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(54) Magnetic shunt for deflection yokes.

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EP-A- 220 777
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DE-A- 3 513 216
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SID INTERNATIONAL SYMPOSIUM; DIGEST OF TECHNICAL PAPERS, New Orleans, Louisiana, 12th-14th May 1987, vol. XVIII, first edition, pages 332-334, SID, New York, US; B.B. DASGUPTA: "18.1: Design of a NS-pin-corrected 110 degree centigrade, COTY yoke for CRTs with very flat faceplates"

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Description

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, in front of the screen thereof.

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 outside of the CRT, and even in front of the screen. This external magnetic field serves no useful purpose and an effort is frequently made to reduce this part of the yoke magnetic field.

Means to provide this reduction have been proposed in the prior art. For example, as shown in EP-A-220 777, one such proposal is the provision of Helmholtz coils disposed "on top of", or radially away from and adjacent to the saddle-shaped deflection 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 residual magnetic field in front of the screen. However, this is a relatively expensive and bulky solution to the problem.

Another proposed solution, shown in DE-A-3 513 216, 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.

An article entitled "Design of a NS-Pin-Corrected 110 degree COTY Yoke for CRTs with Very Flat Faceplates", by Basab B Dasgupta in SID INTERNATIONAL SYMPOSIUM; DIGEST OF TECHNICAL PAPERS, New Orleans, Louisiana, 12th-14th May 1987, vol XVIII, first edition, pages 332-334, SID, New York, US describes the use of a ferrite ring positioned just behind the front flare of the horizontal deflection coil to correct the MS-geometry in a CRT system.

There is therefore 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.

The present invention relates to a cathode ray tube apparatus comprising a viewing screen, means for producing a charged particle beam directed at the screen from the rear thereof, a saddle deflection coil disposed behind the screen generating a magnetic field for deflecting the beam across the screen and generating unwanted magnetic radiation which extends in front of the viewing screen, and means for reducing the unwanted magnetic radiation in front of the viewing screen.

According to the invention the apparatus is characterised in that the means for reducing the unwanted magnetic radiation in front of the viewing screen comprises magnetic shunt means disposed between the coil and the screen and including a ring of magnetically permeable material positioned near or against the end turns of the coil and disposed around the cathode ray tube.

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 front of the coil. The apparatus reduces the net distributed magnetic radiation in front of the coil through the provision of a magnetic shunt disposed between the coil and the screen, wherein the magnetic shunt comprises a magnetically permeable material having its configuration and position relative to the coil selected to minimise the net distributed magnetic field in front of the coil.

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.

Brief Description of the Drawings

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

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

Fig. 3 is a 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 plot showing the effective mu vs. actual mu for the ring depicted in Figs. 4 and 5.

Fig. 7 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. 8 is a set of curves showing the effect of ring 50 on the end turn field shown in Fig. 3.

Fig.9 is an expanded view of the portion of the curve shown in Fig. 7 beyond approximately 2.5 centimeters.

Fig. 10 is a plot like that of Fig. 9, wherein ring 50 is a slightly different distance from the yoke.

Fig. 11 is a diagram like Fig. 9, in which the inner diameter radius of ring 50 is slightly different from that of Fig. 9.

Fig. 12 is a curve like that of Fig. 9 but wherein the distance of the ring 50 from the end of the yoke is different from that of Fig. 9 and Fig. 10.

Fig. 13 is a diagram of a further embodiment, which includes a lip portion 62.

Fig. 14 shows a still further embodiment in which a ring is provided having two portions.

Fig. 15 shows a still further embodiment made by injection molding techniques of a material such as nylon impregnated with ferrite particles.

Fig. 16 is a cross-sectional diagram through a portion of a still further embodiment of ring, made with conventional mu metal laminates.

Fig. 17 shows a further embodiment, having a hexagonal shape.

Detailed Description of the Invention

Fig. 1 shows the pertinent portions of an integrated yoke tube component ("ITC") 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 the electron beam within the tube 12 for horizontal sweeping across the face 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. The useful portion of the loops 20, 22 are the axially aligned portions thereof 24, 26, 28, 30, which produce the main deflection field.

The circumferentially aligned portions of the loop (end turns) 32, 34, 36, 38 serve only to complete the circuit of each of the respective loops 20, 22, and are otherwise unnecessary for the operation of the deflection coils 16, 18. These circumferentially aligned coil portions 32, 34, 36, 38 contribute the major portion of the residual distributed magnetic field that extends a significant distance in front of the screen 14 (Fig. 1) which is to be reduced. In effect, the residual field is the vector sum of the main deflection field and the end turn field. The resulting sum will follow the polarity of the end turn field, since the end turn component is the larger, and both decay at the same rate with distance.

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 Z 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:

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

where $\bar{J}$ is the current, $\bar{R}$ is the direction and R is the distance to a point of interest T on the Z axis.

A plot of the $\bar{B}$ field distribution of a typical horizontal deflection coil, such as is shown in Fig. 1, shielded with high permeability material, like ferrite, 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 a 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 with the preferred embodiment of the present invention.

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, or mu. It also has a high volume resistivity, or rho, for example 1 Meg Ohm or more per cubic centimeter The high rho 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 mu metal 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.

Referring to Fig. 6 a plot is shown of the variation of effective mu, mu_e versus actual mu, mu_a, for a ring such as ring 50 positioned in front of coils 20, 22, as shown in Fig. 5. It can be seen that the effective mu rises abruptly for very low values of mu_a and then reaches some point where it remains relatively constant in spite of ever increasing mu_a. A value of 1,000 represents a point such as point 52 for a linear ferrite ring having dimensions typical for the application described herein. If a mu value of, for example, 10 were selected, it would be in the sloping area 53 of the curve shown in Fig. 6. Such a material would be highly susceptible to variations in manufacturing tolerances, temperature of operation, and the like, and would therefore provide erratic performance depending upon the variation of these factors. By selecting the permeability to be in the flat, horizontal area of the curve of Fig. 6, the above described undesirable variations in performance are substantially avoided. However, the material cost considerations will tend to keep the permeability of the material low within the range of acceptable permeability for providing this preferred stability.

Fig. 7 is a set of curves, on the same set of axes as these 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. 7 is the same as curve A in Fig. 3. Curve D in Fig. 7 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 the field from the ring on the overall magnetic field A, a set of curves is shown in Fig. 8 including curve D, the magnetic field from the ring, and two other curves which help in this understanding. Curve C is the same curve C as is 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. 8 the horizontal axis is the same as that of curves 3 and 7 while the vertical field 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 magnetisation 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 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 of the present invention as disclosed herein, this field can be reduced to very small levels.

