July 10, 1956 L. C. WERNER 2,754,349

INSULATING SPACERS

Filed March 28, 1951

Fig. 1.

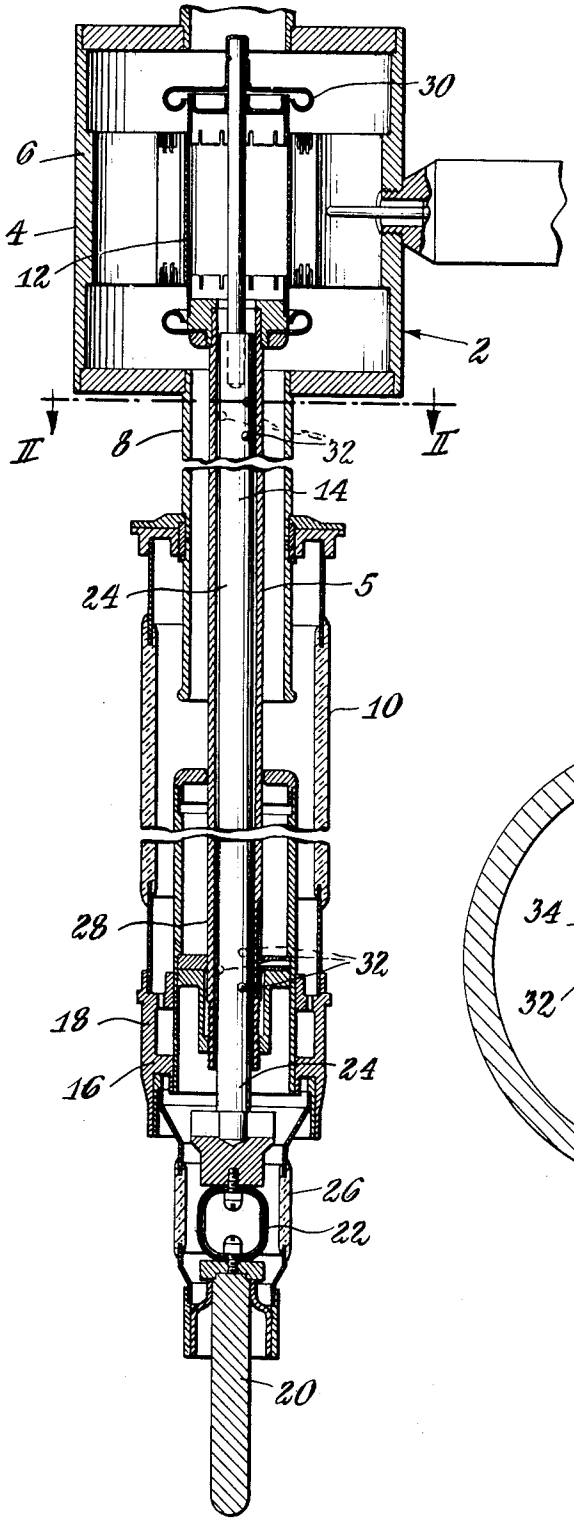


Fig. 3.

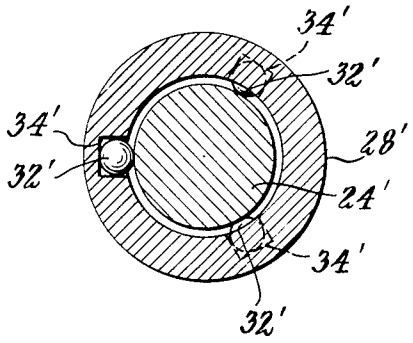
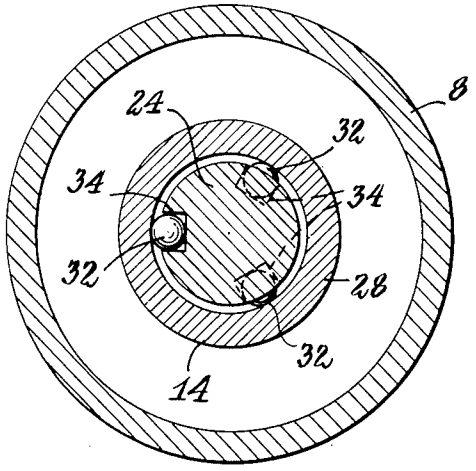


Fig. 2.



