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(71) Applicant: **International Business Machines Corporation**
Old Orchard Road
Armonk, N.Y. 10504(US)

(72) Inventor: **Hevesi, Joseph Francis**
102 Pine Street, P.O. Box 83
West Hurley, New York 12491(US)

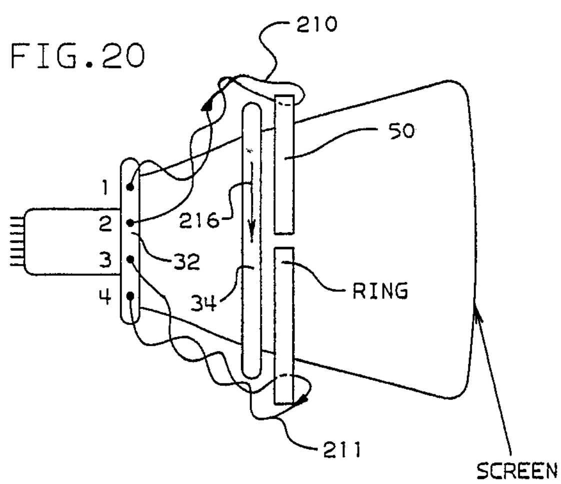
(74) Representative: **Atchley, Martin John Waldegrave**
IBM United Kingdom Limited Intellectual Property Department Hursley Park
Winchester Hampshire SO21 2JN(GB)

(54) Reducing magnetic radiation extending outside CRT display apparatus.

(57) Disclosure is given for a cathode ray tube display apparatus comprising a cathode ray tube including a viewing screen (14), means for producing a charged particle beam directed at the screen from the rear thereof and aligned with a central axis of the apparatus, deflection coils (16, 18) generating a first magnetic field which extends within the tube for deflecting the beam across the screen and a second magnetic field which extends outside the tube, and means for reducing the second magnetic field which extends outside the tube including a ring (50) of magnetically permeable material centred substantially on the central axis and positioned adjacent to the coil.

The apparatus is characterised by means for reducing the second magnetic field, comprises at least one pair of wire loops (210, 211) extending round and through the ring (50) and is electrically connected to the deflection coils (16, 18) so as to induce a magnetic field within the ring to counteract and reduce the second magnetic field which extends outside the tube but has negligible effect on the first magnetic field within the tube.

FIG.20



EP 0 446 501 A1

REDUCING MAGNETIC RADIATION EXTENDING OUTSIDE CRT DISPLAY APPARATUS

The present invention relates to CRT 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 electron beam deflection magnetic field within the device.

Cathode ray tube (CRT) display apparatus generally has associated coils, or yokes, to provide a varying magnetic field for electron beam deflection, for example for a 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 apparatus. This external magnetic field serves no useful purpose and an effort is frequently made to reduce this unwanted 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. That paper shows that the radiated field of the horizontal magnetic circuit of the yoke at mid-range resembles a vertically oriented dipole, whose mathematical centre lies on the long axis slightly ahead of the yoke.

The use of Helmholtz coils to provide reduction of this radiation is proposed in this paper. In one case the Helmholtz coils are "on top" and "below" a saddle-shaped deflection yoke. In another case the Helmholtz coils are behind the yoke. The Helmholtz coils are coupled to the deflection coils and an EMF is induced in the Helmholtz coils, 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 apparatus that provides an inexpensive and compact solution to the problem.

EP-A- 302995 discloses the use of a magnetic shunt in the form of a ring of magnetic permeable material located between the deflection coil and the viewing screen of a CRT display apparatus in order to reduce unwanted magnetic radiation which extends outside the CRT.

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 deflection coil alignment can prevent sufficient coupling of the ring to the coil.

The object of the present invention is to provide an improved arrangement for reducing the unwanted magnetic radiation which extends outside a CRT display apparatus.

The present invention relates to a cathode ray tube display apparatus comprising a cathode ray tube including a viewing screen, means for producing a charged particle beam directed at the screen from the rear thereof and aligned with a central axis of the apparatus, deflection coils generating a first magnetic field which extends within the tube for deflecting the beam across the screen and a second magnetic field which extends outside the tube, and means for reducing the second magnetic field which extends outside the tube including a ring of magnetically permeable material centred substantially on the central axis and positioned adjacent to the coil.

According to the invention the apparatus is characterised in that the means for reducing the second magnetic field comprises at least one pair of wire loops extending round and through the ring and electrically connected to the deflection coils so as to induce a magnetic field within the ring to counteract and reduce the second magnetic field which extends outside the tube but to have negligible effect on the first magnetic field within the tube.

In order that the invention may be more readily understood an embodiment will now be described with reference to the accompanying drawings in which:

Fig. 1 is a diagram showing pertinent portions of the deflection yoke of a CRT display apparatus,

Fig. 2 is a simplified diagram of one winding each from the upper and lower horizontal deflection coils of the deflection yoke 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 diagram showing a CRT yoke like that of Fig. 1, having added thereto a radiation reducing ring 50,

Fig. 5 is a diagram like that of Fig. 2, having added thereto a radiation reducing ring 50,

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 centimetres along the Z axis,

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

Fig. 12 is a diagram showing a CRT display apparatus with a deflection yoke having a ferrite core and the associated fields,

Fig. 13 illustrates the system of Fig. 12 with the radiation reducing ring 50,

Fig. 14 is a sketch of a plan view of the core and coil of the deflection yoke and the radiation reducing ring of Fig. 13 illustrating induced magnetization currents and magnetic fields,

Fig. 15 is a sketch of a front view of the arrangement in Fig. 14 illustrating induced magnetization currents and magnetic fields,

Fig. 16 shows a preferred embodiment of the radiation reducing ring for colour tubes in which the ring is split providing two portions,

Fig. 17 is a sketch of the split ring illustrated in Fig. 16 showing 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 the radiation reducing ring, made with conventional μ metal laminates,

Fig. 19 shows a further embodiment of the ring, having a hexagonal shape,

Fig. 20 is a top view of a CRT, with deflection coils, radiation ring and additional wire loops,

Fig. 21 is an electrical schematic diagram of the arrangement illustrated in Fig. 20,

Fig. 22 is a diagram of one winding of each of the upper and lower horizontal deflection coils of the arrangement illustrated in Fig. 20 with the wire loops connected thereto,

Fig. 23 is an end view of the ring in Fig. 20 illustrating the pair of loops.

Fig. 24 is a sketch of a further arrangement of the ring with quadrature placed pairs of holes through the ring through which the wire loops are passed, and

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

Fig. 1 shows the pertinent portions of the deflection yoke of a CRT display apparatus 10 which includes a 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 an 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 are axes having their common origin in the plane of circumferential coil portions 34, 38 of loops 20, 22 and centrally located between them. The X axis coincides with the central axis of CRT 12 (Fig. 1). Note that the upper and lower loops 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 B field is given by:

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

where $\bar{J}$ is the current, $\bar{R}$ is the direction and R is the distance to a point of interest P on the Z axis. This equation is used in computing the field distribution of Figs. 3 and 6 to 11.

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 a magnetic field along the Z axis. The units depicted in the horizontal axis are centimetres, 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 along the Z axis of the vector sum of the fields represented by curves B and C. In typical uncompensated yokes, at a distance of 55 centimetres in front of the yoke the field can be in the range of approximately 1,000 - 2,000 nanoTesla. Clearly, this is not a very large magnetic field. However, in accordance with the arrangements described herein this field can be reduced to an even smaller quantity. In actual experiments using the arrangements described below, reduction to below 200 nano-tesla at 55 centimetres was measured.

Fig. 4 shows the apparatus 10 of Fig. 1 having added thereto a ring 50 of linear ferrite operating as a magnetic shunt, in accordance with the arrangement described in EP-A- 302995.

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

Ring 50, as mentioned above, is made from linear ferrite. Linear ferrite is a well known material commonly used in transformer and yoke production. According to a 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 centimetre. The high resistivity value keeps eddy currents induced in the ring 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, it was deemed desirable to keep the eddy currents low, and avoid this loading effect in the arrangement described. 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 along the Z axis on the net field A shown in Fig. 3 of a flat ring, such as ring 50 in Fig. 4. 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 scale is the same in Figs. 3 and 7 while the vertical axis scale has been expanded, to aid in clarity.

As mentioned above, curve D is the theoretical field produced by the ring 50 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 in 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 in 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 described in EP-A-302995, this field can be reduced to very small levels.

The portion of Fig. 6 beyond approximately 2.5 centimetres to the right thereof along the Z axis is shown in Fig. 8. In order to see clearly the curve behaviour in that region, the scale is expanded in the vertical direction as compared with Fig. 6. Curves A and E are described in connection with 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 centimetres along the Z axis.

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 centimetres, a thickness of 0.2 centimetres, and a width of 1 centimetre, placed at a distance of 0.4 centimetres from the end of the yoke. As illustrated herein, the term "width" of the ring refers to its radial extent from inner surface to outer surface.

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 50 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 0.3 centimetres. It will be appreciated that this reveals over-compensation, as the curve E' is slightly above the horizontal axis, for example at 9.5 centimetres, and slightly above curve E in Fig. 8.

The curves of Fig. 10 are for a configuration in which the dimensions of the ring 50 are the same as those corresponding to Fig. 8, but wherein the inner surface radius is 5 centimetres, instead of 4 centimetres. 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 of ring 50 are as in Fig. 8, but wherein the distance of the ring from the end of the yoke is 0.6 centimetres, instead of 0.4 centimetres. It can be seen that slightly less compensation is provided, causing curve E''' to cross the horizontal axis at 9.5 centimetres along the Z axis. This was deemed to represent optimum compensation.

