March 15, 1955 L. L. CLAMPITT ET AL 2,704,338

MAGNETIC CIRCUITS FOR MAGNETRONS

Filed Jan. 27, 1954 2 Sheets-Sheet 1

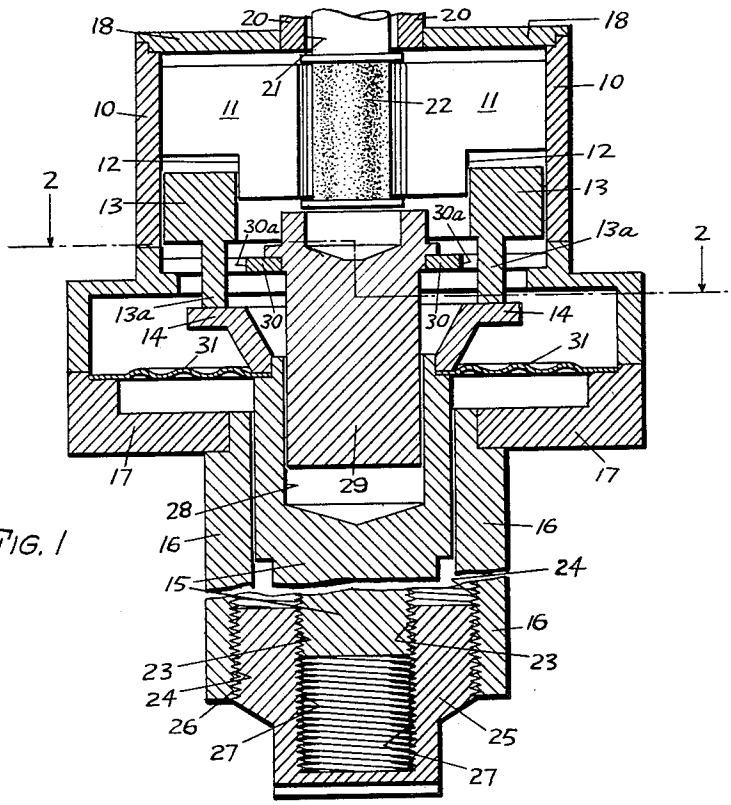


FIG. 1

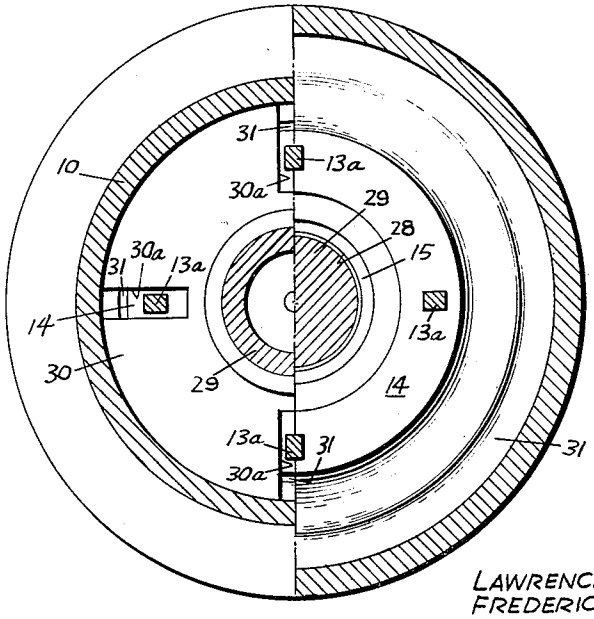


FIG. 2

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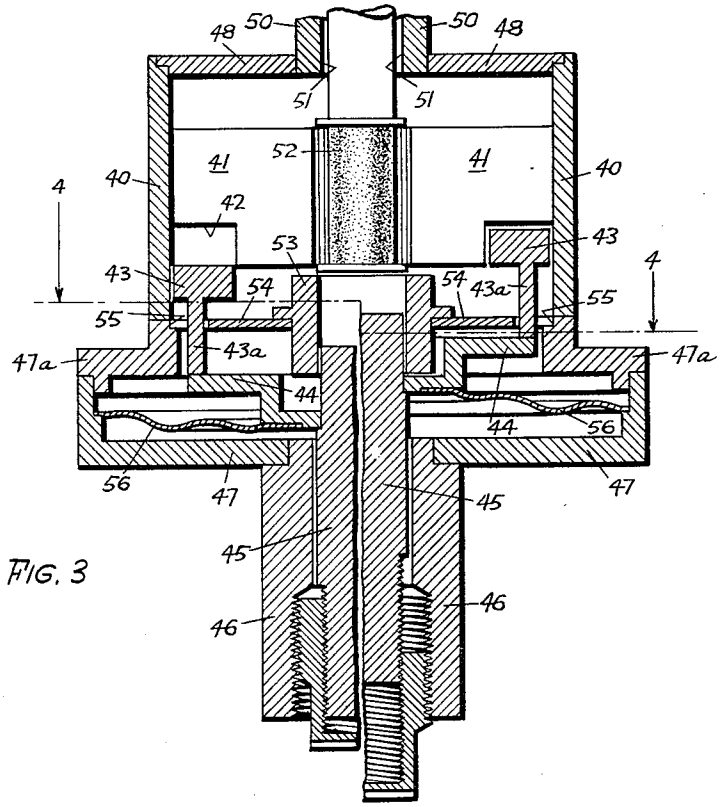


FIG. 3

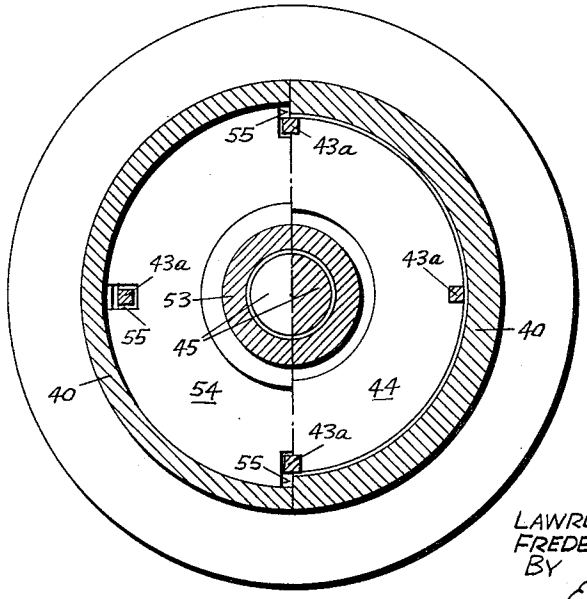


FIG. 4

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United States Patent Office 2,704,338
Patented Mar. 15, 1955

2,704,338

MAGNETIC CIRCUITS FOR MAGNETRONS

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Application January 27, 1954, Serial No. 406,556

3 Claims. (Cl. 315—39.61)

This invention relates to the magnetic circuit of magnetrons. In tunable magnetrons of the "Cookie Cutter" or "Crown of Thorns" type where a piece of non-magnetic material is inserted varying distances into one or more anode cavities of the magnetron through a diaphragm or bellows and one pole piece of the magnetic circuit, the presence of varying amounts of magnetic material in the magnetic circuit as the anode is tuned varies the intensity and distribution of the magnetic field in the region between the cathode and the anode. This variation in the magnetic field effects the performance of the magnetron. Positioning the pole pieces clear of the movement of the tuning structure results in a large gap in the magnetic circuit and requires a larger magnet. It is the purpose of this invention to so construct the pole piece and the tuning structure as to maintain, as nearly as possible, a constant amount of magnetic material in the magnetic circuit throughout the range of movement of the tuning structure and to do this with a minimum magnetic gap, so as to minimize the size of the magnet. This is accomplished by positioning a piece of magnetic material close to the cathode-anode space and extending the movable portion of the pole piece that supports and moves the tuning structure into the region of the added piece so that a considerable area of both pieces are in juxtaposition at every position of the tuning structure so that the variation of the reluctance of the magnetic circuit is kept to a minimum and the gap between pole pieces is kept to a minimum.

