

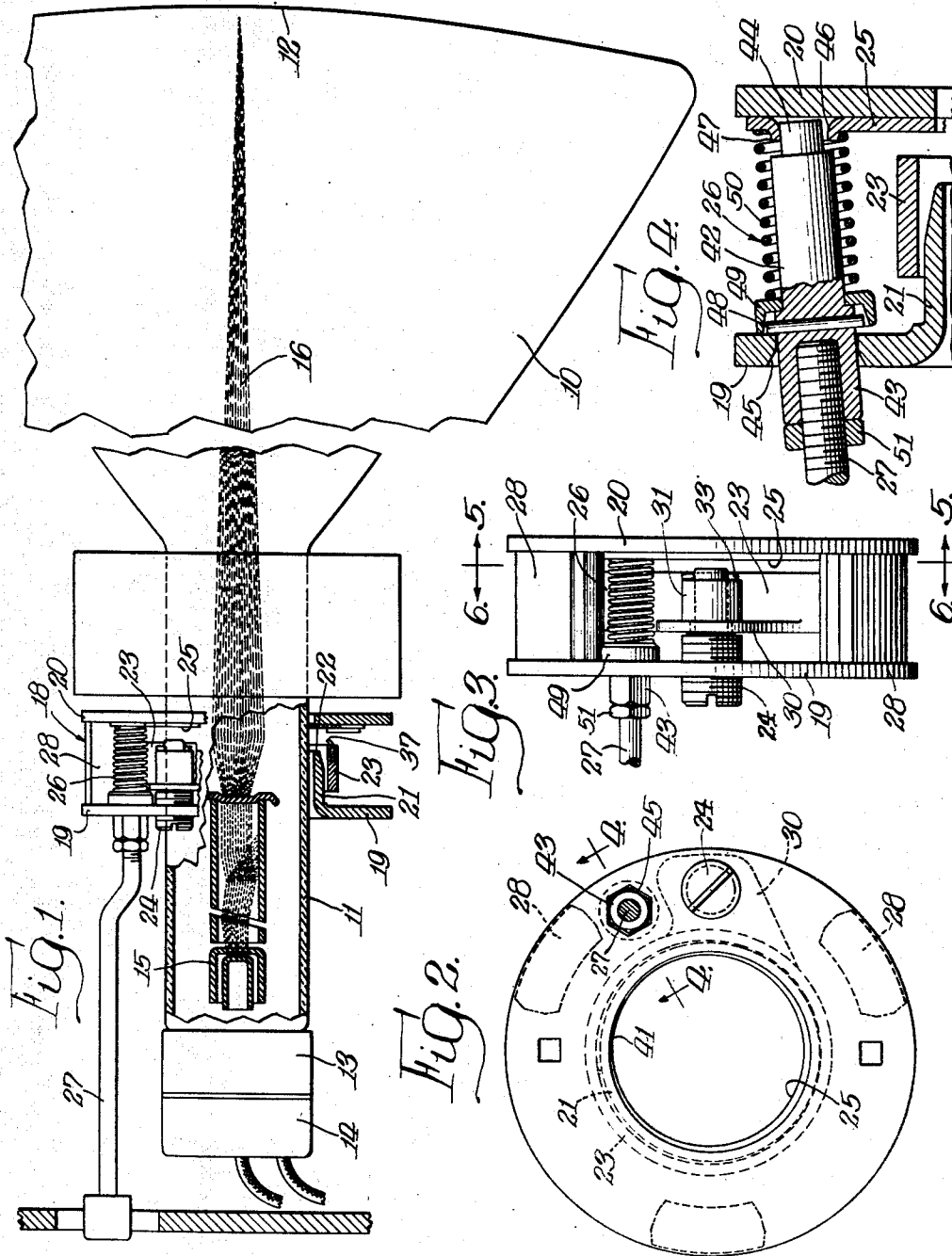
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J. P. QUAM
MAGNETIC FOCUSING DEVICE

2,533,689

Filed June 28, 1950

2 Sheets-Sheet 1



INVENTOR.
James P. Quam,
BY
Zaoman L. Mueller
Atty.