While curves are not provided showing the effect of change of width of the ring 50 on the compensation or field reducing effect, in general decreasing the width will tend to reduce the compensating effect, while increasing the width will tend to increase the compensating effect.

Thus, from the above Figs. 8 - 11 it will be appreciated how changing the various dimensional parameters of the ring 50 affects the performance of the ring in compensating by reducing the magnetic field components on the X axis in front of the screen due to the yoke winding and components. Through an understanding of these effects, a skilled person practising implementing the principles described herein can provide the adjustments deemed desirable to optimize the compensation or reduction affect.

In the above described arrangement the CRT tube 10 has air core horizontal deflection coils without any high permeability shielding about the neck of the tube. The direction of the horizontal deflection field to move the electron 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 are also vertical deflection coils (not shown) positioned about the horizontal deflection coils and under the ferrite core. The magnetic field produced by the horizontal coils with the end loops 32, 34, 36 and 38 extending beyond the ferrite core includes a radiated field which is in the form of a dipole centred forward of the deflection coil loop nearest the screen as shown by arrows 70a in Fig. 12 and this radiated field extends outside the CRT display apparatus. Note the ferrite core 68 reverses the polarity of the radiated field.

In order to reduce the radiated field which is unwanted, a ferrite ring 50 as shown and illustrated in Fig. 13 is mounted forward of the horizontal deflection coils near the centre of the radiated field produced by the horizontal coils. The manner in which this ring compensates for or reduces the radiated field without measurably affecting the deflection field is illustrated in connection with Figs. 14 and 15.

Fig. 14 is a sketch of a plan view of the deflection coil 16, ferrite core 68 and ferrite ring 50 illustrating the deflection current in the deflection coil, the magnetization currents induced in the ferrite components and the resulting magnetic fields. Fig. 15 is a front view of the arrangement illustrated in Fig. 14.

The counterclockwise current in the horizontal deflection coil 16 seen in the plan view is represented by 71. The magnetic field produced by this current is represented by O_H and is directed up out of the Figure towards the viewer. This corresponds to the arrow 70 in Fig. 12. The ferrite core 68 is magnetically coupled to the deflection coil 16 and there is induced in the core 68 an even stronger equivalent magnetization current M_1 represented by the heavy lines 72. The induced current 72 circulates in the opposite direction (clockwise in Fig. 14) with the currents along the adjacent surfaces of the coil and the core flowing in the same direction. The result is a first magnetic field X_1 - (with a direction into the Figure as viewed) in the centre of the core. The field X_1 combines with field O_H and produces a net radiated field O_1 equivalent to the radiated field 70a of Fig. 12 which is the vector sum of O_H and X_1 in front of the ring 50. The radiated field O_1 is a dipole field and is the major component of the unwanted magnetic radiation extending outside the CRT display apparatus. The exposed end turns of the deflection coils 16, 18 are also radiating a minor quadrapole magnetic field which is designated an X_E. Symbols "X" and "O" which are consistent with the sign convention established earlier where X means the field is pointing down into the Figure, and O means the field is pointing up towards the viewer. The sum of X_1 and X_E is the total radiated magnetic field without considering the effect of the ring 50.

When a ferrite ring 50 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 68 induce equivalent magnetization currents M_2 in the ring 50 in the counter clockwise direction. The resulting field is pointing up within the ring (O_2) and pointing down outside the ring (X_2) as illustrated in Fig. 14. 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 deflection coils 16, 18 (top, bottom) induce equivalent magnetization currents M_3 in the ring 50 in a clockwise direction. The resulting field is pointing down within the ring X_3 and pointing up outside of the ring O_3 as illustrated in Fig. 14. 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 it can be concluded that the induced field X_1 in the yoke shield 68 sets up a dipole magnetization O_2 in the ring 50 which opposes the radiated dipole field O_1. Similarly, the quadrapole component X_E of the radiated field due to the exposed end-turns of the horizontal deflection coils 16, 18 induces a quadrapole magnetization in the ring 50 which cancels the radiated quadrapole field.

Variables such as the thickness, inside diameter, outside diameter and permeability of the ring 50 and yoke-ring separation can be selected so as to tune for optimum performance (reduction of the unwanted radiated field). Naturally, the lower limits of the ring dimensions are dictated by the given CRT and yoke combination. In practice, the tendency is to bring the ring 50 as close to the front of the yoke as possible without adversely effecting the deflection field within the tube. This reduces the ring dimensions and ensures minimum cost. The ring has a 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 50 and the main horizontal deflection field, it was found that the presence of the solid ring moves the centre of deflection of the vertical deflection field slightly back toward the electron gun. This is not noticeable in a monochrome system. However, it causes about 10^{-6} metre mis-registration in a colour system and that is detectable. This problem is avoided by using a split ring configuration, see Fig. 16. Here, part of the radiated dipole field which is normally conducted by the ring is forced to enter the bore as shown in Fig. 17 and to join and strengthen the vertical deflection field, thereby causing the centre of vertical deflection to move forward. In practice, it was found that a 2mm air-gap can compensate for the 10^{-6} metre mis-registration.

In an actual prototype experiment, in conjunction with a CRT display apparatus manufactured by Matsushita Company having a serial number of M34JDJ00X1, a ferrite ring 50 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, with ring dimensions of: an inner dimension of 4-3/8 inches (11 cms), a width of 3/8 inches (1 cm), and a thickness of 1/8 inch (0.3 cm). This ring was found to produce excellent radiated field cancellation effects when it was placed against the circumferential wire portions (end closest to the screen) of the yoke provided with this CRT display apparatus with spacing resulting only from the insulation of the yoke wires.

Embodiments of the ring 50 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 above, the compensation effect of the ring 50 is dependent on its width and other dimensions and on its material. These factors and the spacing of the ring 50 from the end turns of the deflection coils can be overcome by coupling a pair of wire loops 210, 211 about the ring 50 as shown in Figs. 20 - 22. Fig. 20 is a top view of the deflection yoke, the tube and the ring. Fig. 21 is an electrical diagram showing the terminals. Terminal 1 is coupled to one end of the driver for the deflection coils and terminal 4 is the return to the driver. "Upper" refers to the upper yoke coil and "Lower" refers to the lower yoke coil. Fig. 22 illustrates an upper yoke coil 220 and a lower yoke coil 221.

The first loop 210 begins at terminal 1 on the rear bundle terminal, passes clockwise round and through the ring 50 and terminates at terminal 2. The upper and lower yoke coils are connected in parallel at one end to terminal 2 and at the other end to terminal 3. The second loop 211 extends from terminal 3 and passes clockwise round and through the ring 50 on the opposite side of the ring from loop 210 (diametrically opposite positions in the horizontal plane) and terminates at terminal 4. In this manner the loops 210, 211 are in series with each other and in series with the parallel yoke coils. An end view of the ring 50 as seen from the screen with the loops 210, 211 is illustrated in Fig. 23. Note the directions of arrows 215 and 216 match in Figs. 20 and 22.

In accordance with another arrangement, compensation for the quadrapole radiated field can be by the loops 210, 211 passing round and through the ring 50 and also through quadrature placed holes 218 in the ring 50 as shown in Figs. 24 and 25 before returning to the terminals 1, 2, 3, 4 illustrated in Fig. 20.

It is recognized that the ring 50 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.

Claims

1. A cathode ray tube display apparatus comprising a cathode ray tube including a viewing screen (14), means for producing a charged particle beam directed at the screen from the rear thereof and aligned with a central axis of said apparatus,
deflection coils (16, 18) generating a first magnetic field which extends within said tube for deflecting said beam across said screen and a second magnetic field which extends outside said tube, and
means for reducing said second magnetic field which extends outside said tube including a ring (50) of magnetically permeable material centred substantially on said central axis and positioned adjacent to said coil,
characterised in that said means for reducing said second magnetic field comprises
at least one pair of wire loops (210, 211) extending

round and through said ring and electrically connected to said deflection coils (16, 18) so as to induce a magnetic field within said ring to counteract and reduce said second magnetic field which extends outside said tube but to have negligible effect on said first magnetic field within said tube.

2. Apparatus as claimed in Claim 1 characterised in that said wire loops are connected in series with said deflection coils.

3. Apparatus as claimed in either of the preceding claims characterised in that said wire loops pass round and through said ring at diametrically opposite positions on said ring.

4. Apparatus as claimed in any one of the preceding claims characterised in that said ring is formed with holes (218) through which said wire loops pass.

5. Apparatus as claimed in Claim 4 characterised in that there are four pairs of holes (218) spaced equally around said ring.

6. Apparatus as claimed in any one of the preceding claims characterised in that said ring is formed with gaps so that it is not continuous.

7. Apparatus as claimed in any one of the preceding claims characterised in that said ring is positioned between said deflection coils (16, 18) and said viewing screen (14).

