Jan. 31, 1956 A. A. PHILLIPS ET AL 2,733,380

DEMOUNTABLE MAGNETRON WITH METAL-TO-METAL VACUUM TIGHT JOINT

Filed June 9, 1952

FIG. 1

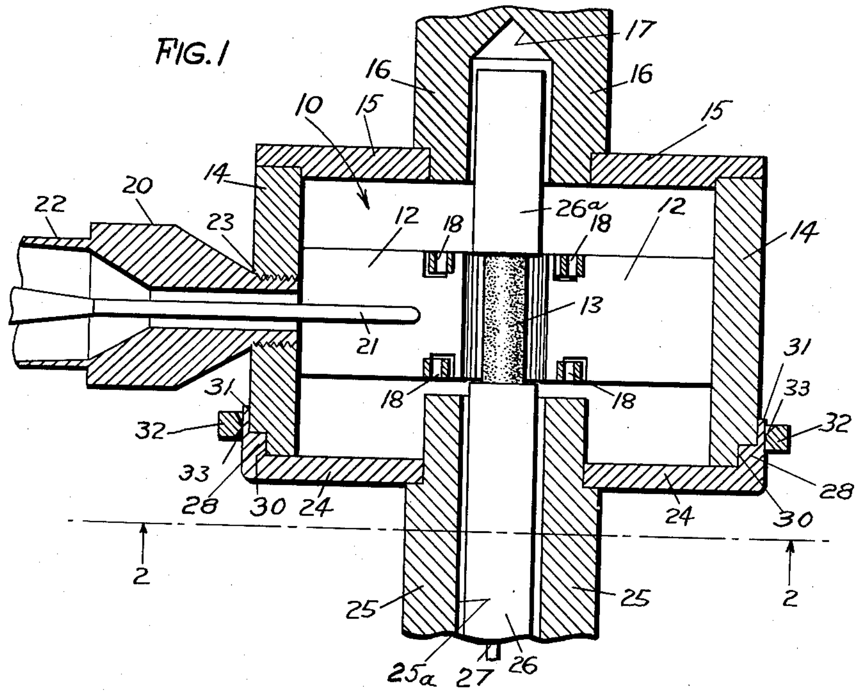
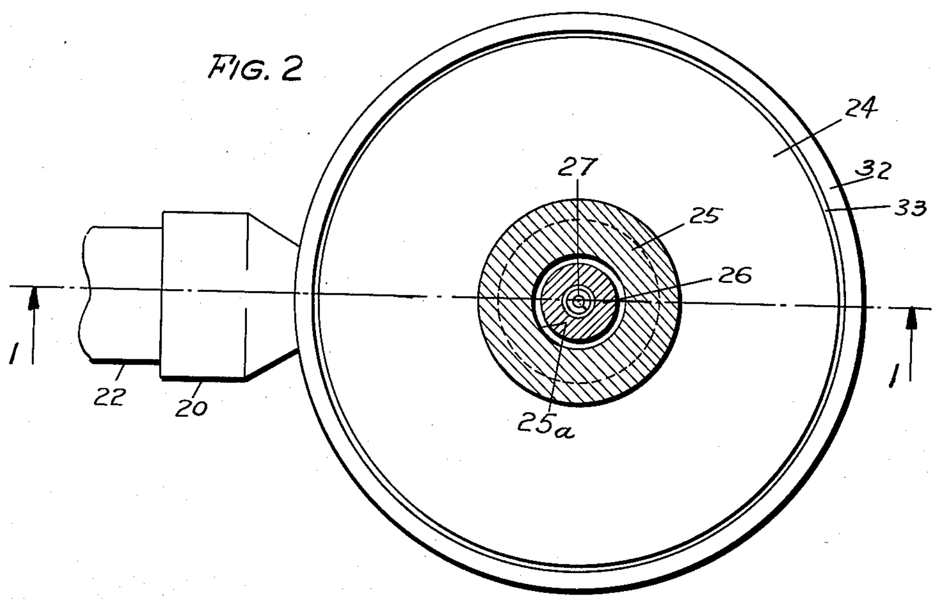


FIG. 2



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DEMOUNTABLE MAGNETRON WITH METAL-TO-METAL VACUUM TIGHT JOINT

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4 Claims. (Cl. 315—39.53)

This invention relates to vacuum-tight metal-to-metal seals.

