April 27, 1965 R. STOCK 3,181,042

PERMANENT MAGNET SYSTEM FOR FOCUSING AN ELECTRON BEAM

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Fig.1

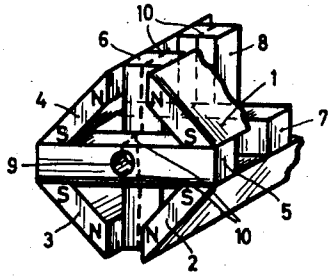


Fig.2

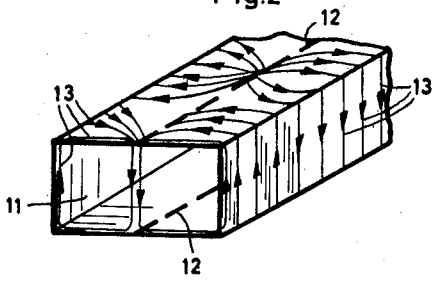
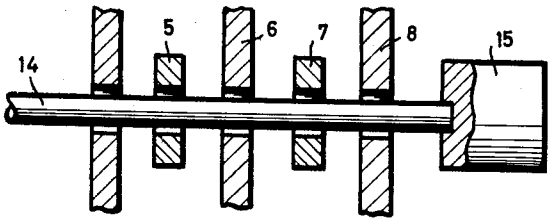


Fig.3



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PERMANENT MAGNET SYSTEM FOR FOCUSING AN ELECTRON BEAM

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3 Claims. (Cl. 317—200)

The invention disclosed herein is concerned with a permanent magnet system for focusing at least one electron beam over an extended path, especially for use in connection with travelling field tubes, wherein soft iron parts which are operative to magentically connect the poles of the permanent magnets are provided with bores formed therein for receiving the discharge vessel. The particular feature which is characteristic of the invention resides in making the magnet system separable along a symmetry axis which extends through the bores.

It is known to produce, for the focusing of the electron beam in a travelling field tube, interiorly of the discharge vessel either a homogeneous magnetic field or a magnetic field alternating in direction along the discharge path. In a system for producing a homogeneous magnetic field, the magnet poles are for the homogenizing of this field interconnected by soft iron cylinders. The bore of the soft iron cylinder is thereby so dimensioned that the discharge vessel can be disposed inside of the cylinder. A permanent magnet system having magnets which extend with their magnetizing direction axially symmetrically to the electron beam in a plane perpendicular to the beam and along such beam, has been found particularly advantageous for producing a directionally alternating magnetic field. Identical poles of the permanent magnets are thereby in electron radiation direction alternately serially connected by pole pieces which have respectively a central bore formed therein for receiving the discharge vessel. The diameter of the bores formed respectively in the pole pieces or in the soft iron cylinder of the indicated prior permanent magnet systems, is so dimensioned, that the tube can be exchangeably inserted into the bores.

The bores should be as small as possible so as to obtain a magnetic field which is along the axis of the electron beam as strong as possible. The tube is therefore inserted into the system with its thinner end. This thinner end is in the known travelling field tubes usually the end at which is arranged the collector. The other end of the discharge vessel, in which is disposed the electron gun, has a diameter which exceeds that of the central part thereof which contains the delay line. However, in the case of tubes of higher capacity, the diameter of the collector exceeds that of the central part of the tube. Accordingly, upon using a permanent magnet system for focusing the beam of such tubes, the bore in the soft iron parts of the magnet system must be larger than the diameter of the part of the discharge vessel in which is contained the delay line. It follows, therefore, that magnets with very high magnetic energy content are required for producing strong magnetic fields along the radiation axis.

The object of the present invention is to provide a permanent magnet system for travelling field tubes, especially travelling wave tubes, wherein the bores have a smaller diameter than would be necessary for passing the relatively thick end of the travelling wave tube to be inserted therethrough.