Other and further advantages of this invention will be apparent as the description thereof proceeds, reference being had to the accompanying drawings wherein:

Fig. 1 is a sectional view of a magnetron utilizing a preferred embodiment of the invention;

Fig. 2 is a section taken along the line 2—2 of Fig. 1;

Fig. 3 is a sectional view of a magnetron utilizing another embodiment of the invention; and

Fig. 4 is a section taken along the line 4—4 of Fig. 3.

In Figs. 1 and 2, the reference numeral **10** designates the anode supporting ring of conductive material, such as copper, of a magnetron to which are attached radial vanes **11** also of conductive material. Recesses **12** are formed in these vanes into which an annular tuning element **13** of conductive non-magnetic material fits. This tuning element **13** is supported on a ring **14**, also of non-magnetic conductive material, by means of mounting lugs **13***a*. The ring **14** is, in turn, attached to a plunger rod **15** of magnetic material such as steel that is positioned within an opening in a pole piece **16** of magnetic material that is fit in an opening in a cover plate **17** of conductive material. A second cover plate **18**, also of conductive material, covers the top of the anode cavity and supports a second pole piece **20** of magnetic material that, in turn, supports, within an opening **21**, a cathode **22** that may be of any of the types used for tubes of this type. The outer end of the rod **15** is threaded in the region **23** as is also the interior of the pole piece **16** in the region **24**. The pitch of the thread in these regions **23** and **24** is made different to cause relative movement between the pieces **15** and **16** when the piece **25** is rotated. A cylindrical piece **25** has threads **26** on its outer surface to engage the threaded region **24** on the pole piece **16**. The inner surface of this piece **25** also has threads **27** to engage the threads **23** of the rod **15**. The inner end of the rod **15** is somewhat enlarged and formed with an opening **28** dimensioned to receive a rod **29** of magnetic material supported directly under the cathode-anode region by a disk **30** on non-magnetic material formed with supports **30***a* to permit the passage of the mounting lugs **13***a* of the tuning element **13**. A flexible diaphragm **31** is fastened to supporting ring **14** and the lower cover plate **17** to permit movement of the tuning element without destroying the vacuum within the cavity.

In operation, as the cylindrical piece **25** is rotated in one direction, the rod **15** is raised to envelop the rod **29** and carries with it the tuning element **13** that penetrates into the recess **12** in the vanes **11**. When the cylindrical piece **25** is rotated in the opposite direction, the rod **15** recedes from about the rod **29** but never entirely leaves it. In this position the tuning element **13** is fully retractive from the recess **12** in the vanes **11**, but it will be seen that there is still a considerable area of the rod **15** and the rod **29** in juxtaposition. It will be seen that the magnetic circuit flows from the magnet (not shown) through the pole piece **16**, the plunger rod **15**, the rod **29** and the upper pole piece **20** back to the magnet. Due to the rod **29** and the opening **28** in the plunger **15** this circuit is never entirely broken. Thus, there is no substantial change in the magnetic circuit between the fully extended and fully retracted positions of the tuning element **13**.

