June 5, 1956 J. E. GOULD 2,749,486

FOCUSSING MAGNET SYSTEMS FOR CATHODE RAY TUBES

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FIG. 1.

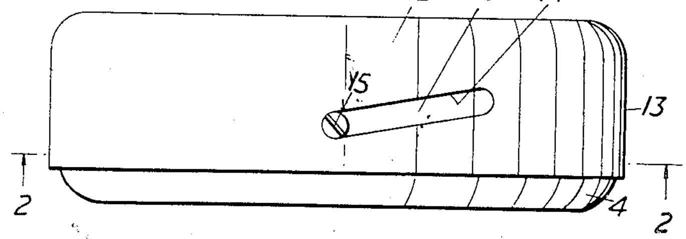


FIG. 2.

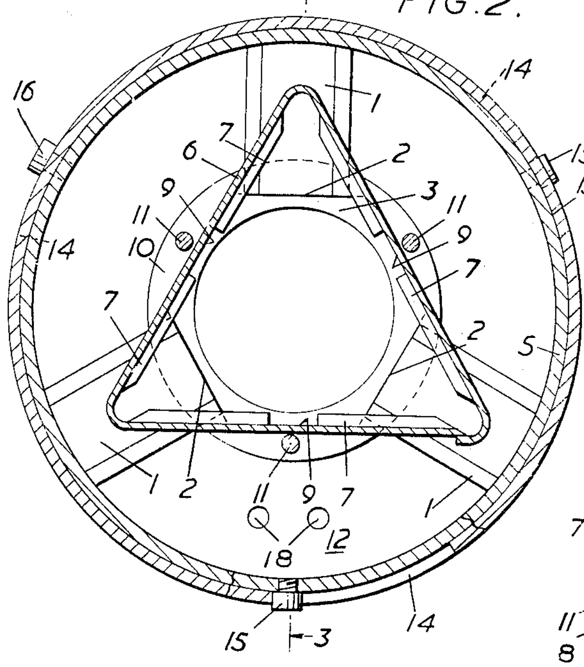


FIG. 3.

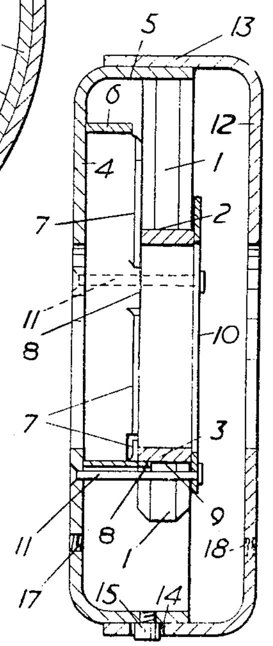
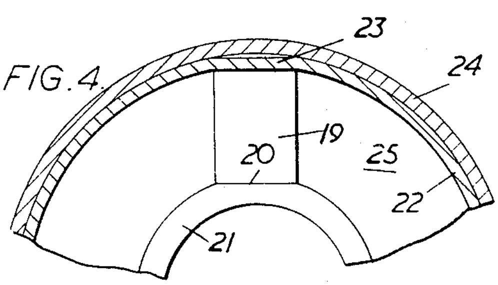


FIG. 4.



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FOCUSSING MAGNET SYSTEMS FOR CATHODE RAY TUBES

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6 Claims. (Cl. 317—200)

This invention relates to permanent magnet focussing systems for cathode ray tubes.

Cathode ray tubes for television receivers usually carry on the neck of the tube between the electron gun and the cone an ion trap system, a focussing system, and a scanning system, all three serving to produce fixed or variable magnetic fields on the axis of the tube. It is desirable to keep the neck as short as possible and these field-producing systems must therefore be limited in their axial dimensions and must be located close to each other. Stray field from the focussing system extending along the axis is likely to interfere with the desired field distribution in either or both of the adjacent systems.

A focussing system comprising an electromagnet shrouded with permeable material such as iron has, in its characteristic distribution of magnetic field along the tube axis, a peak value at the axial midpoint, reducing rapidly to low values with increasing axial distance from the midpoint. The use of a permanent magnet focussing system is advantageous, e. g. by reducing the rectified power requirements in the set, but the usual arrangement of a permanent magnet ring or blocks magnetised in the direction of the axis of the tube and carrying at each end pole pieces with circular holes gives a peak value in the characteristic field distribution reducing rapidly through zero field to negative peaks (of about 20% of the strength of the main peak) and thereafter changing relatively slowly with increasing axial distance (see Figure 8 of "Permanent magnet lenses for television tubes," D. Hadfield, "Electronic Engineering," April 1950. The extended stray field of such permanent magnet systems is a disadvantage, and reduction of the leakage field by the provision of a second permanent magnet with reversed axial polarity at least introduces complication by way of duplication. Moreover, any increase of focussing power, as is required with increased high tension on the cathode ray tube, can only be economically obtained by extending the axial length of the permanent magnet.