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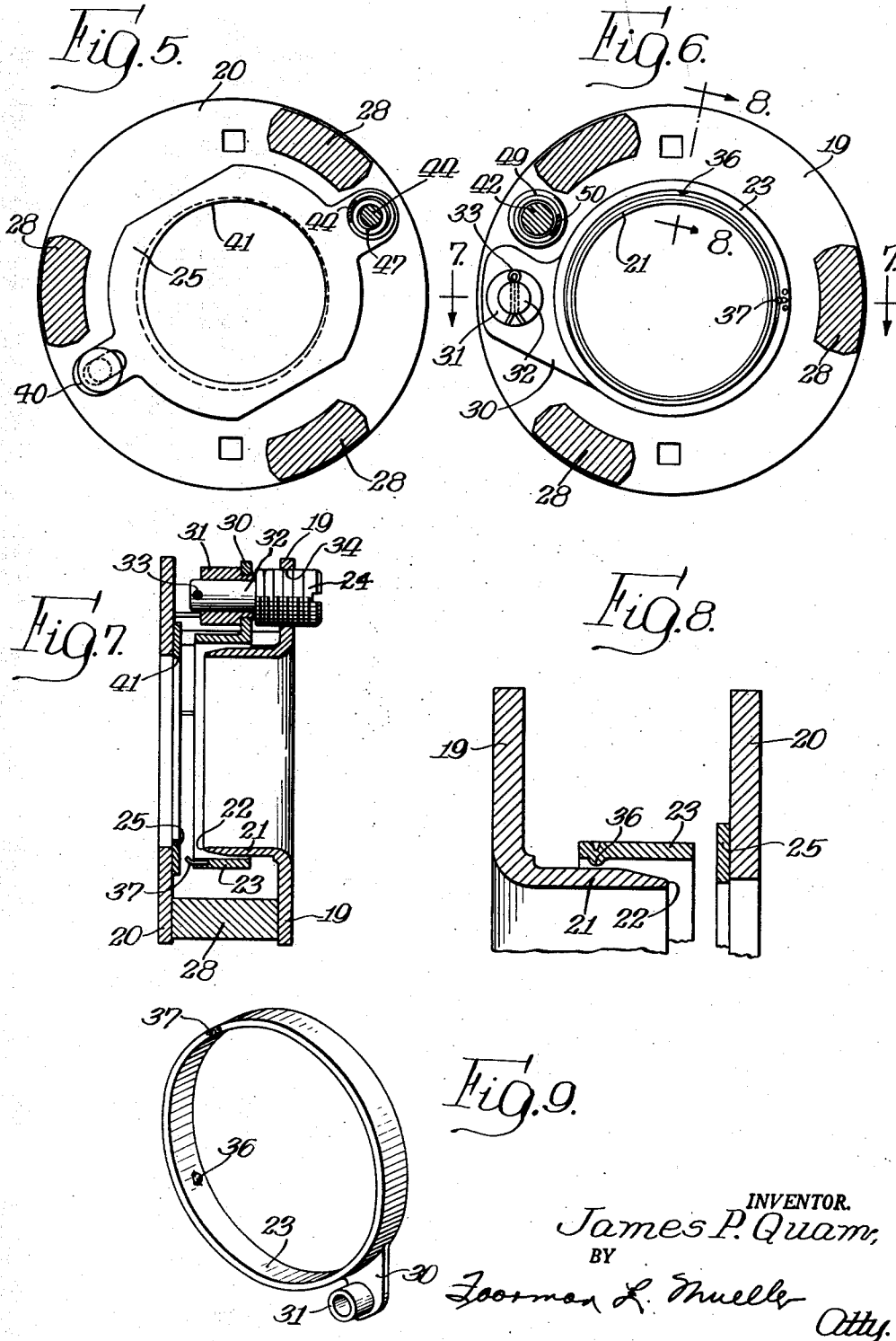
J. P. QUAM

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2 Sheets-Sheet 2



INVENTOR.
James P. Quam,
BY
Lawrence L. Mueller
Att'y.

