Jan. 6, 1953 N. P. NICHOLS 2,624,865

PLUG-IN MAGNETRON AND MOUNT THEREFOR

Filed March 1, 1946 2 SHEETS—SHEET 1

FIG. 1

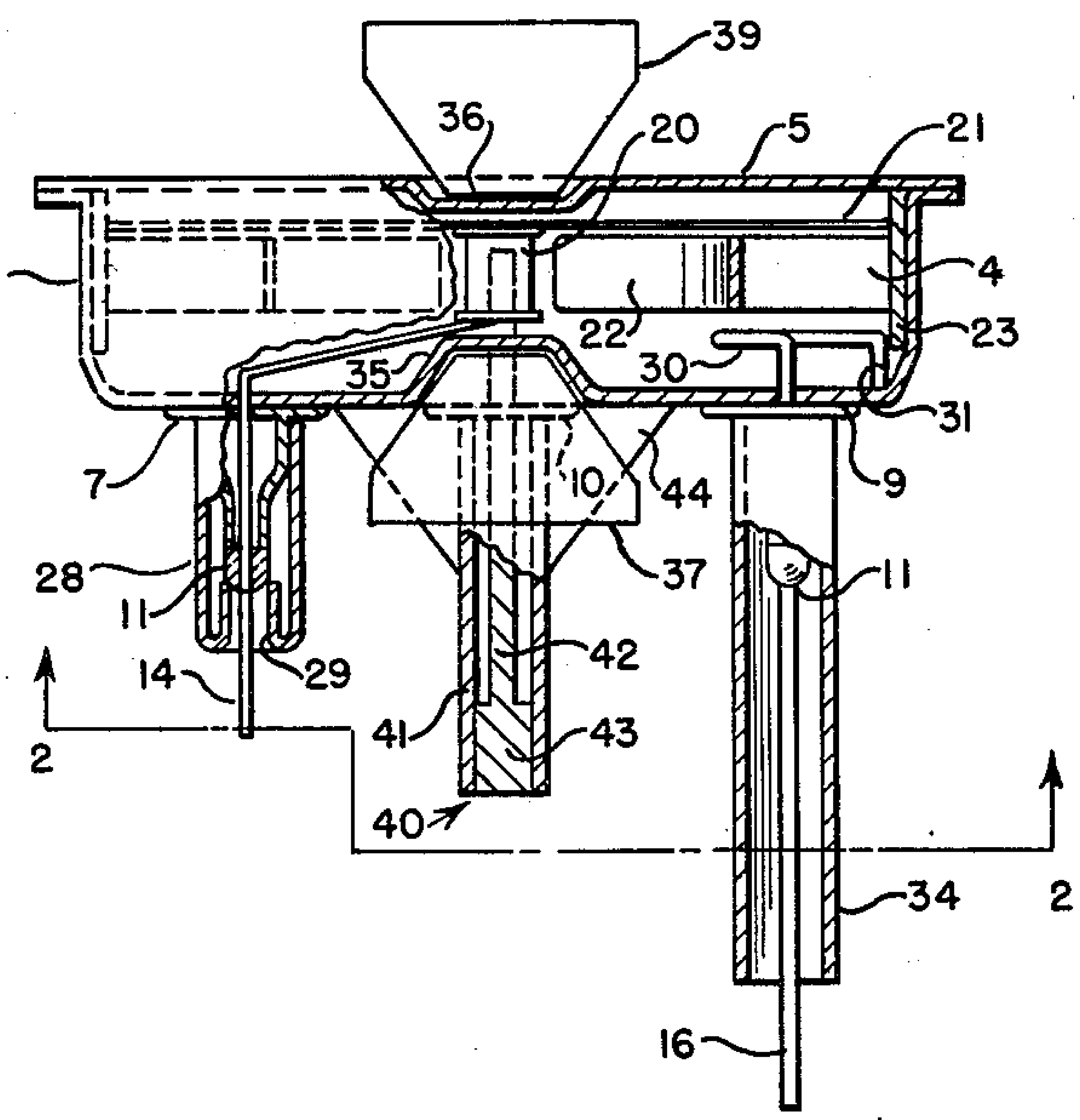

FIG. 2

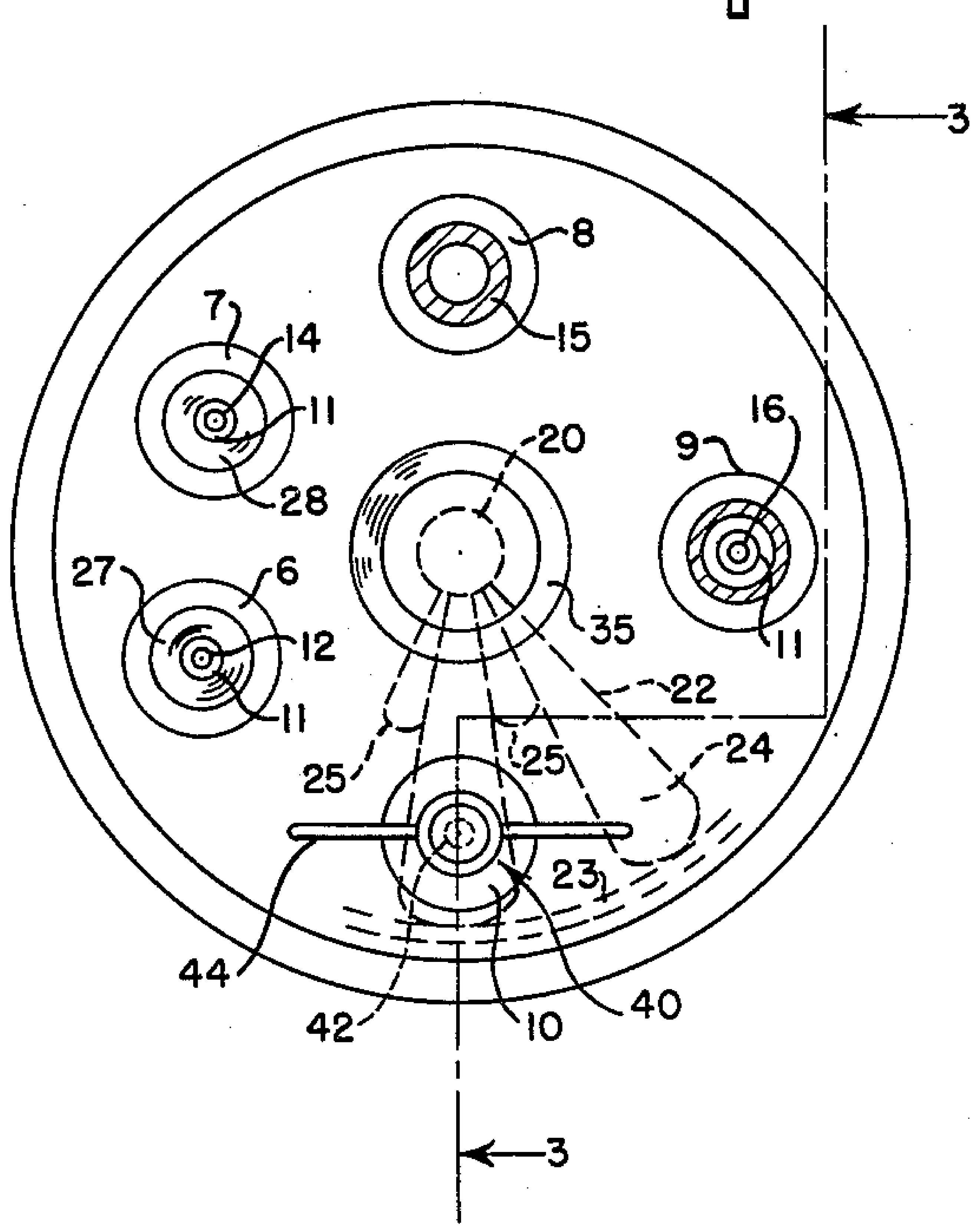

