COMMONWEALTH of AUSTRALIA
Patents Act 1952

APPLICATION FOR A STANDARD PATENT

I/We

International Business Machines Corporation

of

Armonk, New York, 10504, United States of America

hereby apply for the grant of a Standard Patent for an invention entitled:

Magnetic shunt for deflection yokes

which is described in the accompanying complete specification.

Details of basic application(s):–

Number	Convention Country	Date
322470	United States of America	13 March 1989

The address for service is care of DAVIES & COLLISON, Patent Attorneys, of 1 Little Collins Street, Melbourne, in the State of Victoria, Commonwealth of Australia.

DATED this TWENTY SIXTH day of FEBRUARY 1990

To: THE COMMISSIONER OF PATENTS

....
a member of the firm of
DAVIES & COLLISON for
and on behalf of the
applicant(s)

Davies & Collison, Melbourne

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DOCKET NO.: KI9-89-002

COMMONWEALTH OF AUSTRALIA
PATENTS ACT 1952

DECLARATION IN SUPPORT OF A CONVENTION APPLICATION FOR A PATENT

In support of the Convention Application made for a patent for an invention entitled: MAGNETIC SHUNT FOR DEFLECTION YOKES

I, KOICHI TONGU
[full name of declarant(s)]

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do solemnly and sincerely declare as follows:

1. I am authorized by

   International Business Machines Corporation

   the applicant for the patent to make this declaration on its behalf.

2. The basic application as defined by Section 141 of the Act was made
   in United States of America
   on March 13, 1989
   by Joseph Francis Hevesi

3. Joseph Francis Hevesi

   of

   102 Pine Street, P.O. Box 83, West Hurley, New York 12491,(U.S.A.) United States of America

   is/~~are~~ the actual inventor~~(s)~~ of the invention and the facts upon which the applicant is entitled to make the application are as follows:

   The said applicant is the assignee of the actual inventor~~(s)~~ in respect of the invention.

4. The basic application referred to in paragraph 2 of this Declaration was the first application made in a Convention country in respect of the invention the subject of the application.

Declared at Tokyo, this 16th day of February , 1990

Koichi Tongu

TO: THE COMMISSIONER OF PATENTS
AUSTRALIA

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MAGNETIC SHUNT FOR DEFLECTION YOKES

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(56) Prior Art Documents
US 4668929
AU 600156 20555/88 H01J 29/00
AU 10446/88 H01J 29/96 H04N 9/29 G12B 17/02

(57) Claim

1. A cathode ray tube display device having a screen for viewing, means for producing a charged particle beam directed at said screen from the rear thereof and aligned with a central axis but that may be magnetically deflected from said axis, and a deflection coil yoke having a first half and a second half, each of said halves being mounted on outer periphery of said cathode ray tube between said screen and said means for producing a charged particle beam and having a magnetic component from axially aligned wire segments and a magnetic component from circumferentially aligned wire segments relative to said axis and ferrite core about said deflection coil, giving rise to a desired deflection field and an undesirable net magnetic field radiation extending around the outside of said cathode ray tube, characterized by an apparatus for reducing said net distributed magnetic far field radiation in front of said screen and all about said device, while minimizing the effect within said tube, said apparatus comprising:

a substantially ring-shaped arrangement of magnetically permeable material substantially centered on said central axis disposed between end turns of said coil and said screen, said ring positioned near and spaced from said end turns of said coil, and

at least one pair of coupling wire loops about said ring and electrically connected to said deflection coil to induce a magnetic field in the ring to counteract with the magnetic field in front of the ring to reduce said net distributed magnetic field in front of said screen and all about the outside of said device while having negligible effect within the tube.

COMMONWEALTH OF AUSTRALIA

PATENTS ACT 1952

COMPLETE SPECIFICATION

NAME & ADDRESS
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COMPLETE SPECIFICATION FOR THE INVENTION ENTITLED:

Magnetic shunt for deflection yokes

The following statement is a full description of this invention, including the best method of performing it known to me/us:-

Field of the Invention

The present invention relates to display apparatus, and more particularly relates to apparatus for reducing unwanted magnetic radiation external to a cathode ray tube display device without affecting the intended deflection field within the bore of the yoke.

Background Art

Cathode Ray Tubes ("CRTs") generally have associated coils, or yokes, to provide a varying magnetic field for electron beam deflection, for example for raster scan. In addition to manifesting itself within the CRT, for beam deflection, this magnetic field also extends around the outside of the CRT and beyond the display device. This external magnetic field serves not useful purpose and an effort is frequently made to reduce this part of the yoke magnetic field. In particular the unwanted frequency range is from 1K to 350K hertz (VLF).

A. A. Seyno Sluyterman of Phillips describes the radiated field due to the horizontal deflection system in his paper entitled "The Radiating Fields of Magnetic Deflection Systems and Their Compensation" presented in 1987 SID Society of Information Display Proceedings. In that paper it shows that the radiated field of the horizontal magnetic circuit of the yoke at mid-range, resembles a vertically oriented dipole, whose mathematical center lies on the long axis slightly ahead of the yoke, Means to provide reduction of this radiation are proposed in this paper. In one case the Helmholtz coils are "on top" and "below" the saddle-shaped deflection yoke. In another case the Helmholtz coils are behind the yoke. The coils are coupled to the deflection coils and the EMF is induced therein, giving rise to a magnetic field which tends to cancel the unwanted radiated magnetic field. However, this is a relatively expensive and bulky solution to the problem. A similar top and bottom coil configuration is in published Finnish Patent Application 861458, April 4, 1986 of Nokia.

Another proposed solution is the placement of shielding all around the CRT, which results in magnetic radiation reduction from the eddy currents induced in the shielding. However, this is also an expensive solution to the problem, and results in only minimal reduction in the magnetic field in front of the screen.

Accordingly, there is a need for means to reduce to acceptable levels the residual magnetic field in front of the cathode ray tube display device that provides an inexpensive and compact solution to the problem.

In accordance with applicant's Australian Patent Specification No. 600,158 ~~co-pending application Serial No. 07/265,115 filed October 31, 1988 which is a continuation-in-part of Serial No. 07/084,949 filed August 13, 1987,~~ an apparatus for reducing the net distributed magnetic radiation all about the coil uses a ring disposed between the coil and the screen, wherein the ring is of magnetically permeable material having its configuration and position relative to the coil selected to minimize the net distributed magnetic field in front of the coil.

While this is acceptable for many applications other physical constraints such as the shapes of the coils, the tube or the presence of wedges for coil alignment can prevent sufficient coupling of the ring to the coil.

SUMMARY OF THE INVENTION

The present invention finds application in a cathode ray apparatus including a cathode ray tube ("CRT") having a screen for viewing and having a charged particle beam directed at the screen from the rear thereof and aligned with the central axis of the tube, but that may be magnetically deflected from the axis, and having a deflection coil producing a magnetic component from axially aligned wire segments and a magnetic component from circumferentially aligned wire segments relative to the axis, giving rise to a net distributed magnetic field in about the coil. An apparatus for reducing the net distributed magnetic radiation all about the coil uses a ring disposed about the tube, wherein the ring is of magnetically permeable material. In accordance with the present invention a pair of coupling wires are looped about the ring and coupled to the coil to boost the induction of the magnetic field in the ring to reduce the magnetic field about CRT with negligible effect within the tube.

More specifically the invention provides a cathode ray tube display device having a screen for viewing, means for producing a charged particle beam directed at said screen from the rear thereof and aligned with a central axis but that may be magnetically deflected from said axis, and a deflection coil yoke having a first half and a second half, each of said halves being mounted on outer periphery of said cathode ray tube between said screen and said means for producing a charged particle beam and having a magnetic component from axially aligned wire segments and a magnetic component from circumferentially aligned wire segments relative to said axis and ferrite core about said deflection coil, giving rise to a desired deflection field and an undesirable net magnetic field radiation extending around the outside of said cathode ray tube, characterized by an apparatus for reducing said net distributed magnetic far field radiation in front of said screen and all about said device, while minimizing the effect within said tube, said apparatus comprising:

a substantially ring-shaped arrangement of magnetically permeable material substantially centered on said central axis disposed between end turns of said coil and said screen, said ring positioned near and spaced from said end turns of said coil, and

at least one pair of coupling wire loops about said ring and electrically connected to said deflection coil to induce a magnetic field in the ring to counteract with the magnetic field in front of the ring to reduce said net distributed magnetic field in front of said screen and all about the outside of said device while having negligible effect within the tube.

The invention also provides a color cathode ray tube display device having a cathode ray tube having three beams, a tri-color phosphor screen in which the color emitted is dependent upon the angle of approach of a cathode ray beam, magnetic deflecting means about the narrow neck of said tube arranged to cause said beam to scan said screen, said deflection means including yoke with horizontal and vertical deflection coils surrounding a core, said deflection coils have end turns extending toward said screen, said horizontal coils giving rise to undesirable net magnetic field radiation extending around the outside of said cathode ray tube, characterized by an apparatus for reducing said net magnetic far field radiation in front of said screen and all about said device, while minimizing the effect in said central axis and within said tube, said apparatus comprising:

a pair of generally semi-circular bodies of magnetically permeable material spaced by a pair of gaps to form a ring;

said ring being disposed between the end turns of said coils and screen, said gaps being along the plane of the vertical deflection;

said ring being disposed near said end turns of said horizontal coil, said gap size being determined to adjust for mis-registration of said three beams on said tri-color phosphor screen; and

at least one coupling wire loop about each semi-circular body electrically in series with said deflection coils with said loop crossing about the midpoint thereof in a generally horizontal plane.

The invention also provides a cathode ray tube display device having a screen for viewing, means for producing a charged particle beam directed at said screen from the rear thereof and aligned with a central axis but that may be magnetically deflected from said axis, and a deflection coil yoke having a first half and a second half, each of said halves being mounted on outer periphery of said cathode ray tube between said screen and said means for producing a charged particle beam and having a magnetic component from axially aligned wired segments and a magnetic component from circumferentially aligned wire segments relative to said axis giving rise to a desired deflection field and an undesirable net magnetic field radiation extending around the outside of said cathode ray tube, characterized by an apparatus for reducing said net distributed magnetic far field radiation in front of said screen and all about said device, while minimizing the effect within said tube, said apparatus comprising:

a substantially ring-shaped arrangement of magnetically permeable material substantially centered on said central axis disposed between said yoke and said screen, and

at least one pair of coupling wire loops about said ring and electrically connected to said deflection coil to induce a magnetic field in the ring to counteract with the magnetic field in front of the ring to reduce said net distributed magnetic field in front of said screen and all about the outside of said device while having negligible effect within the tube.