UNITED STATES PATENT OFFICE

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MAGNETIC FOCUSING DEVICE

James P. Quam, Chicago, Ill., assignor to Quam-Nichols Company, Chicago, Ill., a corporation of Illinois

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7 Claims. (Cl. 250-161)

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This invention relates generally to a magnetic device for focussing an electron beam and more particularly to a permanent magnet focussing device for providing adjustable focussing and also centering of the beam of a cathode ray tube.

In the use of a cathode ray tube to provide a trace on a screen, the beam of electrons forming the trace must be focussed so that the beam converges at the screen to provide a spot of the desired size. It is well known in the art that such focussing can be accomplished by subjecting the beam of electrons to either an electrostatic or an electromagnetic field. The present invention is directed particularly to a device for producing an electromagnetic field in which the energy for the field is derived from permanent magnets.

In order to compensate for variation in the construction of cathode ray tubes it is required that the focussing devices used with such tubes have some means for adjusting the intensity of the field through a relatively wide range. Further it is desired that such a structure include provisions for shifting the field so that the center position of the beam with respect to the screen of the tube can be adjusted. It is, of course, desirable that these adjustments be independent of each other insofar as this is possible so that the adjustment of the device is thereby simplified. The present invention is related to and is an improvement over the inventions disclosed and claimed in my copending applications Serial No. 95,731, filed May 27, 1949, subject "Magnetic Focussing Device" and application Serial No. 141,473, filed January 31, 1950, subject "Focussing Device."

It is an object of the present invention to provide an improved permanent magnet device for focussing the beam of a cathode ray tube which provides field strength which is variable through a wide range of values.

Another object of the present invention is to provide a permanent magnet device for focussing the beam of a cathode ray tube in which adjustable focus and adjustable centering are provided and are substantially independent of each other.

A feature of this invention is the provision of a focussing device having spaced annular pole pieces one of which has an inturned rim for forming one pole face of an air gap, and a shunting sleeve about the inturned rim and adjustable therealong for controlling the field produced across the air gap.

Another feature of this invention is the provision of a focussing device having a pole piece with an inturned rim and a shunting sleeve sup-

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ported about the rim in a manner permitting pivotal movement of the sleeve with respect to the rim, with the sleeve having a diameter to provide clearance about the rim and an internal projection on one side of the sleeve so that the sleeve is always held closer to the opposite side of the rim and is held against the opposite side by the magnetic flux therethrough.

A further feature of this invention is the provision of a focussing device for a cathode ray beam having a pair of pole pieces forming an annular gap therebetween, with an adjustable sleeve movable with respect to one pole piece to adjust the strength of the focussing field and an adjustable shutter movable with respect to the other pole piece to change the transverse flux component to shift the position of the beam, and single individual controls for adjusting the sleeve and the shutter.

Further objects and features and the attending advantages of the invention will be apparent from a consideration of the following description when taken in connection with the accompanying drawings in which:

Fig. 1 illustrates the focussing device in accordance with the invention in operative position with respect to a cathode ray tube;

Fig. 2 is a front elevation view of the focussing device;

Fig. 3 is a side elevation view of the focussing device;

Fig. 4 is a cross sectional view along the lines 4-4 of Fig. 2;

Fig. 5 is a cross sectional view along the lines 5-5 of Fig. 3;

Fig. 6 is a cross sectional view along the lines 6-6 of Fig. 3;

Fig. 7 is a cross sectional view along the lines 7-7 of Fig. 6;

Fig. 8 is a cross sectional view along the lines 8-8 of Fig. 6; and

Fig. 9 is a perspective view of the shunting sleeve showing the general configuration thereof.

