

Nov. 29, 1949

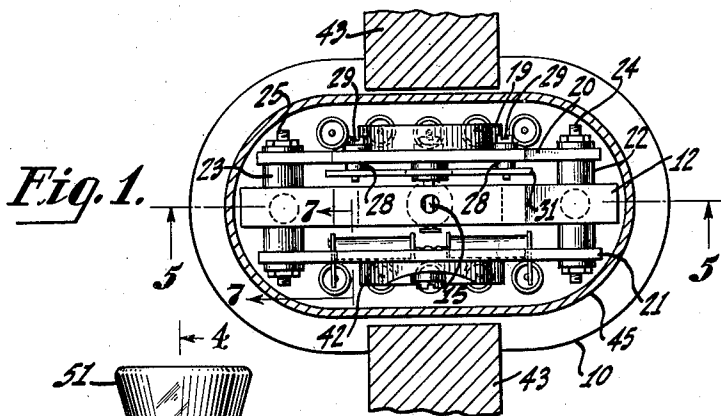
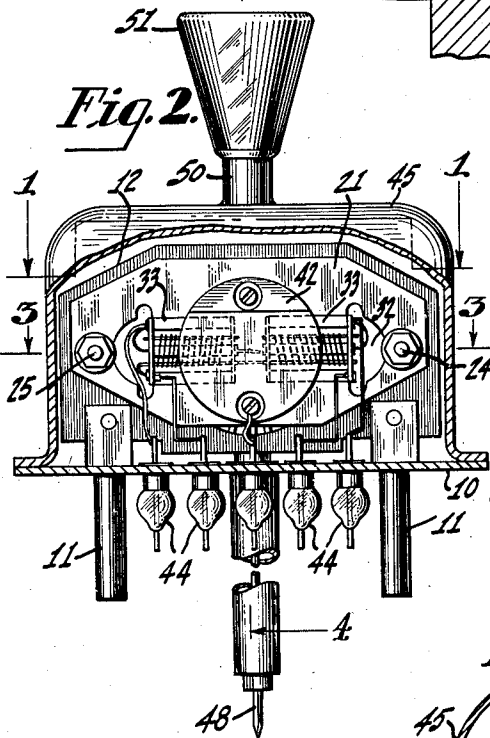
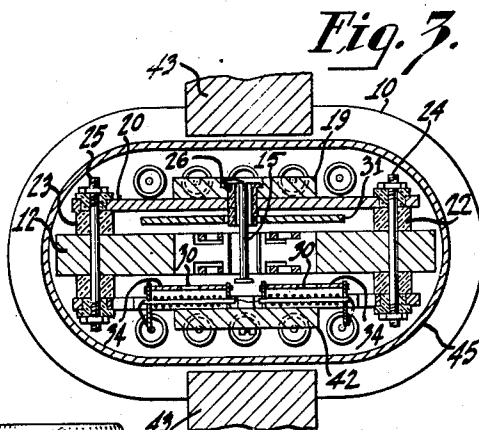
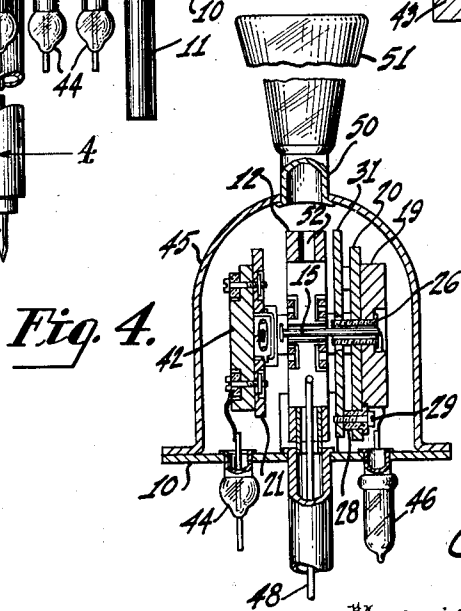
C. I. SHULMAN

