the tube is drawn tight against base portion **41** of the socket. The threads are thus stressed tightly together to provide a friction force preventing accidental loosening of the tube.

It will be appreciated that excellent electrical contact is assured between terminal rings **2–5** and contact rings **42–45** for two reasons. One reason is that the tube and socket parts are designed so that the overlapping contact and terminal rings engage each other before the end wall **10** of the tube bottoms out against base portion **41** of the socket. Thus, during insertion the terminal and contact rings experience a rotating or wiping contact therebetween which cleans the rings and assures good contact. Since the contact rings on the socket are engaged by the tube terminal rings prior to full insertion of the tube it will be appreciated that the contact rings **42–45** are deflected downwardly from their normal free positions. Thus, in addition to the wiping contact during insertion, the rings are stressed into tight contact after the tube has been fully inserted in the socket. Contact rings **42–45** on the socket are preferably made of weaker or thinner material than the terminal rings on the tube so that substantially all of the deflection will be experienced by the socket rings rather than the tube rings, for the reason that deflection of the tube rings might damage the hermetic seals between the tube rings **2–5** and the adjacent ceramic cylinders.

Obviously it is imperative that the outside diameter of terminal ring **2** be greater than the inside diameter of contact ring **42** in order to obtain overlapping contact between these rings. At the same time it is also imperative that the outside diameter of ring **2** be less than the inside diameter of every contact ring above contact ring **42** so that ring **2** can pass through all of the contact rings above ring **42**. Similarly, the outside diameter of each of the terminal rings **3**, **4** and **5** must be larger than the inside diameter of the contact ring it engages in FIGURE 1 and smaller than the inside diameter of every contact ring above the one it engages.

FIGURE 3 discloses the invention embodied in a tube **60** which differs in many respects from the tube in FIGURE 1 and thus portrays the facility with which the invention can be adapted to different types of tubes. For example tube **60** does not have the same internal structure as tube **1**. In addition tube **60** has substantially larger physical size as indicated by the following chart:

	Tube 1	Tube 60
Overall length	2.5 inches	15.5 inches.
Diameter of rim around cooling fins	1.65 inches	9.75 inches.
Weight	4 ounces	50 pounds.

Tube **60** is a generally cylindrical structure in which the lower end of the tube is the terminal end and has a side wall formed by metal terminal rings **62–65** and short ceramic cylinders **66–69**. The terminal rings are of successively increasing diameter starting with the smallest ring **62** up to the largest ring **65**. The end wall at the terminal end of the hermetically sealed tube envelope is formed by a metal disk **70** in cooperation with other structure which will be hereinafter described.

Above ring **65** the tube envelope is formed by ceramic rings or cylinders **73–77**, sealing flanges **78–81**, and a metal anode **82** having a metal mounting flange **83**. Conventional cooling fins **86** are attached to the side of the anode, and a conventional pinch-off tubulation **87** is attached to the top of the anode. The reason for the ceramic rings **73, 74, 75** and **77** is to strengthen the ceramic to metal brazes, and as is conventional, rings **74** and **75** are preferably not brazed to each other, nor is ring **77** brazed to metal flange **83**. The sealing rings are brazed or welded at **88**. As in the case of tube **1**, all the ends of the ceramic cylinders or rings, with the exceptions previously mentioned are metalized and brazed to the adjacent metal parts.

The tube **60** contains a conventional filamentary directly heated type cathode **90** made of hairpin wires **91**. The cathode is surrounded by a conventional wire cage type control grid **92** and a similar screen grid **93**. Metal support cylinders **94** and **95** connect the grids **92** and **93** to the terminal rings **64** and **65**, respectively. The cathode is supported by two metal cylinders **96** and **97** connected to terminal rings **62** and **63**, respectively. Cylinders **96** and **97** are slotted at their upper ends to form interdigital fingers **98** and **99**, respectively. Thus, the lower ends of each hairpin wire are arranged so that one is connected to a finger **98** and the other is connected to a finger **99**. The upper end of each hairpin wire is looped over a radial projection on a disk **102** carried by an insulating sleeve **103**. Sleeve **103** is guided on a center post **104** for axial sliding movement thereon. Sleeve **103** is attached to one end of a tubular member **105** which carries an inverted cup **106** on its other end. Cup **106** is centrally apertured to be freely slideable on post **104**.

As previously stated, the lower end wall of the hermetic envelope of tube **60** is formed in part by disk **70**. The remainder of the end wall is formed by a thick metal disk **107** brazed in cylinder **96** and by the portion **108** of cylinder **96**, which portion extends below disk **107** and is brazed to disk **70**. Thus, it will be noted that electron tube **60** also has an end wall structure which is recessed toward the anode to accommodate the locking means to be hereinafter described.