In practicing the invention there is provided a permanent magnet focussing device for a cathode ray tube including a pair of annular pole pieces made of low reluctance material. To provide a magnetic field between the pole pieces, a plurality of magnets are positioned therebetween which rigidly connect the pole pieces. One of the pole pieces includes an inturned rim having a relatively sharp edge which forms a pole face of the annular air gap between the pole pieces. For adjusting the field in the annular air gap, a shunting sleeve is provided about the inturned rim and

is adjustably supported from one of said pole pieces so that the shunting effect thereof is adjustable to thereby change the magnetic field. The sleeve has an inside diameter greater than the outside diameter of the rim and the mounting thereof permits pivotal movement of the sleeve with respect to the rim. For insuring that the sleeve always has the same relative position with respect to the rim, a projection is provided on the sleeve which serves to hold the sleeve closer to one side of the rim than the other so that the sleeve is always drawn to this one side by the magnetic field through the rim. An adjustable centering shutter may be provided on the other pole piece for universal movement in the plane of the other pole piece for thereby controlling the transverse component of flux in the device which serves to change the center position of the beam. The shutter is controlled by a universally adjustable handle which may extend away from the device.

Referring now to the drawings, in Fig. 1 there is illustrated a cathode ray tube 10 having a neck portion 11 and a front face 12 on which is provided a fluorescent screen. The tube may include a base 13 through which connections are made to the elements within the tube. A socket 14 makes connections to the base for providing connections from energizing circuits to the elements within the tube. The tube includes an electron gun 15 for producing a beam of electrodes 16. The cathode ray tube may be of standard construction and therefore will not be described in detail.

The permanent magnet focussing device is indicated generally at 18 and includes annular spaced pole pieces 19 and 20 positioned about the neck 11 of the cathode ray tube. A plurality of magnets 28 are secured to the pole pieces to form a rigid structure and to provide a field between the pole pieces. The pole piece 19 includes an intumed rim 21 which extends a substantial portion of the distance from the pole piece 19 to the pole piece 20. The rim 21 has a rounded or bevelled end to provide a relatively narrow pole face 22 which serves to concentrate the field close to the tube neck. Positioned about the rim 21 is an annular sleeve 23 of magnetic material which is effective to provide a shunt path between the pole pieces 19 and 20 to thereby control the flux through the air gap formed therebetween. The sleeve 23 is secured to the pole piece 19 by a threaded stud 24 which will be described more in detail. A centering shutter 25 is positioned at the inside face of the pole piece 22 and is controlled by a mechanism 26 having an operating handle 27.

For a more complete description of the shunting sleeve, reference is made to Figs. 2, 3, 6, 7, 8 and 9. As previously stated the sleeve surrounds the intumed rim 21 of the pole piece 19. The sleeve includes a radially extending projection 30 which forms a support therefor. A tubular nipple 31 is secured in the extension 30 and receives the reduced portion 32 of stud 24 therein. A cotter pin 33 may be provided for holding the stud in the nipple 31. The stud 24 has an enlarged threaded portion adjustably threaded in an opening 34 in the pole piece 19. The nipple 31 must be relatively long so that it forms a secure mounting for the sleeve to prevent tipping of the sleeve because of the magnetic pull produced thereon from the flux through the rim 21. It is apparent that as the stud 24 is rotated, the threads cause the stud to move with respect to the pole piece 19 to move the sleeve 23 along the rim 21 and

thereby change the shunting effect of the sleeve 23 to vary the field in the air gap between the pole pieces.

In order to provide free movement of the sleeve 23 along the rim 21 and to prevent direct shorting of the air gap, the inner diameter of the sleeve 23 is somewhat greater than the outer diameter of the rim 21. The mounting for the sleeve allows pivotal movement of the sleeve with respect to the rim. This might result in different magnetic fields produced by the focussing device depending upon the position of the sleeve 23 with respect to the rim 21. To prevent such a difference in the field, a projection 36 is formed on one side of the sleeve 23 to hold that side of the sleeve away from the rim 21. The other side of the sleeve is therefore drawn relatively close to the rim 21 and is pulled up against the rim by the magnetic field through the rim. The projection 36 is therefore effective to insure that the side of the sleeve opposite the projection is in engagement with the rim 21 and this position is always maintained so that the field remains substantially the same. In structures actually used the clearance between the sleeve and the rim is of the order of 25 thousandths of an inch. The projection extends from the sleeve about 15 thousandths so that the other side of the sleeve is about 10 thousandths from the rim. Since this other side is therefore closer to the rim than the side having the projection, the other side is drawn against the rim maintaining the position as previously described.