A modification of this invention is shown in Figs. 3 and 4. This modification may be somewhat easier to construct, but is not quite as effective as the construction shown in Figs. 1 and 2. The anode supporting ring **40** supports a plurality of radial vanes **41**. These vanes, as before, are formed with recesses **42** into which an annular tuning element **43** of non-magnetic conductive material fits. This element **43** is supported on a ring **44**, also of non-magnetic conductive material, by means of supporting lugs **43***a*. This ring **44** is in turn attached to a plunger **45** of magnetic material that is positioned within a cylindrical pole piece **46** of magnetic material that is set in an opening in a cover plate **47** of conductive material. A second cover plate **48**, also of conductive material, covers the top of the anode cavity and supports a second pole piece **50** of magnetic material that in turn supports, within an opening **51**, a cathode **52**. This cathode and its mounting may be of any of the well-known types used in magnetrons. A driving structure for the rod **45** similar to that shown in Fig. 1 is used. A cylindrical piece **53** of magnetic material is mounted concentric with the plunger **45** directly below the cathode-anode space by means of a disk **54** formed with slots **55** to receive the mounting lugs **43***a* of the tuning element **43**. The disk **54** is attached to the lower plate **47**. The anode space is kept vacuum tight by a diaphragm **56** that is attached to a piece **47***a* connecting the ring **40** and the cover plate **47** and to the ring **44**.

In operation, as the tuning element **43** is projected into the recesses **42**, plunger **45** penetrates into the interior of the cylinder **53** as shown in the right-hand side of Fig. 3. As the tuning element **43** is retracted from the recess **42**, the plunger **45** retracts from within the cylinder **53** but never entirely leaves it. Thus the magnetic circuit from the magnet through the lower pole piece **46**, the plunger **45**, the piece **53** and the upper pole piece **50** back to the magnet is never completely broken throughout the range of movement of the tuning element **43**.

Two embodiments of the invention have been illustrated and described. It is to be understood that details of the construction of the magnetron in which the invention is used may be altered. The invention may be used with the other types of mechanical tuning structures for magnetrons.

This invention is not limited to the particular details of construction, materials and processes described, as many equivalents will suggest themselves to those skilled in the art. It is accordingly desired that the appended claims be given a broad interpretation commensurate with the scope of the invention within the art.

What is claimed is:

1. A tunable electron discharge device comprising a cathode, an anode structure formed with resonant cavities,

means for producing a magnetic flux in a direction at right angles to a plane including the openings to the cavity resonators, and tuning means for at least one of the cavities of said anode comprising conductive elements adapted to be inserted in said cavities and means for controlling the degree of insertion of said elements into said cavity, said magnetic flux providing means comprising pole pieces of magnetic material positioned on either side of the resonant cavity openings, one of said pole pieces comprising an external part formed with an opening to receive a second part adapted for movement with the tuning element, means for moving the second portion relative to the first, and a third piece positioned near the space between the anode and the cathode and shaped and located in a manner to present a considerable area in juxtaposition to the second part throughout its motion.

2. A tunable electron discharge device comprising a cathode, an anode structure formed with resonant cavities, means for producing a magnetic flux in a direction at right angles to a plane including the openings to the cavity resonators, and tuning means for at least one of the cavities of said anode comprising conductive elements adapted to be inserted in said cavities and means for controlling the degree of insertion of said elements into said cavity, said magnetic flux providing means comprising pole pieces of magnetic material positioned on either side of the plane of the resonant cavity openings, one of said pole pieces comprising an external part formed with an opening to receive a second part adapted for movement with the tuning element, said second part formed with a recess, means for moving the second portion relative to the first, and a third piece positioned near the space between the anode and the cathode and shaped and located in a manner to fit within the recess in the second piece and present a considerable area in juxtaposition to the second part throughout its motion.

3. A tunable electron discharge device comprising a cathode, an anode structure formed with resonant cavities, means for producing a magnetic flux in a direction at right angles to a plane including the openings to the cavity resonators, and tuning means for at least one of the cavities of said anode comprising conductive elements adapted to be inserted in said cavities and means for controlling the degree of insertion of said elements into said cavity, and magnetic flux producing means comprising pole pieces of magnetic material positioned on either side of the plane of the resonant cavity openings, one of said pole pieces comprising an external part formed with an opening to receive a second part adapted for movement with the tuning element, means for moving the second portion relative to the first, and a tubular third piece positioned near the space between the anode and the cathode and shaped and located in a manner to permit the insertion of the second piece and present a considerable area in juxtaposition to the second part throughout its motion.

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