Aug. 25, 1942. H. MILLER ET AL 2,294,123

MAGNETIC ELECTRON LENS

Filed May 16, 1939 2 Sheets-Sheet 1

Fig. 1

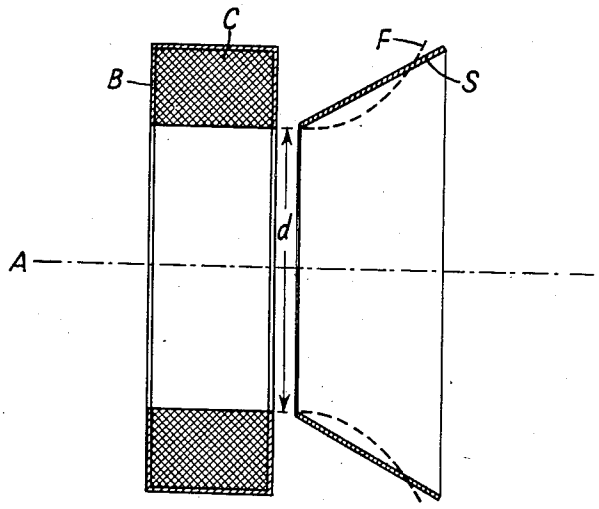
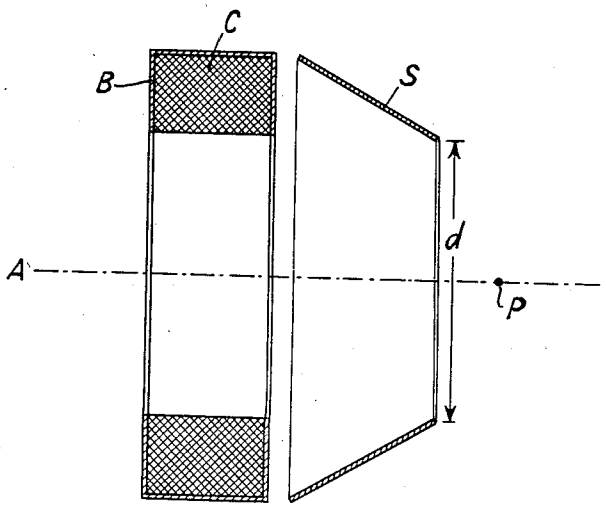


Fig. 2



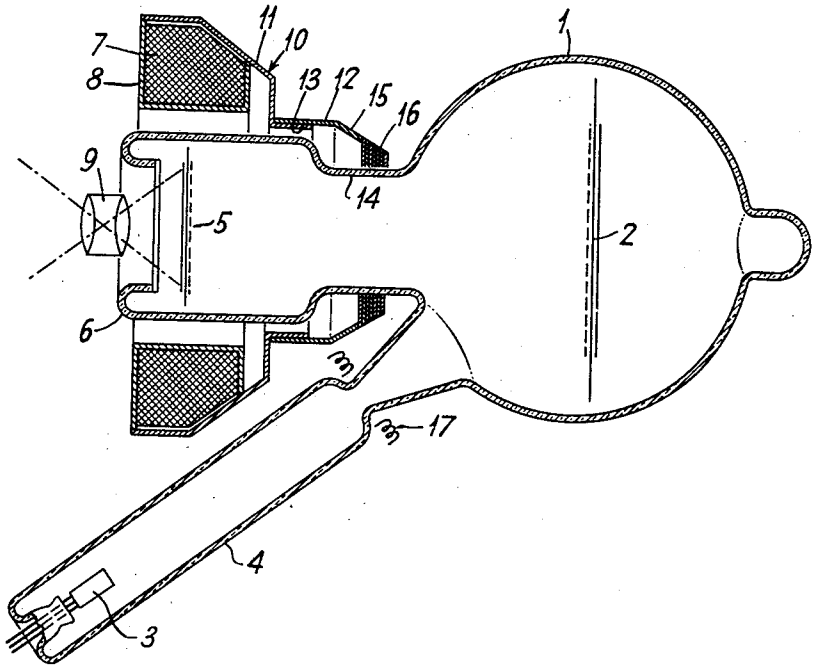
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Fig. 3



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MAGNETIC ELECTRON LENS

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In Great Britain June 28, 1938

3 Claims. (Cl. 250—161)

The present invention relates to magnetic and electron magnetic electron lenses.