In order to prevent the sleeve 23 from making direct magnetic contact with the pole piece 20, and freezing thereto, a non-magnetic insert 37 may be provided at the side of the sleeve opposite to the mounting stud 32. This limits the movement of the sleeve with respect to the opposite pole piece. The shunting sleeve 23, however, extends very close to the pole piece 20 and provides a very wide range of field strength from a given focussing device. Changes in the field strength of 2 to 1 or more are possible using structures as disclosed.

The structure and operation of the centering shutter 25 associated with the pole piece is best shown in Figs. 4 and 5. The shutter is secured to the pole piece 20 by rivet 40 at one side thereof and by the adjusting mechanism 26 at the other side thereof. The shutter has an opening 41 of somewhat smaller diameter than the opening in the pole piece 20 so that the position of the shutter in effect controls the position of pole face of the annular air gap provided by the pole piece 20. The adjusting mechanism 26 includes a stud 42 having a hexagon shaped head 43 and a reduced end portion 44. The head 43 is positioned in a hexagon shaped opening 45 in the pole piece 19 with the opening being somewhat larger than the head so that the head can be moved relatively freely therein. The end portion 44 is positioned in an opening 46 in the shutter having a rim 47 formed thereabout so that the end 44 of the stud cannot easily slip out of the opening 46. To prevent withdrawal of the stud through the opening 45, a pin 48 is provided through the head 43 of the stud. A cup-shaped washer 49 surrounds the pin 48 preventing removal thereof and bears against the pole piece 19. Spring 50 provided about the intermediate portion of the stud 42 bears against the washer 49 and the shutter 25 to hold the shutter firmly against the pole piece and provides a tension for retaining the stud 42 in a particular position.

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The head 31 of the stud has a threaded recess for receiving the control handle 27, and a lock nut 51 may be provided so that the handle does not become loose in the stud. As shown in Fig. 1 the handle 27 may extend to the rear of the cabinet housing the cathode ray tube so that it is easily accessible to a person operating the device.

The annular air gap between the pole face 22 of the pole piece 19 and the pole piece 20 is actually formed between the pole face and the inside edge of the centering shutter 25. The position of the shutter 25 therefore controls the transverse field produced by the device which is operative to shift the center position of the beam of electrons. As the centering shutter is movable universally in the plane of the pole piece 20, universal centering movement of the beam is provided by movement of the operating handle 27. This greatly simplifies the operation required to center the electron beam with respect to the screen of the tube.

The wide variation in field produced by the device described together with the centering provisions results in a greatly improved overall structure. Mounting of the unit is greatly facilitated because the effect of mounting brackets to shunt the field of the device and to distort the same are readily compensated for by the field adjusting provisions and the centering provisions of the unit itself. As previously stated the construction of cathode ray tubes by various manufacturers is considerably different requiring the use of focussing devices providing different field strengths. Actually tubes made by a single manufacturer vary relatively widely and require adjustable focussing provisions. With the structure as illustrated, the magnets can be magnetized sufficiently to provide the strongest fields required and the field can then be reduced by the shunting sleeve to much smaller values which may be required for use with particular individual tubes.

Focussing devices in accordance with the invention have been found highly successful in actual use. The following dimensions have been used in a commercial embodiment of the structure as illustrated and described:

Pole pieces:

Outside diameter, $3\frac{3}{8}$ "
Diameter of opening, $1\frac{3}{4}$ "
Thickness, $\frac{1}{8}$ "
Outside diameter of rim 21, $1\frac{31}{32}$ "
Width of pole face 22, $\frac{1}{2}$ " or less
Material—cold rolled steel

Shunting sleeve:

Inside diameter, 2"
Thickness, $\frac{3}{8}$ "
Length, $\frac{1}{2}$ "

Centering shutter:

Diameter of opening, $1\frac{5}{8}$ "
Thickness, $\frac{1}{8}$ "
Material—cold rolled steel

Air gap between pole pieces, $\frac{1}{16}$ "

Permanent magnets—Alnico #5, $\frac{7}{8}$ " long. Cross section approximately $\frac{1}{8}$ " x $\frac{1}{8}$ "

Although these dimensions are not unduly critical, certain of the dimensions are inter-related and therefore a change in one would require a corresponding change in others. The dimensions, of course, will depend upon the cathode ray structure with which the focussing device is used.