According to the present invention, a focussing system has a number of permanent magnet blocks mounted radially round a central pole consisting of a ring of permeable material, such as mild steel or sintered iron, with their polarisation in the radial direction, and a further pole consisting of a mild steel plate parallel to the plane of the ring, to form with the ring an axial gap, with a central hole coaxial with the ring and its periphery bent over to contact the outer ends of the radial magnet blocks. The ring and the plate pole may be adjustable to vary the axial gap between them.

The axial field distribution curve of such an assembly spacing has a positive peak that falls to a low value very quickly on the mild steel pole side of the assembly, and a lower negative peak that rises more slowly from its peak value on the magnet and ring side of the assembly. With the assembly fitted round the tube neck with the mild steel pole side adjacent to the scanning coils, the rapid drop of the positive field peak results in little interference with scanning.

The extension of the stray field on the opposite side of the assembly is relatively unimportant. However, there may be a second mild steel pole plate in reversed position on the opposite side of the assembly to form a second axial gap. At least one of the mild steel pole plates may be axially adjustable with respect to the ring. The axial field distribution curve for an assembly with two symmetrical axial gaps shows equal but opposite peak fields under the two gaps, the field decreasing rapidly on each side of the assembly. If one pole plate is adjusted to give a reduced axial gap, both field peaks are reduced in value but remain approximately equal. Thus a satisfactory range of focussing power can be achieved without appreciably changing the symmetrical distribution of the axial field or the rapid fall in the leakage field. It is an advantage of such symmetrical positive and negative field systems that image rotation is eliminated and also the small leakage field gives little interference with either scanning coils or the ion trap magnet system.

Three or more magnet blocks, equally spaced round the ring, may be used to give substantially uniform flux distribution round the cylindrical pole face of the ring.

One embodiment of the invention will now be described in greater detail with reference to the accompanying drawings, in which:

Figure 1 is a plan of a focussing system;

Figure 2 is a section on the line 2—2 of Figure 1;

Figure 3 is a section on the line 3—3 of Figure 2; and

Figure 4 is a fragmentary view corresponding to Figure 2 showing an alternative arrangement for mounting the magnets.

In Figures 1 to 3, three blocks **1** of Alcomax III (registered trademark) permanent magnet alloy (13.5% Ni, 8% Al, 23.5% Co, 3% Cu, 0.8% Cb, and the balance Fe and impurities) of $2.1 \times 0.95 \times 2.9$ cms. are mounted on flats **2** at 120° spacing round a mild steel ring **3** of 4.0 cms. inside diameter, 4.4 cms. across the flats, and 1.0 cm. wide, the 2.9 cms. dimension of the blocks being radial and the 0.95 cm. dimension fitting within the width of the ring. The ring **3** constitutes the central pole of the system, the second pole consisting of an inner shell **4** of 2 mm. mild steel plate with a 4.0 cms. central hole, with its cylindrical wall **5** fitting closely over the ends of the magnet blocks **1**. The blocks **1** are secured only to the ring **3**, all being positioned axially with respect to the shell **4** by a triangular support **6** of non-ferrous metal or other suitable non-magnetic material having flanges **7** contacting the surface of the ring **3** and magnet blocks **1**, and flaps **8** (Figure 3) fitting three further flats **9** on the ring **3**. A washer **10** and three rivets **11** hold the ring **3** and magnet blocks **1** in place against the triangular support **6**. A second or outer shell **12** also with a 4.0 cms. central hole has its cylindrical wall **13** fitting closely over the cylindrical wall **5** of the inner shell **4**. The outer shell **12** is adjustable axially with respect to the ring **3**, axial movement being derived from rotation of the outer shell **12** with respect to the inner shell **4** by means of three slots **14** in the wall **13** of the outer shell **12**, which slots **14** are inclined at a slight angle to the plane of the ring **3** and magnets **1**. Two of the slots **14** embrace the heads of small cheese-headed screws **15** screwed firmly into the wall **5** of the inner shell **4** and the third slot embraces the shank of a larger screw **16**, which may be used to lock the two shells **4**, **12** together after adjustment. By this means the gap between the ring **3** and the shell **12** may be varied from 0.6 cm. to 1.1 cms. Three tapped holes **17** in the inner shell **4** are used to attach the system to an upright of the chassis of a television receiver. The neck of the cathode ray tube passes through a hole in the upright and the central hole of the focussing system and is usually supported by resilient packing, e. g. rubber, inserted between the neck of the tube and the ring **3** of the focussing system. Two holes **18** in the outer shell **12** are tapped to receive the screws of a handle (not shown) which may be attached to assist in rotation of the outer shell **12**.