The invention may be embodied in forms which are made of relatively inexpensive linear ferrite materials configured in shapes that are inexpensive to provide, such as a flat ring or the like. As such, it permits a relatively inexpensive solution to the problem. In addition, in tested embodiments the present invention has demonstrated dramatic reductions in the unwanted radiation in front of CRTs to which it has been applied.

The foregoing and other objects, features and advantages of the invention will be apparent from the more particular description of the preferred embodiments of the invention, as illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a diagram showing pertinent portions of an integrated air core yoke tube component.

Fig. 2 is a simplified diagram of one winding each from the upper and lower horizontal deflection coils of the integrated yoke tube component shown in Fig. 1.

Fig. 3 is a computed plot showing the magnetic field intensity along the Z axis for a typical deflection yoke such as is shown in Fig. 1.

Fig. 4 is a figure like that of Fig. 1, having added thereto a ring 50 in accordance with the preferred embodiment of the present invention.

Fig. 5 is a diagram like that of Fig. 2, having added thereto a ring 50 in accordance with the preferred embodiment of the present invention.

Fig. 6 is a set of curves, on the same set of axes as in Fig. 3, showing the effect on the net field A of ring 50.

Fig. 7 is a set of curves showing the effect of ring 50 on the end turn field shown in Fig. 3.

Fig. 8 is an expanded view of the portion of the curve shown in Fig. 6 beyond approximately 2.5 centimeters.

Fig. 9 is a plot like that of Fig. 8, wherein ring 50 is a slightly different distance from the yoke.

Fig. 10 is a diagram like Fig. 8, in which the inner diameter radius of ring 50 is slightly different from that of Fig. 8.

Fig. 11 is a curve like that of Fig. 8, but wherein the distance of the ring 50 from the end of the yoke is different from that of Fig. 8 and Fig. 9.

Fig. 12 is a diagram showing a CRT with yoke with a ferrite core and the associated fields.

Fig. 13 illustrates the system of Fig. 12 with the compensating ring.

Fig. 14 is a sketch of the top view of the core, coil and ring of Fig. 13 illustrating magnetization currents and fields.

Fig. 15 is a sketch of the front view illustrating magnetization currents and fields.

Fig. 16 shows a preferred embodiment of the ring for color tubes in which the ring is split providing two portions.

Fig. 17 is a sketch of the split-ring illustrating the shunt fields across the base of the tube.

Fig. 18 is a cross-sectional diagram through a portion of a still further embodiment of ring, made with conventional μ metal laminates.

Fig. 19 shows a further embodiment, having a hexagonal shape.

Fig. 20 is a sketch of one embodiment of the present invention which is a top view of the CRT, choke coil and ring.

Fig. 21 is an electrical schematic diagram of the present invention.

Fig. 22 is a diagram of one winding of the upper and lower horizontal deflection coils with the wire loops connected thereto.

Fig. 23 is a screen end view of the ring illustrating the pair of loops.

Fig. 24 is a sketch of the ring with quadrature placed pairs of holes through the ring through which the loops are passed before returning to the driver terminal 4.

Fig. 25 is a sketch illustrating how the loops pass through the holes in the ring in Fig. 24.

DETAILED DESCRIPTION OF EMBODIMENTS

Fig. 1 shows the pertinent portions of an integrated yoke tube component ("ITC") 10 which includes CRT 12, having a front screen 14, and upper and lower horizontal deflection coils 16, 18. The deflection coils 16, 18 generate a varying magnetic field between them, inside CRT 12, to deflect the electron beam within the tube 12 for horizontal sweeping across the fact of the screen 14, as is well known in the art.

Fig. 2 is a simplified diagram of one winding each from the upper and lower deflection coils 16, 18 of Fig. 1. Thus, loop 20 is a single loop from coil 16, while loop 22 is a single loop from coil 18. As illustrated, a current i flows through each of the coils so as to generate the above described varying magnetic field for horizontal deflection of the electron beam.

In Fig. 2, X, Y, and Z axes are depicted, having their origin in the plane of circumferential coil portions 34, 38 and centrally located between them. The X axis coincides with the central axis of CRT 12 (Fig. 1). Note that the upper and lower halves 20, 22 are symmetrical about the x-z and y-z planes.

In actual operation the upper and lower loops 20, 22 are interconnected to produce a dipole field on the Z axis as is known. From the known coil shape and current, the $\bar{B}$ field is given by:

$$\bar{B} = \frac{\mu}{4\pi} \int \frac{\bar{J} x \bar{R}}{R^2} \, dl$$

where $\bar{J}$ is the current, $\bar{R}$ is the direction and R is the distance to a point of interest T on the Z axis. This equation is used in computing the field distribution of Figs. 3 and 7 through 12.

A plot of the computed $\bar{B}$ field distribution of an air core horizontal deflection coil, such as is shown in Fig. 1, without any high permeability material, like ferrite shielding, is shown in Fig. 3. The actual $\bar{B}$ field is a directional field, and the plot shown in Fig. 3 shows only the magnitude, or intensity, of such magnetic field along the Z axis. The units depicted on the horizontal axis are centimeters, while the units in the vertical axis are gauss. The curve reflects a typical coil having current flowing so as to produce a field which deflects a 20 kilovolt electron beam to an angle of about 40 degrees.

Curves A, B, and C of Fig. 3 represent the total field, the partial field from the axial wires and the partial field from the end turns, respectively. Curve A is the magnitude of the vector sum of the fields represented by curves B and C. In typical uncompensated yokes, at 55 centimeters in front of the yoke the field can be in range of approximately 1,000 - 2,000 nano-Tesla. Clearly, this is not very large magnetic field. However, in accordance with the present invention this field can be reduced to an even smaller quantity. In actual experiments using the preferred embodiment described below, reductions to below 200 nano-tesla at 55 centimeters was measured.

Fig. 4 shows the ITC 10 of Fig. 1 having added thereto a ring 50 of linear ferrite operating as a magnetic shunt, in accordance the aforementioned Australian Patent Specification ~~with my invention in application Serial No. 07/265,115.~~ No. 600,158.

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Fig. 5 shows the loops 20, 22 of Fig. 2, with the ferrite ring 50 disposed in front of it, to illustrate the relative shape and position of ring 50.

Ring 50, as mentioned above, is a linear ferrite. Linear ferrite is a well known material commonly used in transformer and yoke production. According to the preferred embodiment the ring 50 has a relatively high magnetic permeability, (μ above 2,500). It also has a high volume resistivity, for example 1 Meg Ohm or more per cubic centimeter. The high resistivity value keeps eddy currents at a minimum. Otherwise the loading effects on the yoke would result in a need for more energy to drive the yoke. While embodiments could be constructed, for example out of conventional μ laminates, having this loading effect, and be in accordance with the present invention, it was deemed desirable to keep the eddy currents low, and avoid this loading effect in the preferred embodiment. The cross section of the ring 50 is large enough to avoid saturation.

Fig. 6 is a set of curves, on the same set of axes as those of Fig. 3, showing the effect on the net field A shown in Fig. 3 of a flat ring, such as ring 50 in Fig. 4, in accordance with the preferred embodiment of the present invention. Curve A in Fig. 6 is the same as curve A in Fig. 3. Curve D in Fig. 6 represents the field contribution from the magnetization effect of the ring 50, while curve E represents the resultant curve from the combination of curves A and D.

To better understand the effect of field D on the overall magnetic field A, a set of curves is shown in Fig. 7 including curve D, and the end turn magnetic field component C. Curve C is the same curve C as shown in Fig. 3. Curve F is a curve representing the resultant field from the combination of curves D and C. Note that in Fig. 7 the horizontal axis is the same in Figs. 3 and 7 while the vertical scale has been expanded, to aid in clarity.

As mentioned above, curve D is the theoretical field of the ring alone. This is an intrinsic field which is created by the magnetization force of the end turn field. It should be noted that the presence of the ring attenuates the end turn field. The degree of attenuation is controlled by the variables such as ring dimensions and ring yoke separation, as is discussed in more detail below. It should be further noted that the end turn field combines with the main deflection field, and the area in front of the CRT screen, to form the net measurable residual field whose reduction is an object of this invention. At optimum attenuation, the modified end turn field F is equal it magnitude but opposite in direction to the main deflection field, resulting in a zero vector sum. As a practical matter, the net measurable residual field in front of the CRT screen can never be reduced to zero. However, by application of the principles of my previous invention as disclosed herein, this field can be reduced to very small levels.

The portion of Fig. 6 beyond approximately 2.5 centimeters to the right thereof is shown in Fig. 8. In order to see clearly the curve behavior in that region, the scale is expanded in the vertical direction as compared with Fig. 6. Curves A and E are described in Fig. 6. Curve D is not shown in this figure in the interest of providing more clarity for curves A and E. Note that Curve E is very nearly at a zero field magnitude at approximately 9.5 centimeters.

The compensated curve E is for a typical CRT-yoke configuration, having a ring 50 of ferrite with a permeability of 1,000 - 3,000, and high volume resistivity, and having an inner dimension of 4 centimeters, a thickness of .2 centimeters, a width of 1 centimeter, placed at a distance of .4 centimeters from the end of the yoke. As used herein, the width of the ring refers to its radial extent from inner diameter to outer diameter.

Figs. 9-11 are plots like the plot shown in Fig. 8, for slightly different ring configurations from the configuration producing the curves of Fig. 8. Thus, in Fig. 9 all of the parameters for the ring are the same as those corresponding to Fig. 8, except the distance of the ring from the end of the yoke. In Fig. 9 the curves correspond to a configuration in which this dimension is .3 centimeters. It will be appreciated that this reveals over-compensation, as the curve E' is slightly above the horizontal axis, for example of 9.5 centimeters and slightly below curve E in Fig. 8.

The curves of Fig. 10 are for a configuration in which the dimensions are the same as those corresponding to Fig. 8, but wherein the inner diameter radius is 5 centimeters, instead of 4 centimeters. It can be seen that significantly less compensation is provided, as curve E" is here below the horizontal axis.

Fig. 11 shows a curve for a configuration wherein the dimensions are as in Fig. 8, but wherein the distance of the ring from the end of the yoke is .6 centimeters, instead of .4 centimeters. It can be seen that slightly less compensation is provided, causing curve E''' to cross the horizontal axis of 9.5 centimeters. This was deemed to represent optimum compensation.