Permanent magnet focussing devices as described above have been found to be highly satisfactory in use. These devices have the advantage

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that no external source of power is required and that no heat is developed therein. Both of these advantages are very important in the design of a television receiver. Because of the use of permanent magnets, the field produced by the device is constant and does not fluctuate with power supply variations. The shunting sleeve provides wide variations in the field through the gap so that the field strength required for focussing a particular tube can be easily provided.

The construction of the unit is such that the air gap remains in fixed position with respect to the tube. This is a decided advantage as it permits optimum positioning of the air gap regardless of the adjustment of the field strength. The entire unit including the shunting sleeve and the centering shutter is provided as a compact unit with the adjustments being arranged so that they are easily accessible. The entire unit is smaller and lighter than electromagnetic devices or combined permanent and electromagnetic devices which have been formerly used. Because of the adjustments provided, the mounting and construction of the unit is made less critical.

While one embodiment of the invention has been illustrated which is representative thereof, it is obvious that various changes and modifications can be made therein without departing from the intended scope of the invention as defined in the appended claims.

I claim:

1. A magnetic structure for focussing a beam of electrons including in combination, a pair of pole pieces each having a body portion with a beam receiving opening therein, and with said body portions being spaced apart from one another, permanent magnet means extending between and magnetically coupled to said pole pieces, at least one of said pole pieces having an inturned annular portion at said opening therein providing an annular air gap with the other one of said pole pieces having a width less than one-half the spacing between said body portions of said pole pieces, said inturned annular portion having a bevelled annular edge as a pole face for providing a concentrated field in said air gap, an annular magnetic sleeve about said annular portion of said one pole piece, and adjustable mounting means for said sleeve for providing movement of said sleeve along said annular portion in the space between said body portions of said pole pieces to thereby form an adjustable shunt magnetic path between said pole pieces.

2. A magnetic structure for focussing a beam of electrons including in combination, a pair of pole pieces each having a body portion with a beam receiving opening therein, and with said body portions being spaced apart from one another, permanent magnet means extending between and magnetically coupled to said body portions of said pole pieces, said permanent magnet means being spaced radially outwardly from said openings in said body portions of said pole pieces, at least one of said pole pieces having an annular portion on the inward side thereof at said opening therein forming an annular air gap with the other one of said pole pieces having a length less than one-half the spacing between said body portions of said pole pieces, an annular magnetic sleeve positioned about said annular portion of said one pole piece and within the confines of said permanent magnet means, and adjustable means supporting said sleeve for movement along said annular portion in the

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space between said body portions of said pole pieces to thereby form an adjustable shunt magnetic path between said pole pieces.

3. A magnetic structure for focussing a beam of electrons including in combination, a pair of pole pieces each having a body portion with a beam receiving opening therein, and with said body portions being spaced apart from one another, permanent magnet means extending between said pole pieces and magnetically coupled thereto to provide a magnetic field therebetween, one of said pole pieces having a part on the inward side thereof at said opening providing an air gap between said pole pieces having a length less than the spacing between said body portions of said pole pieces, sleeve means made of magnetic material positioned about said part on the inward side of said one pole piece for providing a shunt magnetic path between said pole pieces, and adjustable mounting means for said sleeve means including a stud threaded in said one pole piece and a nipple about said stud secured to said sleeve means, said mounting means providing movement of said sleeve means along said part of said one pole piece in the space between said body portions thereof to thereby form an adjustable shunt magnetic path between said pole pieces.