The portion of Fig. 7 beyond approximately 2.5 centimeters to the right thereof is shown in Fig. 9. In order to see clearly the curve behaviour in that region, the scale is expanded in the vertical direction as compared with Fig. 7. Curves A and E are as described in Fig. 7. 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 for a typical CRT-yoke configuration is shown, where the ring 50 is of ferrite with a permeability of 1,000 -3,000, and a rho of 1 meg ohm per cubic centimeter or more, 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. 10-12 are plots like the plot shown in Fig. 9, for slightly different ring configurations from the configuration producing the curves of Fig. 9. Thus, in Fig. 10 all of the parameters for the ring are the same as those corresponding to Fig. 9, except the distance of the ring from the end of the yoke. In

Fig. 10 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 farther from the horizontal axis, for example at 9.5 centimeters.

The curves of Fig. 11 are for a configuration in which the dimensions are the same as those corresponding to Fig. 9, 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, and by an amount greater than curve E is above the horizontal axis, at 9.5 centimeters.

Fig. 12 shows a curve for a configuration wherein the dimensions are as in Fig. 9, 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 at 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. 9-12, it will be appreciated that changing the various dimensional parameters of the preferred embodiment of the present invention affects the performance of the ring in compensating by cancelling the magnetic field components on the Z axis in front of the screen due to yoke winding components. Through an understanding of these effects, one practicing the present invention can provide the adjustments deemed desirable to optimize the cancellation effect.

In an actual prototype experiment, in conjunction with an ITC manufactured by Matsushita Company having a series number of M34JDJ00X01, a ferrite ring of ordinary linear ferrite was provided, having a mu of approximately 1,000 - 3,000 and a rho of greater than 1 meg ohm per cc, ring dimensions of: an inner dimension of 111 mm (4-3/8"), a width of 9 mm (3/8"), and a thickness of 3 mm (1/8"). This ring was found to produce excellent cancellation effects when it was placed against the circumferential wire portions of the yoke provided with this ITC with spacing resulting only from the insulation of the yoke wires.

It should be noted that other configurations in accordance with the present invention may be used. For example, as shown in Fig. 13, a ring having a lip portion 62, may be employed to advantage, the lip 62 being believed to serve to enhance the cancellation of the undesired field. However, the additional machining required to make the configuration shown in Fig. 13 results in a more costly article than ring 50.

Another alternative configuration is that of a ring formed from two portions, such as is shown in Fig. 14.

Further, using injection molding techniques, for example with nylon impregnated with ferrite particles, a ring configuration having a cross section, such as is shown in Fig. 15 is also possible. It is believed that this configuration also provides beneficial cancellation field shaping characteristics. However, it also represents a more costly article than a simple flat ferrite ring such as described above.

Fig. 17 shows a hexagonally shaped ring, representing a still further embodiment for use with, for example, a hexagonally configured yoke.

Finally, embodiments may be made with conventional mu metal laminates, yielding rings having a cross-section as shown in Fig. 16.

Claims

1. A cathode ray tube apparatus comprising:
   a viewing screen (14),
   means for producing a charged particle beam directed at the screen from the rear thereof,
   a saddle deflection coil (16,18) disposed behind the screen generating a magnetic field for deflecting the beam across the screen and generating unwanted magnetic radiation which extends in front of the viewing screen, and
   means for reducing the unwanted magnetic radiation in front of the viewing screen,
   characterised in that:
   the means for reducing the unwanted magnetic radiation in front of the viewing screen comprises magnetic shunt means (50) disposed between the coil and the screen and including a ring of magnetically permeable material positioned near or against the end turns of the coil and disposed around the cathode ray tube.

2. An apparatus as in claim 1 in which the ring is flat and formed of linear ferrite.

3. An apparatus as in claim 1 or claim 2 in which the ring has a rectangular cross-section.

4. An apparatus as in claim 1 or claim 2 in which the ring has an L-shaped cross-section.

5. An apparatus as in any of claims 2 to 4 in which the ring comprises a plurality of sections.

Patentansprüche

1. Eine Kathodenstrahlröhrenvorrichtung, umfassend
einen Bildschirm (14),
ein Mittel zur Erzeugung eines Strahls geladener Partikel, der von hinten auf den Schirm gerichtet ist,
eine sattelförmige Ablenkspule (16, 18), die hinter dem Bildschirm angebracht ist und ein Magnetfeld zur Ablenkung des Strahls über den Schirm sowie eine unerwünschte, sich vor dem Bildschirm ausbreitende Magnetstrahlung erzeugt, und
ein Mittel zur Reduktion der unerwünschten Magnetstrahlung vor dem Bildschirm,
dadurch gekennzeichnet, daß
das Mittel zur Reduktion der unerwünschten Magnetstrahlung vor dem Bildschirm ein magnetisches Shuntmittel (50) umfaßt, das sich zwischen der Spule und dem Bildschirm befindet und einen Ring aus magnetisch permeablem Material umfaßt, der in der Nähe des Wickelkopfes der Spule oder in Kontakt mit diesem positioniert ist und um die Kathodenstrahlröhre herum angebracht ist.

2. Eine Vorrichtung nach Anspruch 1, bei der der Ring flach ist und aus linearem Ferrit besteht.

3. Eine Vorrichtung nach Anspruch 1 oder 2, bei der der Ring einen rechteckigen Querschnitt aufweist.

4. Eine Vorrichtung nach Anspruch 1 oder 2, bei der der Ring einen L-förmigen Querschnitt aufweist.

5. Eine Vorrichtung nach einem der Ansprüche 2 bis 4, bei der der Ring mehrere Abschnitte umfaßt.

Revendications

1. Appareil à tube à rayons cathodiques comprenant:
un écran (14) de visualisation,
des moyens pour produire un faisceau de particules chargées dirigé sur l'écran depuis l'arrière de celui-ci,
une bobine (16, 18) de déviation en sellette disposée derrière l'écran engendrant un champ magnétique pour dévier le faisceau sur l'écran et engendrant un rayonnement magnétique non souhaité qui s'étend devant l'écran de visualisation, et
des moyens pour réduire le rayonnement magnétique non souhaité devant l'écran de visualisation ,
caractérisé en ce que:
les moyens pour réduire le rayonnement magnétique non souhaité devant l'écran de visualisation comportent un moyen (50) de shuntage magnétique disposé entre la bobine et l'écran et comportant un anneau en matériau perméable magnétiquement disposé près des enroulements d'extrémité de la bobine ou contre ceux-ci et disposé autour du tube à rayons cathodiques.

