July 23, 1940. E. RUSKA 2,208,939

MAGNETIC DEFLECTING SYSTEM FOR BRAUN TUBES

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Fig. 1.

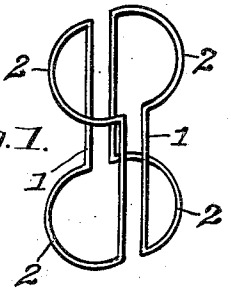


Fig. 2.

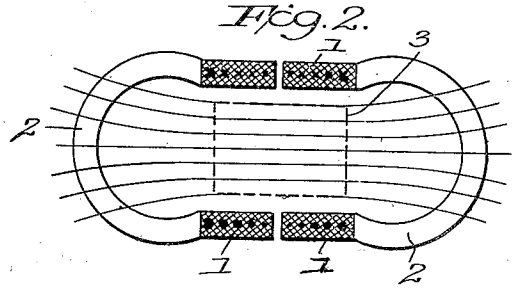


Fig. 3.

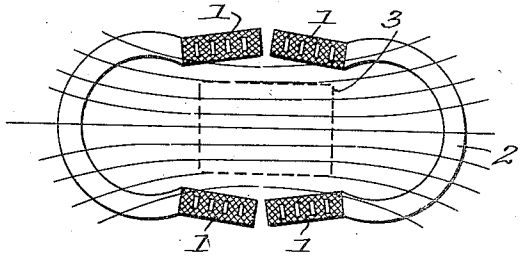


Fig. 10.

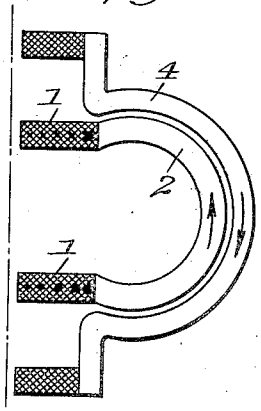


Fig. 4.

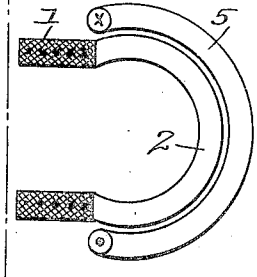
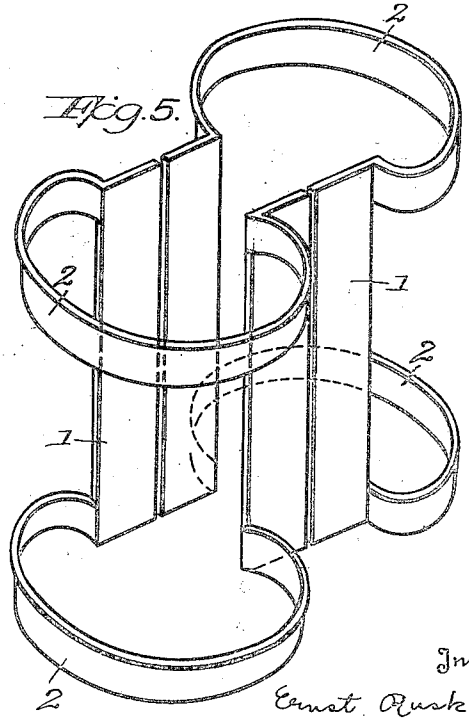


Fig. 5.



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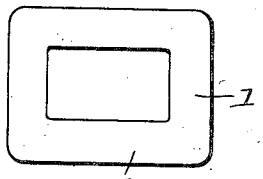
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Attorney

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MAGNETIC DEFLECTING SYSTEM FOR BRAUN TUBES

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Fig. 6.



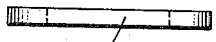
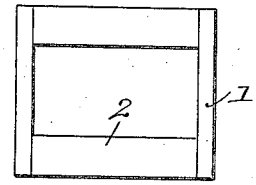


Fig. 6a

Fig. 7.



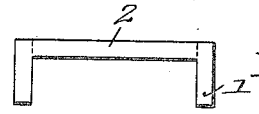
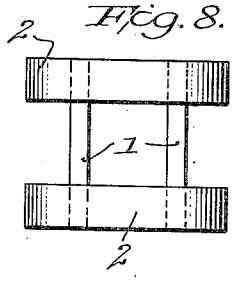


Fig. 7a

Fig. 8.