2,490,008

SINGLE CAVITY MULTISEGMENT MAGNETRON

Filed Jan. 7, 1947

2 Sheets-Sheet 1



Inventor
Carl I. Shulman
Attorney
William A. Zalesak

Nov. 29, 1949

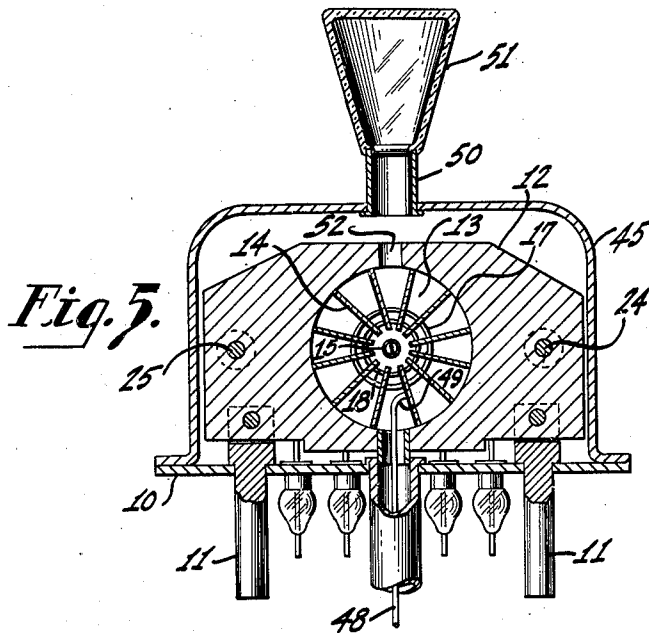
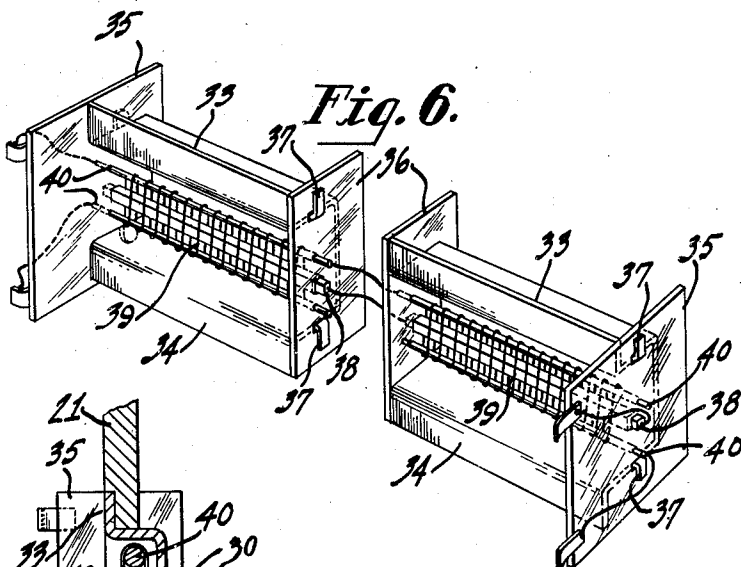
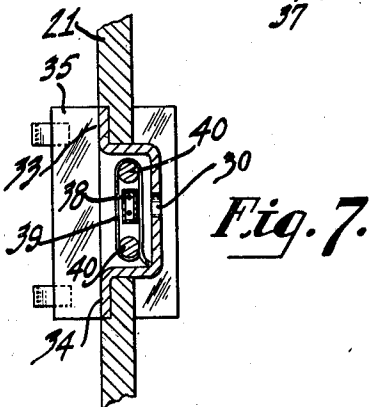
C. I. SHULMAN

2,490,008

SINGLE CAVITY MULTISEGMENT MAGNETRON

Filed Jan. 7, 1947

2 Sheets-Sheet 2



28

Inventor
Carl I. Shulman
By *William A. Zalesak*
Attorney

UNITED STATES PATENT OFFICE

2,490,008

SINGLE CAVITY MULTISEGMENT
MAGNETRONCarl I. Shulman, Princeton, N. J., assignor to
Radio Corporation of America, a corporation
of Delaware

Application January 7, 1947, Serial No. 720,546

9 Claims. (Cl. 250—27.5)

1

This invention relates to generators of micro-wave energy employing cavity resonators and more particularly to electron discharge devices such as magnetrons and a method and means for modulating the generating micro-wave energy.

Various arrangements have been proposed for modulating a magnetron generator. Of particular interest among the proposed arrangements is the one disclosed in U. S. application Serial No. 563,732, filed November 16, 1944, in the name of L. P. Smith, assigned to Radio Corporation of America, in which use is made of electron beams directed into the resonator cavities. The present invention employs the principle of operation disclosed in the above application and has for its object primarily to provide structural improvements in magnetron generators utilizing frequency modulation by means of spiral electron beams.

Another object of the invention is to provide a more compact magnetron structure which may readily be produced in large quantities.