2. Appareil selon la revendication 2 dans lequel l'anneau est plat et est formé de ferrite linéaire.

3. Appareil selon la revendication 1 ou la revendication 2 dans lequel l'anneau a une section en coupe rectangulaire.

4. Appareil selon la revendication 1 ou la revendication 2 dans lequel l'anneau a une section en coupe en forme de L.

5. Appareil selon l'une quelconque des revendications 2 à 4 dans lequel l'anneau comporte une pluralité de sections.

FIG. 1

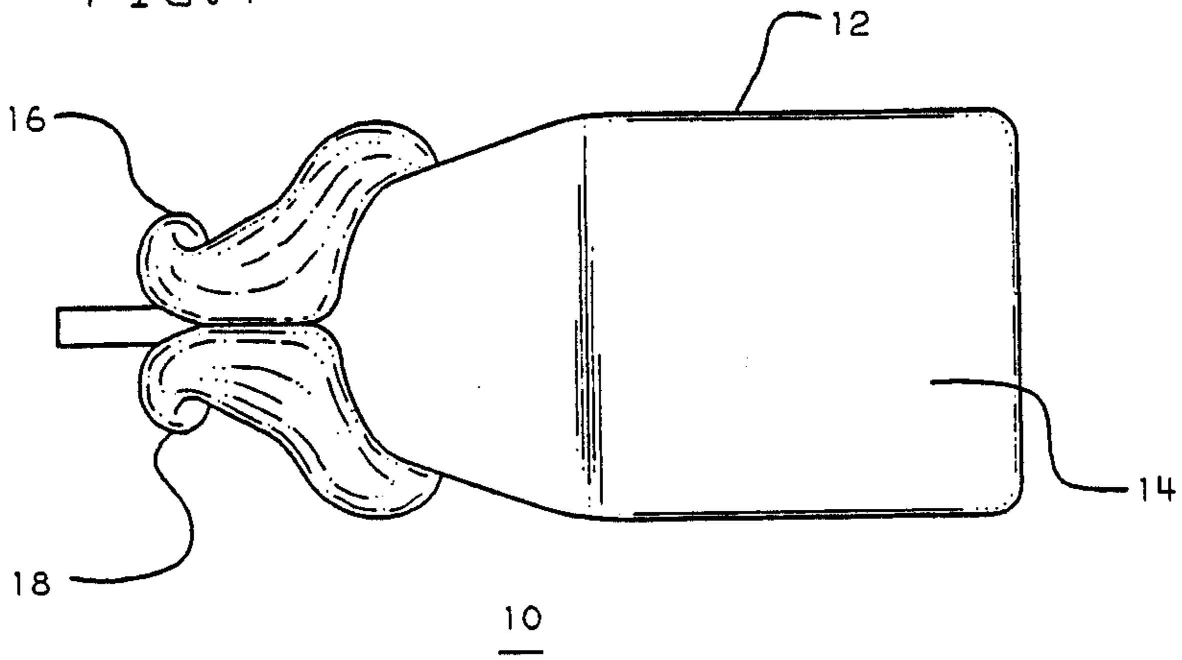