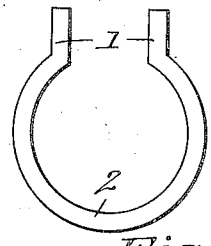


Fig. 8a

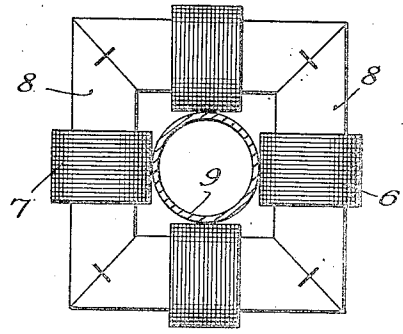


Fig. 9.

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UNITED STATES PATENT OFFICE

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MAGNETIC DEFLECTING SYSTEM FOR BRAUN TUBES

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Application July 1, 1936, Serial No. 88,487
In Germany July 16, 1935

2 Claims. (Cl. 250—157)

The invention relates to magnetic deflecting coils intended for cross-controlling the ray in Braun tubes especially for image scanning and image producing purposes.

Deflecting coils for Braun tubes, insofar as they are not wound on ferromagnetic cores, are either formed as flat, round coils or as rectangular coils, the end conductors of which, lying in a plane perpendicular to the ray, are under certain conditions bent around the neck of the tube. In the case of rays of large diameter and when greater deflecting angles are involved in the magnectic cross control system, such great enlargements and distortions of the focal spot occur when such coils are used that the television images received for example become very unsharp at the outer borders.

The object of the invention is to improve the deflecting coils so as to be able to deflect thicker bundles of rays to greater angular amounts and thus to obtain appreciably clearer pictures while at the same time shortening the tubes.

The cathode ray during the deflecting procedure is acted upon not only by the deflecting fields per se which are produced by the principal sides of the coils extending parallel along the axis of the tube, but also by the field produced by the end conductors. Spot enlargements and distortions thereof occur primarily when the deflecting field in the plane perpendicular to the axis of the ray is not homogeneous. In order to produce as homogeneous a field as possible, the angular cross section thereof, in accordance with the invention, is given the shape of a longitudinally extended, e. g. small, rectangle, and the adjacent side conductors of two half coils are so positioned with their small sides facing each other that they form a compact longitudinally extended current conducting layer. Since, however, the lines of force, even in coil systems of compact longitudinally extended cross section, do not join completely within the two oppositely located coil cross sections, dispersion, according to the invention, is additionally effectively prevented by not making the current layer of the coil sides constant but preferably by raising the same symmetrically outwardly from the value obtaining in the center of each coil side, and making said rise taper in a particularly rapid manner at the outermost ends. Improvement is effected even if the current is kept constant over the length of the winding cross section and if supplementary windings are applied only to both ends of the windings.

A further distortion of the field is caused by the end conductors of the deflecting coils. In the customary constructions the end conductors of both half coils together form a more or less closed circuit. If this circuit is completely traversed by current flowing in the same direction, the resulting field would act upon the ray like one collector coil. Since, however, the two halves of the circuit are traversed by current in opposite directions, the field component parallel to the tube axis disappears in the entire plane passing through the tube axis and separating the two coil halves from each other. On the other hand, the field in the vicinity of each individual end conductor retains the nature of a collector field especially in the center of its arc.

The controlled ray as it issues from the coil approaches very close to the end conductors. The end conductors exert their greatest deflection at that instant and also carry the heaviest current so that the field of the end conductors also becomes particularly effective. This field exerts a supplementary ray-collecting action which manifests itself in an undesirable enlargement of the spot (over-focussing of the bundle of rays) in the border portions of the image field although the spot may be correctly and sharply focussed in the center of the image. This phenomenon becomes all the more evident when two pairs of perpendicularly placed deflecting coils are used, since then the deflection effected by one pair of coils directs the ray towards the center of the end conductors of the other pair of coils.

In order to obviate these influences it is proposed, in accordance with the present invention, to dispose the end conductors at a greater distance from the tube than corresponds to the separation of the effective end conductor. The separation of the side conductors, in order to achieve as great sensitivity as possible, must be made as small as is permitted by the deflection desired. This limit is governed, in the case of deflectional systems disposed in vacuo, by the contacting of the ray with the end conductors at the issue side of the second pair of half coils and, in the case of deflectional systems disposed exteriorly of a vacuum, by the wiping of the ray on the wall of the tube. In both cases, in accordance with the invention, the end conductors are led off outwardly to a greater extent than this limit. In that case the ray, even in its outermost deflected position, is still within the domain of the strength of a small longitudinal magnetic field since its smallest distance from an end conductor never decreases to an extent compared with the difference of the distances from both conductors. The inductivity of the system is not increased

to a harmful extent by increasing the loop of the end conductors since the magnetic flux embraced thereby is equal to zero owing to the direction of current flow in the two half coils.

Embodiments of the invention are shown in the drawings, wherein:

Fig. 1 is a diagrammatic representation of the customary shape of coil.