A further object of the invention is to improve the electron beam emitting elements incorporated in the magnetron structure.

A particular advantage of the improved structure resides in the reduction of the number of component elements and ease of assembly.

A further advantage of the improved magnetron and modulator assembly is manifest in rigidity of structure to withstand shocks incidental to handling and shipping.

Other objects and advantages will be apparent from the following description of the invention pointed out in particularity in the appended claims and taken in connection with the accompanying drawing in which—

Fig. 1 is a plan view of the magnetron generator with the cover cut away along line 1—1 of Fig. 2;

Fig. 2 is a side elevational view with the cover partly cut away;

Fig. 3 is a section along line 3—3 of Fig. 2;

Fig. 4 is a section along line 4—4 of Fig. 2;

Fig. 5 is a sectional view along line 5—5 of Fig. 1; and

Figs. 6 and 7 are enlarged views in perspective and in section, respectively, of the electron emitting elements incorporated in the magnetron structure.

In the application above referred to it was explained that a magnetron may be frequency modulated electronically by introducing an electron beam into the cavity of a resonator of the magnetron provided that the drift velocity of the beam is parallel to the constant magnetic field

2

and normal to the oscillating electric field. It was also pointed out that a negative grid could be used in the beam-producing device to control the total current in the beam and thereby vary the frequency of the oscillating magnetron in accordance with variations in the intensity of the beam current.

The type of beam-producing elements, their location and assembly in the magnetron structure is of great importance from a standpoint of efficiency and practical structure. The arrangement of parts in a magnetron of the type specified presents considerable difficulties particularly when it is desired to produce large quantities for commercial distribution. Accordingly, the present invention, as will be seen, simplifies the structural and assembly difficulties and by an ingenious arrangement of parts of novel design provides a compact, sturdy, and efficient structure which may be produced commercially at a reduced cost.

The arrangement of parts and their assembly will be better understood with reference to the various figures of the drawing. For the purpose of illustration a type of magnetron is shown in which the anode block is an oblong plate with sector-shaped resonators. The structural features of the invention may as well be applied to magnetrons of other types; for example, those which have cylindrical anode blocks and slotted resonators. In the various figures of the drawing similar reference characters are used for identical parts.

Referring to the figures, the complete magnetron assembly is illustrated in the various views in Figs. 1 to 4. The compact structure is built around certain basic elements shown in Fig. 5. To better visualize the various parts which make up the finished product the detailed views will be considered first in describing the magnetron structure characteristic to this invention. In the various figures of the drawing similar reference characters are used for identical parts and reference should be had to these considering at the same time other figures than the particular one under discussion.

As seen in Fig. 5, on a header 10 is mounted by means of studs 11, the anode block 12 provided with a central opening 13 extending there-through. A plurality of radially extending vanes 14 surround a central space in which is mounted an indirectly heated cathode 15. The vanes 14 divide the central opening 13 into a number of sectors and each sector forms a resonator bounded by the vanes on two sides and by the inner wall

3

of the block 12 at one end. At the other end the resonators open into the interaction space surrounding the cathode 15 and are open also on both sides in the direction transverse to the block 12. In this manner there is an electro-magnetic intercoupling between the resonators. The vanes 14 are also strapped together by means of conducting rings 17 and 18 which are connected to alternate vanes to enhance operation in the desired mode. The cathode 15 is supported by means of the disc 19 made of magnetic material and secured to a yoke member 20. A similar yoke 21 is provided on the other side of the anode block 12. Both yokes are supported on the anode block 12 by means of insulating bushings, 22 and 23, preferably of ceramic material, and bolts 24 and 25, respectively. The cathode 15 is also insulated from the yoke 20 by means of the insulating bushing 26 held in the disc 19. Between the anode block 12 and the yoke 20 and mounted thereon by means of insulating washers 28 and screws 29 is a circular plate member 31 of approximately the same diameter as the circular opening 13. The function of this plate member will be explained later.