In the case of a magnetic and electromagnetic electron lenses, used for focussing composite electron beams, for example, in television transmission tubes, or in image electron multipliers or in electron microscopes and telescopes, it is desirable to arrange for the magnetic field due to the lens coil or other field producing device to diminish rapidly along the axis, more especially, in the direction in which the composite beam of electrons proceeds through the lens field. From time to time various devices have been used or proposed for effecting a rapid change in the field along the axis of a magnetic or electromagnetic lens, probably the most well known device for this purpose being the provision in the case of an electromagnetic lens, of a magnetic shield on the lens coil. However, even when a shielded or so-called iron clad coil is used there is still a sufficient spread of field outside the coil to affect detrimentally the production of an image derived by focussing an electron beam through the lens, or to interfere with the operation of the scanning beam in the case of the television transmission tube.

The object of the present invention is to provide a further method of and devices for reducing the spread of the lens field along the axis of a magnetic electron lens.

In accordance with the invention a method of reducing the spread of the magnetic field of a magnetic or electromagnetic lens device arranged to focus a composite beam of electrons at a distance along the axis, is provided, said method comprising arranging on the side of said device on which the spread of the field is to be reduced, a substantially tubular magnetic shield in such manner as to provide a magnetic shunt for the field in the space on the side of said shield remote from said lens device.

In the preferred embodiment of the invention an electron discharge device including a source of electrons arranged to emit of composite beam of electrons corresponding to a desired electron image or pattern and a magnetic or electromagnetic lens device adapted when energized to focus said beam at a surface, is provided, there being located in or about the path of said beam between said lens device and said surface a substantially tubular magnetic shield arranged in such manner as to provide a magnetic shunt for the field in the space between said shield and said surface to reduce the strength of the field due to said lens device. Preferably said shield is of substantially frustro-conical form and is arranged with its larger end adjacent said lens device and its narrower end presented towards said surface, though if desired the direction of the shield can be reversed. The smaller end of the shield is preferably provided with means providing a low reluctance path or paths into said shield, said path or paths extending substantially perpendicularly to the path of said beam.

The nature of the invention and the method of carrying the same into effect will be fully understood from the following description in detail with reference by way of example to

Figs. 1 and 2 of the drawings which are diagrammatic sectional views of arrangements in accordance with the invention,

Fig. 3 shows a section of a preferred form of the invention as included in a television signal transmitting tube.

Referring to the drawings in Fig. 1, the lens coil C is shown arranged about an axis A and is provided with the usual high permeability shield B surrounding the coil on the outside only, the inside of the coil being unshielded.

As is well known, the provision of the shield B tends to confine the field generated by the coil C to the region between the planes of the ends of the coil. However, the provision of the shield B is not in itself sufficient to eliminate completely the spread of magnetic flux along the axis A, and thus in accordance with the invention a further high permeabiilty shield S is provided consisting in the case shown of a frustro-conical member which may be formed of thin sheet iron of high permeability arranged co-axially with the coil C, the smallest diameter *d* of the shield being substantially equal to the internal diameter of the coil. The shield S acts as a magnetic shunt and tends to deflect the lines of force produced by the coil C away from the axis A more rapidly than would otherwise be the case so that the spread of field due to the coil is considerably reduced. For example, in an experimental arrangement it has been found that the introduction of a frustro-conical shield similar to that represented in Fig. 1 of the drawings used in conjunction with an iron clad coil 11 cms. in diameter and 5 cms. long causes a reduction in the field to the extent of a third of its value without the frustro-conical shield present at a point 10 cms. distant from the central plane of the coil along the axis A. A greater reduction in the strength of the field can be obtained by using the shield having a surface which approx-

imates closely to that formed by the revolution of a line of force due to the coil about the axis. Such a surface is represented, for example at F from which it will be seen that in this case the shield S will be flared and have a form somewhat resembling that of the mouth of a trumpet.

If desired, the shield can be made cylindrical, the diameter of the shield being substantially equal to that of the diameter of the coil C or the shield can be reversed as illustrated in Fig. 2. In this case, the reduction in the field strength obtained, is not so great from the coil up to the point P in the neighborhood of the smaller end of the shield, but beyond this point the reduction of field strength produced by the coil is greater than in the case shown in Fig. 1, and in general the arrangement of Fig. 2 is preferred over that shown in Fig. 1.

