MAGNETRONS

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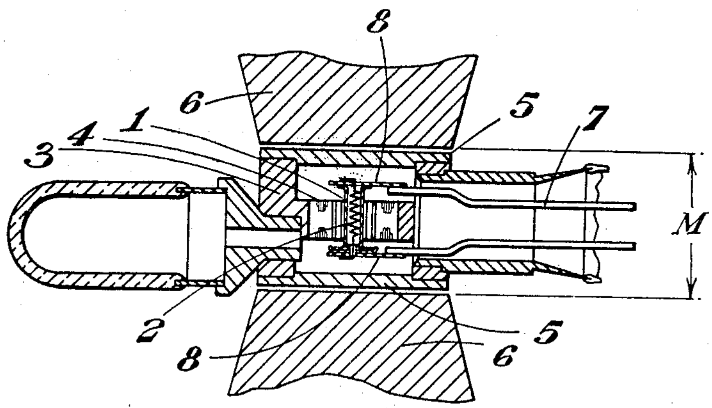

Fig. 1.

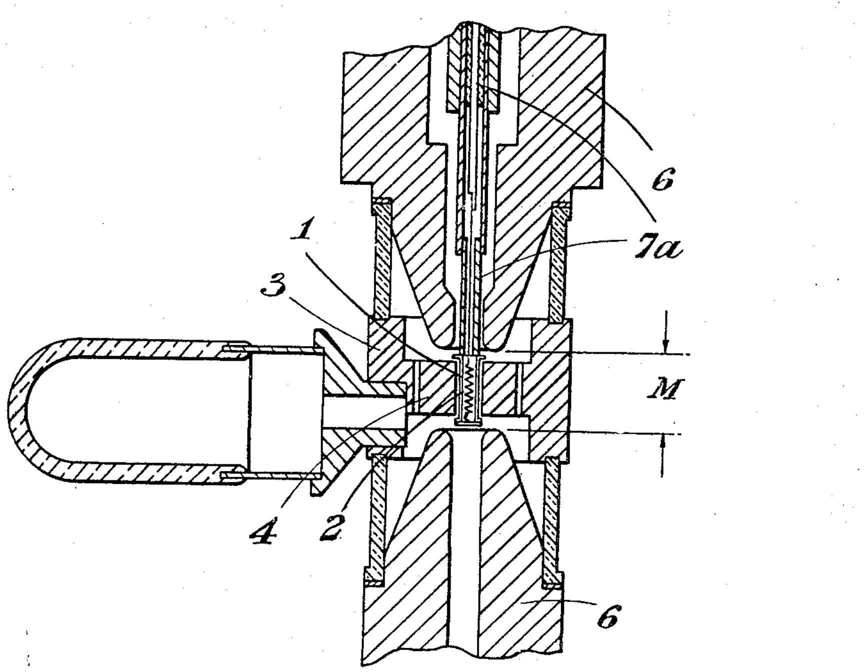

Fig. 2.

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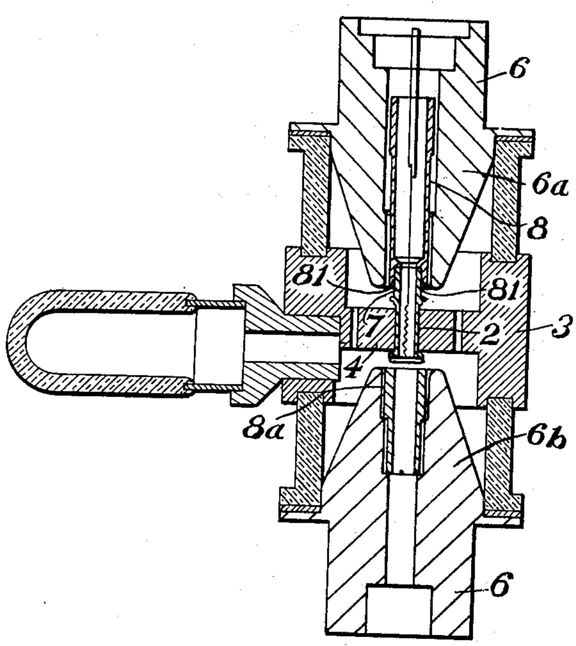

Fig. 3.