While curves are not provided showing the effect of change of width of the ring on the compensation effect, in general, decreasing the width will tend to reduce the compensating effect, while increasing the width will tend to increase the effect.

Thus, from the above Figs. 8-11 it will be appreciated how changing the various dimensional parameters of the ring affects the performance of the ring in compensating by cancelling the magnetic field components on the X axis in front of the screen due to yoke winding and components. Through an understanding of these effects, one practicing the present invention can provide the adjustments deemed desirable to optimize the cancellation affect.

In the above described arrangement the CRT tube has an air core horizontal deflection coil without any high permeability shielding about the neck of the tube. The direction of the horizontal deflection field to move the beam toward the right edge of the screen as viewed from the front is represented by arrow 70 in Fig. 12. In common commercial type yokes the horizontal deflection coils have ferrite shielding (ferrite core) 68 about the horizontal deflection coils as shown in Fig. 12. There is also vertical deflection coils (not shown) about the horizontal deflection coils and under the ferrite core. The radiated field produced by the horizontal coils with the end loops 32, 34, 36 and 38 extending beyond the ferrite core is a dipole centered forward of the loop nearest the screen as shown by arrows 70a in Fig. 12. Note the ferrite core reverses the polarity of the radiated field. A ferrite ring

50 as shown and illustrated in Fig. 13 is mounted forward of the horizontal deflection coil near the radiation center of the horizontal coil. The manner in which this ring compensates for the field radiation without measurably affecting the deflection is illustrated in connection with Figs. 14 and 15. Fig. 14 is a sketch of the top view of the coil 16, core 68 and ring 50 illustrating the deflection current in the deflection coil, the magnetization currents and the resulting fields. Fig. 15 is a front view of Fig. 14. The counterclockwise current of the horizontal deflection coil seen in the top view is represented by 71. The magnetic field produced is represented by O_H at the center that points toward the viewer. This corresponds to 70 in Fig. 12. The ferrite core 68 is coupled to the deflection coil and produces an even stronger equivalent magnetization current M_1 represented by the heavy lines 72. The coupled current 72 circulates in the opposite direction (clockwise in Fig. 14) with current along adjacent surfaces of coil and core flowing in the same direction. The result is a magnetic field X_1 (with a direction into the paper) in the center of the core and O_1 (with a direction out of the paper) in front of the ring. The field X_1 combines with field O_H and produces a net radiated field O_1 or 70a of Fig. 12 which is the vector sum of O_H and X_1. The radiated field O_1 is a dipole field and is the major component of the magnetic radiation. The exposed end-turns are radiating a minor quadrapole field which is designated with X_e. Symbols "X's" and "O's" are consistent with the sign convention established earlier where X means the field is pointing down into the paper, O means the field is pointing up toward the viewer. The sum X_1 and X_e is the total radiated field without the presence of the ring.

When a ferrite ring is placed in front of the yoke as illustrated in Figs. 13 and 14 the ring will be magnetized as described below. Magnetization currents M_1 in the yoke shield induce equivalent magnetization current M_2 in the ring in the counter clockwise directions. The resulting field is pointing up within the ring (O_2) and pointing down outside of the ring (X_2). The polarization of this field is also indicated in Fig. 15 with "N" (north) on top and "S" (south) on the bottom of the ring. The front end-turns of the horizontal coils (top, bottom) induce equivalent magnetization currents M_3 in the ring in a clockwise direction. The resulting field X_3 is pointing down within the ring and pointing up outside of the ring O_3. The polarization of this field is also shown in Fig. 15 with letters "N'" (north) and "S'" (south). From the distribution and polarization of the induced magnetization current end fields we conclude that the radiated field of the yoke shield X_1 sets up a dipole magnetization O_2 in the ring which opposes the radiating dipole. Similarly, the quadrapole component of the radiated field due to the exposed end-turns of the horizontal deflection coils induce a quadrapole magnetization in the ring which cancels the radiating quadrapole. Variables such as ring thickness, inside diameter, outside diameter, permeability and yoke-ring separation can be used to tune for optimum performance. Naturally, the lower limit of the ring dimensions are dictated by the given CRT and yoke combination. In practice, the tendency is to bring the ring as close to the front of the yoke as possible without adversely effecting the deflection field in the bore of the tube. This reduces the ring dimensions and assures minimum cost. The ring has the lower limit of permeability of about 1,000 with the ring placed closest to the yoke. The higher the permeability the greater the distance the ring can be from the yoke.

Despite the effort to eliminate interference between the ring and main deflection field, it was found that the presence of the solid ring moves the center of deflection of the vertical deflection field slightly back toward the electron gun. This is not noticeable in the monochrome system, however, it causes about 10^{-6} meter mis-registration in a color system and that is detectable. This problem is fixed with a split ring, configuration Fig. 16. Here, part of the induced dipole field as shown in Fig. 17 which is normally conducted by the ring is forced to enter the bore, and to join and strengthen the vertical deflection field, thereby causing the center of deflection to move forward. In practice, it was found that 2mm air-gap can compensate 10^{-6} meter mis-registration.

In actual prototype experiment, in conjunction with an ITC manufactured by Matsushita Company having a serial number of M34JDJ00X1, a ferrite ring of ordinary linear ferrite was provided, having a μ of approximately 1,000 - 3,000 and a volume of resistivity of greater than 1 meg ohm per cc, ring dimensions of: an inner dimension of 4-3/8", a width of 3/8", and a thickness of 1/8". This ring was found to produce excellent cancellation effects when it was placed against the circumferential wire portions (end closest to the screen) of the yoke provided with this ITC with spacing resulting only from the insulation of the yoke wires.

Embodiments may be made with conventional μ metal laminates, yielding rings having a cross-section as shown in Fig. 18.

Fig. 19 shows a hexagonally shaped ring, representing a still further embodiment for use with, for example, a hexagonally configured yoke.

As mentioned previously the compensation effect of the ring is dependent on its width and other size and material dimensions. According to the teaching herein these size and material dimensions and the spacing from the end turns of the coil can be overcome by a pair of coupling wire loops about the ring 50 as shown in Figs. 20 - 22. Fig. 20 is a top view of the yoke, coil and tube and ring. Fig. 21 is an electrical diagram showing the terminals. Terminal 1 is coupled to one end of the driver and terminal 4 is the return to the driver. The upper coil refers to the upper saddle yoke and the lower coil refers to the lower saddle yoke. Fig. 22 illustrates the upper saddle yoke 220 and the lower saddle yoke 221. The first loop 210 begins at terminal 1 on the rear bundle terminal, passes clockwise about the ring 50a and terminates at terminal 2. The upper and lower saddle yokes are coupled at one end to terminal 2 and terminate at terminal 3. The second loop 211 extends from terminal 3 and passes clockwise about the ring 50a on the opposite side of the ring (diametrically opposite surfaces in the horizontal plane) and terminates at terminal 4. In this manner the loops are in series with each other and in series with the parallel yoke coils. An end view sketch of the ring as seen from the screen with the loops is illustrated in Fig. 23. The manner in which the loops are connected to the yokes is so that the direction of the current in the loop matches the direction of the current in the front end turn bundle of the deflection coil. Note the direction of arrow 215 and 216 match in Figs. 20 and 22.

In accordance with another embodiment of the present invention correction for the quadrapole effect can be by the placement of the loops passing about the ring and through quadrature placed holes in the ring as shown in Figs. 24 and 25.

It is recognized that the ring may be any of the shapes, sizes, dimensions and material discussed herein and that the number of loop turns can be selected according to the required coupling to achieve the desired reduced radiation.

While the invention has been described herein with respect to the preferred and various other embodiments, it will be understood by those skilled in this art that still other modifications and variations may readily be conceived by one of ordinary skill in the art to which it pertains, without departing from the spirit and scope of the invention as set forth herein. It is contemplated that all such variations, modifications and embodiments are encompassed within the scope of the appended claims.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A cathode ray tube display device having a screen for viewing, means for producing a charged particle beam directed at said screen from the rear thereof and aligned with a central axis but that may be magnetically deflected from said axis, and a deflection coil yoke having a first half and a second half, each of said halves being mounted on outer periphery of said cathode ray tube between said screen and said means for producing a charged particle beam and having a magnetic component from axially aligned wire segments and a magnetic component from circumferentially aligned wire segments relative to said axis and ferrite core about said deflection coil, giving rise to a desired deflection field and an undesirable net magnetic field radiation extending around the outside of said cathode ray tube, characterized by an apparatus for reducing said net distributed magnetic far field radiation in front of said screen and all about said device, while minimizing the effect within said tube, said apparatus comprising:

a substantially ring-shaped arrangement of magnetically permeable material substantially centered on said central axis disposed between end turns of said coil and said screen, said ring positioned near and spaced from said end turns of said coil, and

at least one pair of coupling wire loops about said ring and electrically connected to said deflection coil to induce a magnetic field in the ring to counteract with the magnetic field in front of the ring to reduce said net distributed magnetic field in front of said screen and all about the outside of said device while having negligible effect within the tube.

2. The display device of claim 1 wherein said loops are connected in series with said deflection coil yoke.

3. The display device of claim 2 wherein said loops pass about said ring on opposite ~~horizontal~~ sides and are generally in a horizontal plane when the ring is on the CRT.

4. The display device of claim 3 wherein said first half of said deflection yoke is the upper half and is connected in parallel to said second half being the lower half and a first of said pair of loops is coupled at one end of deflection yoke halves and the second of said loops is connected to the opposite end of the deflection yoke halves.

5. The display device of claim 1 wherein said ring has holes therein and said wire loops pass through said holes.

6. The display device of claim 5 wherein said holes are in pairs with the hole pairs located at quadrature points about the ring.

7. The display device according to claim 1 wherein said ring-shaped arrangement is a ring of ferrite with a permeability greater than 1,000 and spacing from the yoke determined to reduce the far field while having minimum effect within the tube.

8. The display device according to claim 1 wherein said coil is a saddle yoke and said ring-shaped arrangement is spaced from said yoke with no portion thereof under said yoke but all portions forward of the yoke toward said screen.

9. The display device according to claim 1 wherein said ring-shaped arrangement comprises multiple ferrite sections forming a ring.

10. The display device according to claim 1 wherein said ring-shaped arrangement comprises a pair of semi-circular ferrite sections separated by a pair of gaps of non-ferrite material.

