Nov. 18, 1947. R. C. RETHERFORD ET AL 2,431,139

MAGNETRON

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Fig. 1. Fig. 3.

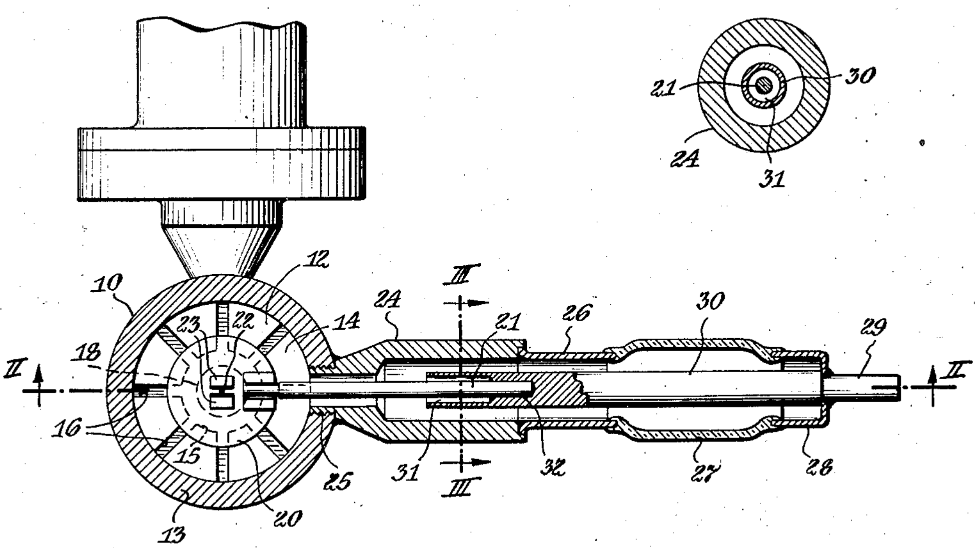


Fig. 2.

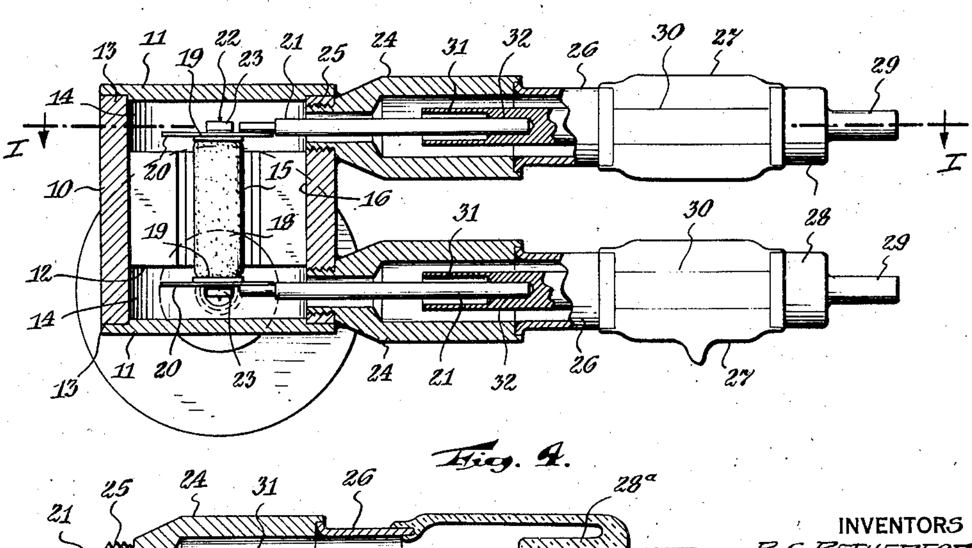
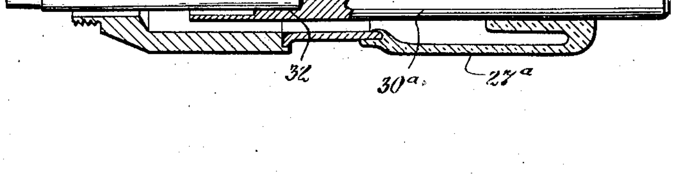


Fig. 4.



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MAGNETRON

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9 Claims. (Cl. 250—27.5)

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This invention relates to magnetrons and particularly to lead-in structure for cathode leads in magnetrons.

