May 23, 1939. E. RUSKA 2,159,534

CATHODE RAY FOCUSING COIL

Filed July 1, 1936

Fig. 1.

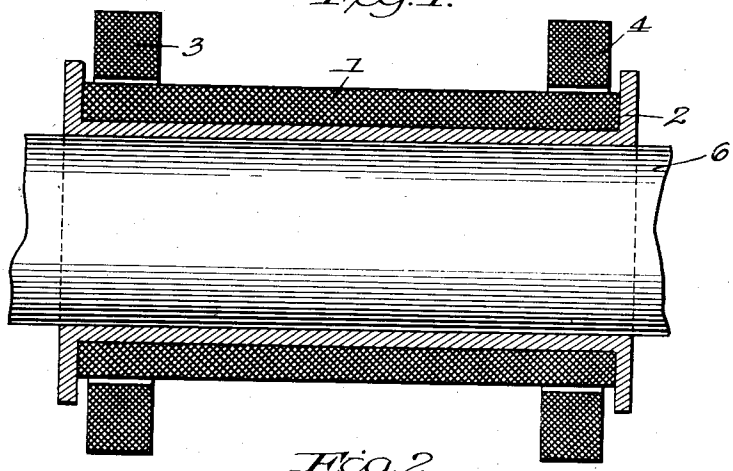


Fig. 2.

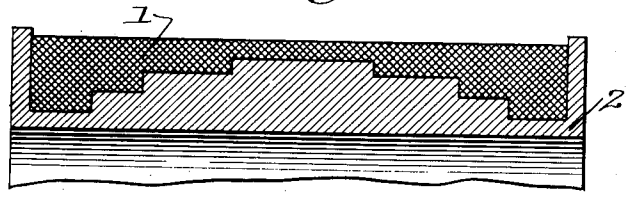


Fig. 3.

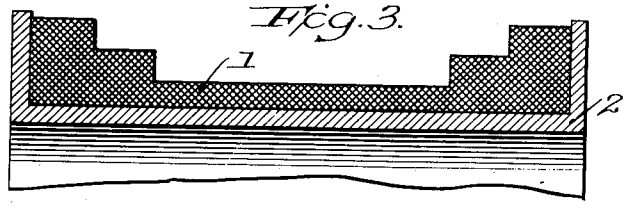
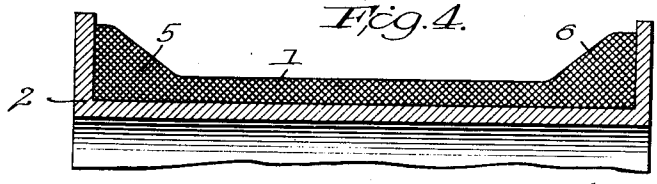


Fig. 4.



Inventor
Ernst Ruska

By Lippincott & Metcalf Attorneys

Patented May 23, 1939 2,159,534

UNITED STATES PATENT OFFICE

2,159,534

CATHODE RAY FOCUSING COIL

Ernst Ruska, Berlin-Zehlendorf, Germany, assignor to the firm Fernseh Aktiengesellschaft, Zehlendorf, near Berlin, Germany

Application July 1, 1936, Serial No. 88,488
In Germany July 23, 1935

1 Claim. (Cl. 250—161)

The invention relates to coils for producing magnetic fields in electron ray tubes especially in television transmitting and receiving tubes as well as sound recording and oscillograph tubes.

If it is desired to delineate expanded cross sections of cathode ray bundles by means of magnetic fields wherein the delineating magnetic field extends essentially over the entire length of the delineated cathode ray, and if the hitherto customary delineating coils are used having a current winding layer which is constant and directed along the electrical axis of the coils, it is found that the borders (of the images) are very unsharp and that geometrically patterned distortions occur in the cross section of the image. Exacting researches have shown that the cause of these faults resides in the non-homogeneity of the magnetic field and is caused by the fact that, for technical reasons, the lengths of the coils cannot be made very much greater than the length of the rays. In some types of electron ray tubes a ray cross section of approximately natural size is delineated by the field of a magnet coil which has about the same length as the electron ray tube. Thus, tubes are used for image scanning purposes in which a photo-cathode of large surface is energized by an optical image formed thereon so as to produce a corresponding emission of electrons and this photo-cathode is electronically-optically delineated in the plane of a receptor by means of the field of a coaxial magnet coil extending over the entire length of the tube. Such delineation is always effected in about natural size, that is, the cross-section of the electron image is the same in the plane of the receptor as at the photo-cathode surface.