11. The display device according to claim 3 wherein said ring-shaped arrangement comprises a pair of sections with the non-ferrite gaps between the sections being in the vertical plane with at least one loop about each section at about the midpoint thereof.

12. The display device according to claim 10 wherein the size of said non-ferrite gaps between said sections is determined to correct for mis-registration.

13. The display device of claim 4 wherein said multiple sections are gapped to adjust for mis-registration.

14. A color cathode ray tube display device having a cathode ray tube having three beams, a tri-color phosphor screen in which the color emitted is dependent upon the angle of approach of a cathode ray beam, magnetic deflecting means about the narrow neck of said tube arranged to cause said beam to scan said screen, said deflection means including yoke with horizontal and vertical deflection coils ~~surrounding a core~~, said deflection coils have end turns extending toward said screen, said horizontal coils giving rise to undesirable net magnetic field radiation extending around the outside of said cathode ray tube, characterized by an apparatus for reducing said net magnetic far field radiation in front of said screen and all about said device, while minimizing the effect in said central axis and within said tube, said apparatus comprising:

a pair of generally semi-circular bodies of magnetically permeable material spaced by a pair of gaps to form a ring;

said ring being disposed between the end turns of said coils and screen, said gaps being along the plane of the vertical deflection;

said ring being disposed near said end turns of said horizontal coil, said gap size being determined to adjust for mis-registration of said three beams on said tri-color phosphor screen; and

at least one coupling wire loop about each semi-circular body electrically in series with said deflection coils with said loop crossing about the midpoint thereof in a generally horizontal plane.

15. A display device as claimed in claim 14 wherein the horizontal and vertical deflection coils are located within a core.

16. A cathode ray tube display device having a screen for viewing, means for producing a charged particle beam directed at said screen from the rear thereof and aligned with a central axis but that may be magnetically deflected from said axis, and a deflection coil yoke having a first half and a second half, each of said halves being mounted on outer periphery of said cathode ray tube between said screen and said means for producing a charged particle beam and having a magnetic component from axially aligned wired segments and a magnetic component from circumferentially aligned wire segments relative to said axis giving rise to a desired deflection field and an undesirable net magnetic field radiation extending around the outside of said cathode ray tube, characterised by an apparatus for reducing said net distributed magnetic far field radiation in front of said screen and all about said device, while minimizing the effect within said tube, said apparatus comprising:

a substantially ring-shaped arrangement of magnetically permeable material substantially centered on said central axis disposed between said yoke and said screen, and

at least one pair of coupling wire loops about said ring and electrically connected to said deflection coil to induce a magnetic field in the ring to counteract with the magnetic field in front of the ring to reduce said net distributed magnetic field in front of said screen and all about the outside of said device while having negligible effect within the tube.

17. A cathode ray tube display device substantially as hereinbefore described with reference to the drawings.

DATED this 12th day of February, 1992
INTERNATIONAL BUSINESS MACHINES CORPORATION
By its Patent Attorneys
DAVIES COLLISON CAVE