In magnetrons unavoidably subjected to a rapid reciprocation in use, and in service for target detection, frequency or wavelength shifts of finite amount resultant from vibrational changes in cathode position with respect to the anode, produce resonance peaks of cathode vibration which algebraically add with the inherent frequency perturbations of a promulgated signal to increase the microwave frequency band width of transmitted signals, thereby necessitating an increase in the width of the substantially flat maximum of the receiver response curve which results in decrease of the maximum range at which a target can be detected. Heretofore the frequency range corresponding to the substantially flat maximum of the response curve has been increased to eliminate the undesired modulation, but such a wide frequency range has undesirable effects, wherefore, a general object of the invention is to provide a magnetron structure overcoming the need for widening of this frequency range and its resultant ill effect.

Considered further in its most general aspect, the invention has as an object to improve cathode support and lead-in connections for magnetrons.

Likewise generally expressed, an object of the invention is to prevent development in a magnetron of extraneous perturbations materially increasing normal inherent perturbations.

A further object of the invention is to eliminate or substantially reduce relative mechanical displacement of the cathode with respect to its anode notwithstanding applied disturbing forces.

More specifically, an object of the invention is to provide an improved lead-in for the cathode and acquire increased rigidity thereby.

Another object of the invention is to combine the structure promoting increased rigidity of the lead-in with provision of a microwave choke therein.

Still further objects of the invention will appear as the description proceeds, both by direct recitation thereof and by implication from the context.

Referring to the accompanying drawing in which like numerals of reference indicate similar parts throughout the several views;

Figure 1 is a cross-sectional view of a magnetron taken transverse to the cathode axis and longitudinally of one lead-in to the cathode as upon line I—I of Fig. 2;

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Figures 2 and 3 are sectional views on line II—II and III—III respectively of Fig. 1; and

Figure 4 is a modified construction of support for the rod of the lead-in assembly.

In the specific embodiment of the invention illustrated in said drawing, the reference numeral 10 designates a cylindrical magnetron body having end plates or covers 11 sealed thereto whereby the interior may be evacuated. The interior of said body is formed to comprise an anode 12 of generally cylindrical shape, shorter than the body which has end flanges 13 for spacing the covers 11 from the ends of the anode and thereby afford the usual and necessary end spaces 14 within the magnetron.

The present showing of magnetron provides a cathode cavity 15 coaxial with the magnetron body and anode, and extending through the anode so as to open into both end spaces 14. The anode likewise provides a plurality of resonant cavities 16, shown herein as of slot-like shape and symmetrically distributed around and radiating from the cathode cavity. The ends of the resonant cavities open into the end spaces 14.

A cathode 18 extends axially through the cathode cavity, projecting at its ends into said end spaces. The ends of the cathode have ceramic or other insulating collars 19 engaging the same and on the outer ends of the collars are mounted discs 20 to which lead-in wires 21 are radially attached. Electrical connection and mechanical support for a heater wire or filament 22 extending through the interior of the cathode is provided by means of brackets or the like 23 welded or otherwise forming a unitary structure with the said discs. Lead wires 21 accordingly supply the filament with current, and also constitute a mounting means for the cathode. However, since these lead-in wires have to extend from the exterior of the magnetron and radially of the end spaces to the discs 20 without contact with the magnetron, they have to be sealed exterior to the magnetron body, and require microwave chokes, the mechanical support afforded to the cathode in prior art constructions has been found to permit cathode vibrations of the character previously discussed herein.

According to the present invention, the lead-in assembly has been improved to substantially eliminate undesirable vibration in the cathode. As shown, the lead-in assembly comprises a copper, brass or other tubular casing 24 having a reduced and threaded terminal portion 25 screwed through the flange 13 of the magnetron body and sealed in place. The outer end of said casing is recessed to receive a flanged edge of a sleeve or casing extension 26 which is also tubular and unified with the casing as by welding or otherwise. This sleeve is preferably an alloy essentially of nickel, cobalt and iron sold under the trade name of "Kovar" and having the characteristic of substantially the same coefficient of expansion as a particular borosilicate glass known as Corning 704. The outer rim of the sleeve 26 has a borosilicate or other glass tube 27 sealed thereto, this tube in any event being an insulator. To the outer end of the glass tube is sealed a "Kovar" or other cup 28. The mid part of the cup end wall is apertured to receive therein a reduced terminal portion 29 which projects outside the cup and which is the end of a stout metallic rod 30 that extends inwardly and axially of the cup, tube and sleeve. Preferably the rod is of steel and of adequate diameter to be very rigid. The cup 28 is sealed around its aperture to the said rod 30. The assembly accordingly is entirely sealed except that it provides an opening into the end space of the magnetron and may accordingly be evacuated therewith.