FIG. 1

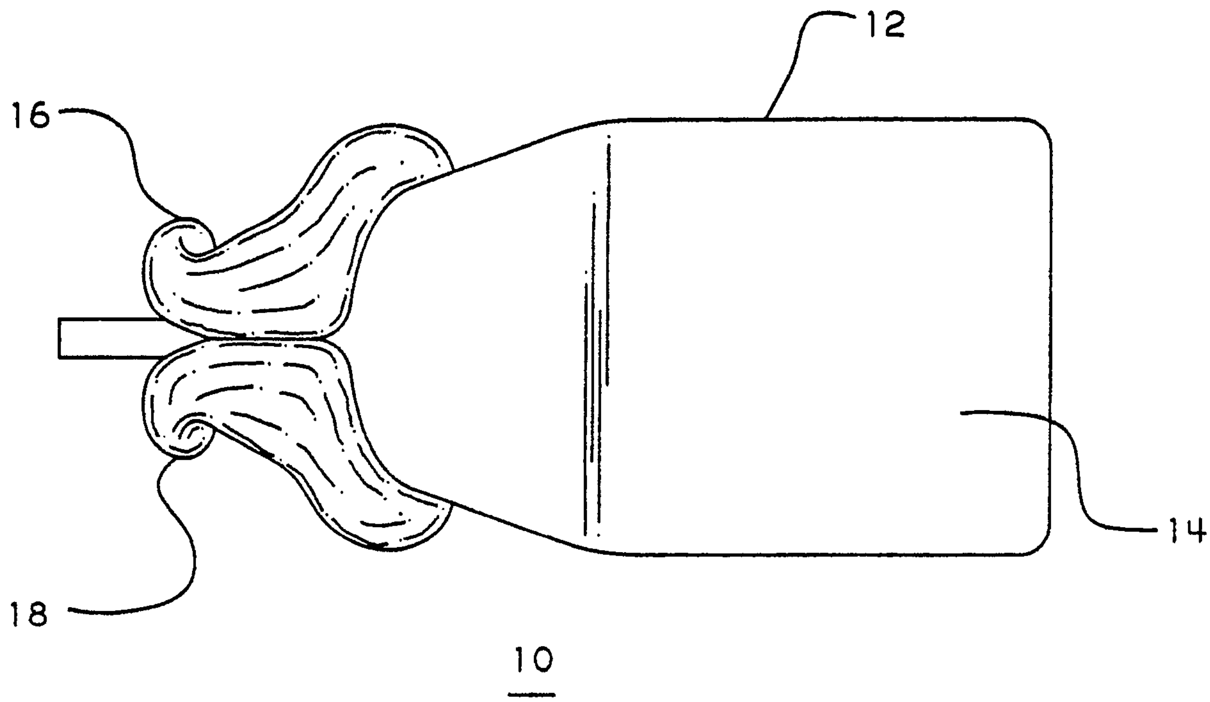


FIG. 4

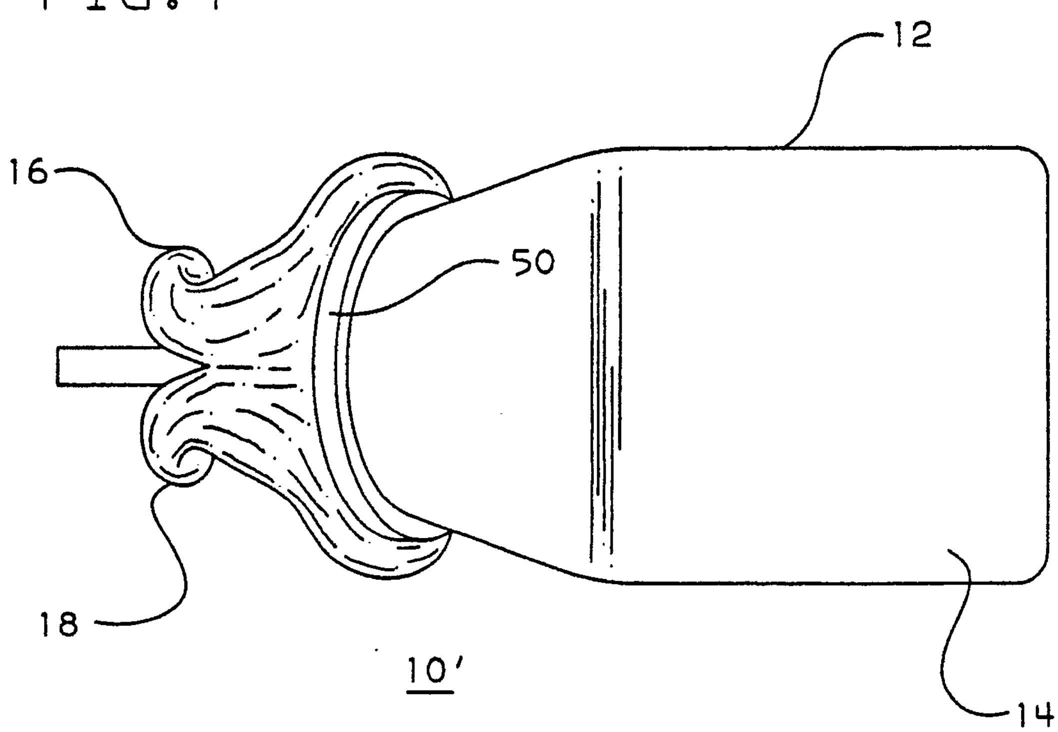


FIG.2

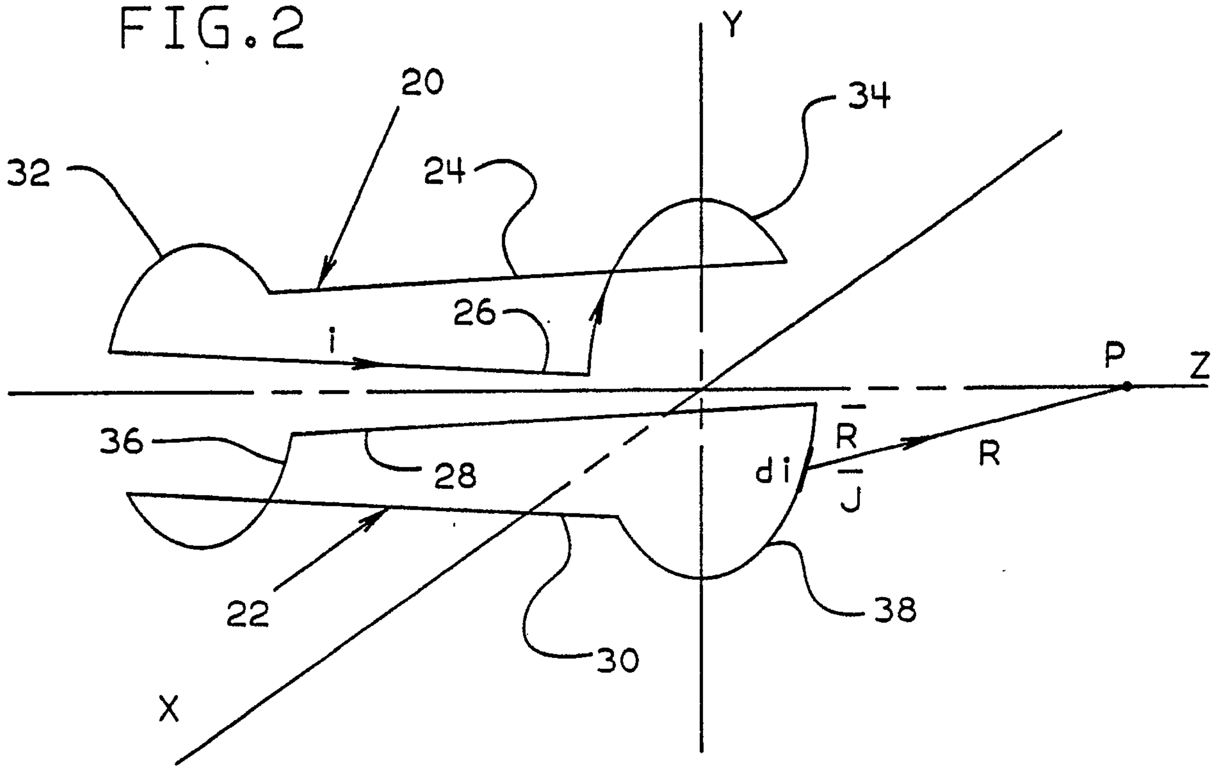


FIG.5

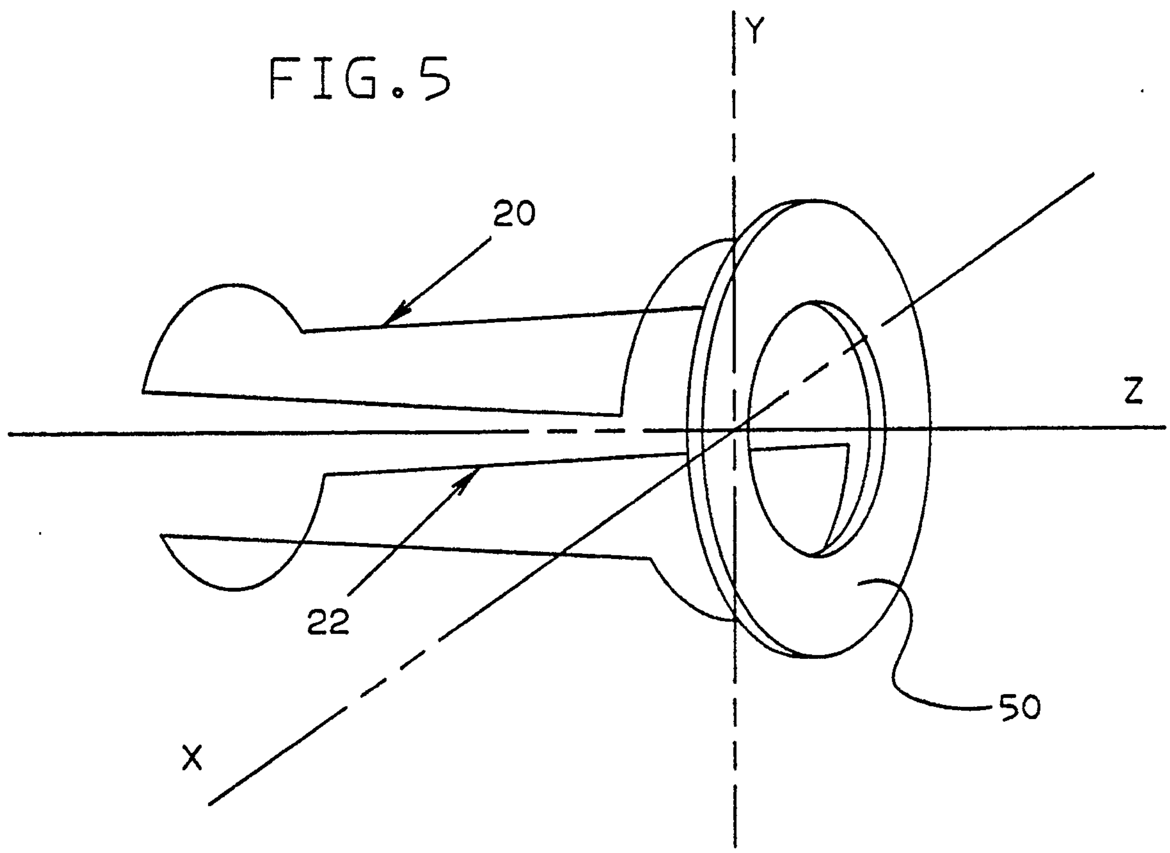


FIG. 3

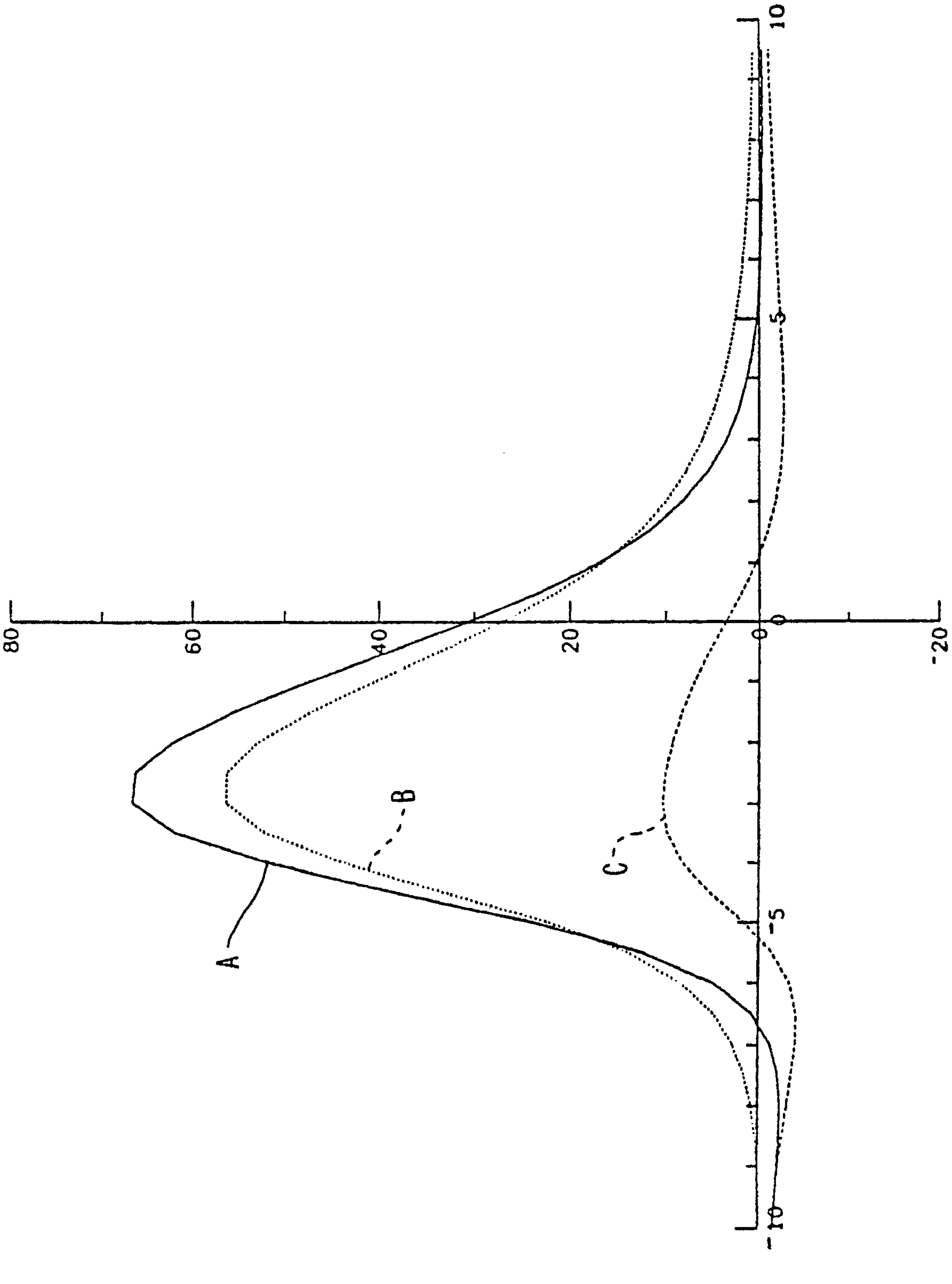


FIG.6

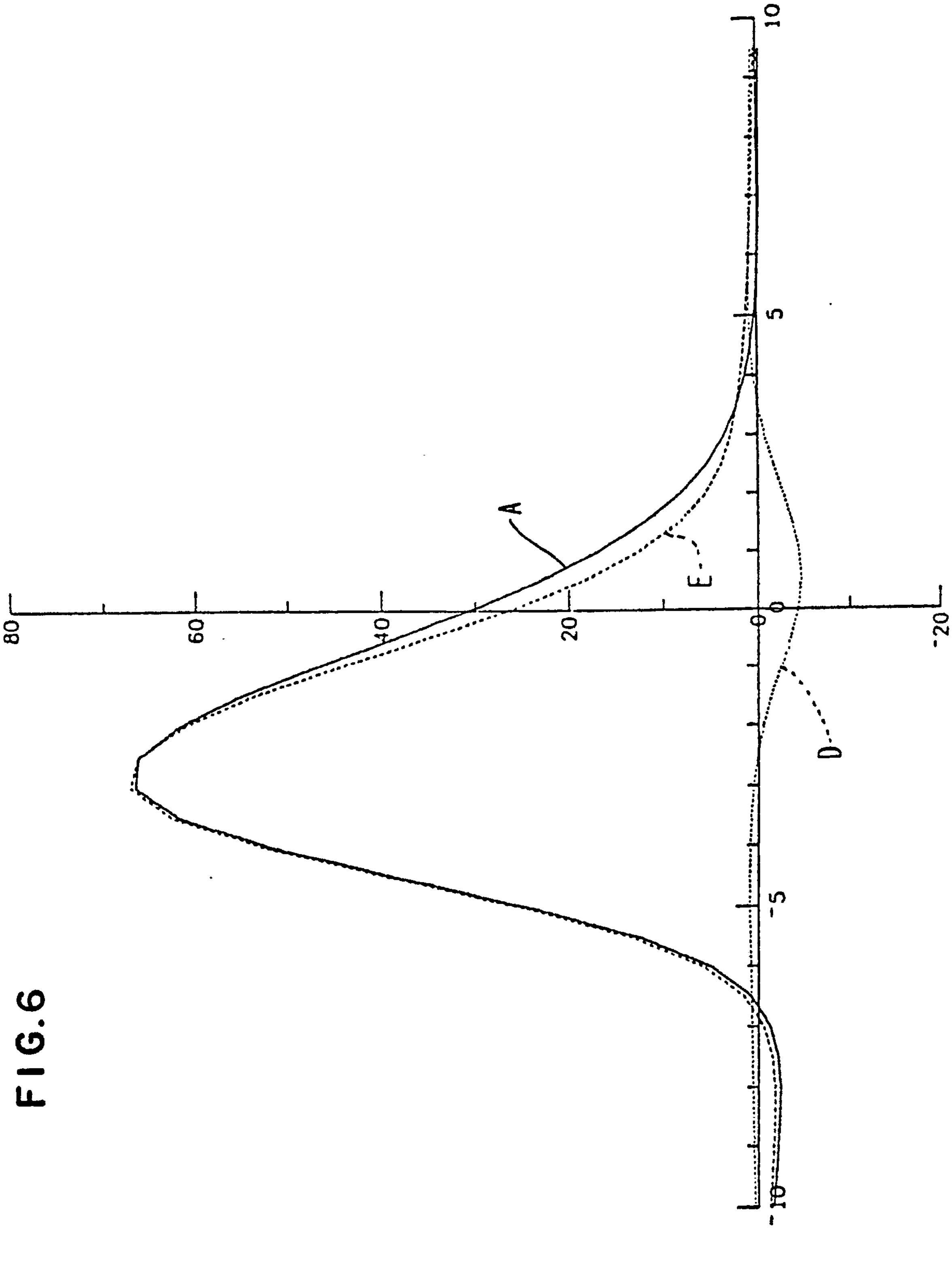


FIG. 7