FIG. 1

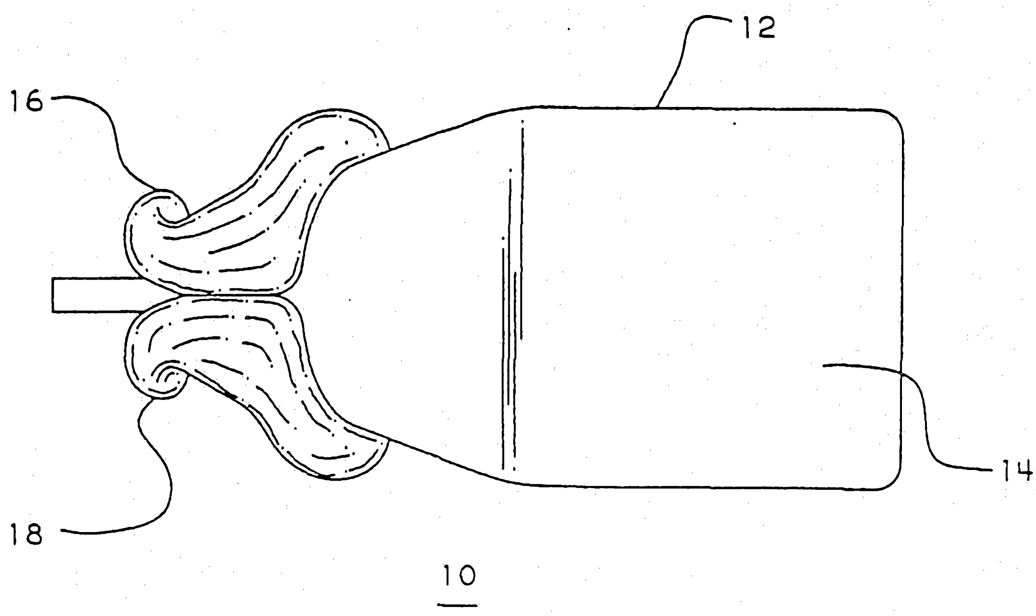

FIG. 4

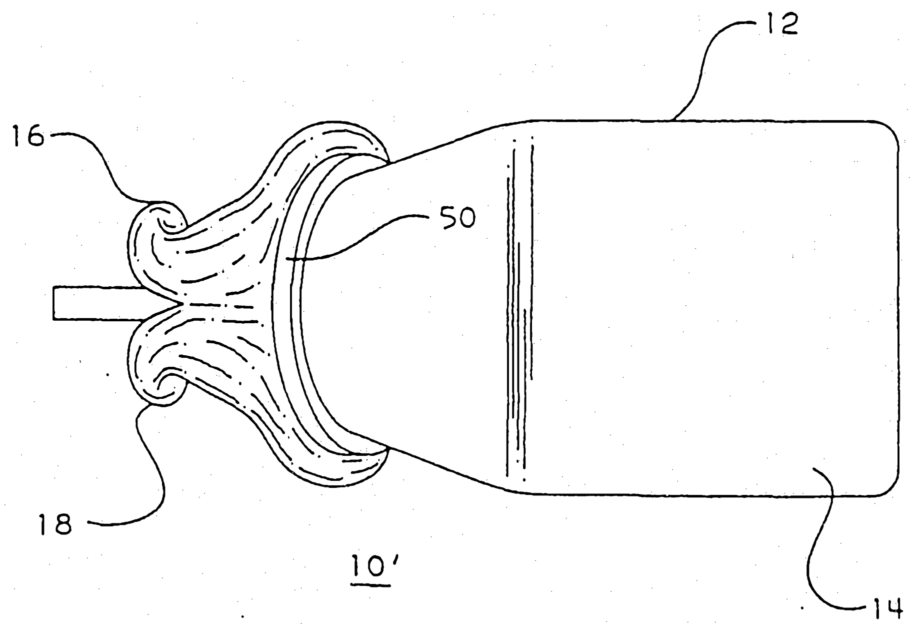

FIG.2

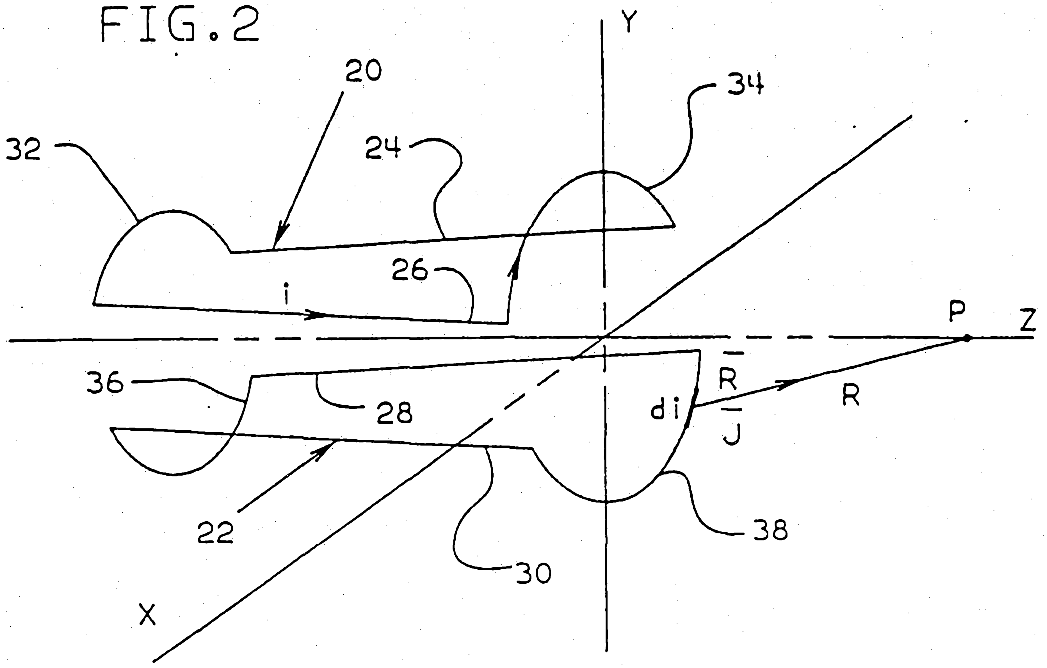

FIG.5

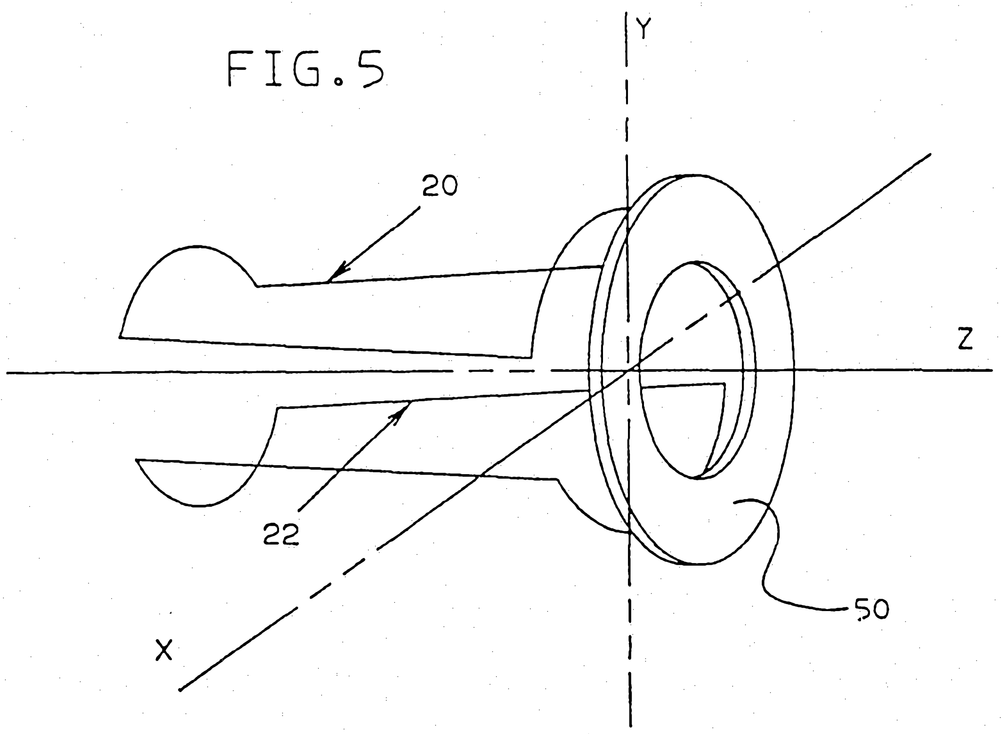

FIG. 3