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MAGNETRONS

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4 Claims. (Cl. 313—30)

This invention relates to magnetrons and more specifically to magnetrons of the so-called "packaged" type i. e. the type in which, in order to reduce the length of the air gap in the magnetic circuit, the discharge envelope is completed by members of magnetic material which also form part of the magnetic circuit so that, in effect, the magnetic poles are brought inside the envelope.

Although packaged magnetrons have the advantage over the non-packaged types that, owing to the improved magnetic system they can be made of substantially reduced weight and size, this advantage is accompanied by important difficulties and disadvantages the nature of which will be better understood upon reference to the accompanying drawings in which Fig. 1 shows, in section, the essential parts of a typical known magnetron of the non-packaged type; Fig. 2 is a similar view of a typical known packaged magnetron; and Fig. 3 is a simplified sectional view showing the general pole piece and cathode structure arrangement of a magnetron embodying the present invention.

In Fig. 1 the cathode **1**, heated by an internal heater **2** is axially situated within a copper anode structure **3** having anode segments **4**. The structure **3** forms part of the discharge space envelope which is completed by flat copper side plates **5** and located between the poles **6** of the magnet system. The magnetic gap is, as will be seen, a long one, being indicated by the dimension M. The cathode structure is supported by support members **7** which enter the envelope from the side and extend more or less at right angles to the axis. End caps in the form of discs **8** prevent electrons leaving the anode cathode space and being collected by parts of the anode structure other than the anode segments. The discs **8** thus serve to maintain a high conversion efficiency but their presence as well as that of the transverse support structure for the cathode, and that of the side plates **5**, results in a long air gap M with consequent necessity to provide a heavy and bulky magnet system.

In the typical known packaged magnetron shown in Fig. 2 the air gap length M is much reduced with consequent ability to use a much stronger magnetic field with the same or a smaller magnet system by dispensing with the side plates **5**, using the pole pieces **6** as part of the envelope structure, and supporting the cathode structure by means, generally designated ***7a*** which run axially through a hole in one of the pole pieces instead of transversely as in Fig. 1. However, it is a requirement that the magnetic field in the space between anode and cathode shall be as uniform as possible and run as nearly as possible parallel to the cathode surface and this requirement strictly limits the maximum diameter which can be tolerated for the hole in the pole piece. For a magnetron to work efficiently the lines of magnetic force in the anode-cathode space should run as nearly as possible parallel to the axis of the anode and cathode and any departure from this "ideal" parallelism should be such as to make the field barrel-shaped and not in the other direction i. e.

such as to give the field a "waist" between the opposed pole faces. Any "waisting" of the field will tend to cause electrons near the ends of the cathode to spiral outwards and away from the anode with consequent losses of power and lowered conversion efficiency. Any hole in the pole piece tends to produce some "waisting" of the field since the lines of force tend to spread into the hole. In known packaged magnetrons therefore the said hole has had to be kept of very small size and this in turn means in practice that either the cathode support tube in the hole must be made very thin and consequently weak mechanically or the spacing between the support tube and the surrounding pole piece must be kept smaller than is desirable. In this connection it will be remembered that, in a known packaged magnetron, the pole piece is at anode potential and in consequence the full anode-cathode potential is applied between said pole piece and the support tube. Since there is very little magnetic field inside the pole piece hole any electron emission from the cathode support tube will be collected by the pole piece acting as the anode of a simple diode. In known packaged magnetrons there is, therefore, the probability of the existence of a diode in parallel with the magnetron proper and this diode is capable of absorbing a large amount of power, with consequent further loss of efficiency. This diode effect can grow seriously during the life of a magnetron for barium or other emissive material can migrate from the cathode to the cathode support tube and since the said cathode is usually mounted directly on the said tube the operating temperature of the latter is usually high enough for it to emit readily.