The sizes, materials and stout character of the assembly of casing, sleeve, tube, cup and rod obtain a very rigid construction and reduce to insignificance any vibration of detrimental character in the end portion of said rod located within the casing.

Extending from said rod 30 to the disc 20 is lead-in wire 21 previously referred to. This wire is made as stout and rigid as available space will permit, and is preferably tungsten, which, by reference to page 1212 of Handbook of Chemistry and Physics, 21st edition, is credited with having the highest Young's modulus there tabulated. The length of this lead-in wire is comparatively short to lead-wires of prior art constructions, and as length cubed enters as a factor in the equation for vibration displacement of a wire, the present construction utilizing a short length only of lead-in wire represents a decided gain in stiffness and consequential reduction in vibrational displacement in use. In fact, the vibration existent in the cathode due to flexure in the lead-in wire of the present construction is so minute, that vibration perturbations in microwave frequency, as explained above, are negligible. Thus the present construction enables microwaves to be projected into space practically unmodulated by vibration perturbations and therefore of a character which, under the heterodyning in the receiver, still come within the substantially flat maximum of the receiver response curve. As shown, the lead-in wire 21 extends outwardly only about equally as far as the outer end of tubular casing 24, and its length is shorter than the rod 30 from which it is supported.

The construction is of a character which may also provide a radio frequency choke in the lead-in assembly without introducing added mass on the lead-in wire. It will be appreciated that addition of extra weight on a lead-in wire increases the vibration amplitude. In the present construction a choke is provided avoiding introduction of added mass to form the same. As shown, the end of rod 30 is recessed or hollowed at 31 longitudinally inward a distance equal approximately to a quarter wave length, said recess being larger than the lead-in wire 21. The open end of said radio frequency choke 31 is located at a distance of three-quarters of one wave-length or some other odd multiple of quarter wave-length from the end of the "Kovar" seal 26 at which the glass is attached. This distance provides the most efficient choking action. At the bottom of the recess is provided a socket 32 of less diameter than said recess and preferably just the size of the lead-in wire 21. The end of the lead-in wire 21 is secured in said socket by welding or otherwise. The thinned wall of the rod resulting from presence of the recess has no supporting or mass effect upon the lead-in wire, therefore having no detrimental vibration-producing or support-weakening characteristics on the assembly, and yet constitutes a perfect choke for microwave energy seeking exit along the lead-in wire.

With reference to Figure 4, a modification is there shown for the sealed end of the lead-in assembly. Instead of providing a "Kovar" cup 28, glass tube 27a is made reentrant at its outer end thereby providing a stem portion 28a sealed around rod 30a. By this construction the rod is sealed directly to the glass and has even less of its length unsupported. The rod in this instance is preferably "Kovar" or other metal to which glass sealing may be effected and desirably one having substantially the same coefficient of expansion as the glass employed for tube 28a. The conductive characteristics as well as the rigidity of "Kovar" are comparable to the steel rod referred to above, and if desired "Kovar" may be utilized instead of steel for the rod 30 of the first-described construction.

We claim:

1. A magnetron comprising a metallic body portion having end spaces therein and having an anode as part of said body portion interposed between said end spaces, and said anode having a cathode cavity extending therethrough from one end space to another, a cathode in said cathode cavity and projecting at the ends thereof into said end spaces of the body portion, and lead-in assemblies at both ends of said cathode, each of said assemblies comprising a rigid rod having a socket at its end toward the cathode and a lead-in wire having one end secured in said socket and its other end in said end space supporting the cathode, said assemblies at both ends of the cathode having rigidity confining cathode vibration to a value by which microwave output of the magnetron is held within the flat maximum of the response curve thereof.

2. A magnetron comprising a body portion having end spaces therein and a cathode cavity extending from one end space to another, said body portion having an opening at the side of an end space for a lead-in assembly, a cathode in said cathode cavity and projecting at the ends thereof into said end spaces, and a lead-in assembly for said cathode, said assembly comprising a hollow casing carried in said opening and having a restricted passage therein next to and opening into said end space, a rigid rod in part in said casing and having a socket at its inner end, a lead-in wire having one end secured in said socket, said lead-in wire having smaller diameter than said passage and out of contact from said casing and passing therethrough into said end space and supporting the cathode at the inner end of said lead-in wire, said lead-in wire being rigid and shorter than said rod.