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FIG. 3

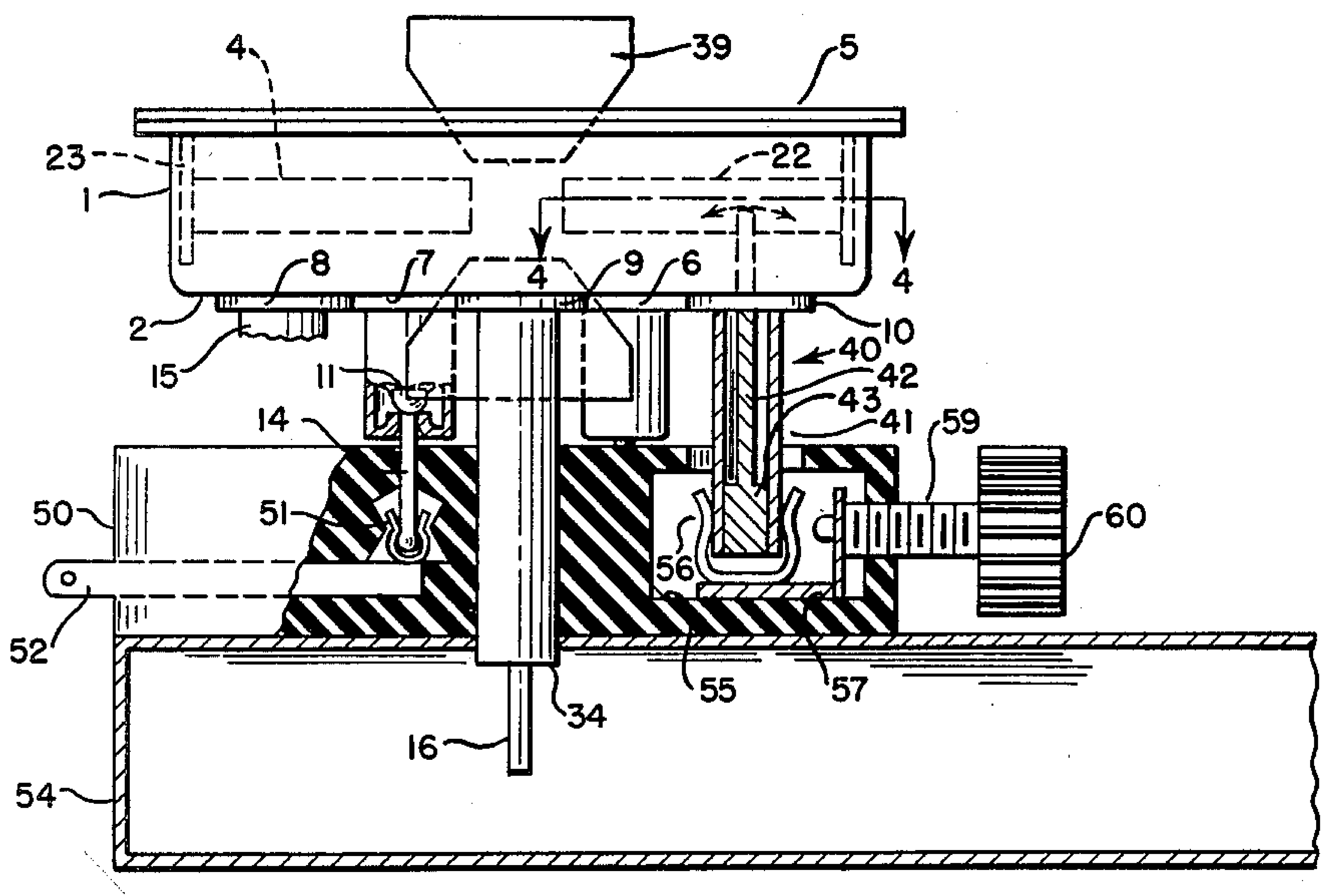
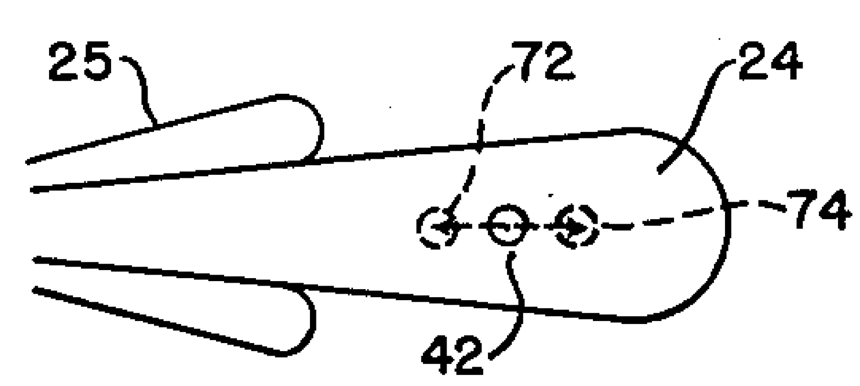