4. A magnetic structure for focussing a beam of electrons including in combination, a pair of pole pieces each having a body portion with a beam receiving opening therein, and with said body portions being spaced apart from one another, permanent magnet means extending between said pole pieces and magnetically coupled thereto to provide a magnetic field therebetween, one of said pole pieces having an annular portion on the inward side thereof at said opening providing an annular air gap between said pole pieces having a width less than the spacing between said body portions of said pole pieces, annular sleeve means made of magnetic material positioned about said annular portion for providing a shunt magnetic path between said pole pieces, said sleeve means having an inner diameter greater than the outer diameter of said annular portion to provide clearance therebetween, and adjustable mounting means for said sleeve means for supporting the same for movement along said annular portion between said body portions of said pole pieces, said sleeve means being movable with respect to said rim portion and being attracted to said rim portion by the magnetic field therethrough, said sleeve means having an inwardly extending projection on one side thereof for holding said sleeve means in a position in which the side of said sleeve means opposite to said one side is closer to said annular portion than said one side of said sleeve means, so that said opposite side of said sleeve means is held against said annular portion by said magnetic attraction.

5. A magnetic structure for focussing a beam of electrons including in combination, a pair of pole pieces each having a body portion with a beam receiving opening therein, and with said body portions being spaced apart from one another, permanent magnet means extending between said pole pieces and magnetically coupled thereto to provide a magnetic field therebetween, one of said pole pieces having an annular rim portion on the inward side thereof at said opening providing an annular air gap between said pole pieces having a width less than the spacing between said body portions of said pole pieces,

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annular sleeve means made of magnetic material positioned about said rim portion for providing a shunt magnetic path between said pole pieces, said annular sleeve means having an inner diameter greater than the outer diameter of said rim portion to provide clearance therebetween, and adjustable mounting means for said sleeve means including a stud secured to said one pole piece, said sleeve means including a portion rotatably mounted on said stud providing the sole support for said sleeve means, said sleeve means being movable with respect to said rim portion and being attracted to said rim portion by the magnetic field therethrough, said sleeve means having an inwardly projecting portion on one side thereof for holding said sleeve means in a position in which the side of said sleeve means opposite to said one side is closer to said rim portion than said one side of said sleeve means, so that said opposite side of said sleeve means is held against said rim portion by said magnetic attraction.

6. A magnetic structure for focussing a beam of electrons and for shifting the position thereof including in combination, first and second pole pieces each having a body portion with a beam receiving opening therein, and with said body portions being spaced apart from one another, permanent magnet means extending between and magnetically coupled to said pole pieces, a centering member having a beam receiving opening therein slidably supported on the inward side of said body portion of said first pole piece, said second pole piece having an annular portion on the inward side thereof at said opening therein providing an annular air gap with said centering member having a width less than one-half the spacing between said body portions of said pole pieces, means for moving said centering member for shifting the field in said annular air gap in a direction transverse to the axis of said air gap, an annular magnetic sleeve about said annular portion of said second pole piece, and adjustable means supporting said sleeve for movement along said annular portion in the space between said body portions of said pole pieces, to thereby form an adjustable shunt magnetic path between said pole pieces.

7. A magnetic structure for focussing a beam of electrons and for shifting the position thereof including in combination, first and second pole pieces each having a body portion with a beam receiving opening therein, and with said body portions being spaced apart from one another, permanent magnet means extending between and magnetically coupled to said pole pieces, a centering member having a beam receiving opening therein on the inward side of said first pole piece, said centering member being slidably supported on said first pole piece for limited universal movement in a plane, said second pole piece having an annular portion on the inward side thereof at said opening therein providing an annular air gap with said centering member having a width less than one-half the spacing between said body portions of said pole pieces, said annular portion having a bevelled edge as a pole face for providing a concentrated field in said air gap, means for moving said centering member for shifting the field in said annular air gap in a direction transverse to the axis of said air gap, an annular magnetic sleeve about said annular portion of said second pole piece, and adjustable mounting means for said sleeve including a stud threaded in said second pole

piece and a nipple secured to said sleeve and positioned about said stud providing movement of said sleeve along said annular portion in the space between said body portions of said pole pieces to thereby form an adjustable shunt magnetic path between said pole pieces.

JAMES P. QUAM.

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