

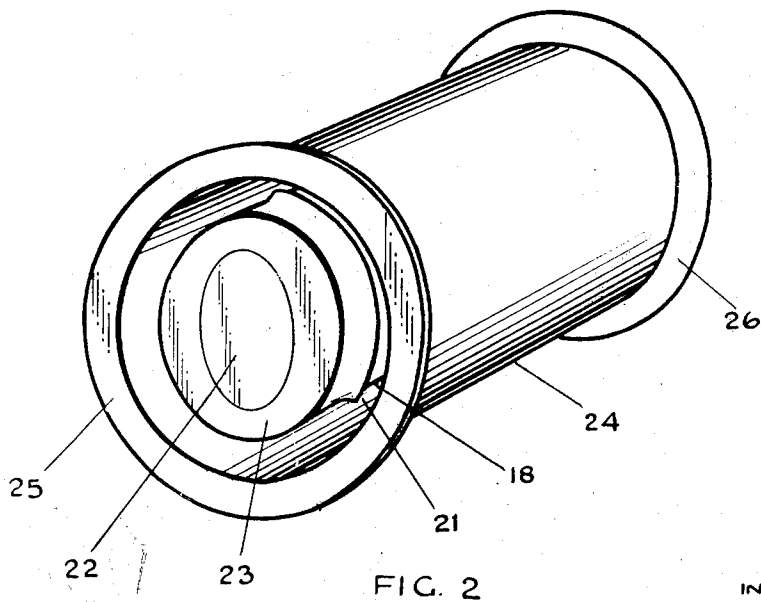
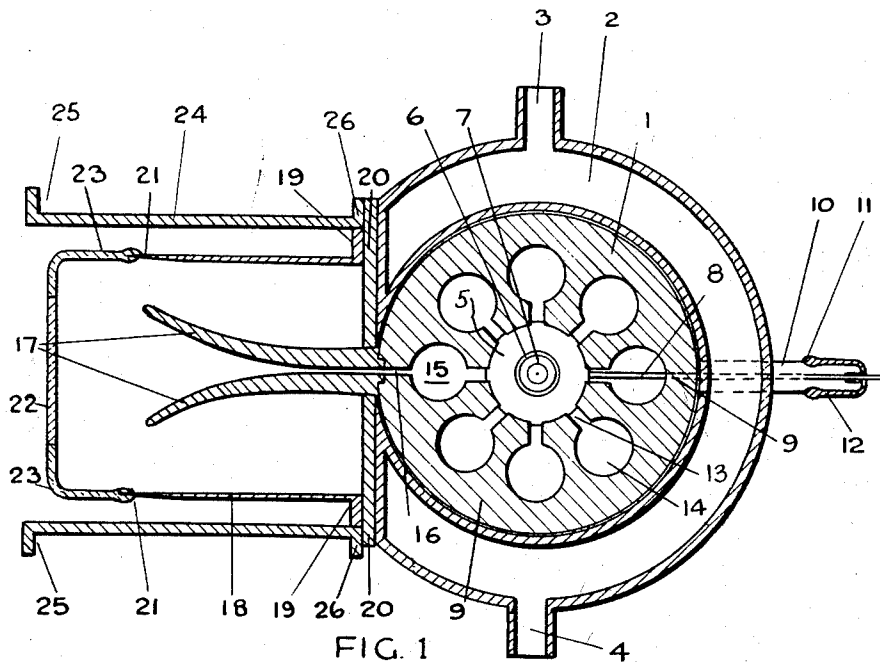
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SEALED SAPPHIRE WAVE GUIDE WINDOW

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SEALED SAPPHIRE WAVE GUIDE WINDOW

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3 Claims. (Cl. 333—98)

This invention relates to electrical devices including a hollow metal tube arranged to act as a waveguide carrying high frequency energy in operation of the device and closed by the sealing to the tube of a closure member of insulating material. The closure member usually consists of a disc, which may in some cases be dished into the form of a cup. The invention is especially, though not exclusively, concerned with such devices in which the gas pressures on the two sides of the said closure member are appreciably different, for example linear electron accelerators, or magnetrons in which the tube forms part of the output section and the closure member separates the evacuated interior of the magnetron from the external atmosphere.

In such devices adapted to handle high power, we have found that considerable heat is generated in the said closure member, and that if this member is of glass, which is usually preferable for ease and efficiency of sealing to the metal tube, it is liable to soften and be destroyed, especially if there is a difference of gas pressure on the two sides of the member. The softening of the glass invariably takes place at the centre of the closure member, the outer part of the member being cooled by thermal conduction along the metal tube.

The object of the invention is to provide a convenient method of reducing this difficulty.

According to the invention, in an electrical device of the kind referred to the said closure member of insulating material consists of a central portion of relatively refractory material sealed to a less refractory outer portion of glass which is in turn sealed to the metal tube.

The outer portion of glass may in some cases consist of two or more rings of glasses of different thermal expansion coefficients sealed together to form a graded seal matching on one side the said relatively refractory material and on the other side the metal of the tube.

The said relatively refractory material may consist, for example, of ceramic material but preferably it consists of a disc of sapphire which may conveniently be sealed to the glass outer portion by the following method.