FIG. 4



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PLUG-IN MAGNETRON AND MOUNT THEREFOR

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Application March 1, 1946, Serial No. 651,301

6 Claims. (Cl. 315—40)

1

This invention relates to ultra-high frequency oscillators and particularly to an improved form of magnetron.

The use of the magnetron as an ultra-high frequency oscillator is well understood in the art. It provides a very satisfactory means of generating high power oscillations at these frequencies, and especially the sharply peaked pulses used in radio object locating systems.

The cost of manufacturing magnetrons is substantial, however, because of the necessity for accurate machining to the desired shapes, and the weight of the units is objectionably high.

This invention provides a form of magnetron which can be readily produced in volume at low cost and will have substantial advantages in savings of weight and ease of production. It incorporates certain novel features described in the U. S. Patent application of Nathan P. Nichols, Serial No. 627,038, filed November 6, 1945, for Continuous Strip Anode for Magnetrons, issued as Patent No. 2,548,808 on April 10, 1951. In that application there was described a form of magnetron in which the anode structure was formed of a ribbon which could be stamped out of sheet metal and bent by suitable jigs or stamping devices into the desired shapes to form resonant cavities.

The present invention represents an improvement in which such ribbon type anode elements are utilized in a tunable magnetron constructed so it can be plugged into a special socket.

In the drawings:

Fig. 1 is a side view, partially in section, of a preferred form of a tube incorporating the invention, indicating the proper operating relation thereto of permanent magnetic pole pieces;

Fig. 2 is a bottom view of the embodiment of Fig. 1 taken as indicated by line 2—2 in that figure;

Fig. 3 is a view, partially in section, of a socket member arranged to receive the tube shown in Fig. 1, the view of the tube being taken looking in the direction indicated by line 3—3 of Fig. 2; and

Fig. 4 is a fragmentary view showing the relation of the tuning means to the resonant cavity, taken as indicated by line 4—4 of Fig. 3.

Referring now to the drawings for a more detailed description of the invention, there is shown in Fig. 1 a short cylindrical shell 1 having a closed end 2 and formed as by die casting an easily worked metal. Within shell 1 is mounted a preferred form of anode assembly 4 such as that set forth in the pending application referred to above. This assembly is described in greater

2

detail below. Opposite closed end 2 is an end closure 5, secured in position by welding or equivalent means for effecting a secure air-tight joinder after the various elements described hereafter have been properly disposed within the shell 1.

A plurality of hollow elongated eyelets 6–10 inclusive (Figs. 1 and 2), formed of an alloy described below, or of a functionally equivalent material, are disposed symmetrically around the closed end 2, with their long axes parallel to that of the shell 1. These eyelets are welded or brazed to the closed end 2, which is suitably bored therethrough in registry with each of said eyelets so that leads, which may also be formed of said alloy may be passed into the interior of shell 1. Each lead may then be sealed to the appropriate eyelet by a glass bead 11 (Fig. 1). The junctures between the glass beads 11 and the eyelets 6–10 must form secure vacuum-tight seals. This is facilitated by the use of commercially known alloys having a composition substantially as follows: Nickel, 29%; cobalt, 17%; magnesium, 0.2%; and the balance iron, which can be securely joined to the glass beads because they have similar thermal expansion characteristics.