It is old in the art to provide tensioning means for a filamentary cathode such as cathode **90**. The means herein for accomplishing the tensioning comprises a compression spring **110** which abuts cup **106** and disk **107**. Thus, the cathode top disk **102** is forced upwardly by spring **110** and serves to tension the hairpin wires **91** because the bottom ends of the wires are held in fixed position by the fingers **98** and **99**.

The upper end of post **104** projects through top plates **111** and **112** on grids **92** and **93** respectively. A ceramic sleeve **113** is brazed to post **104** and to plates **111** and **112**. Thus post **104** is rigidly held at the top by grid cages **92** and **93** and at the bottom by disk **107** in which it is securely brazed.

The locking means for tube **60** comprises a metal plate made of two pieces **116** and **117** brazed together. The reason for two pieces is that strength is required but only the thinner upper piece **117** can be brazed to ceramic without cracking the ceramic. Piece **117** is brazed to a ceramic ring **118** which is in turn brazed to end wall **70**. If piece **117** were brazed directly to wall **70**, the combined metal thickness would crack ceramic **66**. An extra ceramic ring **119** is brazed to piece **117** to prevent cracking of ceramic **118**. The locking means on tube **60** comprises a sleeve **120** which is brazed in central apertures in pieces **116** and **117**. The sleeve **120** has a pin **121** brazed therein and extending diametrically across the sleeve.

FIGURE 3 shows tube **60** mounted in a generally cylindrical socket **140** comprising a metal base portion **141** and four metal contact rings **142–145**. These metal parts are spaced apart by four insulating parts of dielectric material such as ceramic. The base insulating part is a cup-shaped member **146** having a central bore **147**. Base portion **141** fits across bore **147** and is connected to member **146** by a plurality of bolts **148**. The other insulating parts are short cylinders or rings **149–151** which separate the contact rings **142–145**. Electrical contact can be made to rings **142–145** where they project outwardly

of the insulating rings **149–151**. The metal rings **142–145** and the insulating rings **146, 149–151** can be conveniently assembled by a plurality of circumferentially spaced bolts **152**.

In order to obtain insertion of the tube **60** in the socket **140** and hold it there, the base portion **141** is provided with a centrally located cylinder **153**, as indicated in FIGURES 3 and 4. It will be understood that cylinder **153** as shown in FIGURE 4 is rotated slightly from its position in FIGURE 3 in order to present a clearer view of its groove configuration. Cylinder **153** is attached to base portion **141** by means of bolts **153'**. Cylinder **153** is provided with symmetrically opposite cam grooves **154** and **155** on opposite sides thereof. Each of the grooves has a vertical inlet portion **156**, a sloping side portion **157**, a horizontal end portion **158**, and a holding arc **159** at the tip of the end portion **158**.

As in the case of FIGURE 1, cooling of the structure of FIGURE 3 is made possible by means of circumferentially spaced holes **160–164** in members **146, 142, 143, 144**, and **65**, respectively. It is also possible of course to make the socket contact rings **142–145** so that instead of being solid rings the inner periphery of each ring is formed by closely spaced inwardly projecting contact fingers. If the latter structure is used, cooling air can flow through the spaces between the contact fingers.

As previously explained, tube **60** is of such weight and size that holding it for insertion into the socket requires both hands. Thus it is not practical to use the threaded locking means of FIGURE 1. The substantial top heavy weight of tube **60** combined with the required two-hand grip would make it difficult to engage threads and rotate the tube without damaging the threads. However, the locking means of FIGURE 3 is a very practical arrangement for tube **60**. In order to socket tube **60**, it is grasped with both hands and lowered into the socket until sleeve **120** on the tube slides over cylinder **153** on the socket thus centering the tube in the socket. The lowering of the tube is continued until pin **121** on the tube rests on the upper rim of the socket cylinder **153**. It is then a simple matter to rotate the tube until pin **121** enters the inlet portion **156** of each of the cam grooves **154** and **155**. The tube then drops straight down making initial contact between terminal rings **62–65** and contact rings **142–145**. Then the tube is rotated so that pin **121** is cammed down along groove portions **157**. This provides the wiping and stressing action between the terminal and contact rings. The holding arcs **159** prevent accidental loosening of the tube. Intended removal of the tube is accomplished by pushing down on the tube to release pin **121** from arcs **159** and then rotating the tube so that pin **121** moves back along groove portions **157**. The relative strengths and dimensions of the rings **62–65** and **142–145** are the same as described for rings **2–5** and **42–45** in FIGURE 1.