In sealing certain metal enclosures vacuum tight, it is not desirable to apply the amount of heat necessary with such processes as brazing. The application of heat, for instance, to the resonant cavity of a magnetron type of election discharge tube may well adversely affect the parts within the cavity. One of these adverse effects is oxidization of both the outside of the cavity and the interior. If a cavity of this type is sealed by brazing, it is very difficult to reopen the cavity to inspect or replace any of the parts without damaging the tube due to the necessity for applying intense heat.

By the use of the seal of the present invention, these difficulties are avoided. The seal is formed by two overlapping edges of metal bound tightly together by a continuous band of metal shrunk onto the outside of the overlapping edges. The band of metal is formed so that it expands sufficiently when heated to red heat to just slip on over the parts to be joined. The heated band is slipped over the pieces forming the joint while they are held in position. As the band cools it contracts, tightening the joint until it is vacuum tight. Should it be desired to inspect the interior of the evacuated cavity, or to replace an internal part, such as the cathode assembly, all that is necessary is to cut through the band and separate the parts. Thus the disassembly operation avoids the use of intense heat with its attendant risk of damaging the parts. The cavity can be resealed by shrinking a new heated band onto the joint.

The foregoing and other advantages, objects and features of the invention will be better understood from the following description taken in conjunction with the accompanying drawings, wherein:

Fig. 1 is a section along the line 1—1 of Fig. 2 showing a cavity magnetron made with the seal of the invention; and

Fig. 2 is a section taken along the line 2—2 of Fig. 1.

In the drawings, the reference numeral **10** designates generally the resonant cavity of a magnetron. The magnetron comprises an anode having a plurality of vanes **12** forming resonant cavities. A cathode **13** is located with its axis at the center of the anode vanes **12**. The cavity **10** is formed with a cylindrical outer wall **14** and a circular top plate **15**. A pole piece **16** is inserted coaxially with the cathode **13** through an opening in the plate **15** of the cavity **10**. The upper end of the cathode **13** extends into a hole **17** in the pole piece **16**. Strapping **18** of one of the well-known types is provided across the inner ends of the vanes **12**. The output is obtained from one of the resonant cavities between the vanes **12** by the coaxial probe **20** comprising a central conductor **21** terminating in a loop, and an outer conductor **22** terminating in a bushing **23** that fits into the side wall **14** of the magnetron. The bottom of the magnetron cavity **10** is formed of a cup-shaped cap **24** that fits over the lower end of the cylindrical walls **14** of the resonant cavity **10**. A second pole piece **25** is inserted in an opening formed at the center of the cap **24**. This pole piece **25** is formed with a hole **25***a* concentric with the axis of the cathode **13** to receive the lower end of the coaxial connector **26** of the cathode **13**. This coaxial connector **26** has a central connector **27**. The upper end of the cathode **13** is terminated in a coaxial connector **26***a*. This cathode construction and mounting is best shown in the application of William C. Brown for United States Patent No. 583,624, filed March 19, 1945, and which is now U. S. Patent No. 2,624,861, granted January 6, 1953.