It is in accordance with the invention proposed to realize this object in connection with a permanent magnet system for focusing along an extended path, at least one electron beam, especially in a travelling field tube, wherein bores for receiving the discharge vessel are provided in

the soft iron parts which interconnect magnetically the poles of the permanent magnets which are adjacent the electron beam, to make the magnet system separable along a symmetry axis which extends through the axis of the bores.

Further details of the invention will now be described with reference to the accompanying drawing.

FIG. 1 shows in schematic manner a separable permanent magnet system for producing a directionally alternating magnetic field;

FIG. 2 indicates in schematic manner, for use with the permanent magnet system of FIG. 1, a wave guide which may likewise be separable; and

FIG. 3 represents in schematic sectional view part of the permanent magnet system of FIG. 1 with a travelling field tube extending through bores formed in the soft iron members.

Referring now to FIG. 1, numerals 1, 2, 3, 4 indicate magnets which are in known manner arranged axial symmetrically to the electron beam so as to form the sides of a square, with identical poles abutting at the corners of the square. Oppositely disposed corners with identical polarity are, in planes extending perpendicularly to the electron beam axis, alternately interconnected by means of soft iron pole pieces such as indicated at **5**, **6**, **7**, **8**. All pole pieces are provided with a central bore **9**, such bores being axially aligned for receiving the discharge vessel.

The permanent magnet system shown in FIG. 1 is in accordance with the invention split and separable along the dash lines **10**. The system thus comprises two portions between which can be inserted the central part of the discharge tube.

In the event that coupling and uncoupling wave guides are to be included in the magnet members of a permanent magnet system made in accordance with the invention, such wave guides can likewise be made so as to be separable. FIG. 2 shows as an example a rectangular wave guide **11** which is separable along the dash line **12**. As will be seen, the separation line leaves the field pattern, for example, of the H_{10}-wave, undisturbed. The lines **13** indicate the high frequency currents of the H_{10}-wave.

A part of the permanent magnet system of FIG. 1 is shown in FIG. 3 in sectional view in combination with part of a travelling field tube, in order to further explain the advantages obtained by the invention. Since the magnet system can be opened along the line of separation indicated in FIG. 1, the pole pieces **5**, **6**, **7** and **8** can be brought into positions directly adjacent to the central part of the discharge tube **14** which contains a delay line (not shown), despite the larger diameter of the collector **15**.

The invention is not inherently limited to details shown and described herein. The invention is particularly likewise applicable in connection with a system comprising ferrite rings or in connection with a permanent magnet system for producing a homogeneous magnetic field.

Changes may be made within the scope and spirit of the appended claims which define what is believed to be new and desired to have protected by Letters Patent.

I claim:

1. A permanent magnet system for focusing along an extended path at least one electron beam, particularly for use in connection with a traveling field tube which is of greater thickness at the end portions thereof than at the intermediate portion thereof, comprising permanent magnets and soft iron parts magnetically connecting poles thereof, extending such poles toward the electron beam, said soft iron parts having bores formed therein for receiving the relatively thin intermediate portion of such a tube, which bores are smaller in diameter than the end

portions of such a tube, said magnet system being split to form two parts which are separable along a symmetry plane extending through the axis of said bores for receiving such intermediate portion.

2. A permanent magnet system according to claim 1, for producing an approximately sinusoidal field strength distribution, comprising permanent magnets arranged axially symmetrically with respect to and extending along said axis, and having pole pieces which are in the axial direction successively disposed for reception of such a tube, said pole pieces alternately magnetically interconnecting identical poles of oppositely positioned permanent magnets, said magnet system being split in a plane extending along the longitudinal axis of mutually aligned successively disposed pole pieces, so as to form two parts abutting along such plane and being separable therealong.

3. A permanent magnet system according to claim 2, wherein said magnet system has wave guides built thereinto respectively for the coupling and uncoupling of high frequency energy, said separation plane extending through wall parts of said wave guides which are free of the flow of transverse currents.

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