The yoke 21 has a longitudinally expanding slot 32 which holds a pair of electron beam emitting elements so constructed as to fit easily into the slot for simple assembly. The particular construction of the electron emitting elements will be better understood by referring to the enlarged perspective view of Fig. 6 and the cross-sectional view of Fig. 7. The electron beam emitters 33 are essentially individual triode assemblies having specially constructed and shaped elements. The entire assembly is built around a U-shaped member 34 which is provided with flanges along its longitudinal sides and an elongated aperture 30 in its flat side. Two insulating plates 35 and 36 which may be of mica or similar material are held by the member 34 by means of turned down flaps 37 and between these plates is mounted an indirectly heated cathode sleeve 38 surrounded by a grid winding 39 wound on rods 40 extending through the plates 35 and 36. The U-shaped member 34 is the accelerating electrode and also the framework support for the assembly which fits into the slot of the yoke 21. Furthermore, the flanges of this member fit into a recess in the yoke 21 whereby the entire assembly is centered and held in place without other mounting means or holes which otherwise would have to be drilled with precision in parts of the magnetron.

In the figures showing the complete magnetron it is seen that the two beam emitters 33 are so arranged as to be juxtaposed with certain resonators of the anode block. In this manner the accelerating electrode 34 has its aperture 30 so directed as to introduce an electron beam in the direction transverse to the anode block 12 into and through the cavity of certain resonators. The function of the plate 31 previously described is to collect the electrons of the beams. The single plate 31 eliminates the need of separate beam collecting electrodes for each emitter. In this manner several electron emitters may be used with one electron collecting electrode.

A disc 42 of magnetic material, similar to the disc 19, is secured against the yoke 21 and presses also against the flanges of the member 34 whereby the emitters are firmly held in place. The discs 19 and 42 being of magnetic material serve as internal magnetic members for the field pro-

4

ducing magnet 43 used externally in the operation of the magnetron.

Connecting wires to the individual elements are brought out of the tube through the various seals 44 in the header 10. The complete assembly on the header 10 is provided with a suitable cover 45 which may be welded or brazed to the header 10 and is evacuated through the stem 46. The output of the magnetron may be taken off through the sealed-in output electrode 48 which terminates in a coupling loop 49 in one of the resonators.

It is to be noted also that the cover 45 has a tubular portion 50 which is closed by a cover seal 51. In line with the portion 50 there is an opening 52 in the anode block 12 which communicates with one of the resonator cavities. This opening, together with the portion 50, may be used for assembling a tuning device on the magnetron of the type disclosed in an application Serial No. 711,683, filed November 22, 1946, in the name of J. Kurshan, assigned to Radio Corporation of America. The tuning mechanism and method of operation described in the above application may readily be adapted to the magnetron structure herein disclosed, in which case it replaces the cover seal 51.

I claim:

1. An electron discharge device including a cavity resonator subjected to a magnetic field, means for directing an electron beam in the direction parallel to said field into said resonator along a predetermined path comprising an electron gun assembly adjacent said resonator and including an accelerating electrode having an aperture, a pair of insulating members affixed to said electrode, an electron emitting cathode and a grid electrode inside said accelerating electrode and supported from said members in alignment with said aperture, and an electron collecting electrode oppositely disposed to said gun and in said path.

2. An electron discharge device including a cavity resonator subjected to a magnetic field, means for directing an electron beam in the direction parallel to said field into said resonator along a predetermined path comprising an electron gun assembly adjacent said resonator and including an elongated U-shaped accelerating electrode flanged outwardly having an elongated aperture, a pair of insulating members closing both ends of said electrode, supports extending between said members, a grid electrode helically wound on said supports and an electron emitting cathode inside said grid and extending between said members in alignment with said aperture, a support for said assembly comprising a plate member adjacent one end of said resonator, said plate member having a longitudinal aperture accommodating said U-shaped electrode and a recess accommodating said flanges and an electron collecting electrode adjacent said resonator and in said path.

3. A magnetron discharge device including a cathode, an anode electrode surrounding said cathode having a plurality of cavity resonators spaced around said cathode and open on both sides of said anode, a first yoke member adjacent one side of said anode and insulated therefrom, a second yoke member adjacent the other side of said anode and insulated therefrom, a pair of electron emitting elements supported by said first yoke member, each of said elements being oriented in juxtaposition with one of said resonators whereby the electrons emitted from said elements pass through the cavity of said resonators and a plate

5

electrode for collecting said electrons supported by said second yoke member.

4. A magnetron discharge device including a cathode, an anode electrode surrounding said cathode having a plurality of cavity resonators radially spaced around said cathode and open on both sides of said anode, a first yoke member adjacent one side of said anode and insulated therefrom, a second yoke member adjacent the other side of said anode and insulated therefrom, a pair of electron emitting elements comprising a cathode, a grid and an accelerating electrode spaced equidistantly from said cathode and supported by said first yoke member, each of said elements being oriented in juxtaposition with one of said resonators whereby the electrons emitted from said elements pass through the cavity of said resonators and a disc shaped electrode having a diameter substantially equal to the spacing between said elements for collecting said electrons supported by said second yoke member.