In addition the necessity for strictly limiting the diameter of the hole in the pole piece involves that it is impracticable in known magnetrons to fit large end caps such as the caps **8** of Fig. 1, for a cathode structure with such caps would not pass, in assembly, through the necessarily small hole in the pole piece and, in general, it is, if not absolutely impossible, at any rate very difficult and impracticable for manufacturing reasons to fit the end caps to the cathode structure after the latter has been mounted on the pole piece.

It has therefore been the practice, with known packaged magnetrons, either to omit end caps altogether or to be content with very small end caps with resultant waste power and loss of efficiency.

The present invention seeks to avoid or eliminate the above difficulties and defects.

According to this invention a packaged magnetron wherein the cathode structure includes a cathode support member mounted within a hole in a pole piece is characterized in that said support member is mounted in a sheath of magnetic material at cathode potential and arranged to have good thermal insulation with respect to the cathode.

In the preferred embodiment of the invention the cathode support member is a tube inserted into a sheath of magnetic material which is mounted within a hole in the pole piece and insulated therefrom, said sheath being thermally insulated from the cathode by a long conducting path.

Fig. 3 illustrates an embodiment of the invention. Here the pole pieces ***6a***, ***6b*** are alike and provided with axial holes which may be made as large in diameter as may be required. The cathode which is indirectly heated by an internal heater, not shown, is on a cathode support tube **7**. The end of the support tube **7** is fitted into the end of a sheath **8** of magnetic material which is mounted in the pole piece ***6a*** and is at cathode potential, being insulated from the said pole piece. The sheath **8** is preferably shaped as shown being undercut at **81**. By virtue of this undercutting and of the general arrangement illustrated the surface of the sheath opposite the wall of the hole in the pole piece will be much cooler than the cathode and cathode support tube, and it will be obvious that it is unlikely to be appreciably contaminated by electron emitting material from the cathode. The magnetic field can be made to approach closely to the ideal since the diameter of the hole in the magnetic material including pole piece and sheath within it may be made equal to or even less than that of the cathode despite that the pole itself has a large hole. Further the arrangement enables a mechanically strong cathode structure to be employed with little liability to becoming eccentric in use.

In the illustrated embodiment the lower pole piece *6b* is fitted with an internal magnetic sheath *8a* to ensure symmetry of the magnetic field about the transverse mid-plane of the anode, not shown.

Of course the material of which the sheath 8 is made must be such as to ensure that it remains magnetic at its operating temperature. Such materials are commercially available.

We claim:

1. A magnetron structure comprising an axial cathode structure having a cathode on a cathode support tube, an anode structure concentrically surrounding said cathode, a pair of magnetic pole pieces, one adjacent each end of said cathode and adapted to provide magnetic lines of force threading said cathode in a direction substantially parallel to the axis of said cathode, an evacuated envelope of which part is constituted by said anode structure and parts by said pole pieces, one of said pole pieces being tubular, and a sheath of magnetic material mounted within, and electrically insulated from, said one tubular pole piece, said cathode

support tube having its end inserted into the end of said sheath adjacent to said cathode supporting said cathode from said sheath and electrically connecting said cathode to said sheath.

2. A structure according to claim 1 wherein said support tube is undercut and forms a constricted linearly extending heat conducting path.

3. A structure as claimed in claim 1 wherein the other of said pole pieces is also tubular and is substantially co-linear with the first mentioned tubular pole piece and a second sheath of magnetic material fitted in said last mentioned tubular pole piece.

4. A structure according to claim 1 wherein said support tube is undercut and forms a constricted heat conducting path and wherein the other of said pole pieces is also tubular and is substantially co-linear with the first mentioned tubular pole piece and a second sheath of magnetic material fitted in said last mentioned tubular pole piece.

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