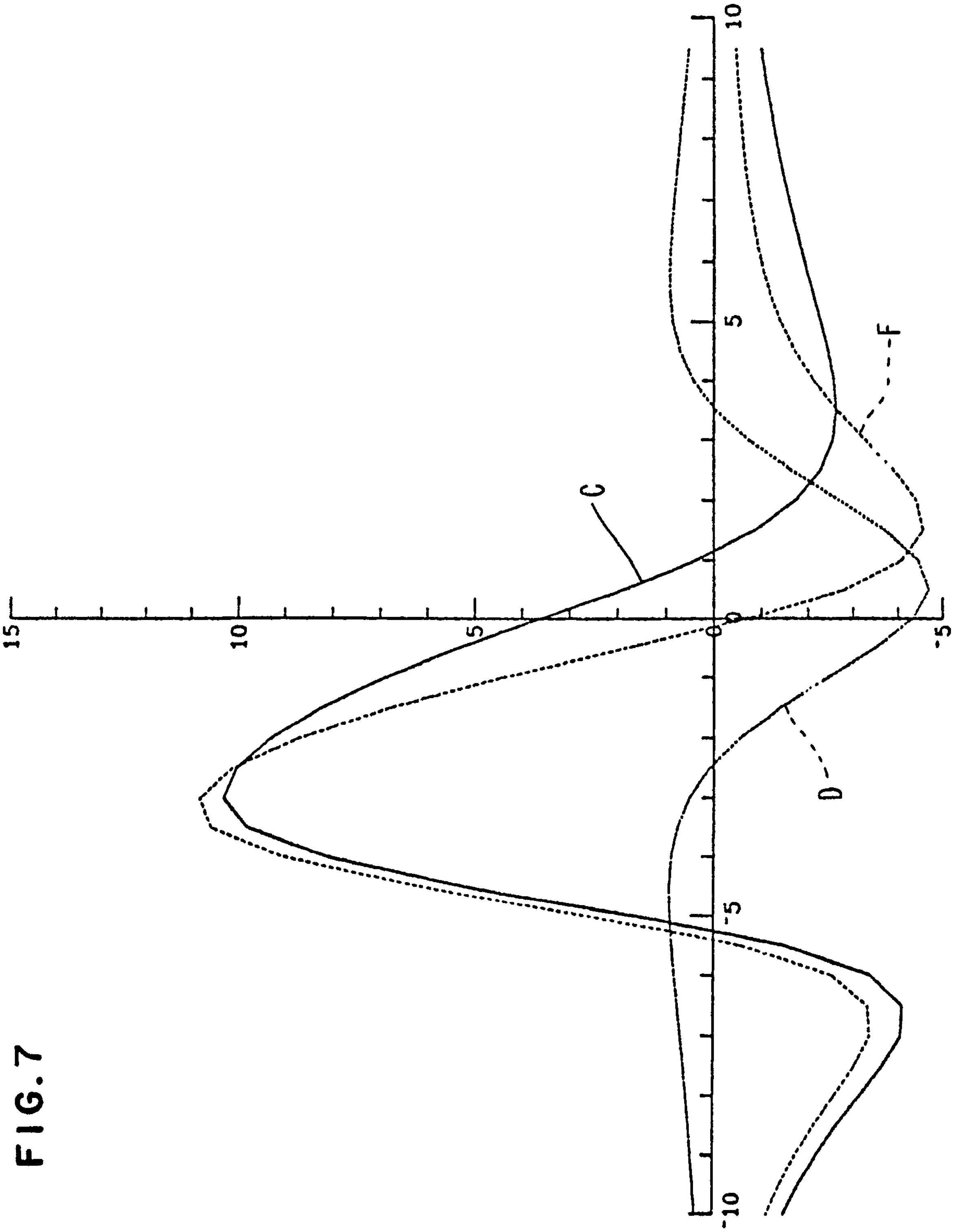


FIG.8

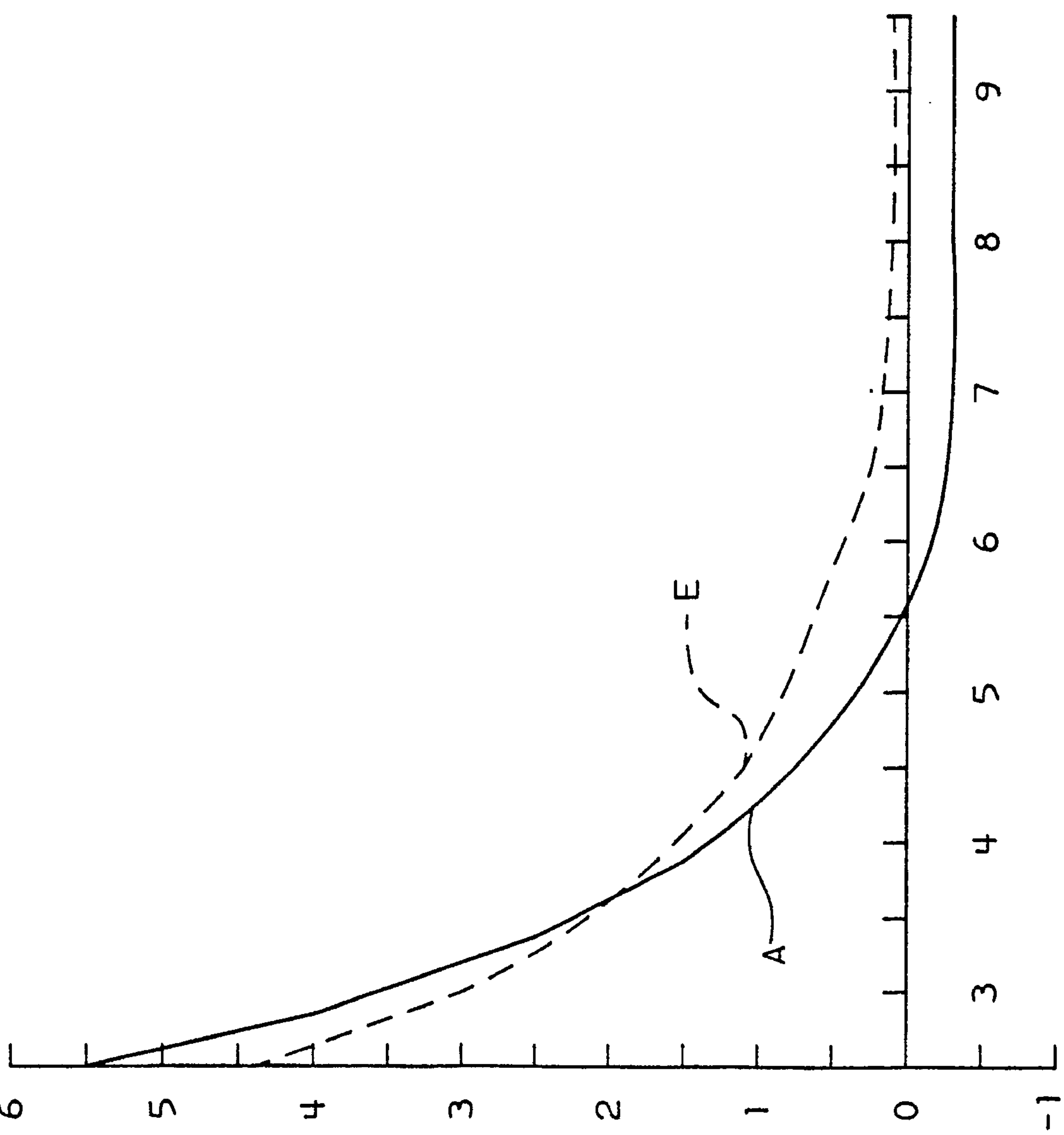


FIG. 9

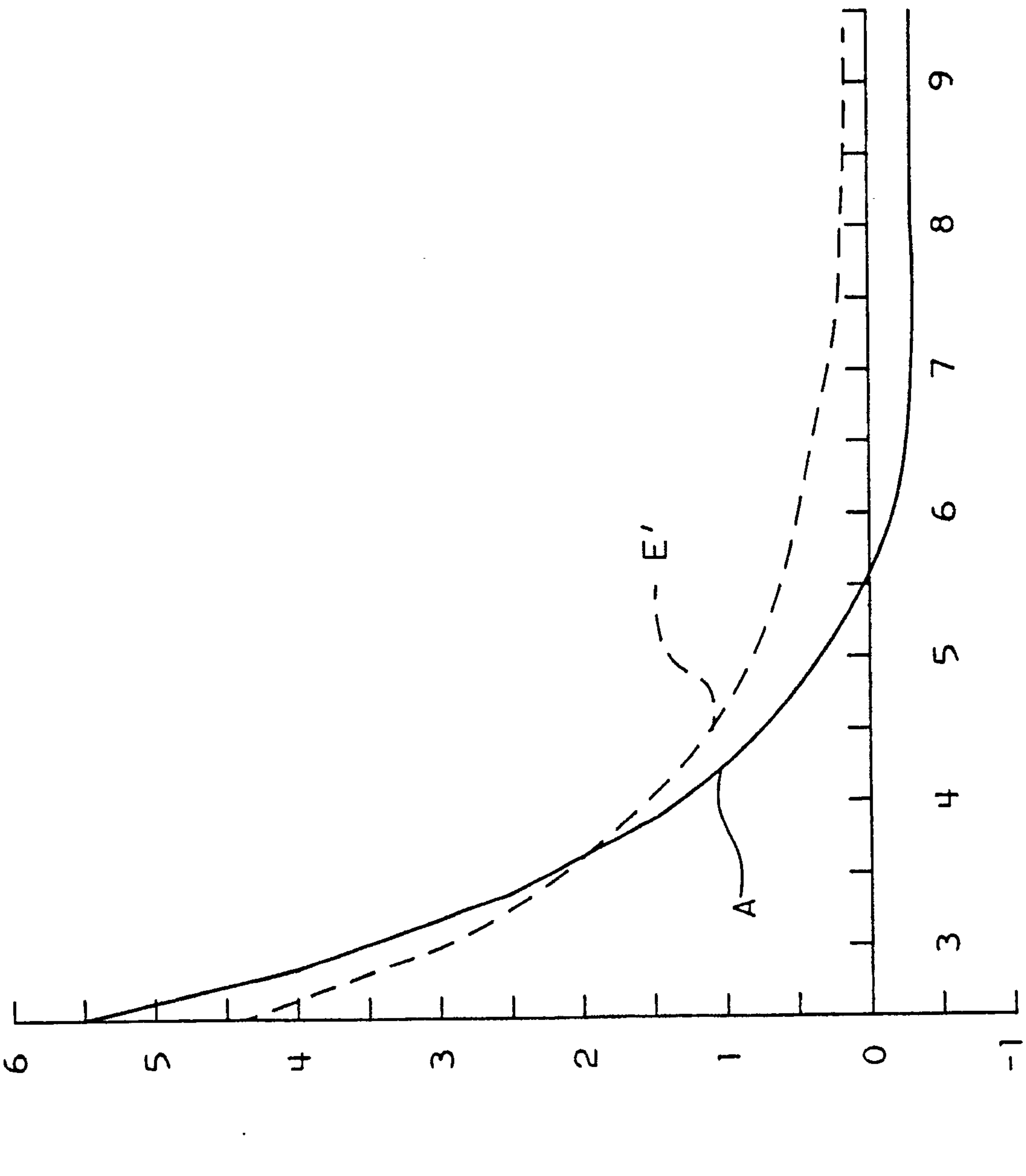


FIG.10

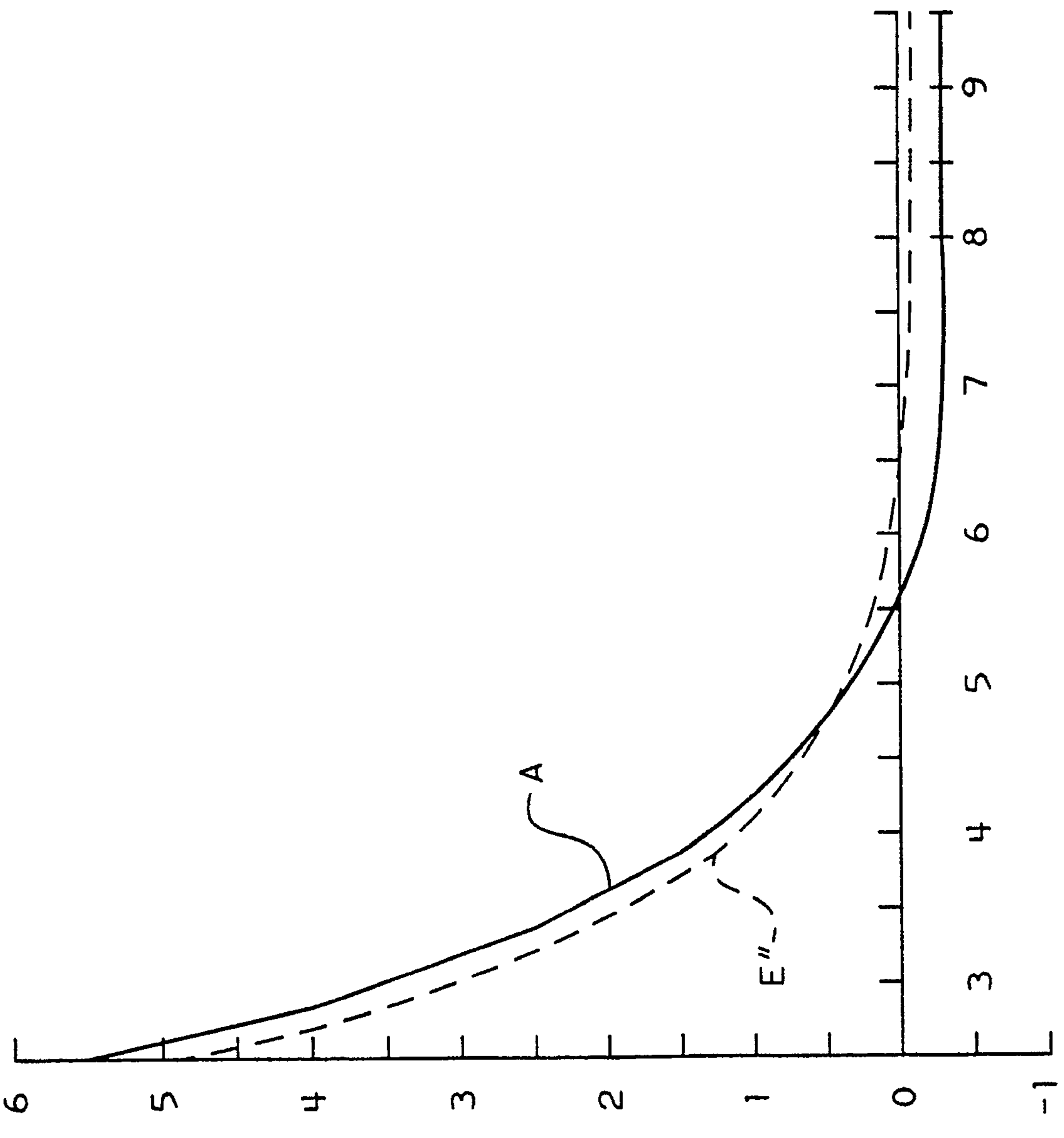


FIG. 11

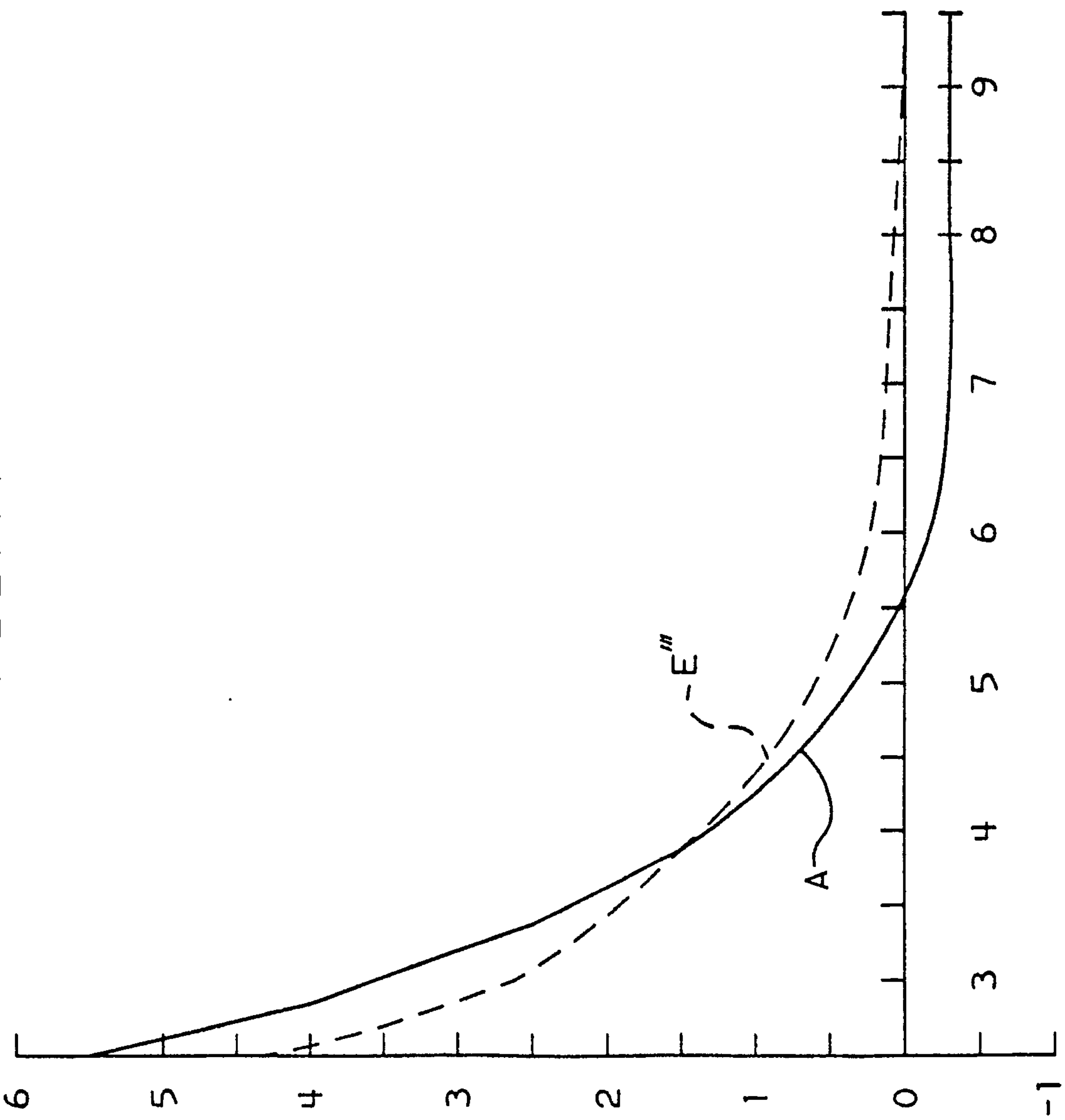


FIG.12

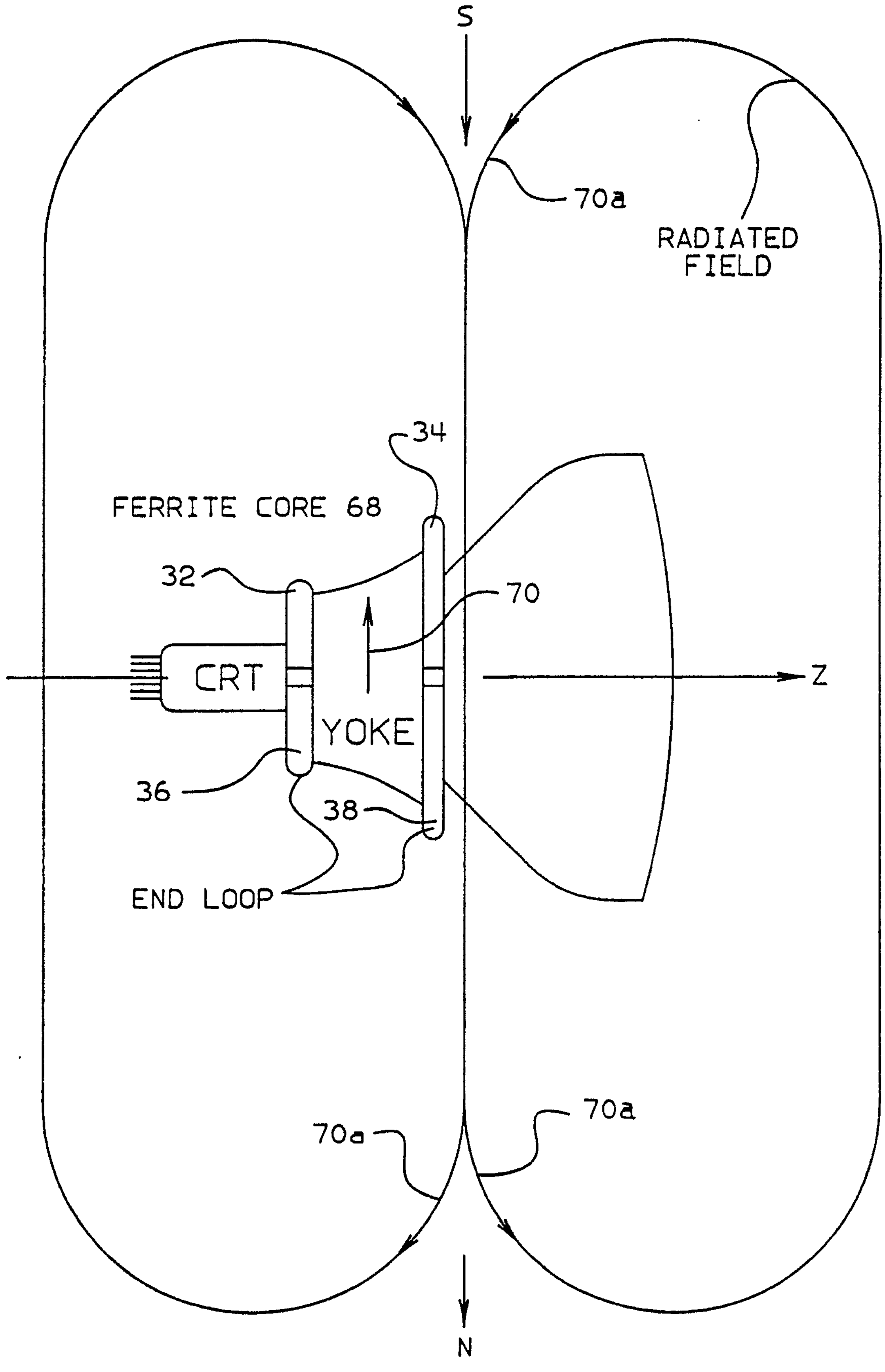

S
70a
RADIATED
FIELD
34
FERRITE CORE 68
32