If desired, shields such as S in Figs. 1 and 2 can be provided on each side of the coil C.

The additional shield or shields provided in accordance with the invention is or are preferably made of a material having a high permeability at field strengths of the order, say, up to 10 gauss, which is the possible magnitude of the field in the appropriate region, in the case of coils used in standard projection tubes used for television transmission for example. Thus the shield can be formed of pure annealed iron though the high permeability alloys are preferred. The thickness of the shield is preferably of the order of a few millimetres.

A practical form of the invention as applied to a television transmitting tube is shown in the accompanying drawings in which Fig. 3 is drawn to scale.

Referring to Fig. 3, it will be seen that the tube therein shown comprises a bulb 1 within which is mounted a mosaic electrode 2 in such a position as to be scanned by a scanning beam projected from an electron gun mounted in an extension 4 of the bulb 1 as diagrammatically represented at 3 the electrode 2 also receiving a composite beam of electrons emitted from a photo-cathode 5 mounted in a further extension 6 of the bulb. The composite beam of electrons from cathode 5 is focussed on the mosaic 2 by means of a magnetic lens coil 7, which, in the preferred arrangement, is mounted on a copper former 8 and is formed in two parts through which energizing currents flow in opposite directions in the manner described by Bruche in "Zeitschrift fur Technische Physik," 1936, page 588. An image of the subject to be televised is projected on the cathode 5 by means of the optical system 9. The mode of operation of the parts in Fig. 3 so far referred to is well understood in the art and will not be further described in detail.

The lens coil 7 operates to produce an intense field in its own neighborhood and the double coil arrangement results in a reduction of the field spread along the axis of the coil. However, as in the case of the iron clad coil C shown in Figs. 1 and 2 of the drawings, the arrangement can, according to the invention, be further improved by the provision in association with the lens coil 7, of a substantially frusto-conical shield 10. This shield is formed of highly permeable magnetic material, for example, radio metal. The shield 10 is generally frusto-conical in form and is formed in two parts 11 and 12 which are arranged to telescope one within the other as indicated at 13, the part 11, which has the larger diameter, providing a housing for the lens coil 7 and the part 12 fitting closely round the constricted portion 14 of the extension 6 of the bulb 1. The telescopic arrangement of the parts 11 and 12 of the shield 10 facilitates the adjustment of the position of coil 7 with respect to cathode 5 whilst maintaining continuity of shielding. The narrow or constricted end 15 of shield 10 is preferably provided with a ring 16 formed of annular laminations of magnetic material fitting closely on the portion 14 of aforesaid extension 6. This ring 16 affords a low reluctance path for flux which would otherwise pass axially of the extension to the vicinity of the mosaic electrode 2, the flux entering the ring 16 being returned through the shield 10 around the coil 7. The provision of the ring 16, while it is found to increase the spiral distortion of the electron image produced on the mosaic electrode 2 is found to produce such a reduction in the field due to coil 7 at the electrode 2, that the slight disadvantage produced is wholly outweighed.

Moreover the use of a substantially frustro-conical shield 10 arranged with its narrow end remote from the lens coil 7 provides an arrangement of which the efficacy is in no way interfered with by the necessity of accommodating the extension 4 of the tube wherein the scanning beam is generated. Moreover ample space can be provided outside the shield 10, in which space scanning coils, indicated at 17, can be arranged.

If desired, means such as the ring 16 affording a low reluctance path or paths into the shield 10 might be provided on the smaller end of the shield S of Fig. 1.

What is claimed is:

1. An electron lens arrangement for focusing a composite group of electrons comprising coil means for focusing said composite group and a member having a high magnetic permeability positioned externally to and immediately adjacent said coil means for intercepting a portion of the flux from said coil means, whereby said flux may be intercepted substantially normal to said member, said member having a frustro-conical shape.

2. Apparatus in accordance with claim 1 wherein said member of highly permeable magnetic material is positioned on the side of the coil from which the composite group of electrons emerges, the end of said frustro-conical section having the least radius being positioned adjacent said coil.

3. Apparatus in accordance with claim 1 wherein said member of highly permeable magnetic material has at least a portion thereof formed of highly permeable annular laminations.

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