United States Patent

[11] 3,617,802

[72] Inventor **Arthur E. Manoly**
Palos Verdes Peninsula, Calif.

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[73] Assignee **The United States of America as represented by the Secretary of the Navy**

[54] **TRAVELING-WAVE TUBE**
6 Claims, 2 Drawing Figs.

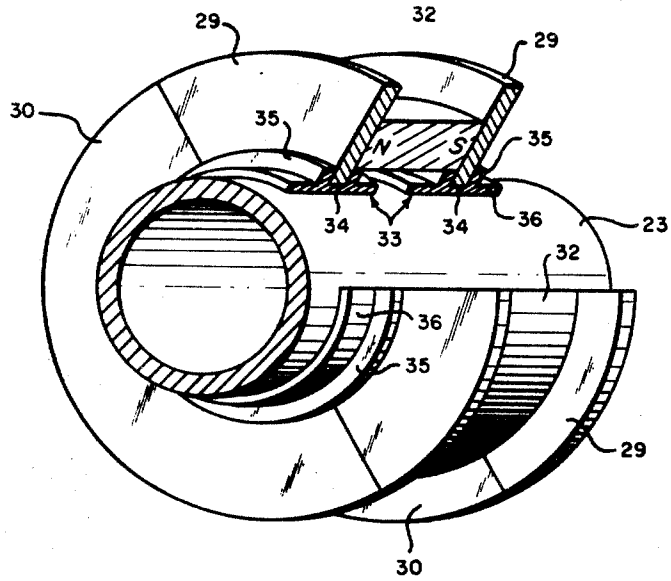
[52] **U.S. Cl.** **315/3.5,** 313/84, 335/210, 315/5.35
[51] **Int. Cl.** **H01j 25/34**
[50] **Field of Search** 315/3.5, 3.6, 5.35, 39.3, 84; 335/210, 211

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Primary Examiner—Herman Karl Saalbach
Assistant Examiner—Saxfield Chatmon, Jr.
Attorneys—R. S. Sciascia and Henry Hansen

ABSTRACT: A traveling-wave tube including an improved permanent magnet assembly for collimating an electron beam. The assembly comprises a plurality of ferromagnetic pole piece hubs spaced along the tube with annular channels for the insertion of ferromagnetic segmented arcuately formed pole pieces. Annular magnets are slidable over the outer periphery of the pole piece hubs and alternately spaced between the adjacent segmented pole pieces.



