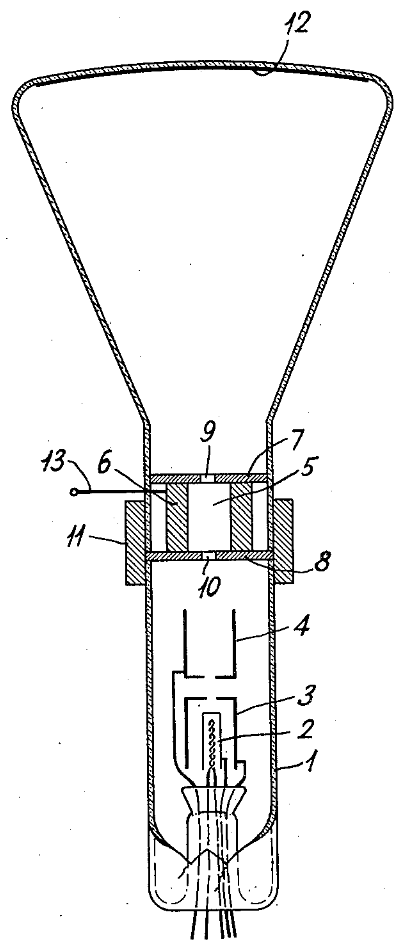
Aug. 20, 1940. G. HOLST ET AL 2,212,206

ELECTRON DEVICE

Filed Oct. 21, 1937



INVENTORS
GILLES HOLST
MENNO WOLF
BY H. S. Grover
ATTORNEY

Patented Aug. 20, 1940

2,212,206

UNITED STATES PATENT OFFICE

2,212,206

ELECTRON DEVICE

Gilles Holst and Menno Wolf, Eindhoven, Netherlands, assignors, by mesne assignments, to Radio Corporation of America, New York, N. Y., a corporation of Delaware

Application October 21, 1937, Serial No. 170,147
In the Netherlands October 30, 1936

9 Claims. (Cl. 250—161)

This invention relates to electronic devices and more particularly to methods and means for concentrating electrons into a well-defined beam by the use of fixed magnets in electron optical systems.

In contradistinction to the concentration of cathode rays by electric fields the use of magnetic fields for this purpose has the advantage that one has not to take exactly into account the dimensions and the mutual position of the parts producing the field, to the extent as is the case in electro-static focusing.

However, magnetic fields involve the difficulty that their effect cannot easily be localized and their influence on the beam of cathode rays extends over a comparatively great length. Particularly undesirable is the penetration of the magnetic field in the region where the beam of rays is deflected. To limit as much as possible the effect of the concentrating magnetic field to a definite point, the coils generating the magnetic field are enclosed in an iron casing having a slit.

Furthermore cathode ray tubes have already been described in which the magnet coil is provided inside the tube so that it has a small diameter. This construction is satisfactory also with a view to limiting the space effect of the coils, since this decreases with the diameter of the coils. However, it has the disadvantage that there is space available only for a limited number of turns per unit of length and in addition that the construction of magnet coils withstanding the required degasifying temperatures and not releasing detrimental gases during operation, is very difficult.

These difficulties are disposed of by the present invention, which is based on the recognition that the prime quality kinds of magnet steel used of late allow of generating a concentration field of sufficient intensity by means of a permanent magnet. Thus not only a strong induction can be achieved but the material is also capable of withstanding the heating necessary for degasifying it, without its magnetic properties being altered.

Accordingly, it is one of the objects of this invention to provide new and improved method and means for focusing electrons.

Another object is to produce an improved focusing system for electrons using fixed electromagnets.

A further object is to provide an improved combined electromagnetic and electrostatic electron optical system utilizing fixed electromagnets.

According to the invention a permanent magnet for the magnetic concentration of the beam of rays is located in the vacuum space of a cathode ray tube. Such a permanent magnet may with much advantage consist of an alloy containing iron, nickel, aluminum and in addition, cobalt, and, preferably, titanium. If desired, additional metals such as copper may be incorporated. By way of example we may mention an alloy containing about 15% nickel, 15 to 25% cobalt, 5% aluminum and at most 5% titanium. The remainder of the alloy consists of iron but may sometimes contain small admixtures (totaling some percent), of copper, manganese and chromium, which do not affect the magnetic properties of the alloy.

The invention has the advantage that permanent excitation by electric current is dispensed of. The intensity of the magnetic field in the space traversed by the beam of rays can also be controlled in the tube according to the invention. For this purpose a magnetic shunt may be used which may be movably arranged outside the tube and by which a variable portion of the magnetic flux is taken off from the path of the rays.

The permanent magnet may at the same time be used as an electrode, for instance, as an accelerating anode. Preferably, a cylindrical magnet body is closed by two terminal plates which constitute the magnet poles and have a central aperture for the passage of the beam of rays. This aperture has preferably a smaller diameter than the cylindrical portion of the magnet. Furthermore, it is advantageous to give the external diameter of these plates a higher value than the external diameter of the cylindrical part. They may either fit in the tube, or, if desired, be sealed to the glass wall thereof.

One form of construction of a cathode ray tube according to the invention will be set forth with reference to the accompanying drawing, in which a cathode ray tube embodying the invention is represented schematically.