3. A magnetron comprising a body portion having end spaces therein and a cathode cavity extending from one end space to another, a cathode in said cathode cavity and projecting at the ends thereof into said end spaces, and a lead-in assembly for said cathode, said assembly comprising

a tubular casing projecting from the body portion, said casing having a restricted passage at its end next said body portion opening into one of said end spaces, a rigid rod projecting into the end of the casing away from the magnetron body and into proximity to said restricted passage in axial alignment therewith, and a rigid lead-in wire extending through said restricted passage into said one end space and supporting the cathode, said lead-in wire and rod overlapping and being secured together within said casing, said rod constituting the sole support for said lead-in wire and the cathode being supported by said lead-in wire.

4. A magnetron comprising a body portion having end spaces therein and a cathode cavity extending from one end space to another, a cathode in said cathode cavity and projecting at the ends thereof into said end spaces, and a lead-in assembly for said cathode, said assembly comprising a tubular casing projecting from the body portion, a rigid lead-in wire projecting into the inner end of the casing from the body portion, and a rigid rod of greater diameter than said lead-in wire projecting into the outer end of the casing and having a socket at its inner end portion, said lead-in wire being secured in said socket, and said casing having its tubular interior of larger diameter than said rod where containing the rod and larger diameter than said lead-in wire where containing the same, and said rod and lead-in wire having sole support from the outer end of said casing and maintained out of contact with the tubular interior of the casing by inherent rigidity of said rod and lead-in wire.

5. A magnetron comprising a body portion having end spaces therein and a cathode cavity extending from one end space to another, a cathode in said cathode cavity and projecting at the ends thereof into said end spaces, and a lead-in assembly for said cathode, said assembly comprising a tubular casing projecting from the body portion, a rigid lead-in wire projecting into one end of the casing from the body portion, and a rigid rod of greater diameter than said lead-in wire projecting into the other end of the casing and secured to the lead-in wire, said rod having a recess at its end portion of greater diameter than said lead-in wire and coaxially receiving the end portion of said wire and forming a microwave choke therewith.

6. A magnetron comprising a body portion having end spaces therein and a cathode cavity extending from one end space to another, a cathode in said cathode cavity and projecting at the ends thereof into said end spaces, and a lead-in assembly for said cathode, said assembly comprising a tubular casing projecting from the body portion, a rigid lead-in wire projecting into one end of the casing from the body portion, and a rigid rod of greater diameter than said lead-in wire projecting into the other end of the casing and secured to the lead-in wire, said rod having a recess of quarter wave-length depth at its end portion of greater diameter than said lead-in wire and coaxially receiving the end portion of said wire and forming a radio frequency choke therewith.

7. A magnetron comprising a body portion having end spaces therein and a cathode cavity extending from one end space to another, a cathode in said cathode cavity and projecting at the ends thereof into said end spaces, and a lead-in assembly for said cathode, said assembly comprising a tubular casing projecting from the body portion, a rigid lead-in wire projecting into the inner end of the casing from the magnetron body, and a rigid rod projecting into the outer end of the casing, said lead-in wire and rod being secured together, and means insulating and supporting said rod from said casing at a part of said rod remote from the casing, said means constituting sole support for said rod and said rod constituting sole support for said lead-in wire, inherent rigidity of said rod and lead-in wire maintaining the same substantially non-vibrating and out of contact from said casing.

8. A magnetron comprising a body portion having end spaces therein and a cathode cavity extending from one end space to another, a cathode in said cathode cavity and projecting at the ends thereof into said end spaces, and a lead-in assembly for said cathode, said assembly comprising a tubular casing projecting from the body portion, a rigid lead-in wire projecting into one end of the casing from the body portion, and a rigid rod of greater diameter than said lead-in wire projecting into the other end of the casing and secured to the lead-in wire, said rod having a recess at its end portion of greater diameter than said lead-in wire and coaxially receiving the end portion of said wire and forming a radio frequency choke therewith, and means insulating and supporting said rod from said casing at a part of said rod remote from the casing.

9. A magnetron comprising a body portion having end spaces therein and a cathode cavity extending from one end space to another, a cathode in said cathode cavity and projecting at the ends thereof into said end spaces, and a lead-in assembly for said cathode, said assembly comprising a tubular casing projecting from the body portion, a rigid lead-in wire projecting into one end of the casing from the body portion, and a rigid rod of greater diameter than said lead-in wire projecting into the other end of the casing and secured to the lead-in wire, said rod having a recess of quarter wave-length depth at its end portion of greater diameter than said lead-in wire and coaxially receiving the end portion of said wire and forming a radio frequency choke therewith, and means insulating and supporting said rod from said casing at a part of said rod remote from the casing.

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