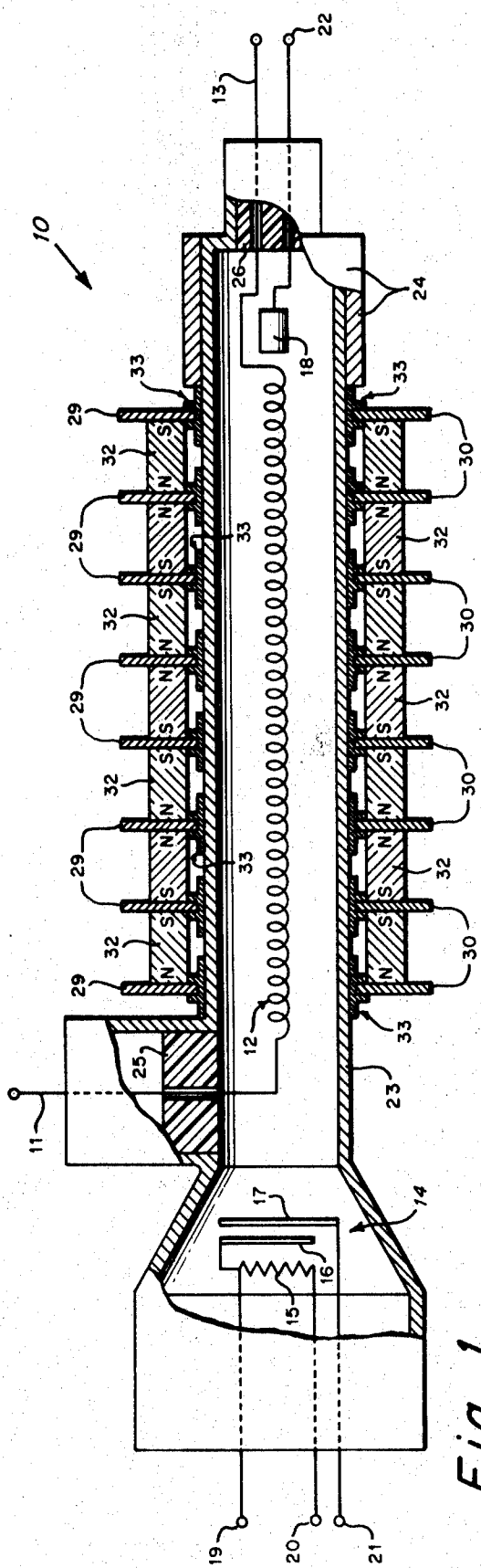


Fig. 1

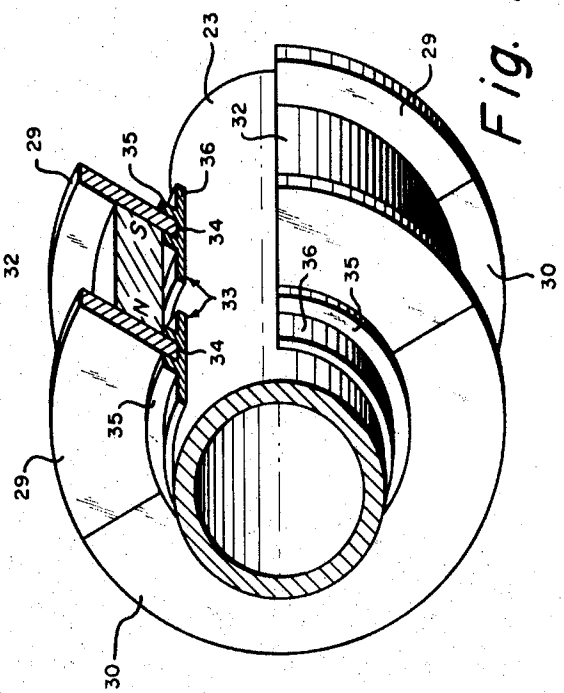


Fig. 2

INVENTOR.
ARTHUR E. MANOLY

BY

ATTORNEY

TRAVELING-WAVE TUBE

STATEMENT OF GOVERNMENT INTEREST

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

BACKGROUND OF THE INVENTION

This invention relates generally to a traveling-wave tube and more particularly, to a unique axial magnetic beam collimating device therefor.

A problem in assembling such devices of the prior art is that both ends of the traveling-wave tube normally have "bumps;" that is, the central portion of the tube containing the magnetic assembly is of smaller diameter than both ends. The usual way of assembling such a device is to place the pole pieces of the magnetic system on the outside of the tube by sliding them over the collector end before a bump is formed by bonding a cooling sleeve to the collector end of the tube. The bonding of the cooling sleeve utilizes high temperatures that a permanent magnet cannot withstand and therefore the permanent magnets are not inserted in place until after the cooling sleeve is bonded to the traveling-wave tube. After the cooling sleeve is bonded to the tube, split ring permanent magnets are placed between the pole pieces.

Problems that have been encountered with the split magnet method include difficulty in knowing the exact magnetic field when assembled, caused by the decrease in magnetic field due to the split in the magnet. The decrease is caused by the fact that the magnetic properties are somewhat changed by the splitting. In addition, a clamp or tape is needed to hold the repelling half-magnets together.

SUMMARY OF THE INVENTION

Accordingly, it is the general purpose of this invention to provide an improved periodic permanent magnetic traveling-wave tube in which the electron beam is collimated inside the axial length of a helix of conductor material carrying a radiofrequency signal to be amplified.

This is accomplished by providing a periodic permanent magnet system comprising pole piece hubs with an inner diameter to provide a tight fit over a metal jacket surrounding the helix. The outer diameter of the pole piece hubs must exceed that of one of the bumps on the ends of the traveling-wave tube. Permanent ring magnets axially magnetized are provided that have an inside diameter that is larger than one of the bumps on the end of the traveling-wave tube so that the permanent magnets may be placed on the traveling-wave tube after the components forming the bumps have been bonded to the traveling-wave tube. In addition, split pole pieces are provided that are inserted between the permanent magnets.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows in schematic form a longitudinal cross section of a preferred embodiment of a traveling-wave tube according to the invention;

FIG. 2 is an isometric cutaway view of a ring magnet and associated pole pieces in the embodiment of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1 there is shown a periodic permanent magnet traveling-wave tube 10 having an evacuated envelope 23 constructed of a nonmagnetic material such as copper or stainless steel. An RF signal to be amplified is supplied from a center conductor 11 of coaxial cable through an insulated seal 25 to a helix 12 of wound conductive material such as copper. The RF input signal passes along the axial length of the helix 12 to a center conductor 13 of an RF coaxial output cable 13 that passes the RF signal through an insulated seal 25. It is to be understood that the means for providing both the input and output of RF signal could also be

waveguides with their associated couplings that are well known in the art.

A conventional electron gun 14 comprising a heater 15, cathode 16 and anode 17 fires an electron beam through the axial center of helix 12 and the beam is collimated to strike a collector 18. Appropriate DC power supplies, not shown, are connected to terminals 19, 20, 21 of gun 14 and terminal 22 of collector 18 in a known manner. A heat sink or cooling sleeve 24 made of copper or other heat-conducting material is bonded to envelope 17 at the collector end of the traveling-wave tube 10. Surrounding envelope 23 along an axial portion thereof and adjacent helix 12 is a magnetic beam collimating device comprising a plurality of permanent ring magnets 32 alternately spaced between arcuately formed segmented pole pieces 29 and 30. Each pair of pieces 29 and 30 are retained concentrically disposed about envelope 23 by a pole piece hub 33. Ring magnets 32 are magnetized in an axial direction.

