Aug. 26, 1952 R. J. PARKER 2,608,665

PERMANENT MAGNET FOCUSING DEVICE

Filed July 29, 1950

Fig. 1.

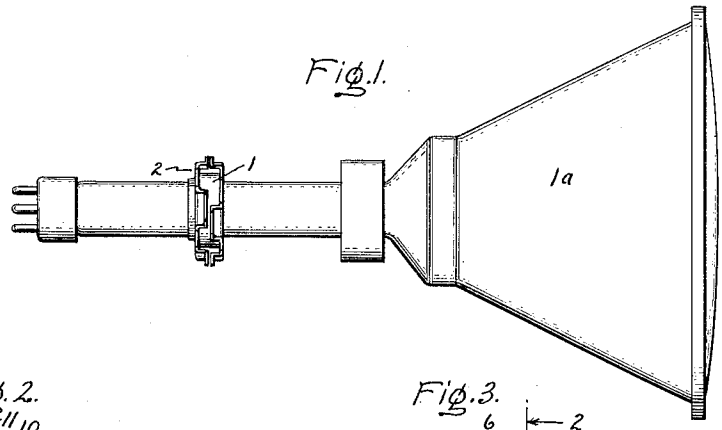



Fig. 2.

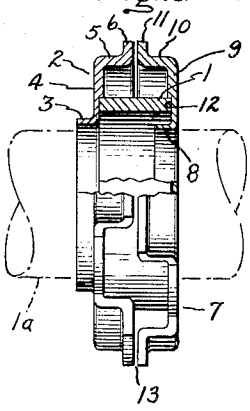



Fig. 3.

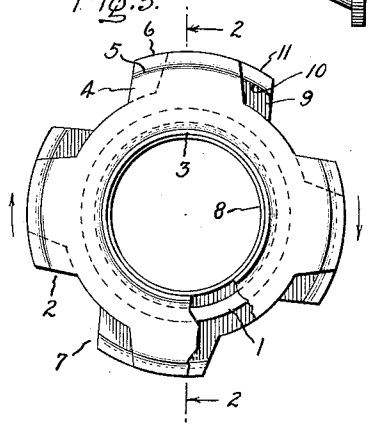



Fig. 4.

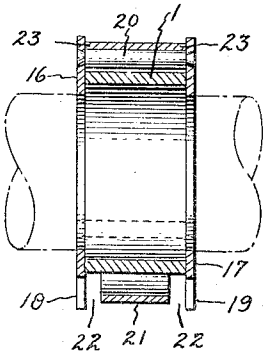
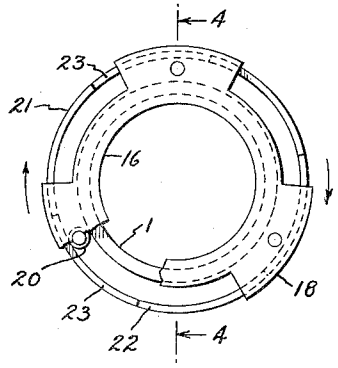



Fig. 5.




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## PERMANENT MAGNET FOCUSING DEVICE

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1 Claim. (Cl. 313—84)

1

This invention relates to focusing devices and, in particular, to a new and improved permanent magnet focusing device for an electronic tube of the cathode ray type.

In a cathode ray tube of the conventional type, either an electric magnet or a permanent magnet is employed for supplying a magnetic field to focus an electron beam on a suitable impact target. Such a magnetic field producing device might be referred to as a magnetic lens. Magnets of the subject type require a means for varying the flux density of the magnetic field produced within a cathode ray tube to vary the focusing characteristics thereof. This variation in flux density may be produced by changing the current passing through an electromagnet or by changing air gaps in permanent magnets to vary the density of the flux that acts on the electron beam.