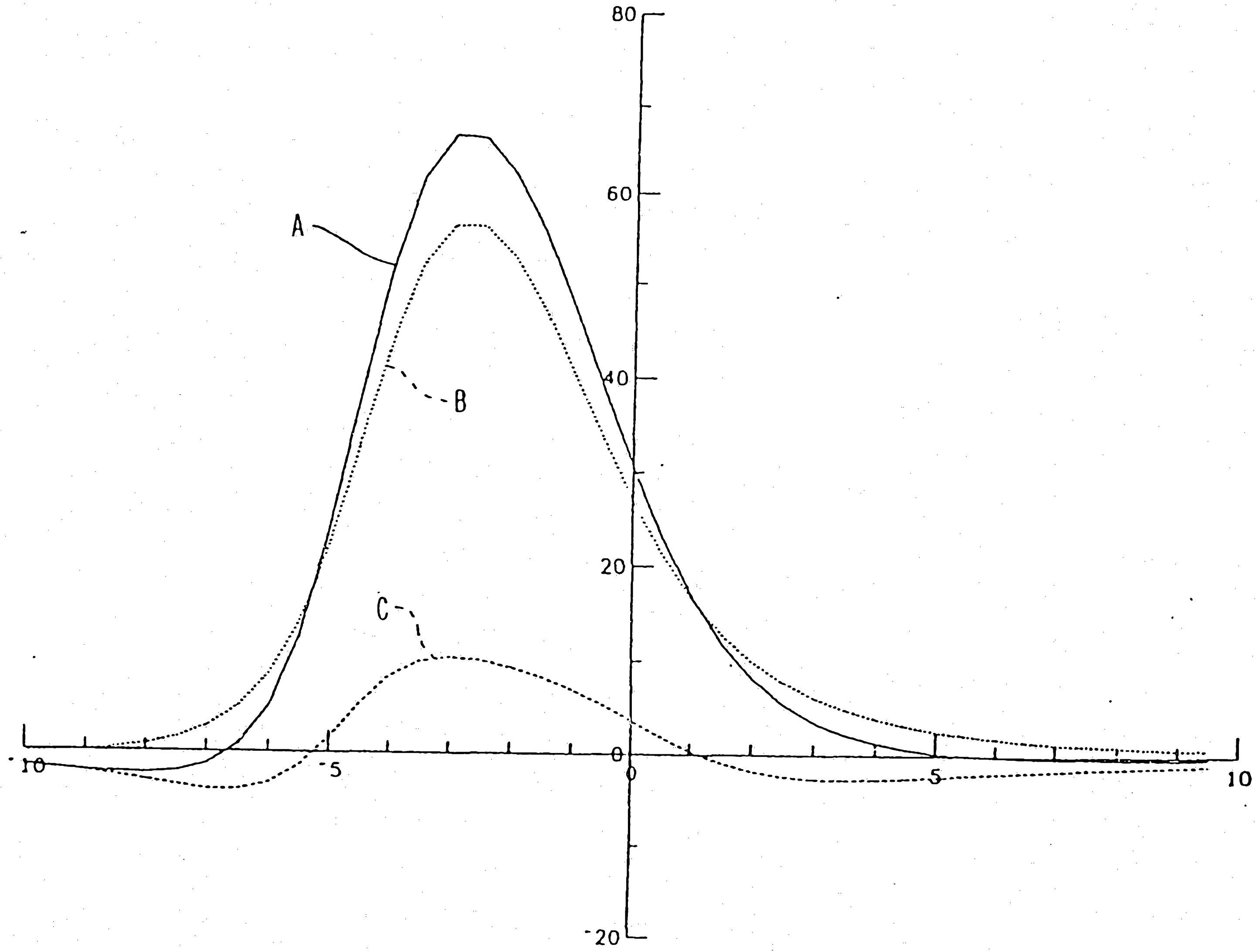

FIG.6

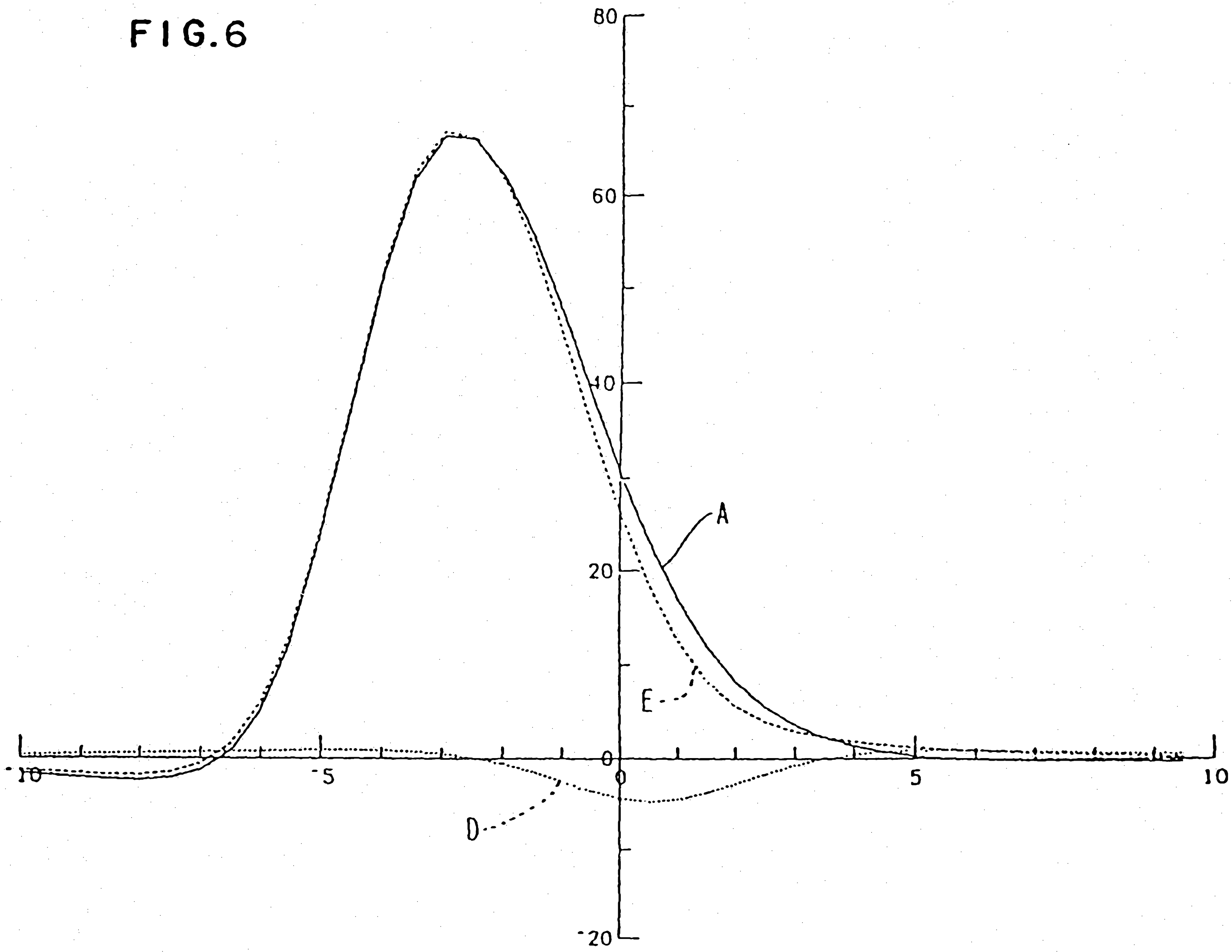

FIG.7

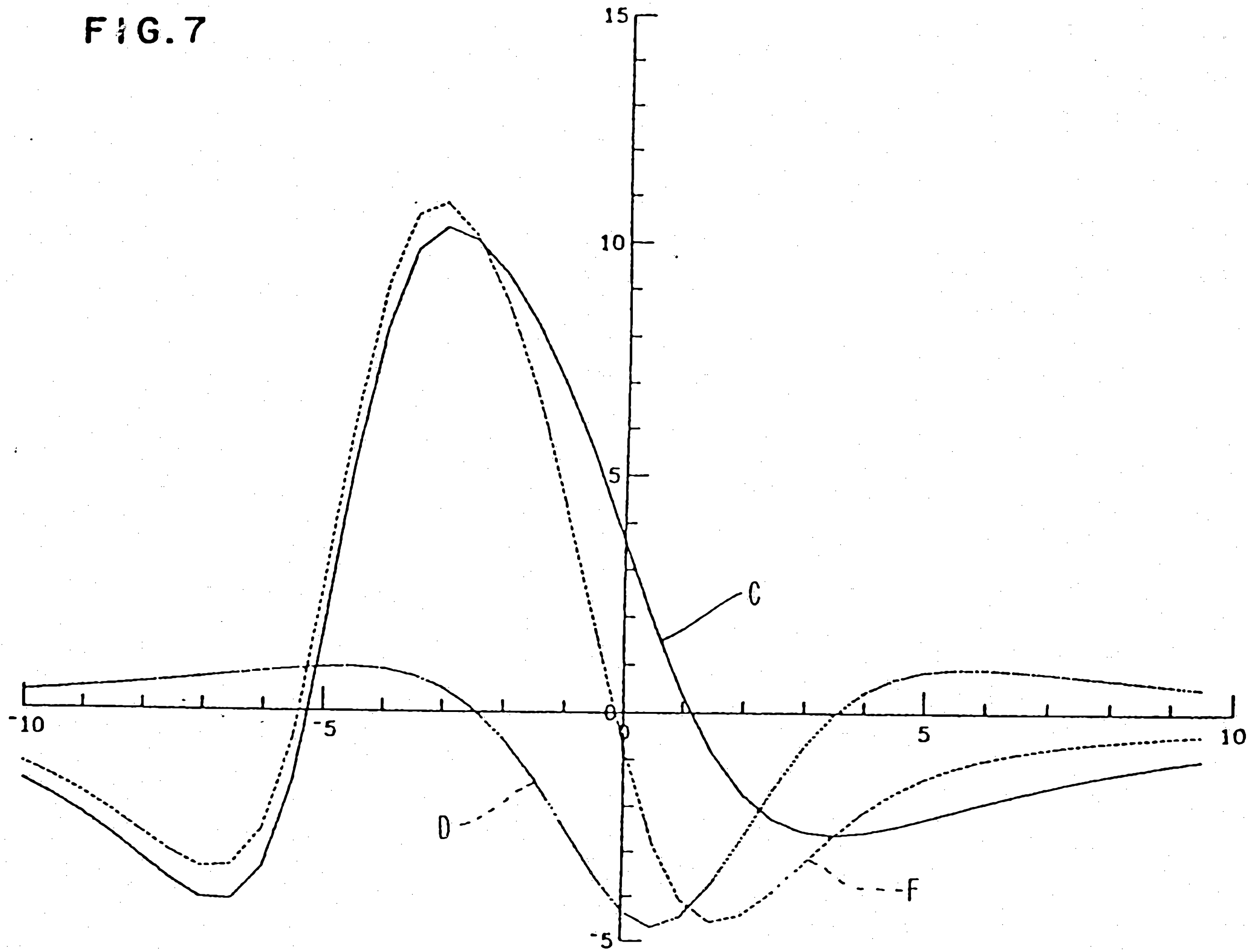

FIG.8

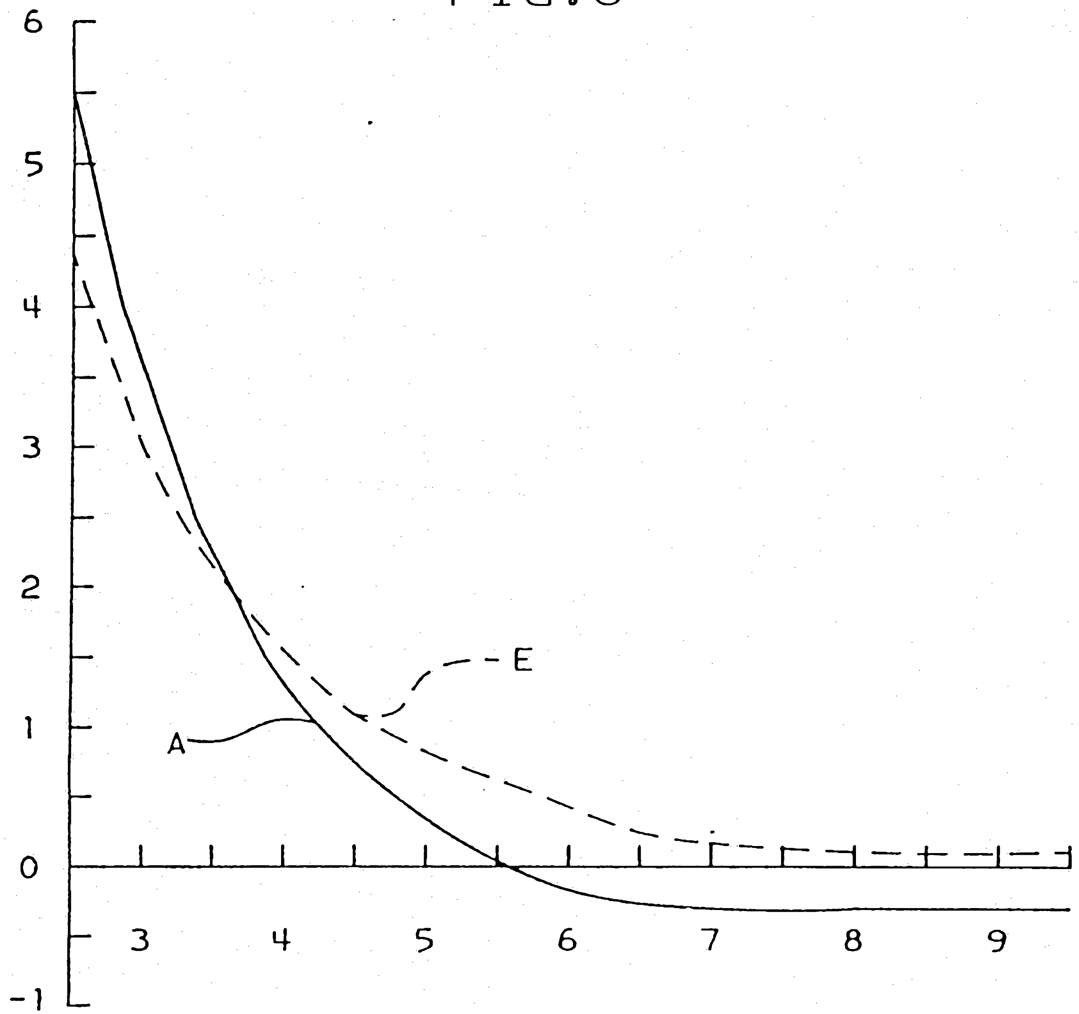

FIG. 9

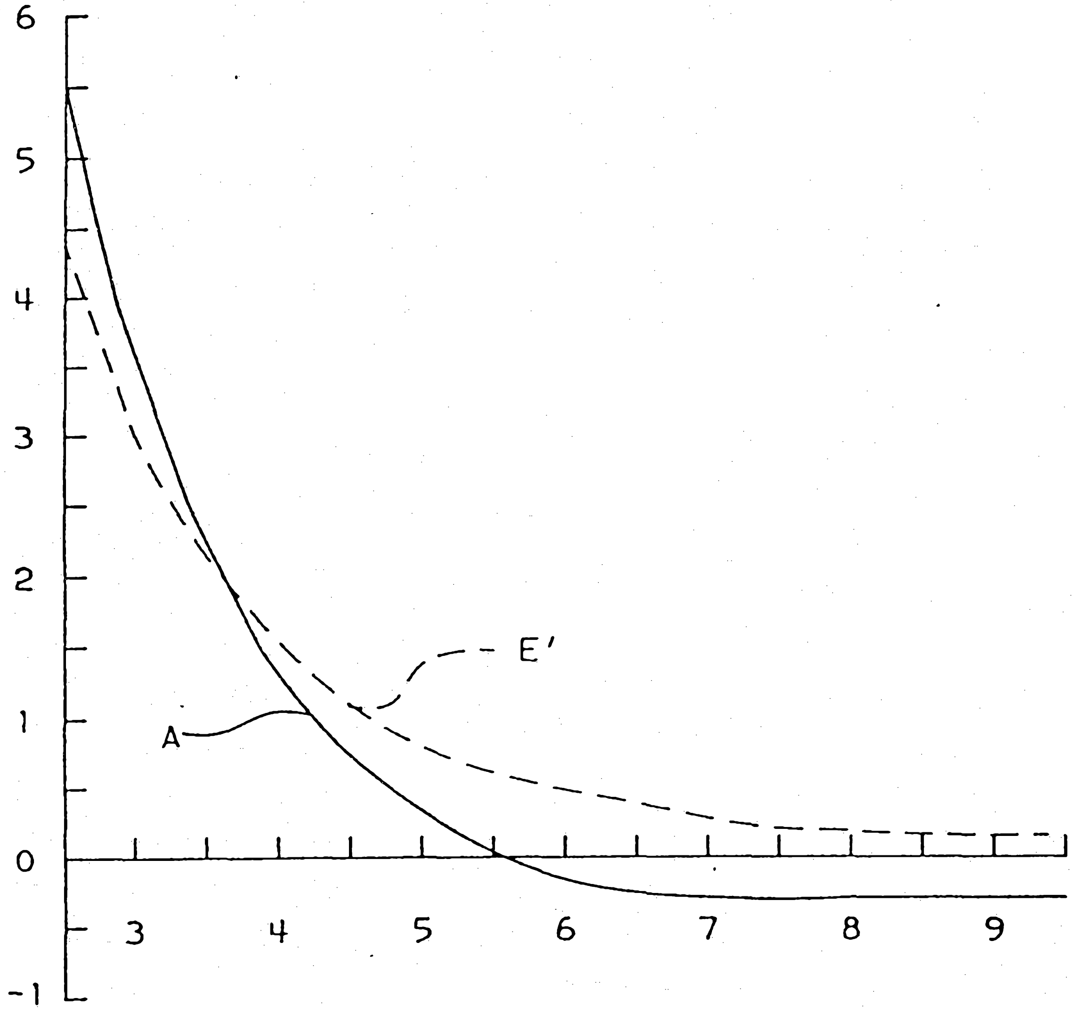

FIG. 10