Through the eyelets 6 and 7 are disposed a cathode lead 12 and cathode heater lead 14, respectively. To eyelet 8 is sealed an exhaust tube 15 leading to a conventional vacuum pump system, not shown. An output lead 16 is sealed through eyelet 9, and a tuning member to be described hereafter is secured to eyelet 10.

All of the leads and eyelets described above are arranged parallel to the axis of the shell 1 so that they may be inserted in a suitable socket such as that shown in Fig. 3.

Within the shell 1 and connected to the cathode lead 12 is a centrally disposed cathode and cathode heater means 20, the latter being connected to cathode heater lead 14. A thin spacer 21 of mica may also be disposed in shell 1 to provide additional support for cathode 20. Surrounding cathode 20, a ribbon anode 22 is arranged in convolutions within the anode ring 23 to form alternately large resonance chambers 24 (Figs. 2 and 4) and small resonance chambers 25 disposed in a "rising sun" pattern such as that described in the application referred to above. Each of the large chambers 24 is secured at its outer end to the anode ring 23 as by brazing. Suitable strapping, not shown in the figure, may be provided, as is understood in the art, to increase mode separation, if desired.

Radio-frequency chokes 27 and 28 (Fig. 2) may be disposed about the cathode lead 12 and the cathode heater lead 14, respectively. Each of these chokes may have the form of a metal sleeve secured coaxially about the appropriate eyelet and having a free end re-entrantly curved at 29 (see Fig. 1) for a distance substantially equal to one-quarter of a wavelength at the intended frequency of oscillation. Leads 12 and 14 cooperate with the re-entrant sleeve portions 29 to form a quarter-wave coaxial line, the effect of which, as is understood in the art, is to prevent passage of high frequency currents.

Output lead 16 (see Fig. 1) is carried into the shell 1 through eyelet 9. It is shaped to form a coupling loop 30 anchored by brazing or welding the inner end 31 to the shell 2. Lead 16 is surrounded by a conducting sleeve 34 fixed to eyelet 9 concentrically thereabout, and constituting with lead 16 a coaxial line long enough to deliver the magnetron output to associated apparatus, which may be a wave guide such as set forth hereinafter.

Closed end 2 is centrally recessed at 35, as is the end closure 5 at 36, in order that the permanent magnet pole pieces, the operating position for which is indicated at 37 and 39, may extend as near as possible to the center of the resonant chamber space, and the magnetic field may be maintained at its highest possible value.

Tuning of the magnetron is accomplished by changing the position of a flexible tuning post 40, a portion of which extends into one of the large resonant cavities 24 formed by ribbon anode 22.

The flexible tuning post 40 is composed of two parts, an outer tube 41 of easily deformable metal, and an inner stiff tuning probe 42 secured throughout its lower end 43 solidly within the outer tube 41. The inner probe 42 is of substantially lesser diameter than is the tube 41. A reinforcing rib 44, disposed normal to the line in which it is intended that motion of the post 40 is to occur, is fixed to closed end 2, to which also is rigidly secured the upper end of outer tube 41.

Adjustment of the tuning probe 42 is effected by exerting lateral pressure against the lower end of outer tube 41 in a direction along a radius of the shell 1. As tube 41 is bent in one direction, the probe 42 will swing in the opposite direction within its associated resonant cavity 24 (Figs. 3 and 4), its motion being limited by its diameter relative to the internal diameter of tube 41. The movement of the probe is substantially limited to a path along a radius of the shell, by virtue of the resistance offered by rib 44 to bending in other directions.