The disc of sapphire is supported on a block of refractory material which does not readily oxidise (for example an iron-chromium-nickel alloy), with an annular washer of a suitable heat-resistive material (such as silver) intervening between the disc and the block, the inner edge of the washer extending everywhere slightly within the periphery of the disc and the outer edge of the washer projecting for an appreciable distance beyond the periphery of the disc; the open end of a tube of glass suitable for sealing to the disc and fitting closely around it is rested on the projecting edge of the washer, and the glass tube and disc are heated by heating of the block so as to soften the end of the glass tube and cause it to flow on to and seal to the edge of the disc.

The tube and disc are removed from the block, with the washer adherent thereto, the washer is then stripped

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off, and the seal between the disc and the glass is further heated to produce a smooth seal and for annealing. The end of the tube containing the sapphire disc can then be cut off to any desired length.

One embodiment of the invention will be described, by way of example, with reference to Figure 1 and Figure 2 of the accompanying drawing, wherein:

Figure 1 shows a cross-sectional view along the longitudinal axis of a magnetron provided with a waveguide output section in accordance with the invention, and

Figure 2 shows a perspective view of the waveguide output section sealed with a composite closure member in accordance with the invention.

In this embodiment the magnetron comprises a sealed evacuated envelope 1, partially surrounded by a water cooling jacket 2 provided with inlet and outlet pipes 3, 4 respectively for the passage of cooling water in operation; the envelope 1 includes a substantially cylindrical anode block of conducting material, such as copper, recessed from each end to leave a central portion which forms the anode proper; this central portion is perforated by a central hole 5 along the axis of the block, and within this hole, substantially at the centre thereof, there is supported a hollow cylindrical cathode within which is arranged a heater 7 and which is provided with end discs in the usual manner.

For supporting the cathode, and making the necessary electrical connections to it and the heater, the cathode is attached at each end to a stout lead-in-wire (one only of which appears in the Figure 1 view); the lead-in-wires pass on either side of the anode through a hole in the wall 9 of the block, and through a pipe 10 forming a passage sealed through the water-jacket 2, each pipe 10 being closed at its outer end 11 by means of a glass to metal seal 12, through which the lead 8 passes.

A plurality of slots 13 are formed in the anode around the central hole 5, extending radially from the hole, and each of the slots terminates in a further circular hole 14 formed through the block parallel with the central hole, the slots 13 and holes 14 constituting the anode cavity resonators in known manner.

One 15, of the cavity resonators is continued through the wall of the anode block by a further radial slot 16, and this slot is continued by a pair of exponentially curved lip plates 17, mounted one along each side of the slot parallel to the axis of the block 1, so as to form a waveguide transformer for the passage of high frequency electrical energy from the magnetron, in operation, into a waveguide output section.

The latter includes a copper tube 18 formed with a flange 19 at its end adjacent to the anode block, the flange being sealed to a mounting plate 20 which is fixed to the water jacket 2 and sealed to the outer surface of the block around the edge of the slot 16, the other end of the tube 18, remote from the block, is formed with a feather edge 21 around its periphery and is closed by a composite closure member in accordance with the invention.

This composite closure member comprises a sapphire disc 22, sealed to the inner periphery of a cup-shaped glass outer ring 23 by any suitable method, such, for example, as that previously described; the member is sealed across the end of the copper tube 18 by means of a glass to metal seal formed between the outer edge of the ring of glass and the feather edge of the copper tube; a further copper tube 24 of larger internal diameter than the external diameter of the tube 18 and formed at one end with a flange 25 for attaching the tube to a further waveguide section is provided at the other end with a further flange 26 and is attached, by means of

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this flange, to the mounting plate 20, so that this tube surrounds the tube 18.

In operation of this embodiment, when the magnetron is placed between two suitable magnetic poles (not shown) for creating an axial magnetic field and the magnetron is supplied with the appropriate operating current and voltage, high frequency oscillations are set up within the magnetron which are transmitted through the exponentially curved lip-plates 17 into the tube 18 and pass from this tube through the closure member formed by the sapphire disc 22 and glass outer ring 23, into the further tube 24, which forms a further waveguide section.

When this high frequency energy passes through the closure member a considerable amount of heat is produced in it due to dielectric losses; the outer part of the closure member which is formed from glass is, however, cooled by thermal conduction along the metal tube and the centre portion of the member, being formed from sapphire, is capable of withstanding considerably more heat than is ordinary glass, so that the magnetron can operate with a very high power output without damaging the closure member.

I claim:

1. An electrical device including a hollow metal tube arranged to act as a waveguide carrying high frequency energy in operation of the device and closed by a thin closure member of insulating material, said closure member consisting of a central flat sapphire disk and an annular glass piece, the outer periphery of said annular

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glass piece being sealed to the metal tube and the inner periphery of said annular glass piece being sealed to the periphery of the sapphire disk.

2. A magnetron including a waveguide output section including a hollow metal tube having an output end, and means closing said end, said means consisting of a central flat sapphire disk and an annular glass piece, the outer periphery of said annular glass piece being sealed to the metal tube and the inner periphery of said annular glass piece being sealed to the periphery of the sapphire disk.

3. An electrical device according to claim 1 wherein the said outer portion of glass consists of two or more rings of glasses of different thermal expansion coefficients sealed together to form a graded seal matching on one side the said refractory material and on the other side the metal of the tube.

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