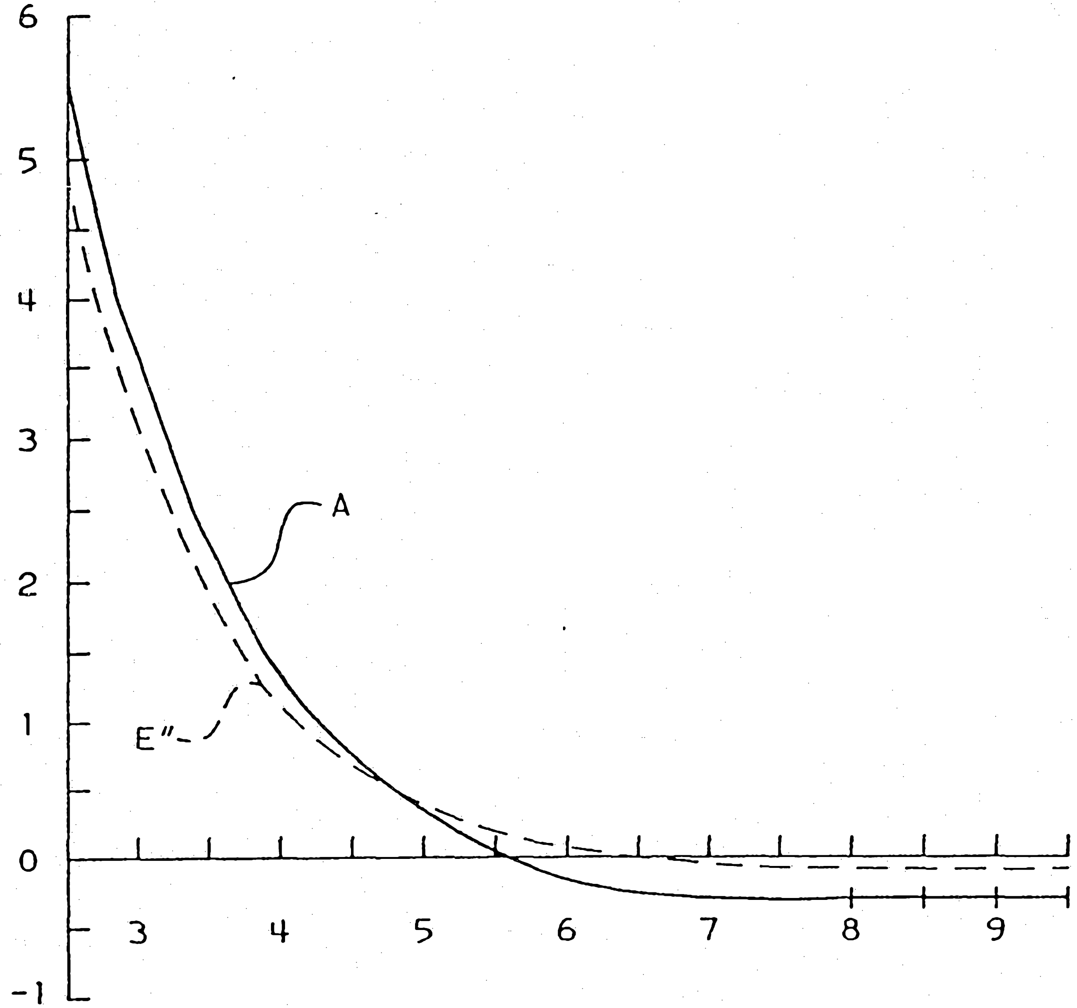

FIG. 11

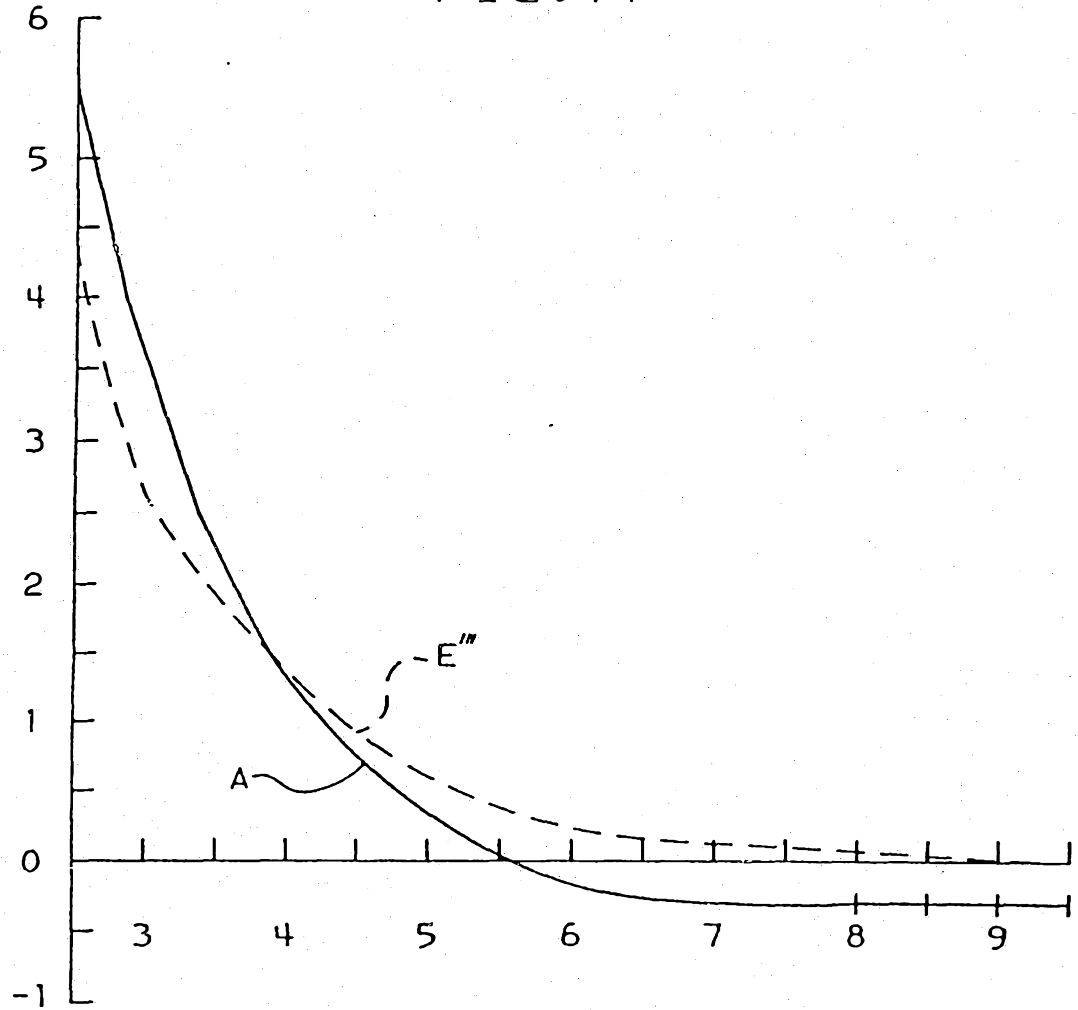

FIG. 12

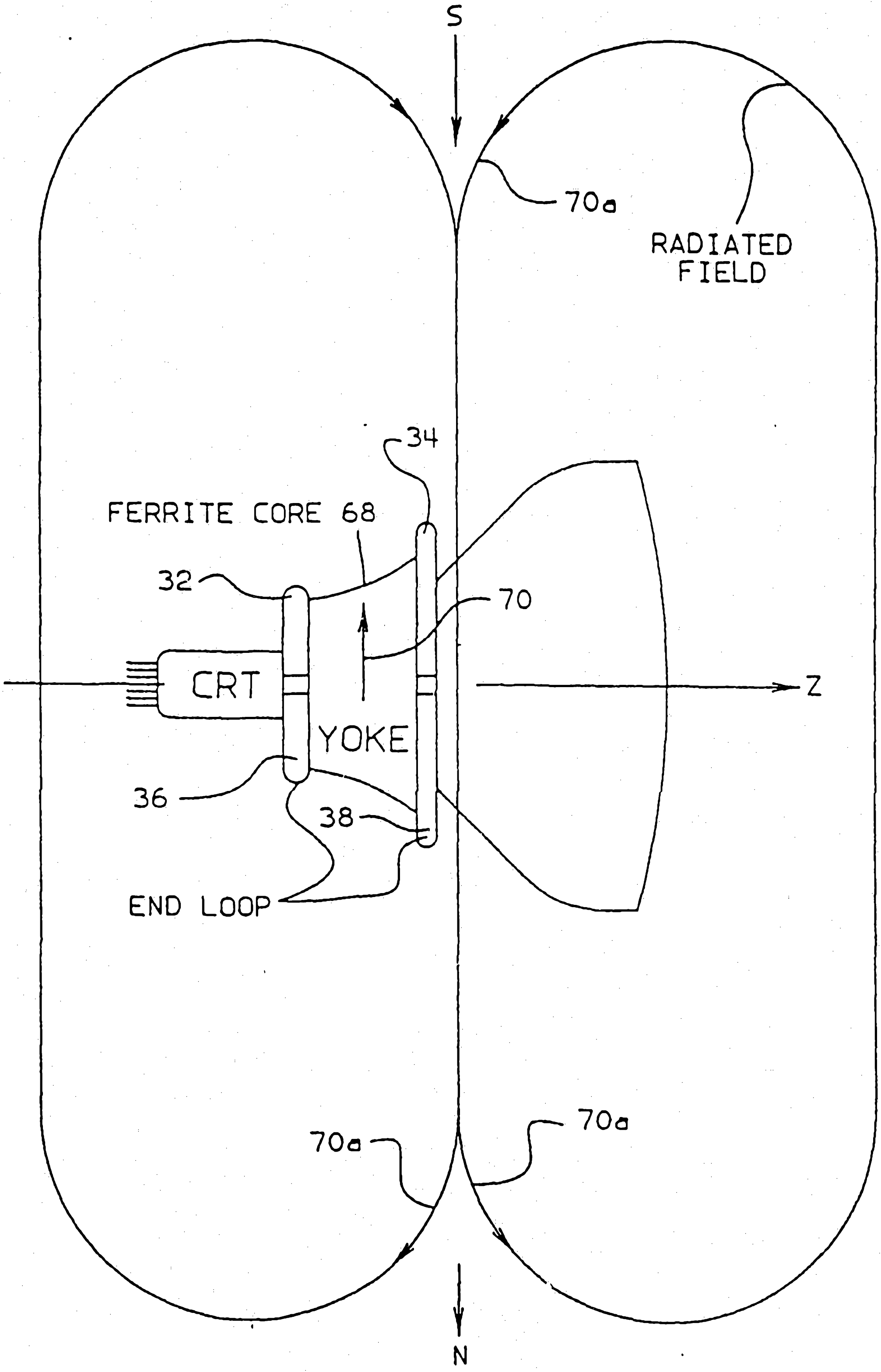
S
70a
RADIATED
FIELD
34
FERRITE CORE 68
32
70
CRT
Z
YOKE
36
38
END LOOP
70a
70a
N