In order to obtain thoroughly homogeneous fields and hence sharp images even with coils which are but slightly smaller than, the same size as, or only slightly longer than the length of the electron ray bundle, the field, in accordance with the invention, is rendered homogeneous by suitably distributing the current winding layer over the length of the coil. For this purpose the current winding layer must increase outwardly from the value prevailing in the center of the coil. This increase is preferably effected first in a gradual manner and in a more rapid manner towards the ends of the coils.

Several preferred embodiments are illustrated in the drawing wherein:

Fig. 1 shows a coil with two supplementary coils, surrounding a cathode ray tube.

Fig. 2 shows a semi-cross-section of a coil with a graduated coil core.

Fig. 3 shows a semi-cross-section of a coil with graduated winding.

Fig. 4 is a semi-cross-section of a coil in which the winding at each end terminates in a raised portion.

In Fig. 1, which exhibits a simple method of securing fairly good distribution, 1 is a uniformly distributed focusing coil wound on a coil core 2, and energized by a constant current. The core 2 is shown in position about a cathode ray tube 6. Supplementary coils 3, 4 are disposed at each end of the coil in order most effectively to produce the current distribution desired by the invention and each end may also be provided with a short supplementary winding layer, not shown, energized by a constant current. The currents in the principal coil and in the supplementary coils may then be regulated independently and the degree of homogeneity of the field may thus be adjusted at will. According to Fig. 2 the coil core 2 is built in graduated formation so that the thicker current winding layer is disposed at both ends of the coil, the finished coil being cylindrical in shape throughout. A reverse relation in the structure of the coil is shown in Fig. 3 in which a cylindrical coil core 2, such as is used in Fig. 1, serves for receiving the winding which has a graduated profile. According to Fig. 4 the winding of the base coil 1 is thicker at the ends so that protuberances 5, 6 are produced. Obviously, even in the case of the coils of Figs. 2, 3 and 4, the winding of the base coil need not be of unitary nature but partial (sectional) windings may be used which are traversed by currents of different magnitude.

In operating such cathode ray tubes the ray is usually cross-deflected by means of electrical or magnetic cross fields within the length of the focusing field. This cross deflection of the electron image causes an additional unsharpness and distortion of the image, since the elementary bundles of rays which produce the individual image points pass in sequency through varyingly homogeneous domains of the field of the focusing coil. The homogenization of the field of the coil produced in accordance with the invention possesses appreciable advantages especially in the case of these cross deflected bundles of rays, these advantages being manifested by an image deflection which is sharp and completely free from distortion.

In order to increase the quality of the image when using such tubes it has been proposed to

vary the total flow in the focusing coil as by altering the current in an auxiliary coil of the same shape in relation to the degree of the two cross displacements effected, in order to achieve good focusing in each position. In this procedure only the strength of the focusing field is varied without influencing the geometrical pattern of the field.

It has however been found that particularly good image sharpness can be achieved by varying the geometric pattern of the field (i. e. its degree of homogeneity). The geometric patterning of the focusing field is altered in rhythm with the deflecting field in such a manner that the superposed partial fields of varied geometric shape which, for example, are produced on the one hand by the principal coil and on the other hand by the two supplementary coils, are both varied cyclically, with the deflecting fields but in different degree and, if desired, in a different manner of dependence on the amount of the cross deflection. The currents in the individual partial windings are thus controlled by the superposition of alternating components of definite shape upon a constant basic direct current. Likewise one partial field may remain unaltered, e. g. the field of the principal coil. In that case the control of the geometric pattern of the focusing field is effected solely by altering the influence exerted by the field of the edge field coil.

Furthermore, it is preferable to feed the control currents to the coils in an inductive manner through agency of transformers.

I claim:

In combination with a cathode ray tube, an electromagnetic focusing coil disposed thereabout, said coil having an axial dimension approximately equal to the ray path in said tube, and also having a radial depth of windings which is less at the midpoint of said coil than adjacent the ends thereof.

ERNST RUSKA.