FIG. 4

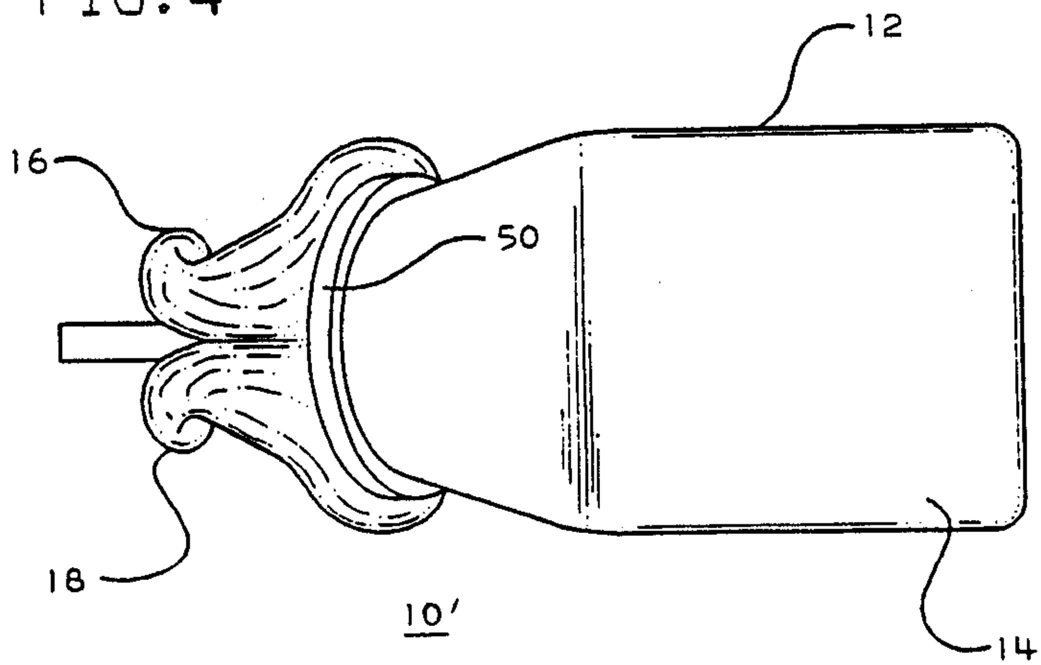


FIG.2

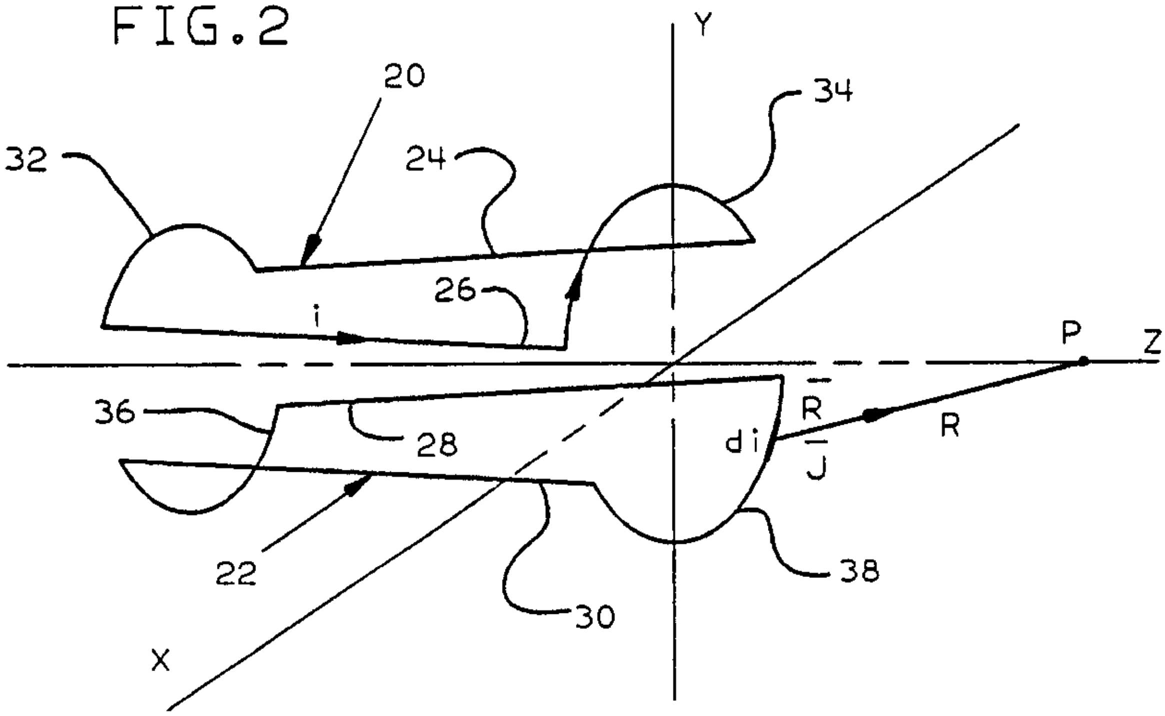


FIG.5

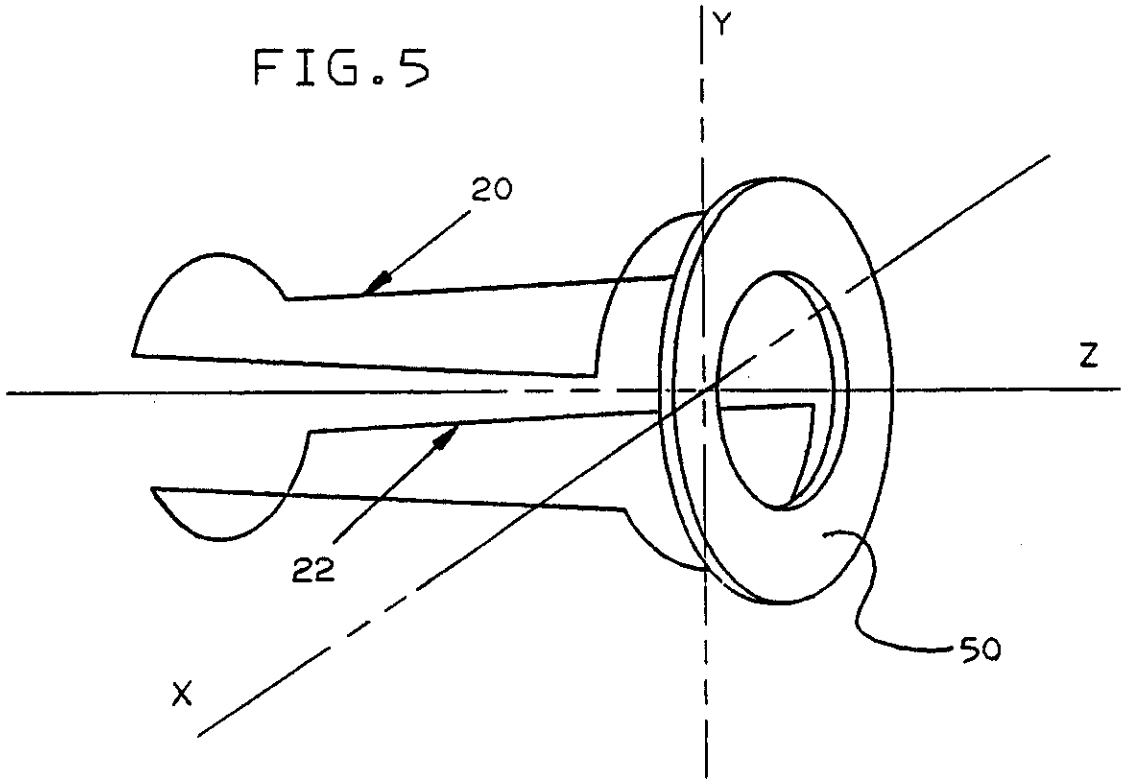


FIG. 3

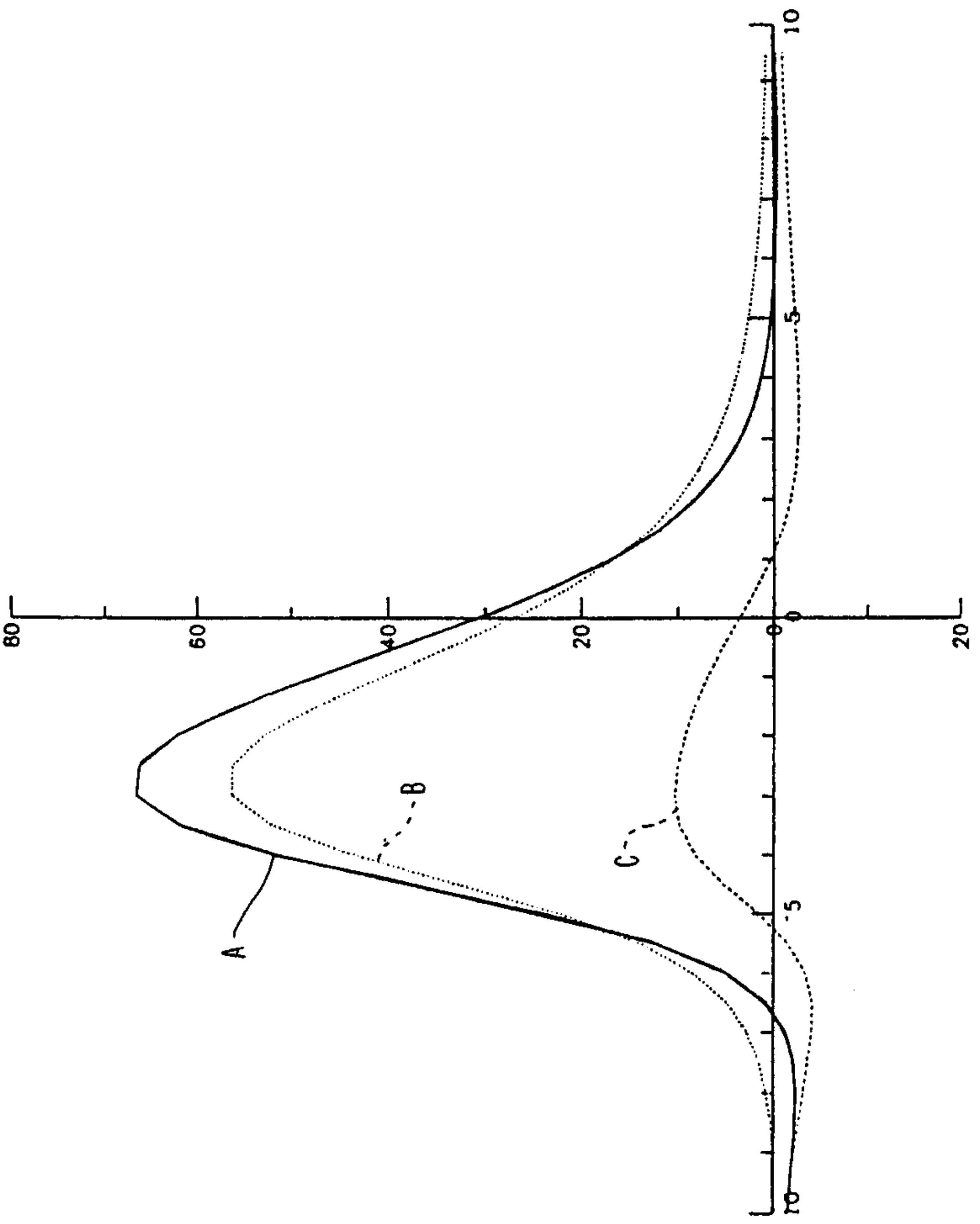
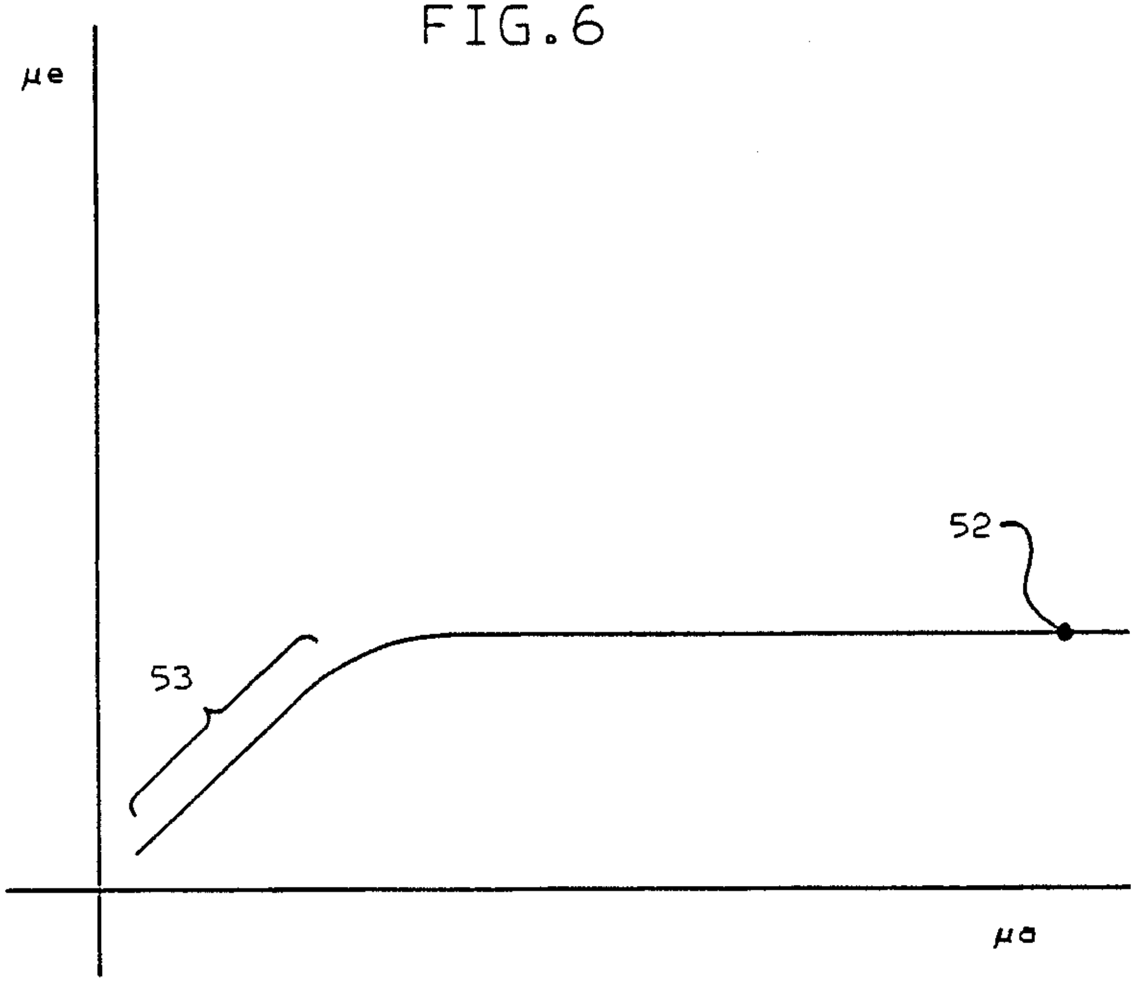