The cap **24** is formed with an upwardly projecting wall **28** made to fit into recess **30** formed in the end of the cylindrical wall **14** of the magnetron cavity **10**. A thinner portion **31** of the wall **28** of the cap **24** projects beyond the recess **30**. The cap **24** is made of a highly conductive material such as copper, as is the wall **14**, and the end plate **15**. A ring **32** is formed of a metal having a somewhat greater coefficient of expansion than the copper of the cap **24**. Stainless steel has been successfully used for this purpose. The ring or band **32** is formed with a double taper **33** so that it makes contact with the thin extension **31** of the cap **24** over a restricted area. This ring **32** is made with an inside diameter at the region of contact less than the outside diameter of the cap **24** at normal temperatures. The ring is heated to a point where it expands sufficiently to increase its inside diameter at the region of contact to an amount greater than that of the outside diameter of the cap **24**. In the case of the stainless steel ring mentioned above, this temperature was found to be red heat or approximately 1400° F. (760° C.). When the ring **32** has expanded sufficiently, it is slipped over the cap **24** and permitted to cool in place. The resulting constrictive pressure forces the edge **31** of the cap **24** so tightly against the walls **14** that the resulting joint is vacuum tight. As the tube is heated in use, the copper will expand together with the ring and the seal will not loosen. The relative masses and thermal conductivity of the magnetron cavity **10**, the cap **24**, and the ring **32** are such that, while the ring itself is at a high temperature when it is applied, it does not increase the temperature of the magnetron cavity substantially. In a representative case, the application of such a ring of stainless steel heated to 760° C. to a cavity of copper only heated the cavity to a temperature of 75° C. Thus, there is no danger of the heat transmitted from the ring **32**, in the forming process, damaging the parts of the cavity or parts within the cavity, as is likely to be the case in brazing and soldering where the parts to be joined must themselves be brought to a high temperature in order to assure a vacuum-tight seal.

When it is desired to break the seal, there is no need to apply heat as would be necessary if the joint had been brazed or soldered. The ring **32** is simply cut through and pried off. The magnetron can then be disassembled, the parts inspected, repaired or replaced, as desired, and the sealing process repeated with another ring. The particular type of cathode structure shown is one that permits the magnetron to be readily disassembled when such a seal is used. It can be readily seen that with this type of mounting, a cathode subassembly comprising the cathode **13**, the cathode connectors **26** and **26***a*, the pole piece **25**, and the cap **24** could easily be removed and replaced by a new one, thus readily salvaging the anode structure of magnetrons having defective cathodes.

The seal of this invention can be used for forming vacuum-tight metal-to-metal seals wherever they are needed. While the seal is shown as applied to the joining of two cylindrical pieces, it can also be used to join pieces of other shapes. The ring or band **32** is shown formed with a triangular cross-section in the region of contact. Other configurations of the band **32**, such as curved surfaces, can be used that provide a restricted area of contact. While it is desirable to reduce the area of contact to a minimum, this is not essential to the success of this type of seal.

This completes the description of the particular embodiments of the device disclosed herein. However, many modifications thereof will be apparent to persons skilled in the art without departing from the spirit and scope of this invention. Accordingly, it is desired that this invention be not limited by the particular details of the embodiments described herein except as defined by the appended claims.

What is claimed is:

1. An electron discharge device of the magnetron type comprising an anode member formed with an evacuated resonant cavity comprising two parts of oxidizable metal with overlapping edges held together in a vacuum-tight joint by a restricting metallic band having a reduced area in the region of said joint.

2. An electron discharge device of the magnetron type comprising an anode member formed with an evacuated resonant cavity comprising two parts of oxidizable metal with overlapping edges at a region of reduced wall thickness held together in a vacuum-tight joint by a restricting metallic band having a reduced area in the region of the said joint.

3. An electron discharge device of the magnetron type comprising an anode member formed with an evacuated resonant cavity comprising two cylindrical parts of oxidizable metal with overlapping edges held together in a vacuum-tight joint by a restricting metallic ring having a reduced area in the region of the said joint.

4. An electron discharge device of the magnetron type comprising an anode member formed with an evacuated resonant cavity comprising two cylindrical parts of oxidizable metal with overlapping edges at a region of reduced wall thickness held together in a vacuum-tight joint by a restricting metallic ring having a reduced area in the region of the said joint.

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