The glass wall of the tube is denoted by **1**. The conical portion contains the projection screen **12**.

The electrons emitted by the cathode **2** and controlled by the electrode **3** are accelerated by the electric field of the cathode and of the electrode **4** and concentrated by the magnetic field of the permanent magnet **5**. The magnet consists of a cylindrical steel body **6** and two terminal plates **7** and **8**. These plates may consist of soft iron and have a bore **9** and **10** for the passage of the beam of rays. The magnetic flux passes from the inner edge of one of the plates axially through the space surrounded by the cylindrical portion 6 to the inner edge of the other plate. The intensity of field in the discharge space outside the part surrounded by the cylinder 6 is but small and does not intervene with the effect of the electric or magnetic deflecting fields set up there. The flux passes partly between the outer edges of the plates 7 and 8. This part of the flux is completed substantially through the magnetic shunt 11 which can be shifted and surrounds the tube in the form of a cylinder. The part of the magnetic flux traversing the yoke 11 is larger as the distance not shunted by the yoke 11 is made shorter. Thus the intensity of field in the path of the rays can be controlled.

The plates 7, 8 and the cylinder 6 form together mechanically one part. By anchoring this part it can be prevented from being shifted. If desired, the glass wall of the tube may be sealed to the edges of the plates 7 and 8. Between the plate 7 and the electrode 4 may be set up a potential difference so that the magnet system constitutes at the same time one of the electrodes of the tube.

To enable the arrangement of a permanent magnet of sufficient strength inside the tube the alloy must have a high energy per $cm.^3$ contents, this energy being expressed in the value of BH_{max}. For a tube according to the invention an alloy will generally be required whose magnetic properties do not appreciably vary by heating to a temperature of say, 500° C. for degasifying, and whose BH_{max} exceeds 10^6 cgs. units.

Of course, the volume of the magnet may be larger when the diameter of the tube is larger. Since, however, larger dimensions of the tube generally involve a higher power thereof, the magnetic flux of force must accordingly be larger so that irrespective of the size of the tube the above value for BH_{max} should generally not be made smaller.

Having described our invention, what we claim is:

1. A cathode ray tube comprising an envelope, a source of electrons within said envelope, an annular cylindrical fixed magnet within the tube positioned in register with said source of electrons, and an apertured terminal plate positioned upon each end of the cylindrical magnet and concentric therewith.

2. A cathode ray tube as claimed in claim 1, in which the internal diameter of the cylinder is larger than the diameter of the aperture in the terminal plates.

3. A cathode ray tube as claimed in claim 1 in which the external diameter of the cylinder is smaller than the external diameter of the terminal plates.

4. A cathode ray tube as claimed in claim 1, in which the glass wall of the tube is sealed to the edges of the terminal plates.

5. A cathode ray tube comprising an envelope, a source of electrons within the envelope, means to direct electrons from the source along a predetermined path, an annular cylindrical fixed magnet within the tube positioned coincident with the predetermined path, an apertured soft iron disk positioned on each end of the cylindrical magnet, and a cylindrical magnetic shunt surrounding at least one of the soft iron disks and concentric with the fixed magnet.

6. A cathode ray tube comprising an envelope, a source of electrons within the envelope, means to direct electrons from the source along a predetermined path, an annular cylindrical fixed magnet within the tube positioned coincident with the predetermined path, an apertured soft iron disk positioned on each end of the cylindrical magnet, a cylindrical magnetic shunt surrounding at least one of the soft iron disks and concentric with the fixed magnet, and a target mounted within the envelope and in register with the apertured soft iron disks, said target being adapted to be bombarded by the electrons after passing along the predetermined path.

7. A cathode ray tube comprising an envelope, a source of electrons within the envelope, means to direct electrons from the source along a predetermined path, an annular cylindrical fixed magnet within the tube positioned coincident with the predetermined path, an apertured soft iron disk positioned on each end of the cylindrical magnet, a cylindrical magnetic shunt exterior of the envelope surrounding at least one of the soft iron disks and concentric with the fixed magnet, and a target mounted within the envelope and in register with the apertured soft iron disks, said target being adapted to be bombarded by the electrons after passing along the predetermined path.

8. A cathode ray tube comprising an envelope, a source of electrons within the envelope, means to direct electrons from the source along a predetermined path, an annular cylindrical fixed magnet within the tube positioned coincident with the predetermined path, an apertured soft iron disk positioned on each end of the cylindrical magnet, a symmetrical magnetic shunt surrounding at least one of the soft iron disks and concentric with the fixed magnet, and a target mounted within the envelope and in register with the apertured soft iron disks, said target being adapted to be bombarded by the electrons after passing along the predetermined path.

9. A cathode ray tube comprising an envelope, a source of electrons within the envelope, means to direct electrons from the source along a predetermined path, an annular cylindrical fixed magnet within the tube positioned coincident with the predetermined path, an apertured soft iron disk positioned on each end of the cylindrical magnet, a symmetrical magnetic shunt exterior of the envelope surrounding at least one of the soft iron disks and concentric with the fixed magnet, and a target mounted within the envelope and in register with the apertured soft iron disks, said target being adapted to be bombarded by the electrons after passing along the predetermined path.

GILLES HOLST.
MENNO WOLF.