FIG.6



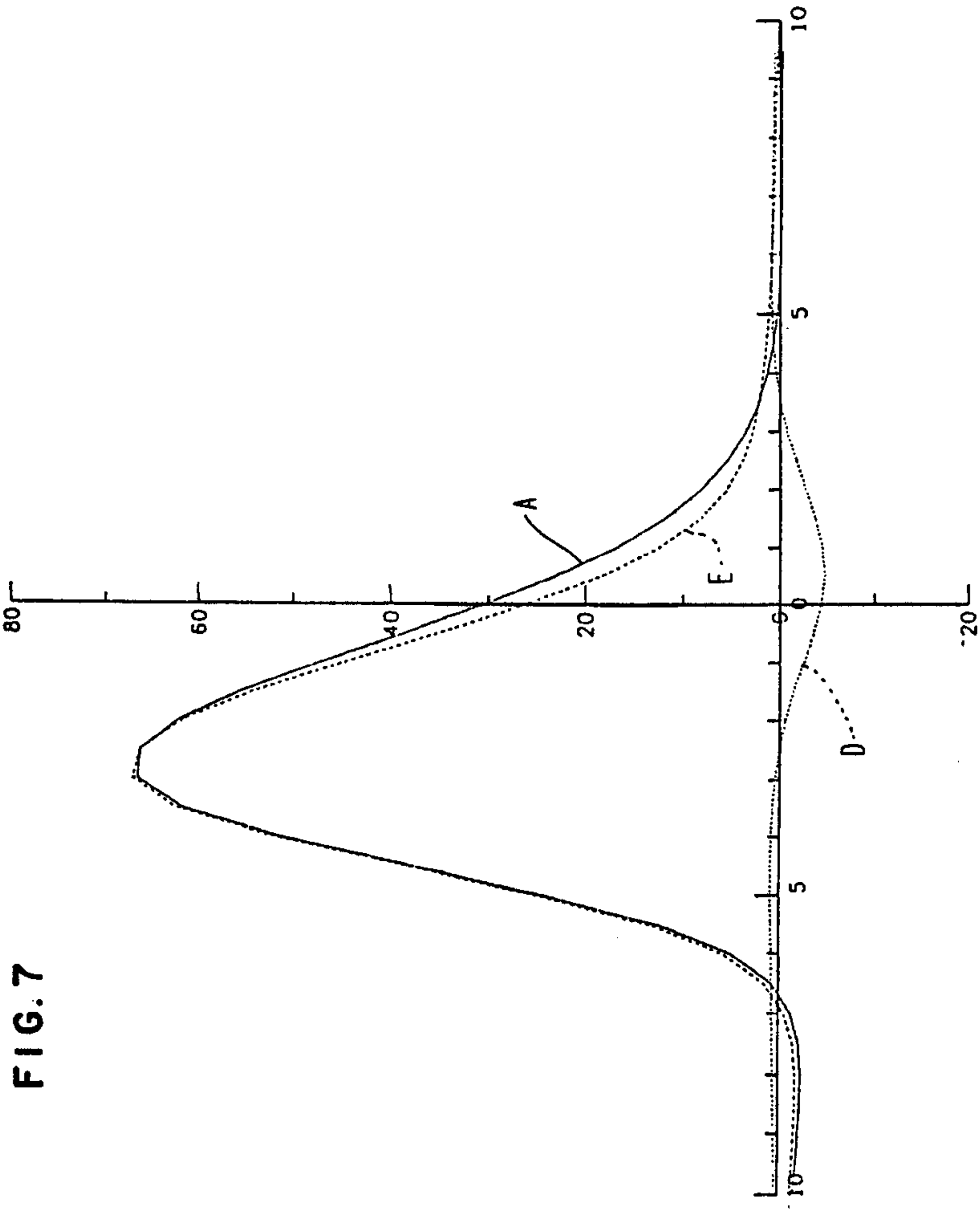


FIG. 7

FIG. 8

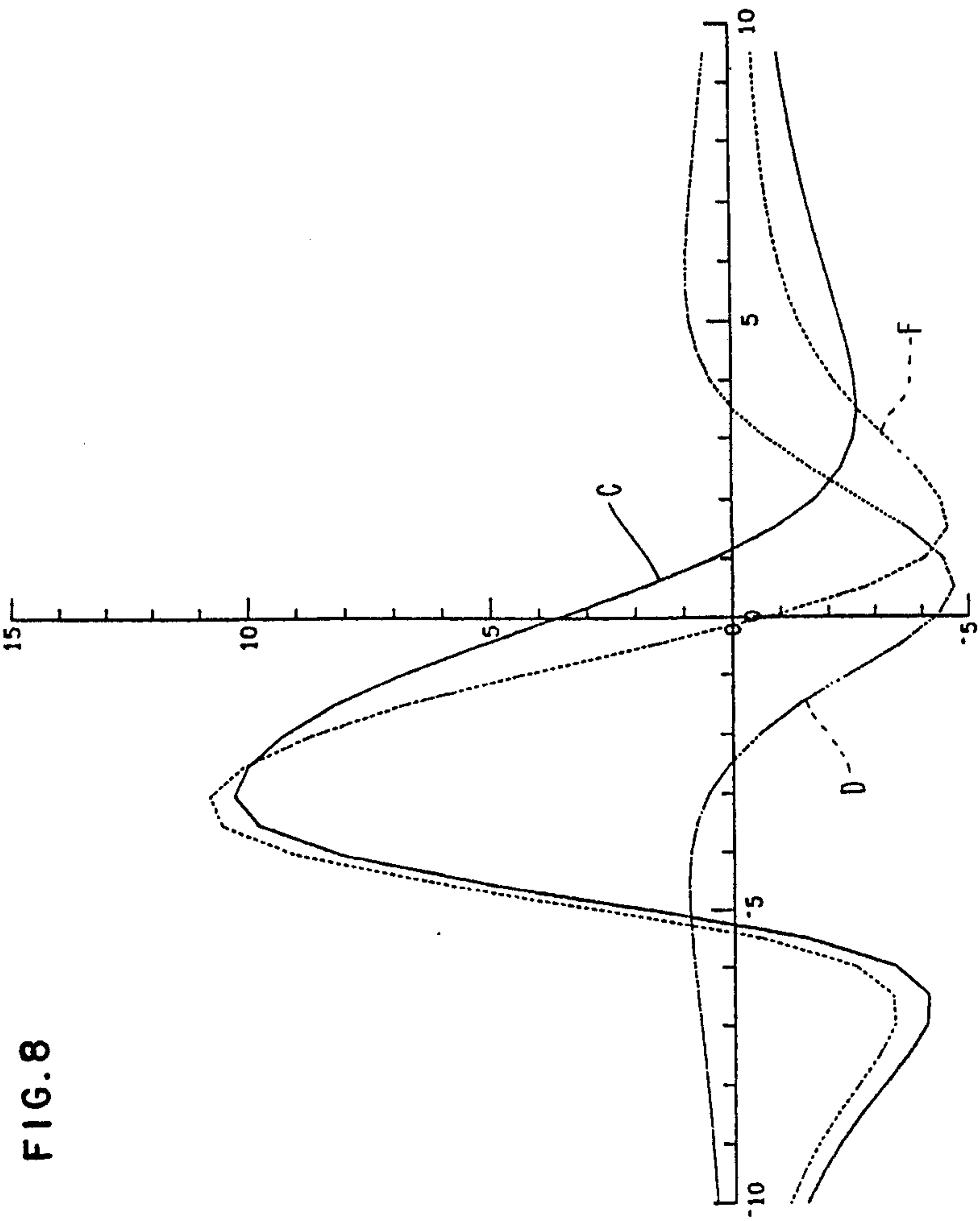