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INSULATING SPACERS

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3 Claims. (Cl. 174—28)

My invention relates to structures in which there is relative movement between the parts and, more specifically, to means for maintaining a predetermined clearance between the parts which have relative movement.

Clearance between members of a structure is commonly maintained by the use of bushings or ball bearings. If the parts are to be electrically insulated from one another, ceramic bushings are often used; this is especially true in the case of coaxial conductors. Metal ball bearings and bushings are commonly used between surfaces which move relative to each other when one surface does not have to be electrically insulated from the other surface. However, when metal balls or bushings are used to separate metal surfaces operating at high temperatures, the metals will tend to fuse together. In the case of ceramic bushings used as insulators, the bushings become fragile when small clearances are involved; ceramic bushings are also exceedingly difficult to manufacture to close tolerances. The ceramic bushings also offer a large amount of resistance to relative movement because of the plane to plane contact.

Therefore, it is an object of my invention to provide means for maintaining clearance between two members of a structure, which means will freely allow relative movement between the two members.

It is another object of my invention to provide clearance maintaining means which will electrically insulate the two members from each other.

It is a further object of my invention to provide clearance maintaining means which will not fuse with metal surfaces when subjected to high temperatures.

Yet another object of my invention is to provide a clearance maintaining means which will be strong and also inexpensive to manufacture to accurate tolerances.

A still further object of my invention is to provide insulating spacers between two elongated coaxial conducting members, one member being fastened at one end to an end of the other member and said spacers allowing each member to longitudinally expand independently of the other member.

The above objects are accomplished in my invention by using spacers of non-electrically conducting material, such as sapphire, set into recesses of one member and extending beyond the surface of that member to maintain it a predetermined distance from another member.

The novel features that I consider characteristic of my invention are set forth with particularity in the claims. The invention itself, however, together with additional objects and advantages thereof, may be best understood from the following description of specific embodiments, when read in conjunction with the accompanying drawings in which:

Fig. 1 is a cross-sectional view of a magnetron wherein the cathode is constructed in accordance with my invention;

Fig. 2 is a cross-sectional view taken along line II—II of Fig. 1;

Fig. 3 is a cross-sectional view taken along line II—II of Fig. 1 and shows one modification of my invention.

The apparatus shown in the drawing comprises a magnetron **2** which has an anode assembly **4** and a cathode assembly **5**. The anode assembly has as its essential parts an anode **6**, here shown as cylindrical, and a mounting means **8** at one end of the anode **6**. An electrical connection to the anode **6** is made through the mounting means **8**, which is insulated from the cathode assembly **5** by a non-conducting cylinder **10**. The cathode assembly **5** comprises, in general, a cathode body **12** coaxial with the anode **6** and having an emissive exterior surface, a cathode support structure **14** coaxial with the cathode body **12**, and cathode adjusting mechanism **16** at one end of the cathode support structure. The cathode body **12** is attached to the support structure **14** at the opposite end from the cathode adjusting mechanism **16**.

An annular metallic ring **18** which is part of the adjusting mechanism **16** provides one terminal for supplying heating current to the cathode, a second terminal **20** for the heating current supply is connected at its one end to the outside periphery of a copper leaf ring **22**, the axis of the terminal lying along an extension of one diameter of the ring. In turn, the copper leaf ring **22** is connected to an inner rod member **24** of the cathode support assembly at a point on the outside periphery of the ring which is diametrically opposed to the point at which the second terminal **20** is fastened to the ring **22**. The leaf ring **22** is fastened to the end of the inner rod member **24** farthest from the cathode body **12** and allows the inner member to move axially with respect to the second terminal. A non-conducting cylinder **26** coaxial with the adjusting mechanism **16** and second terminal **20** provides insulation therebetween. Heating current flows through the adjusting mechanism **16** to a hollow outer member **28** of the cathode support structure **14**, to and longitudinally of the cathode body **12** to a cathode end shield **30** and from thence through the inner rod member **24** and copper leaf ring **22** to the second terminal **20**. It should be noted that not only the heating current, but also the input pulses to the cathode, are supplied through the adjusting mechanism **16** and the outer member **28**.