The advantage of permanent magnets over electromagnets is the fact that the permanent magnet does not require an external power source. Consequently, it is possible with a permanent magnet to use a smaller power supply in an instrument that employs such a cathode ray tube. In addition, a permanent magnet eliminates the necessity of a coil that would activate an electromagnet. Furthermore, a permanent magnet would eliminate the cost of a variable resistor of some sort that is used in conjunction with an electromagnet to control the amount of current passing therethrough to vary the flux density within the cathode ray tube.

In the prior art, permanent magnets have been used in conjunction with a central core that surrounds a cathode ray tube and which is positioned within the permanent magnet. The core is axially slidable within the permanent magnet to decrease the density of the flux that sets up the magnetic field within the cathode ray tube. Such a variation is usually brought about by regulating the operative or unshunted axial length of the permanent magnet. That is, by sliding the core within the permanent magnet the effective length of the permanent magnet and as a result the depth of penetration of the magnetic flux is limited to that portion of the magnet which is not separated from the cathode ray tube by the core. With a structure of this sort, however, the flux produced is distributed over a considerable axial length of the cathode ray tube. It is reasonable, and it has been established in the art, that a more desirable method of producing this magnetic flux is over as short an axial length of the tube as possible, since the shorter the axial concentration of the magnetic field, the better the focus produced. Specifically, if the permanent magnet is distributed over a long axial tube length, the flux density that is produced thereby does not concentrate its effect at a central point and the fringe of a picture on an impact target of a cathode ray tube, consequently, is distorted at the outer edges, even though the picture may be focused properly at the center of the tube.

2

A still further problem that is encountered with permanent magnets of the variable effective axial length type is that when the density of the flux that is produced within the cathode ray tube is changed, the shape of the flux path within the tube is also changed. This varying flux path has a deleterious effect upon the picture that is produced on the impact target of the cathode ray tube in that it produces distortion. It is important, then, to produce a permanent magnet wherein the density of the flux produced can be varied without changing the shape of the flux path within the tube.

It is an object of this invention to provide a new and improved permanent magnet focusing device.

It is a further object of this invention to provide a focusing magnet that operates over a short axial length of the cathode ray tube.

It is a still further object of this invention to provide a permanent magnet focusing device that is simple in construction and which is more efficient in operation.

It is a still further object of this invention to provide an improved focusing magnet that maintains a constant shape for the flux path produced thereby while regulating the magnitude of the flux.

Further objects and advantages of this invention will become apparent and the invention will be more clearly understood from the following description referring to the accompanying drawing, and the features of novelty which characterize this invention will be pointed out with particularity in the claim annexed to and forming a part of this specification.

Briefly, this invention comprises the use of an annular Alnico magnet with steel lips extending radially from two axially disposed ends thereof. When the lips are brought into or out of engagement by rotating one relative to the other, the flux produced by the permanent magnet is effected by a different reluctance and, consequently, this variable reluctance that is offered to the flow of the flux through the internal path of the magnet has an effect upon the flux that is

produced within the cathode ray tube. Specifically, if the lips on the adjacent sections of this permanent magnet are aligned, then the least possible resistance to the flow of flux exists across the lips; consequently, a minimum amount of flux flows through the cathode ray tube. If, on the other hand, the lips on the adjacent magnetic sections are displaced circumferentially one from the other, then a great resistance is offered to the flow of flux through these lips and a maximum amount of flux flows through the cathode ray tube.

In the drawing, Fig. 1 is a side view of one of the embodiments of this invention; Fig. 2 is a side view, partly in section, of the new focusing device; Fig. 3 is a front view of the focusing device; Fig. 4 is a side view, partly in section, of variation of the improved focusing device; and Fig. 5 is a front view of the variation.

Referring to the drawing, an annular permanent magnet 1 made of Alnico is shown about a cathode ray tube 1a and in contact with a punching 2 held in engagement therewith preferably by magnetic attraction. Punching 2 is of steel or soft iron and comprises a central annular sleeve 3, a radially extending portion 4, and plurality of axially extending portions 5 which are substantially equally spaced about the periphery of the radially extending portion 4. An upturned lip 6 is positioned on each of the axially extending portions 5.