FIG.9

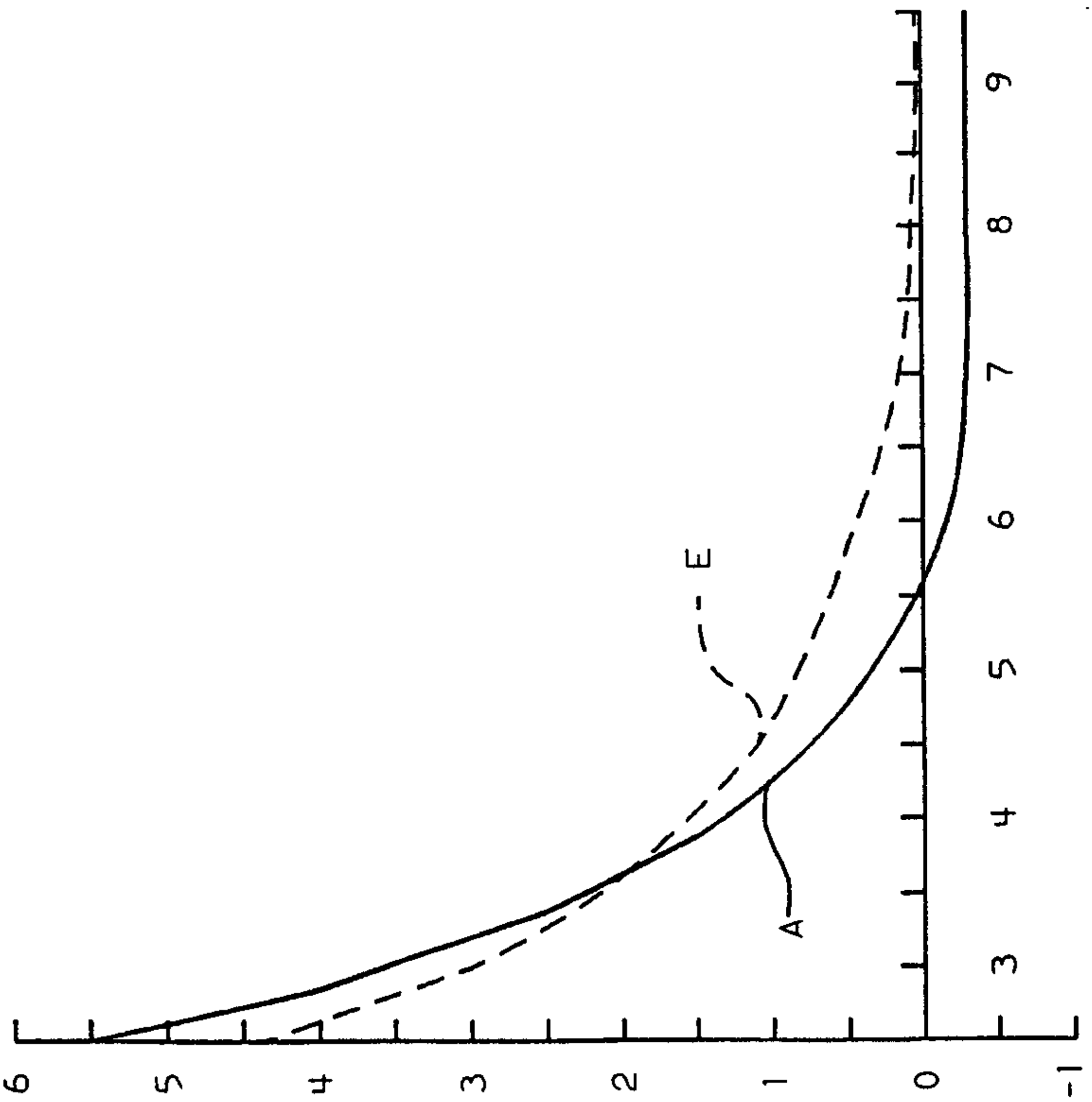


FIG.10

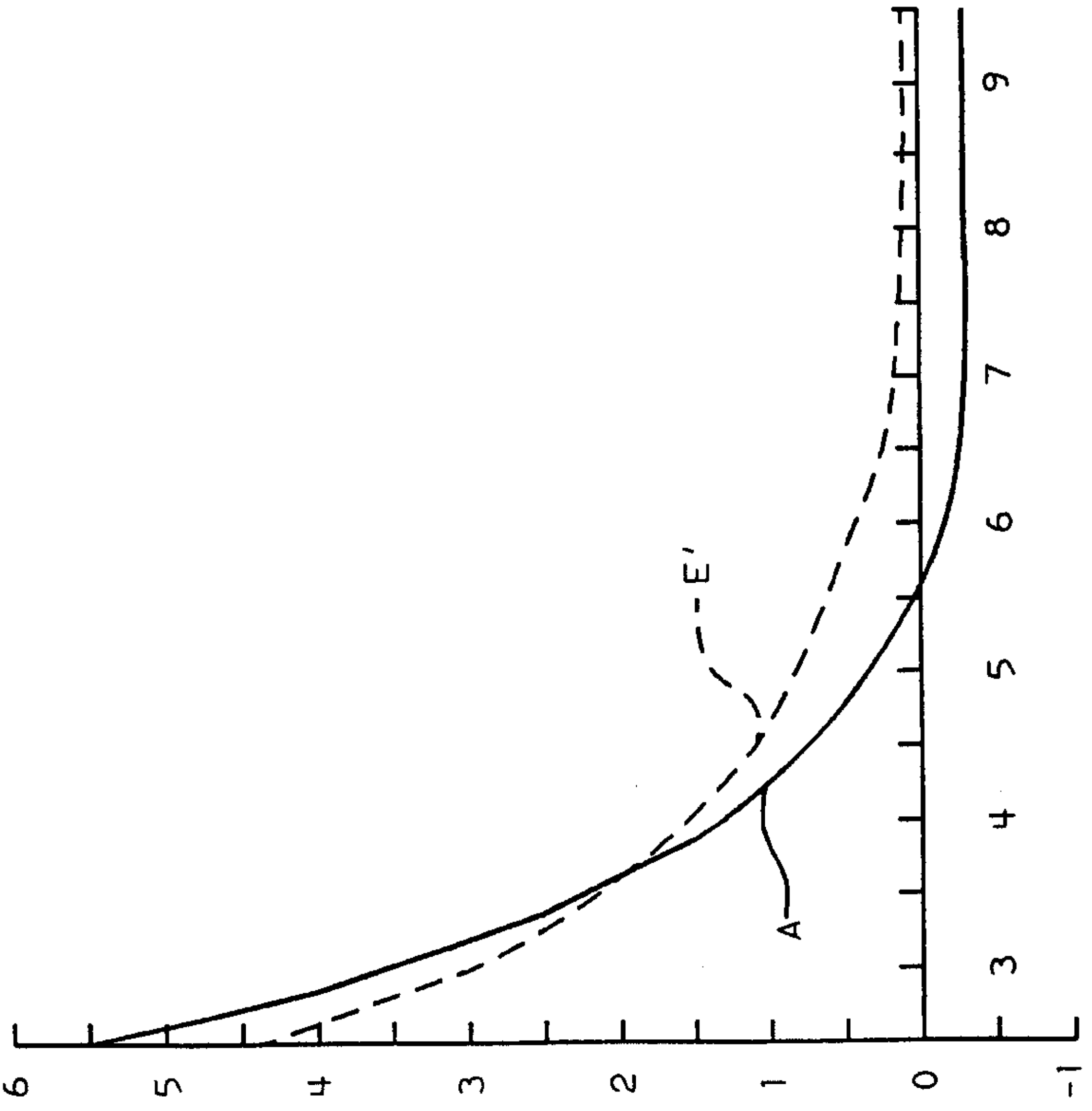