70
CRT
Z
YOKE
36
38
END LOOP
70a
70a
N

FIG. 13

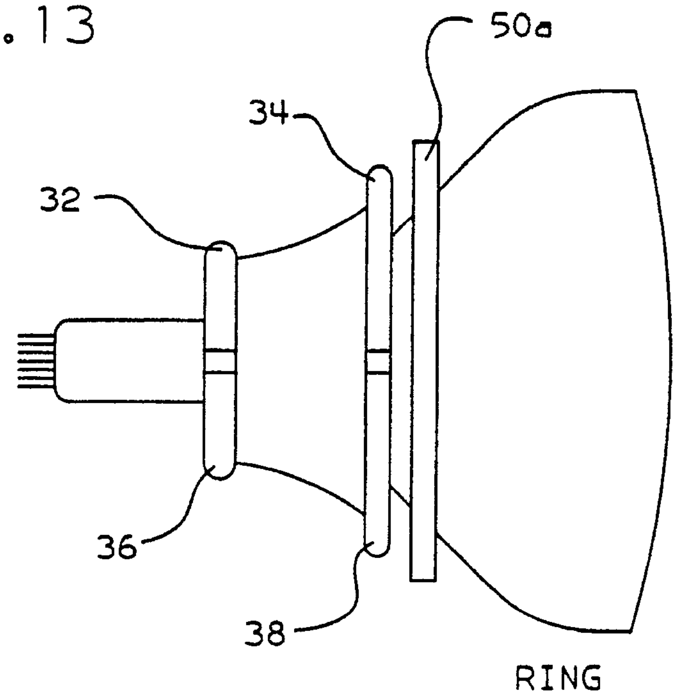


FIG. 14

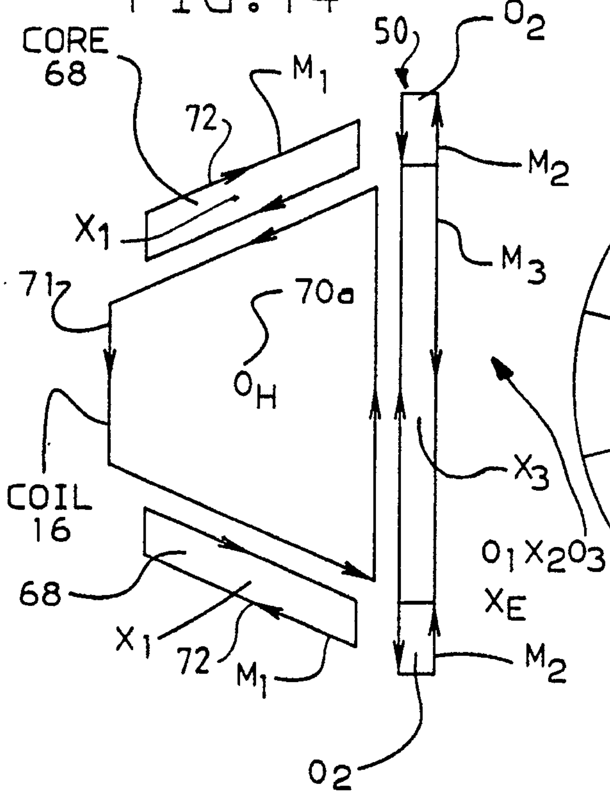


FIG. 15

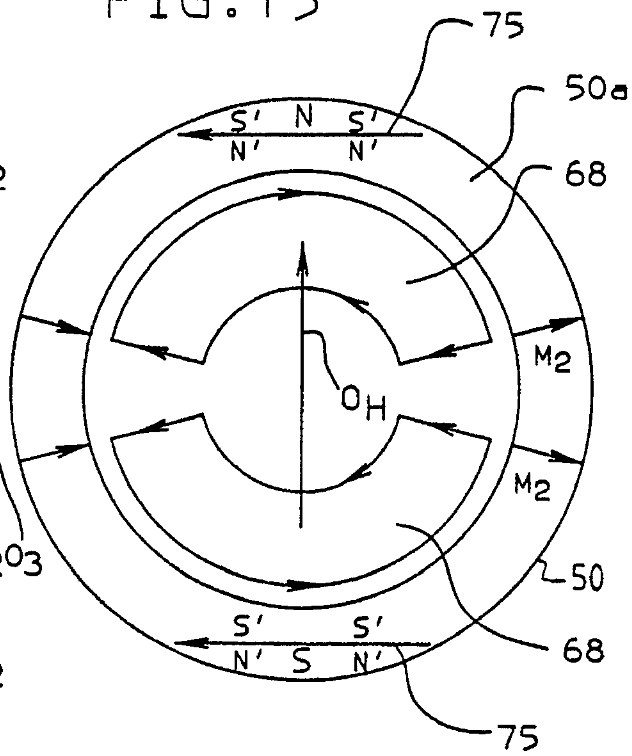


FIG.16

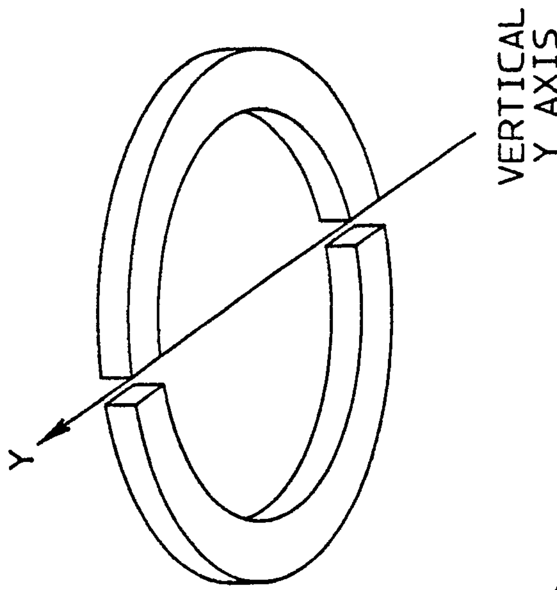


FIG.17

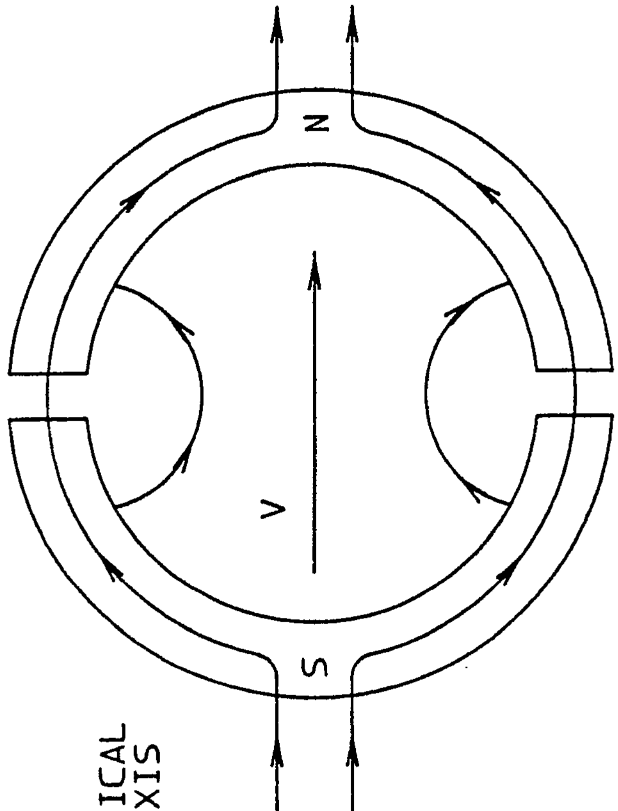


FIG.18