A second punching 7 of steel or soft iron comprises a central annular sleeve 8, a radially extending portion 9, and a plurality of axially extending portions 10 each having bent up edges 11. The lip portions 11 on punching 7 correspond substantially to the lips portions 6 on punching 2. Specifically, the lips 6 and the lips 11 are equal in number and their shape is such that when axial alignment is given to the central annular sleeves 3 and 8 the lips 6 and 11 are radially equally distant from the axial center of the device.

Punching 7 is not fixedly secured to magnet 1, but it is held in contact therewith by magnetic attraction. Punching 7 is provided with a grooved portion 12 having an internal diameter that equals the external diameter of the annular magnet 1. Consequently, when punching 7 is placed in an operative position with annular magnet 1, the grooved portion 12 surrounds magnet 1, to guide punching 7 in its rotative movement relative to punching 2. That is, punching 7 cannot be moved transverse to the punching 2 while groove 12 surrounds permanent magnet 1.

Sleeves 3 and 8 have an internal diameter that corresponds substantially to the external diameter of the cathode ray tube with which this permanent magnet is to be used. The advantage of this structure is that the annular rings 3 and 8 are in close proximity with the outer shell of the cathode ray tube. It is to be noted that the closer these sleeves 3 and 8 are to the cathode ray tube, the greater is the efficiency of the use of the magnetic properties of the annular magnet 1. Specifically, if an air gap is present between the annular sleeves 3 and 8 and the cathode ray tube, then the greater the radial thickness of this air gap, the greater is the reluctance that is offered to the magnetic path of the flux that emanates from the annular magnet 1. This structure, as shown, gives a greater efficiency to the operation of the annular magnet 1.

It is to be further noted that the upturned lips 6 and 11 of punchings 2 and 7, respectively, are so positioned that when punching 7 is in operative contact with annular magnet 1, a slight air gap 13, say in the order of .015 inch, exists between the lips 6 and 11. The purpose of this is to present a minimum air gap between these two portions while allowing rotative movement of punching 7 relative to punching 2. With this structure, and with the minimum air gap between lips 6 and 11, a substantially closed magnetic path is offered for the flux emanating from annular magnet 1. Specifically, the flux can travel from magnet 1 to punching 7, through axial portion 10 to lip 11, across air gap 13 into lip 6, through axially extending portion 5, through punching 2, and back into annular magnet 1. Under these conditions, since a low reluctance is offered to the flow of flux from annular magnet 1, a minimum of flux is produced within the internal diameter of annular magnet 1 and within the cathode ray tube about which this annular magnet would be positioned.

With the design and structure as shown, punching 7 may be rotated relative to punching 2. It is possible to displace lip 11 from lip 6 to vary the dimensions of air gap 13. Specifically, each of the lips 6 and 11 cover a radial sector of about 30°. Fig. 3, for example, shows four lips 6 and four lips 11; consequently, there is a total of 8 times 30° or 240° of lip portions extending about the punchings 7 and 2 if the lips do not overlap at all. It is obvious, then, with this structure that the lips can either be in alignment or completely displaced one from the other. When the lips are completely displaced one from the other, a maximum air gap is produced between the lips 11 and 6; consequently, a high reluctance is offered to the flow of magnetic flux from annular magnet 1 through punching 7, through axial portion 10, through lip 11 into lip 6, because of the great air gap between lips 11 and 6. Under these circumstances, the flux density within the annular magnet 1 and within the cathode ray tube is increased. This is what is intended to be accomplished by this new and improved structure—that is, when the lips 11 and 6 are in alignment, a minimum amount of flux will pass into the center of the tube about which this magnet is placed, while, if the lips 11 and 6 are displaced one from the other, a maximum amount of flux will flow into the center of the tube.