In the construction described above the outer ends of the magnet blocks **1** must be finished to the same curvature as the cylindrical wall **5** of the inner shell **4** in order to get a close fit. In Figure 4 the magnet blocks **19** (only one shown) are mounted on flats **20** round a ring **21** and the cylindrical wall **22** of the inner shell is formed with flat portions **23** fitting closely over the square ends of the blocks **19**. The cylindrical wall **24** of the outer shell **25** is similar to that in the previous construction and all other constructional details are the same.

The focussing power of a magnetic electron lens is proportional to the quantity:

$$\int H^2 dz$$

where H is the field component along the axis z. Tests of an assembly with three magnet blocks as described above gave the following results for the unit fully open and fully closed.

	Open	Closed
Axial length of unit, cms	3.6	3.1
Axial gaps, cm	1.1+1.1	1.1+0.6
Positive peak field, oersted	262	223
Negative peak field, oersted	262	217
Axial separation of peaks, cms	2.5	2.3
$\int H^2 dz$	210,000	130,000

In both the open and the closed condition the axial field had fallen to 20% of its peak value at about 1.5 cms. from the assembly and was continuing to fall rapidly.

The values and range of focussing power found in these tests are very similar to those found in other magnetic focussing systems for use in television receivers but with less stray field and a smaller volume of permanent magnet material in the example according to the invention. Greater focussing power can be obtained if required with the same advantages and without increase of the axial dimensions of the unit. As an example an assembly of the same general dimensions but fitted with six Alcomax III blocks, i. e. at 60° spacing around the central ring, gave on test peak field values of 335 oersteds and a focussing power, $\int H^2 dz$, of 340,000.

Magnetisation of the assembly is readily effected by the use of pancake type magnetising coils, one on each side of the assembly, and connected so as to produce mutual repulsion, through which a heavy current is momentarily passed.

The invention thus enables adequate focussing strength to be maintained with modest axial dimensions of the assembly, and efficient utilisation of permanent magnet material.

What I claim is:

1. A focussing magnet system for cathode ray tubes, comprising a central ring pole of magnetically permeable material, a number of permanent magnet blocks mounted

on the central ring pole each with its direction of polarisation extending radially outwardly from the outer periphery of the ring pole, and a further pole consisting of a magnetically permeable plate parallel to the plane of the ring pole and spaced from the ring pole to form a gap, with a central hole coaxial with the ring pole, and with its periphery bent over to contact the radially outer ends of the magnet blocks, like poles of the magnets respectively contacting the ring pole and the further pole.

2. A focussing magnet system as in claim 1, wherein the ring pole and the plate pole are mounted for relative movement in an axial direction, and means are provided for causing such movement to adjust the gap between the poles.

3. A focussing magnet system for cathode ray tubes, comprising a central ring pole of magnetically permeable material, a number of permanent magnet blocks mounted on the central ring pole each with its direction of polarisation extending radially outwardly from the outer periphery of the ring pole, a further pole consisting of a magnetically permeable plate parallel to the plane of the ring pole and spaced from the ring pole to form a gap, with a central hole coaxial with the ring pole, and with its periphery bent over to contact the radially outer ends of the magnet blocks, like poles of the magnets respectively contacting the ring pole and the further pole, and a second magnetically permeable plate pole with coaxial hole and bent-over periphery disposed in reverse position with respect to the first plate pole to form a second axial gap.

4. A focussing magnet system as in claim 3, wherein one plate pole is fixed with respect to the ring pole and the other plate pole is mounted for relative movement in an axial direction with respect to the ring pole, means being provided for causing such relative movement to adjust the gap between the ring pole and that other plate pole.

5. A focussing magnet system as in claim 3, wherein the bent-over periphery of one plate pole fits closely over the bent-over periphery of the other plate pole, with inclined slots in the one for engagement by the other to permit axial adjustment by relative rotation of the two plate poles.

6. A focussing magnet system as in claim 3, comprising flats on the outer periphery of the ring pole to receive the inner ends of the magnet blocks, further intermediate flats on the ring pole, and a non-magnetic support interposed between the ring pole and one plate pole, said support being formed with flanges for engaging the adjacent end surface of the ring pole to determine the extent of the gap between the ring pole and the plate pole and flaps for engaging the intermediate flats.

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