5. The structure in accordance with claim 3 wherein each of said electron emitting elements comprises an assembly including a cathode, a grid electrode, and an accelerating electrode in the form of a longitudinally extending U-shaped member flanged on both longitudinal sides and having a longitudinally extending aperture, a pair of insulating plates attached to the ends of said U-shaped member, said cathode and grid electrode being mounted inside said U-shaped member in alignment with said aperture on supports held between said plates, said first yoke member having a longitudinally extending slot accommodating said U-shaped member and a vertically extending recess accommodating said flanges.

6. A magnetron discharge device including a base header, an oblong metal anode electrode mounted on said header, said electrode having a circular aperture divided into sectors each of which opens into a central space and surrounds a cathode electrode transverse to said anode, said sectors forming resonators, first and second yokes, one member on each side of said electrode and parallel therewith, supporting means for said yokes comprising insulating bushings secured to each side of said anode, said yokes being fastened to said bushings thereby being insulated from said anode, a disc of magnetic material fastened to said second yoke on one side, an insulating bushing traversing said second yoke and supported in said disc, said bushing surrounding said cathode electrode, a circular plate electrode mounted on the other side of said second yoke and insulated therefrom, said plate electrode having a diameter substantially equal to that of said aperture, a pair of electron beam forming elements mounted on said first yoke and oriented in the direction to form an electron beam transverse to said anode electrode and through a pair of said sectors, said circular plate electrode being adapted to collect the electrons of the beams emitted from said elements, a plurality of terminals sealed in said header and connections from said terminals to said cathode electrode, to said plate electrode, and to said beam forming elements.

7. A magnetron discharge device including a base header, an oblong metal anode electrode mounted on said header, said electrode having a circular aperture divided into sectors each of which opens into a central space and surrounds

6

a cathode electrode transverse to said anode, said sectors forming resonators, first and second yokes, one on each side of said anode electrode and parallel therewith, supporting means for said yokes comprising insulating bushings secured to each side of said anode electrode, said yokes being fastened to said bushings thereby being insulated from said anode electrode, a disc of magnetic material fastened to said second yoke on one side, an insulating bushing traversing said second yoke and supported in said disc, said bushing surrounding said cathode electrode, a circular plate electrode mounted on the other side of said second yoke and insulated therefrom, said plate electrode having a diameter substantially equal to that of said aperture, a pair of electron beam forming elements each comprising cathode, grid and accelerating electrodes mounted on said first yoke, said accelerating electrodes having apertures oriented in the direction to form electron beams transverse to said anode electrode and directed through a pair of said resonators, said circular plate electrode being adapted to collect the electrons of the beams emitted from said elements, a second disc of magnetic material fastened to said first yoke, said discs providing internal magnetic materials for a field producing magnet, a plurality of terminals sealed in said header and connections from said terminals to said cathode electrode, said plate electrode, and to the electrodes of said beam forming elements.

8. The structure in accordance with claim 3 wherein each of said electron emitting elements comprises an assembly consisting of an accelerating electrode in the form of a longitudinally extending U-shaped member flanged on both its longitudinal sides and having a longitudinally extending aperture, a pair of insulating plates attached to the ends of said accelerating electrode, a cathode and grid electrode mounted inside said accelerating electrode in alignment with said aperture, said cathode comprising a thoriated sleeve extending through said plates and accommodating heater wires inside said sleeve, said grid electrode being a winding over a pair of rods parallel to said cathode and extending through said plates and said first yoke member having a longitudinally extending cut-out portion accommodating said U-shaped member and a vertically extending recess accommodating said flanges, and a disc of magnetic material secured to said first yoke member and resting over said flanges.

9. A magnetron discharge device including a cathode, an anode electrode surrounding said cathode having a plurality of cavity resonators spaced around said cathode and open on both sides of said anode, a plurality of electron emitting elements, means supporting each of said elements adjacent one side of said anode and oriented in juxtaposition with one of said resonators whereby the electrons emitted from said elements pass through said resonators, and a plate electrode mounted adjacent the other side of said anode for collecting said electrons.

CARL I. SHULMAN.

REFERENCES CITED

The following references are of record in the file of this patent:

Proceedings I. R. E., July 1947, pages 644-657, original manuscript received by the Institute, Apr. 26, 1946.