My invention pertains, more particularly, to the cathode support structure and cathode lead-in of the magnetron, although it will be obvious to one skilled in the art that the invention is not limited to this use. In designing a magnetron, practical considerations determine the optimum outside and inside diameter of the outer member **28** of the cathode support structure **14**. Because of the large amount of heating current supplied to the cathode, it is desirable to have the outside diameter of the inner member **24** as great as possible; this diameter is obviously limited by the inside diameter of the outer member **28** and the fact that an insulating clearance must be maintained between the inner and outer member to prevent short-circuiting of the cathode. To maintain this insulating clearance, which is desired to be as small as possible, non-conducting spacers **32** are set in individual recesses **34** in the inner elongated member **24**. These recesses are distributed longitudinally and circumferentially spaced along the elongated member **24**. The spacers extend beyond the surface of the inner member **24** and contact the outer member **28** to keep the necessary clearance between said members. These spacers are floating and are capable of relative movement with respect to both the inner member **24** and the hollow outer member **28**. I have found that balls of substantially spherical configuration made of sapphire serve very well as spacers. It is obvious, however, that the invention is not necessarily limited to the use of sapphire spacers, or to the use of spacers of spherical configuration. Sapphire balls, however, are inexpensive and easy to manu-

facture to close tolerances. Where small clearances are involved, sapphire balls provide a spacer which is not fragile and which will offer a minimum of mechanical resistance to relative movement and yet offer maximum electrical resistance. When large heating currents are supplied to the cathode, the inner member **24** and outer member **28**, which are fastened together at one end by the cathode body **12** and the cathode end shield **30**, will tend to expand longitudinally, because of the heating effect of the current. The copper leaf ring **22** and the sapphire balls **32** will allow relative movement between the inner and outer members **24** and **28**, respectively, when they become heated. It should be noted that the same size balls may be used with different sizes or spacings of inner or outer rods by varying the depth of the recesses **34**.

Figure 3 shows a modification of my invention. In this modification, the recesses **34'** are in the outer member **28'** rather than in the inner rod member **24'**. The sapphire balls **32'** are set in these recesses and function as explained above to permit movement between the members, but maintaining spacing and electrical insulation between said members.

Non-metallic spacers such as sapphire balls set in recesses may also be used to sepaarte two metallic parts where relative movement at high temperature is desired, even though no problem of insulating electrically exists. The advantage of using sapphire balls, or other non-metallic spacers instead of metal balls, lies in the fact that there will be no fusion of the metals at high temperatures.

It can thus be seen from the foregoing that a structure is provided by my invention which will prevent fusion of relatively movable members at high temperatures, electrically insulate said members from each other, and yet will not become expensive when made to close tolerances, nor sacrifice strength when close clearances are required.

Although a preferred embodiment of my invention has been disclosed, it will be understood that modifications may be made within the spirit and scope of the appended claims.

I claim:

1. A coaxial conductor comprising a tubular member and an elongated member capable of relative movement with respect to and within said tubular member, one of said members having a plurality of individual recesses therein, said recesses in said one recessed member having substantially identical cross-sectional dimensions and depths, each of said recesses in said one recessed member being circumferentially spaced on said one recessed member and longitudinally spaced thereon from one another, non-conducting substantially identical spacers set in each of said recesses in said one recessed member, said non-conducting spacers each having a diameter greater than the depth of said recesses in said one recessed member, and each of said spacers simultaneously contacting the said recess in said one recessed member in which it is set and the non-recessed member.

2. A coaxial conductor comprising a tubular member having an inner surface and an elongated member having an outer surface, said elongated member being capable of relative movement with respect to and within said tubular member, said tubular member having a plurality of individual recesses on the inner surface thereof, said tubular member recesses having substantially identical cross-sectional dimensions and depths, each of said tubular member recesses being circumferentially spaced on the inner surface of said tubular member and longitudinally spaced thereon from one another, non-conducting substantially identical spacers set in each of said tubular member recesses, said non-conducting spacers having a diameter greater than the depth of said tubular member recesses, and each of said spacers simultaneously contacting the said tubular member recess in which it is set and said outer surface of said elongated member.

3. A coaxial conductor comprising a tubular member having an inner surface and an elongated member having an outer surface, said elongated member being capable of relative movement with respect to and within said tubular member, said elongated member having a plurality of individual recesses on the outer surface thereof, said elongated member recesses having substantially identical cross-sectional dimensions and depths, each of said elongated member recesses being circumferentially spaced on said elongated member and longitudinally spaced thereon from one another, non-conducting substantially identical spacers set in each of said elongated member recesses, said non-conducting spacers each having a diameter greater than the depth of said elongated member recesses, and each of said spacers simultaneously contacting the said elongated member recess in which it is set and said inner surface of said tubular member.

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