Figs. 2, 3, 4 and 10 each show cross sections through the deflecting coils perpendicular to the axis of the tube.

Fig. 5 is a diagrammatic view of two deflecting coils of the invention.

Figs. 6, 6*a*, 7, 7*a*, and 8, 8*a* show the coils during the process of their formation.

Fig. 9 shows a further embodiment, viewed in the direction of the axis.

Fig. 1 shows two coil halves with side conductors 1 and end conductors 2. The field produced by the side conductors is not homogeneous in the deflecting space since the lines of force do not run parallel but are curved at the outer portions of the field. This fault also occurs partially when the cross section of the two side conductors is, in accordance with the invention, so formed that a rectangle is produced with the large side of the rectangle extending in the direction of the axis of the coil.

In accordance with the invention, as shown in Fig. 2, the winding is so arranged that the current layer in the side conductors 1 is made to increase outwardly. The desired distribution of the current layer while keeping the winding cross section constant is achieved by interposing insulating strips of suitable thickness. In order to render the field uniform, a uniformly wound coil, may also be used as shown in Fig. 3, with the side conductors 1 disposed somewhat obliquely to each other whereby the field in the deflecting cross section 3 is rendered homogeneous. A further embodiment, shown in Fig. 4, consists in so providing a supplementary winding 5 that it strengthens the field on the outer side of the side conductor.

In order to reduce the influence of the end conductors, as shown in Fig. 5 they are given such a shape that they are removed as far as possible from the deflecting field. The coils which have a rectangular cross section are made as thin as the heating of the coil or the exigencies of the winding process permit, making allowance for subsequent bending. The coil after being wound on a mandrel in flat (plane) shape as shown in Fig. 6 is either impregnated and wrapped, or merely wrapped and bent in the manner shown in Figs. 7 and 8. The end conductors 2 of both half coils may be elliptical or rectangular. Likewise the longitudinal sides 1 of the coil may be bent off in such a manner over against the end conductors that end conductors of bent flat-edged type are produced.

If two crossed pairs of coils of this type are to be used for the same height of ray, then the axial expansion of one pair of coils must be made smaller, by an amount equal to double the height of the windings of the end conductors than those of the other pair, in order that the coil sides may interengage with each other. In order that the two pairs of coils do not differ too much with respect to their length (unequal ampere turns) the height of the end conductors should be as small as possible. Nevertheless the height of the side conductors may be artificially increased by inserting strips, e. g. of insulating material, between the layers at definite distances. The longer pair of deflecting coils which embraces the other pair of coils is preferably used for line deflecting purposes in order to secure approximately the same ampere turn values for both coils notwithstanding the presence of unequal deflecting angles.

The influence of the end conductors may be completely obviated while at the same time avoiding loss of sensitivity in the coil system if, in accordance with Fig. 9, coils are used in which the electrical axis does not cut the axis of the tube at right angles but merely by-passes at right angles to the tube axis at a given distance therefrom. In that case the longitudinal sides pertaining otherwise to two half coils are united into one coil 6, whereas the other likewise adjacent longitudinal sides of both half coils constitute the second coil 7. Such coils may be wound on a rectangular mandrel 8 in a simple manner. The mandrels 8 may remain in the coils and may be united into a framework of finished form by means of screws or pins and adapted to surround the neck 9 of the tube.

A further possibility of obviating the harmful influences due to the end conductors resides in applying an equalizing winding 4 (Fig. 10) adjacent to the end conductors 2 but traversed in opposite direction by the current. By suitably connecting the principal and equalizing coils in series, the deflecting current may be used direct in the principal coil. The coil, compared with the principal coil, should be made so broad that its magnetic flux only slightly decreases the deflecting field of the principal coil.

The compensation of the end conductor ampere turns need not amount to 100% since even a partial equalization is of advantage.

Removal of the disturbing field produced by the end conductors may be effected in accordance with the invention even without effecting a separate homogenization of the field of the side conductors.

I claim:

1. In combination with a cathode ray tube, opposed deflecting coils having end windings and flat side windings parallel to the axis of said tube, so arranged that adjacent flat sides of said opposed coils are coplanar, and having end windings arranged with greater separation from said tube than said side windings, said flat side windings having an increasing current layer away from the axis of said tube.

2. In combination with a cathode ray tube having deflecting coils including end and side conductors, said side conductors being normal to the deflecting field, means for minimizing the field about the end conductors only of said coils comprising compensating windings on the same side of said tube and disposed closely adjacent, and adapted to neutralize the field due to, the end conductors only, said deflecting coils and compensating windings being connected in series.

ERNST RUSKA.