We claim:

1. A generally cylindrical electron tube comprising an anode at one end of the tube, a plurality of other electrodes in the tube, the other end of said tube being the terminal end and having a side envelope wall comprising disk-shaped circular terminal rings separated by insulating cylinders, support means connecting said terminal rings to said electrodes inside said tube, said terminal rings projecting outwardly from said insulating cylinders and having successively decreasing diameters starting with the largest diameter ring adjacent said anode end of the tube, and means on the axis of the tube at said terminal end for locking said tube in a socket, said locking means having a smaller diameter than the diameter of the terminal end of said side envelope wall.

2. An electron tube as claimed in claim **1** in which said locking means comprises a screw-threaded member.

3. An electron tube as claimed in claim **1** in which said locking means comprises a locking member having a circular bore therein, and a pin projecting across said bore.

4. A generally cylindrical electron tube comprising an anode at one end of the tube, a plurality of other electrodes in the tube, the other end of said tube being the terminal end and having a side wall comprising disk-shaped circular terminal rings separated by insulating cylinders, support means connecting said terminal rings to said electrodes inside said tube, said terminal rings projecting outwardly from said insulating cylinders and having successively decreasing diameters starting with the largest diameter ring adjacent said anode end of the tube, an end wall for the envelope of said tube at said terminal end, said end wall being centrally recessed toward said anode end, and means on the axis of the tube at said terminal end for locking said tube in a socket, said locking means being located at least partially in said recess, said locking means comprising a cam surface arranged at a slope with respect to the axis of the tube, and said locking means having a smaller diameter than the diameter of said side wall at the terminal end of the tube.

5. An electron tube as claimed in claim **4** in which said end wall includes a cylinder coaxial with said tube and a closure member across said cylinder, said closure member being substantially spaced from the end of said cylinder whereby said recess is formed in the end of said cylinder, and said locking means project into the open end of said cylinder.

6. An electron tube as claimed in claim **4** in which said tube includes a center post projecting through said end wall, and said locking means comprises a screw-threaded end on the projecting portion of said post.

7. An electron tube and socket assembly comprising a generally cylindrical tube having an anode at one end, a plurality of other electrodes in said tube, the other end of said tube being the terminal end and having a side envelope wall comprising disk-shaped circular terminal rings separated by insulating cylinders, support means connecting said terminal rings to said electrodes inside said tube, said terminal rings projecting outwardly from said insulating cylinders and having successively decreasing diameters starting with the largest diameter ring adjacent said anode end of the tube, and said socket comprising a base portion, a plurality of spaced disk-shaped circular contact rings supported one above the other from said base portion, said contact rings having successively increasing inside diameters starting with the smallest inside diameter adjacent said base portion, the outside diameters of said terminal ring and the inside diameters of said contact rings being such that each of said terminal rings overlaps one of said contact rings and has an outside diameter smaller than the inside diameter of the remainder of said contact rings toward said anode end, and locking means on the terminal end of said tube cooperating with locking means on the base portion of said socket to pull said tube and socket together upon rotation of the tube and sockeet relative one to the other, said locking means on the tube having a smaller diameter than the diameter of the terminal end of said side envelope wall.

8. A tube and socket assembly as claimed in claim **7** in which said locking means on the tube component and socket component comprises a locking member on one of said components and having a cam groove therein and sloping with respect to the axis of said tube and socket, and a pin on the other of said components fitting in said groove.

9. A tube and socket assembly as claimed in claim **7** in which said locking means on the tube component and socket component comprises an externally threaded member on one of said components and a locking member on the other of said components having internal threads matching the threads on said externally threaded member.

10. A tube and socket assembly as claimed in claim **7** in which the annular partitions formed by said overlapping terminal and contact rings are provided with apertures

for permitting flow of cooling fluid along said side envelope wall.

11. A generally cylindrical electron tube comprising an anode at one end of the tube, a plurality of other electrodes in the tube, the other end of said tube being the terminal end and having a side wall comprising disk-shaped circular terminal rings separated by insulating cylinders, support means connecting said terminal rings to said electrodes inside said tube, said terminal rings projecting outwardly from said insulating cylinders and having successively decreasing diameters starting with the largest diameter ring adjacent said anode end of the tube, an end wall for the envelope of said tube at said terminal end, said end wall being centrally recessed toward said anode end, and means on the axis of the tube at said terminal end for locking said tube in a socket, and said locking means having a smaller diameter than the diameter of said side wall at the terminal end of the tube, said locking means comprising a support plate attached to the terminal end of said tube, a locking sleeve on said plate and projecting into said recess, and a locking pin projecting across said sleeve.

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