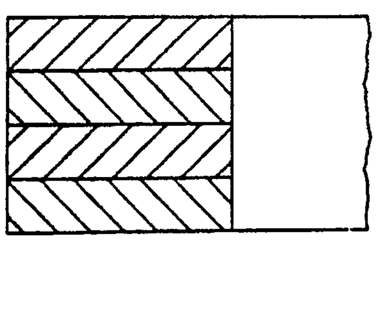


FIG.19

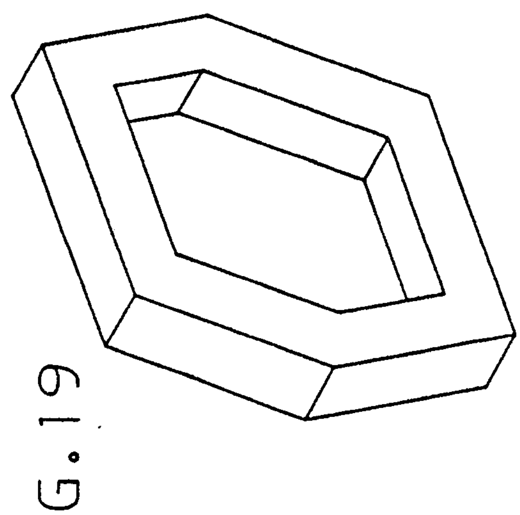


FIG.20

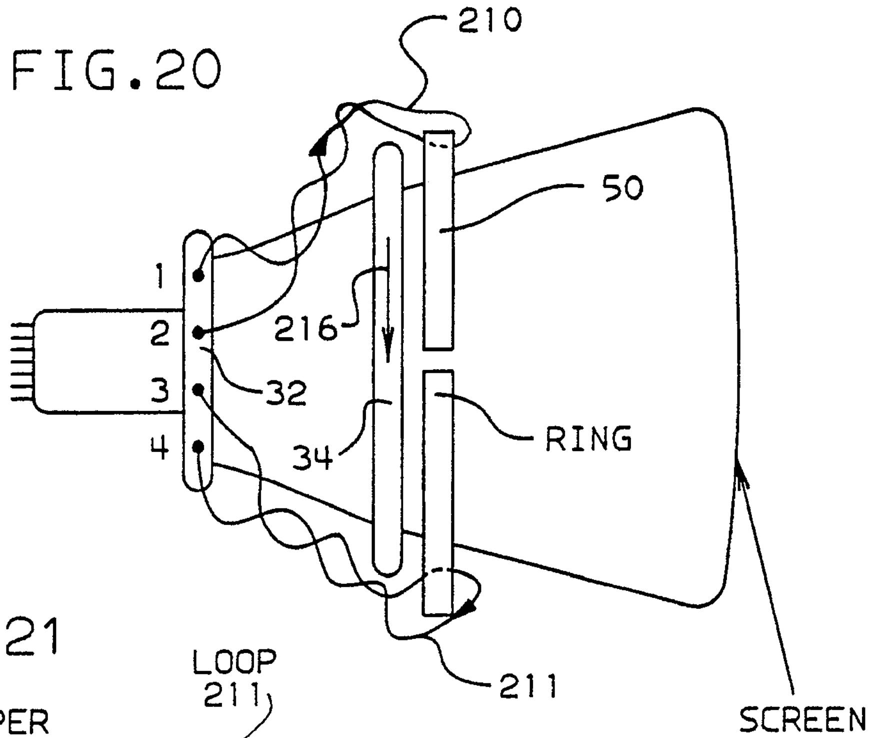


FIG.21

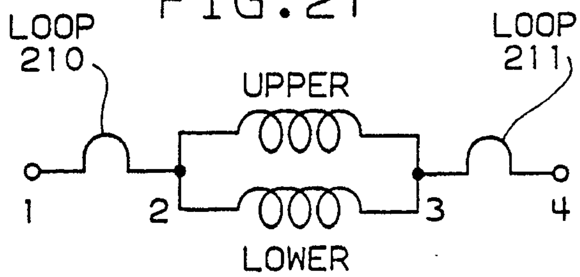
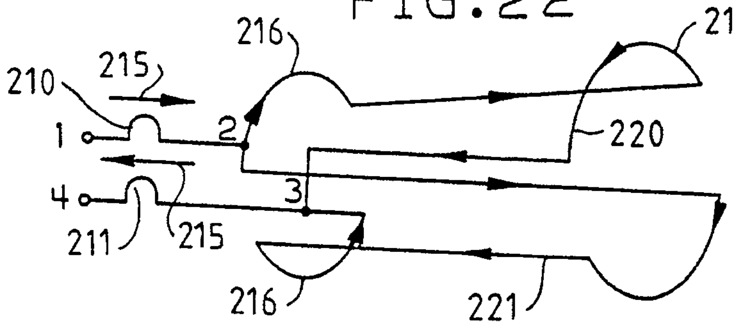


FIG.22



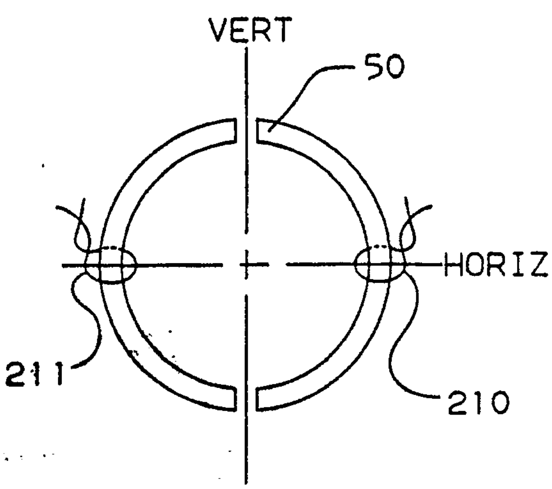


FIG.23

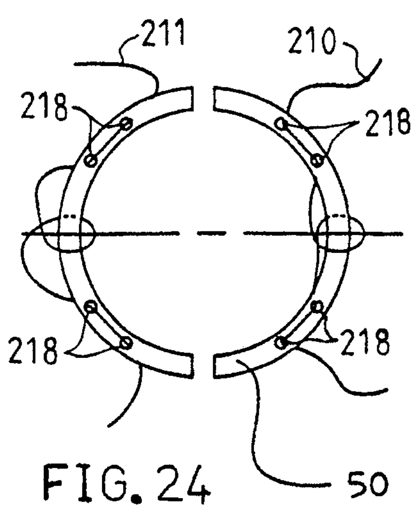


FIG.24

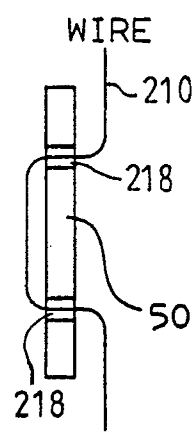


FIG.25

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 90302248.1

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
D,A	EP - A1 - 0 302 995 (IMB) * Fig. 2,5; column 5, lines 8-28; claims 1,2,6 * --	1	H 01 J 29/00 H 01 J 29/76 G 12 B 17/02
A	WO - A1 - 88/06 346 (HANTAREX SPA) * Fig. 1; claims * --	1	
A	EP - A2 - 0 258 891 (DENKI ONKYO) * Abstract; claims * ----	1	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			H 01 J 29/00 H 01 J 9/00 G 12 B 17/00 H 05 K 9/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	16-05-1991	BRUNNER

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