As best seen in FIG. 2, the inner diameters of ring magnets 32 are larger than the outside diameters of both cooling sleeves 24 and hubs 33 ro permit ring magnets 32 to be slid thereover. Hubs 33 are annular and of ferromagnetic material. The outer diameter of each hub 33 has an annular channel 34 with shoulders 35 on both sides thereof.

Pole pieces 29 and 30 are also made of ferromagnetic material. They have an inner diameter and axial thickness of such size to permit insertion in the channel 34 of hubs 33. The outer diameters of the pole pieces 29 and 30 extend beyond the outer diameter of the magnets 32 in order to act as cooling fins.

The assembling of the magnetic beam collimating device 31 on the envelope 23 will now be described.

Prior to placing cooling sleeve 24 on envelope 23, an appropriate number of hubs 33 are assembled on envelope 23 by sliding hubs 33 over the collector end of the tube 10. Cooling sleeve 24 is then bonded to envelope 23 by suitable means such as brazing. At this time, due to the heat needed in bonding cooling sleeve 24 to envelope 23, it is not practical to place permanent magnets 32 on traveling-wave tube 10 as they would undergo damage due to the excessive heat. After cooling sleeve 24 has been bonded to envelope 23, magnets 32 are slid over cooling sleeve 24 and positioned on confronting shoulders 35 of adjacent hubs 33. A pair of segmented pole pieces 29 and 30 are then inserted between each pair of adjacent magnets 32 in annular channel 34 of a respective hub 33.

In this manner it can be seen that traveling-wave tubes with bumps, for additional space at both ends, can use ring magnets as part of their periodic permanent magnet system. In addition, improved reliability in the collimating system and ease of assembly are also obtained.

Many modifications and variations of the present invention are possible in the light of the above teachings. Accordingly, it is to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A support device for a periodic permanent magnet traveling-wave tube comprising:

an annular pole piece hub of low magnetic reluctance with a base at the inner diameter, and a pair of axially spaced shoulders extending radially from said base forming a channel therebetween, the axial length of said base being greater than the axial length between the distal ends of said shoulders at the outer diameter thereof;

and segmented pole pieces of a low magnetic reluctance arcuately formed to be inserted in said channel to form a ring.

2. In a periodic permanent magnet traveling-wave tube having a cylindrical envelope containing a beam fired down its axial length, a collimator comprising:

a plurality of annular pole piece hubs of low magnetic reluctance spaced in an axial direction along the envelope;

a plurality of unitary permanent ring magnets bridging the space between said plurality of hubs; and

a plurality of segmented pole pieces abutting said plurality of hubs and said plurality of permanent ring magnets.

3. A collimator according to claim 4 wherein each of said annular pole piece hubs further comprises:

a material of low magnetic reluctance with a base at the inner diameter, and a pair of axially spaced shoulders extending radially from said base forming a channel therebetween, the axial length of said base being greater than the axial length between the distal ends of said shoulders at the outer diameter thereof.

4. A collimator according to claim 3 wherein said segmented pole piece further comprises:

an inner diameter and sidewalls formed to be inserted in said channel of said annular pole piece, and an outer diameter larger than the outer diameter of said permanent ring magnet for heat dissipation.

5. A collimator according to claim 4 wherein said plurality of permanent ring magnets are magnetized in the axial direction.

6. A periodic permanent magnet traveling-wave tube comprising:

an evacuated envelope;

a conducting helix extending axially through said evacuated envelope;

input means for providing an RF input signal to one end of said conducting helix;

output means located in an orthogonal direction to said input means for receiving an output signal from said conducting helix;

beam-producing means at one end of said helix for providing an interacting beam for amplifying said RF signal;

collector means at the opposite end of said helix from said beam-producing means adapted to receive said beam;

cooling means bonded to said envelope forming a bump at the end opposite to said beam-producing means;

a periodic permanent magnet system including a plurality of annular pole piece hubs spaced in axial direction along at least the axial portion of said envelope that includes said helix with a channel formed on the outer radial portion of each of said hubs and shoulders extending axially from both sides of said channel and a base forming the inner diameter of each of said hubs that is longer in the axial direction than the outer diameter portion of each of said hubs, a plurality of segmented pole pieces arcuately formed to be inserted in said channel to form a ring, said ring having an outer diameter larger than the diameter of a plurality of permanent ring magnets for heat dissipation, and said plurality of permanent ring magnets have an inner diameter large enough to slide over said cabling means and magnetization in the axial direction with the inner diameter portions abutting said hub shoulders and the surfaces extending in the radial direction abutting the radial surfaces of said plurality of segmented pole pieces.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,617,802 Dated November 2, 1971

Inventor(s) Arthur E. Manoly

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 3, line 5, "claim 4" should read -- claim 2 --. Column 4, line 20, -- outer -- should be added after "the".

Signed and sealed this 30th day of May 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

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