FIG.13

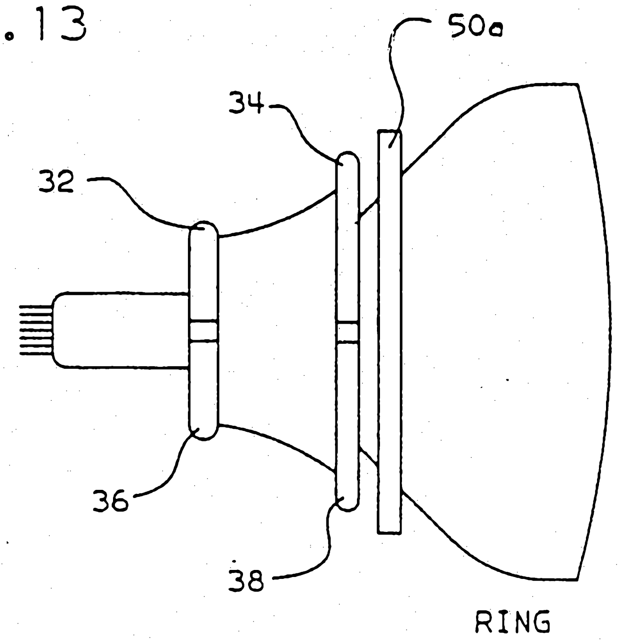

FIG.14

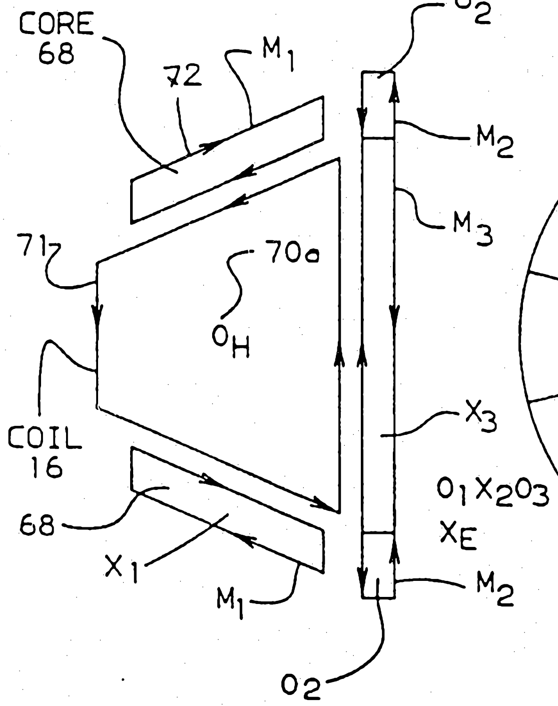

FIG.15

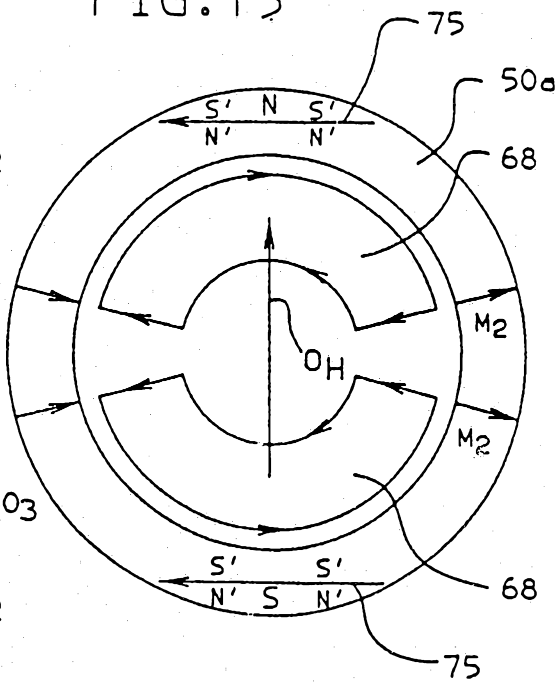

FIG.18

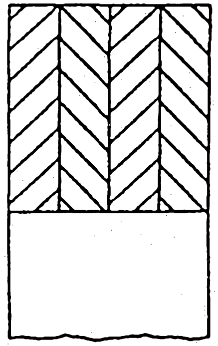

FIG.16

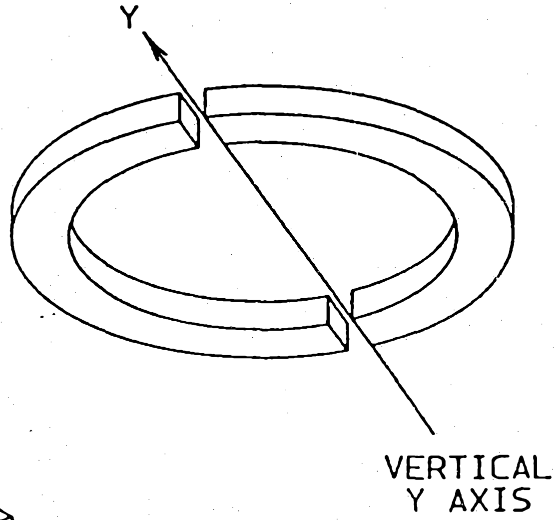

FIG.17

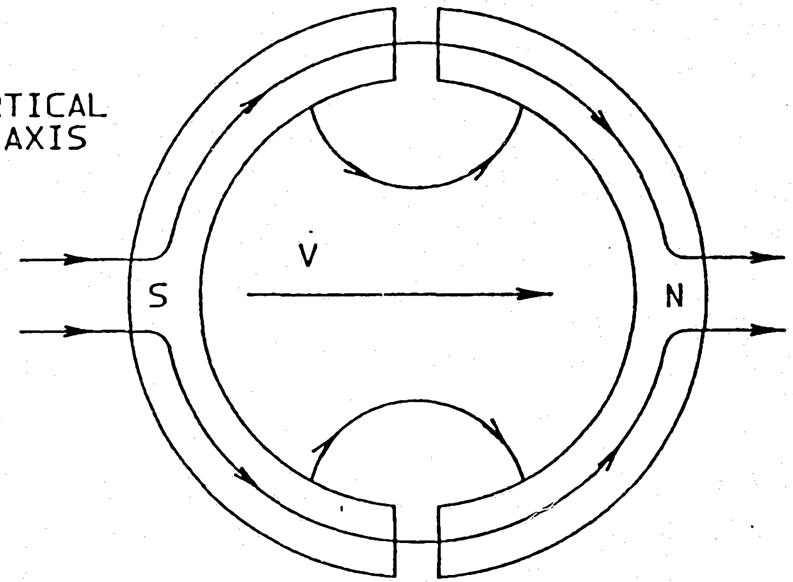

FIG.19

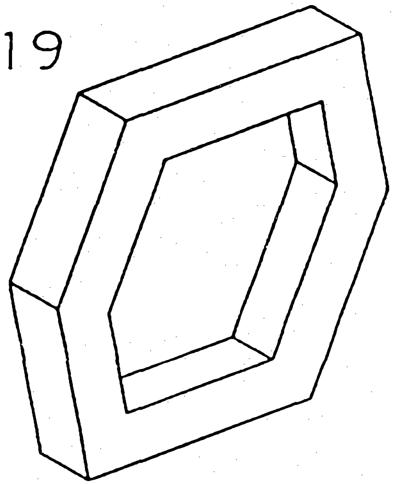

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FIG.20

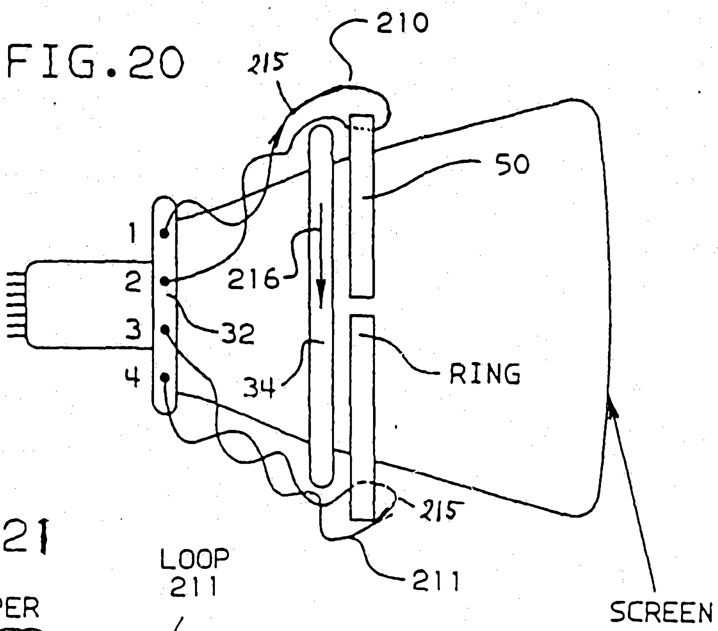

FIG.21

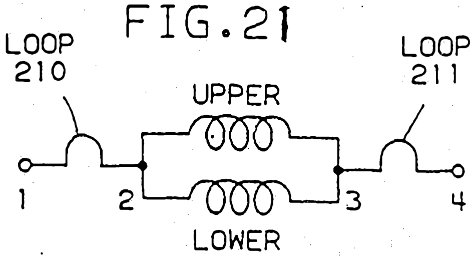

FIG.22

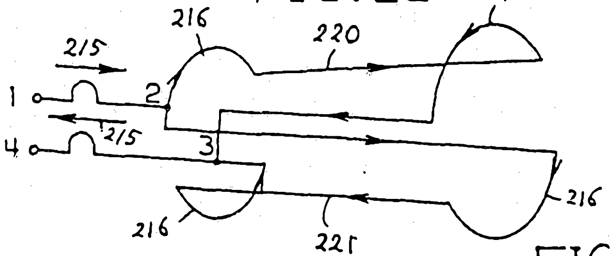

FIG.23

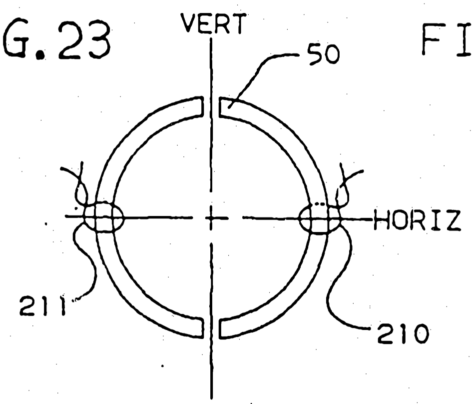

FIG.24

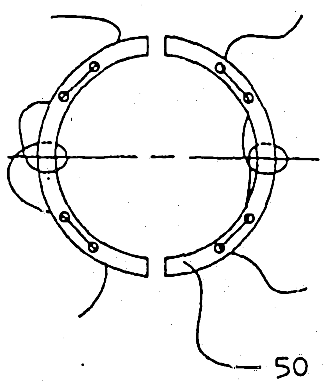

FIG.25