In an embodiment of this invention shown in Fig. 4, the same type annular magnet 1 is shown positioned between a pair of flat parallel circular discs 16 and 17. Each of these discs has a plurality of extending ears 18 and 19, respectively, that extend radially beyond the annular magnet 1. The lips 18 and 19 are somewhat akin to the lips 11 and 6, as shown in Fig. 1. By that is meant that there are three ears on each of the discs 16 and 17 and each ear occupies approximately a 30° sector. The two discs 16 and 17 are held in parallel juxtaposition by a plurality of rivets or the like 20 that are secured to each of the discs 16 and 17. Rivets 20 are employed to act as a bearing surface for an annular ring 21 which has an internal radius that corresponds to the displacement of rivets 20 from the center of magnet 1. Consequently, the ring 21 is revolvable about the bearing rivets 20. Ring 21 has a maximum axial length equal to the distance between the disc 16 and 17. Ring 21 also has a plurality of aligned indentations 22 which, in turn, provide a plurality of lips 23 on either end of ring 21 which are of substantially the same circumferential length as the lips 18 and 19. Consequently, with this struc-

ture, it is possible to have the lips 23 in axial alignment with the lips 18 and 19, or it is possible to displace the lips 23 from the lips 18 and 19 and, thus, have the indented portions 22 in alignment with the lips 18 and 19, whichever happens to be desired at the particular time. When the lip portions 23 are in alignment with the lips 18 and 19, there is a substantially closed magnetic circuit from magnet 1 through lip 19, through lip 23 and ring 21, to an opposite lip 23, to lip 18, and back into magnet 1. When lips 23 are displaced from lips 18 and 19 and instead the indentations 22 are in alignment with the lips 18 and 19, then a considerable reluctance is offered to the flow of flux from magnet 1 through lip 19, across an indentation 22 into ring 21, and across another indentation 22 into lip 18 and back into the magnet 1. Under these conditions, a greater density of flux flows into the center of the annular magnet 1 and, consequently, a greater flux density is produced within the center of the cathode ray tube.

It is particularly interesting to note that in each of these embodiments, when it is desired to shunt the flux to decrease the flux density within the tube 1, the flux is shunted away from the tube into upwardly extending lips instead of by decreasing the effective axial length of the permanent magnet. This is a distinct improvement, since the flow of flux into the center of the tube always has the same shaped path and it is not distorted such as it would be if an axially slidable core were mounted between the magnet and the cathode ray tube. Consequently, this improved structure acts as a true magnetic lens, since the shape of the flux path is constant, and only the density of the flux path is varied. This eliminates the deleterious effect of having a picture with a focused center and a distorted fringe area.

Modifications of this invention will occur to those skilled in the art and it is desired to be understood, therefore, that this invention is not to be limited to the particular embodiment disclosed, but that the appended claim is meant to cover all the modifications which are within the spirit and scope of this invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

A cathode ray tube permanent magnet focusing device for varying the density of the magnetic field within said cathode ray tube without changing the shape of the flux path comprising an annular permanent magnet, a pair of soft steel members positioned in parallel planes one on either end of said magnet, a plurality of supports positioned equidistant from the center of said magnet joining said parallel members and a soft steel annular ring mounted for rotation on said supports between said parallel members, each of said members having a plurality of ears extending radially therefrom, said soft steel ring defining a plurality of notches on either axial end thereof, said notches leaving extended portions of said ring corresponding in circumferential extent to said ears on said members and of a width substantially equal to the axial distance between said members to facilitate the alignment of said extended portions and said member ears at either end of said ring, said ring being rotatable relative to said ears to increase or decrease the reluctance of a flux path from said permanent magnet through one of said parallel members through said ring through said other parallel member into said permanent magnet, the reluctance of said magnetic path being at a minimum when the extended portions on said ring are in alignment with the corresponding ears on said parallel members and said reluctance being at a maximum when the notches on said ring are in alignment with the ears on said parallel members.



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