The position of the tuning probe 42 is controlled in use by a vernier adjustment described below and forming part of the socket of this invention, which is illustrated in Fig. 3. The elements of such a socket include an insulating member 50 having fixed therein resilient connections such as 51 adapted to receive the cathode and cathode heater leads 12 and 14, respectively, and having external connection means 52 associated therewith. The insulating member 50 is arranged for mounting on a wave guide 54 or other suitable power conductor, into which is extended the coaxial line constituted by the output lead 16 and its surrounding sleeve 34. A connecting link may be provided in the socket between the exhaust tube 15 and the vacuum pump (not shown) if desired. The vernier tuning adjustment is provided by a rectangular guideway 55 in which is a clip 56 adapted to receive the lower end of the tuning post 40. Clip 56 is secured to an angle member 57, the position of which is manually controlled by a screw 59 fixed to tuning knob 60. The direction of movement of the clip and angle member 57 is limited by guideway 55 to a radial path relative to the shell 1.

The tuning effect of the probe 42 in its different positions is shown in Fig. 4, which shows its normal position within a large resonant cavity 24 in solid lines. When the probe is at the inward limit of its traverse, as indicated in dotted lines at 72 its effect is to add capacitance to the circuit. When at the outward limit of its traverse, as indicated in dotted lines at 74, the effect is the same as that of adding inductance to the circuit.

The construction as described provides a form of lightweight magnetron which is susceptible of manufacture at a relatively low cost, and which may be readily mounted and dismounted as the need arises.

What is claimed is:

1. A magnetron, comprising a cylindrical shell enclosing a ribbon-type anode mounted within said shell and forming a plurality of symmetrically and radially disposed cavity resonators, cathode means positioned centrally of said cavities, an output loop disposed within said shell, sealed leads extending parallel to the axis of the said shell from said cathode means and output loop, means disposed at the hose of said shell through which said shell may be maintained highly evacuated, a flexible tuning post extending substantially parallel to the axis of said shell and having a probe therein extending into one of said cavity resonators; and means disposed at the hose of said shell, for mounting said magnetron including receptacles for said leads, a waveguide communicating receptacle for said output lead, and a tuning post receptacle for positional adjustment of said tuning post.

2. A magnetron, comprising a cylindrical shell having centrally recessed ends to receive external pole pieces a ribbon-type anode symmetrically disposed within said shell and forming a plurality of cavity resonators, cathode means disposed centrally of said resonators, leads for said cathode means extending through said shell and parallel to the axis of said shell, a pickup loop disposed within said shell, an output lead extending from said loop through said shell and parallel to the axis of said shell, a connection disposed at the hose of said shell through which said shell may be evacuated, and tuning means including a flexible tube extending parallel to the axis of said shell, a probe of lesser diameter sealed within the outer end of said tube and extending therefrom into one of said cavity resonators.

3. A cavity magnetron having input and output means and a tuning post, all extending parallelly and unidirectionally therefrom, a probe within said post and extending into a cavity of said magnetron, and means for mounting said magnetron, said means having a tuning control for adjustable cooperation with said tuning post, said tuning control comprising a receptacle contacting said tuning post, a slidable mounting connected to said receptacle, and means all affixed to said mounting means for moving said slidable mounting in a direction transverse to the axis of said tuning post.

4. A magnetron having a tuning post extending outwardly therefrom, and a mount for said magnetron, said mount having a control mounted thereon for positional adjustment of said tuning

post, said control comprising a receptacle contacting said tuning post, a movable mounting connected to said receptacle, and means affixed to said mount for positioning said movable mounting.

5. A magnetron having a tuning post extending outwardly therefrom, and a mounting to which said magnetron is affixed including a tuning control means mounted thereon separately from said magnetron and cooperating with said tuning post to tune said magnetron.

6. A mounting for a tunable magnetron having input and output leads and tuning post, all extending parallelly and unidirectionally therefrom, said mounting comprising, plug-in type receptacles for receiving the leads from said magnetron, a waveguide communicating receptacle for receiving the output lead from said magnetron, and a tuning control affixed to said mounting and re-

ceptive of said tuning post for varying the position of said tuning post.

NATHAN P. NICHOLS.

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