FIG.11

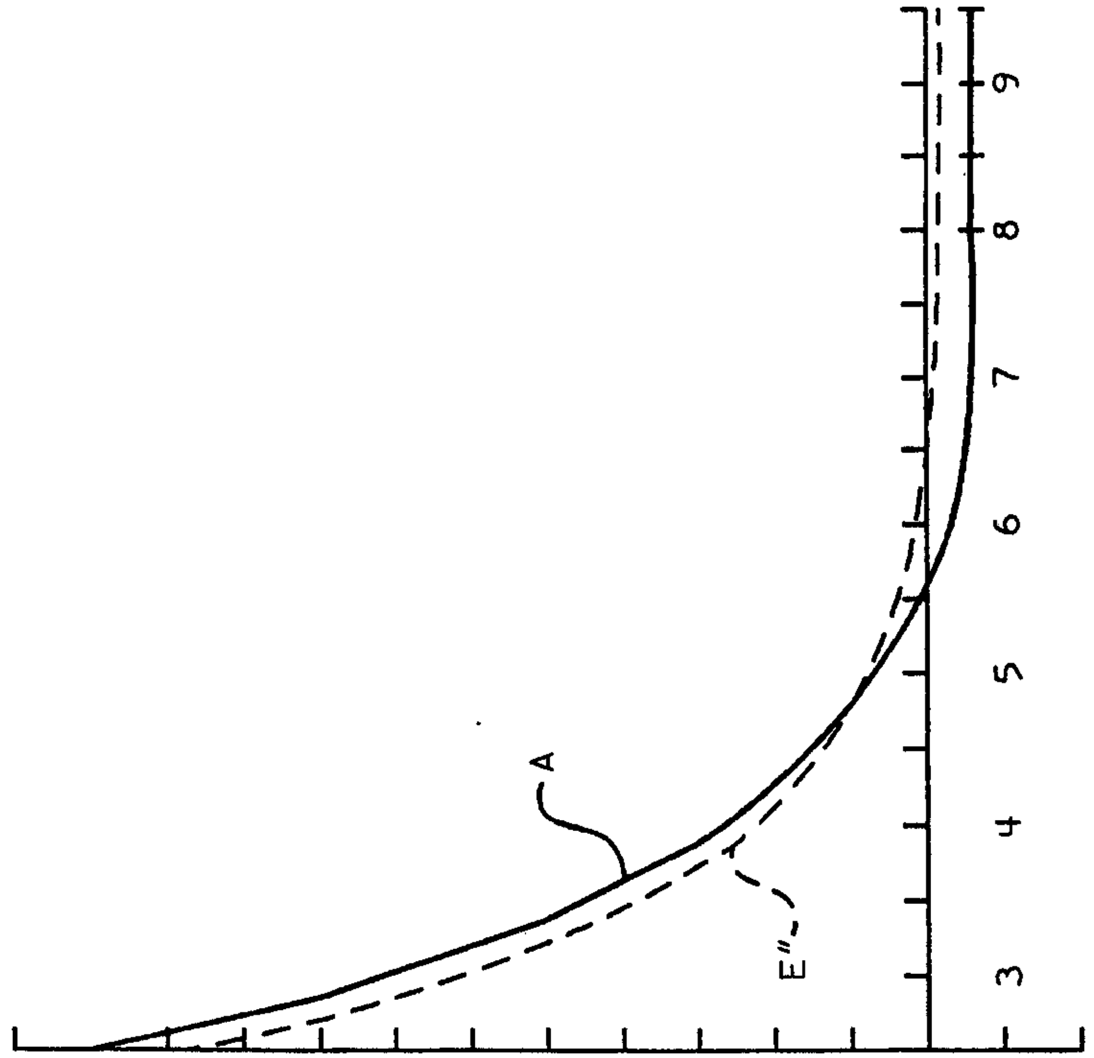


FIG.12

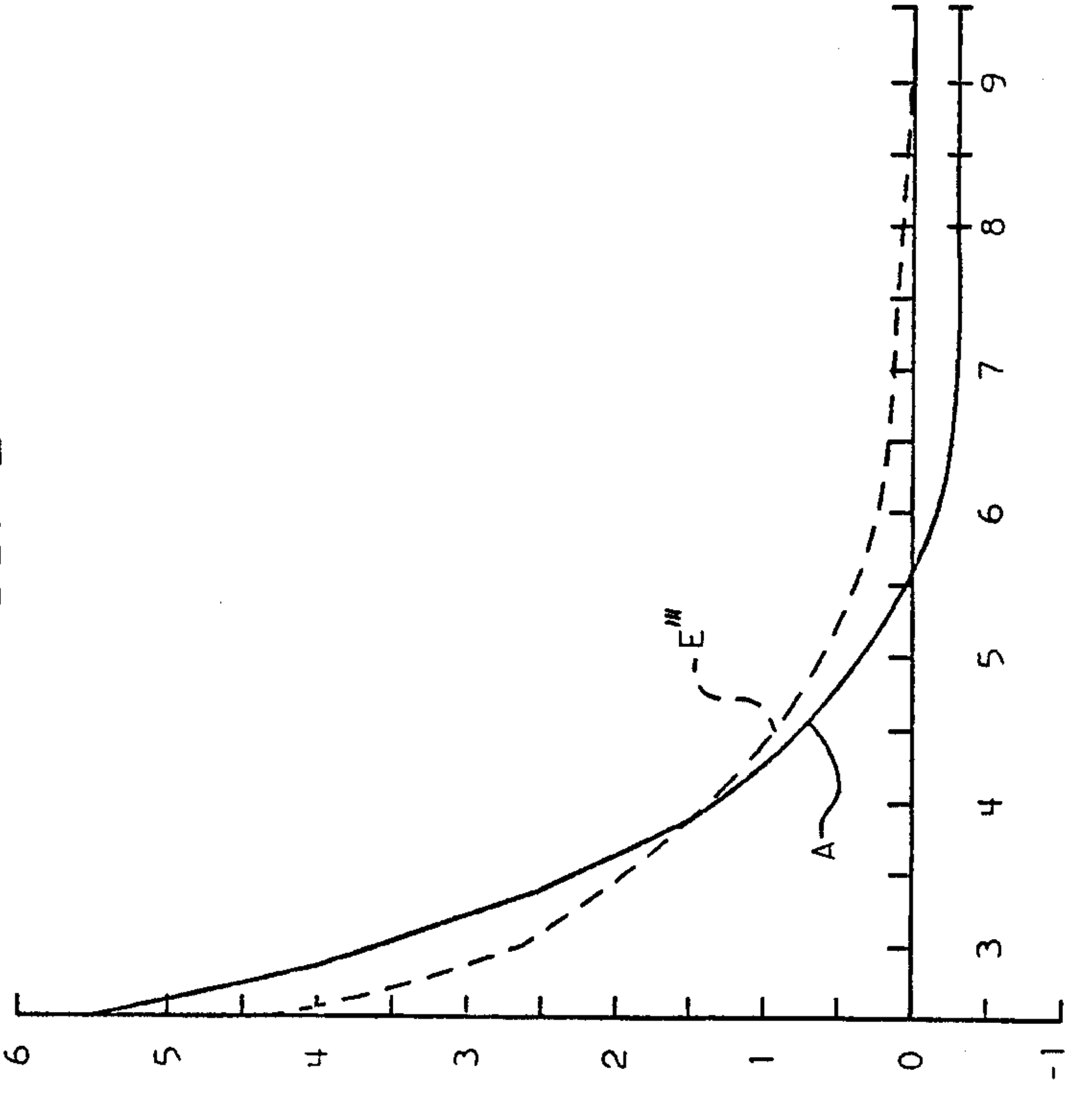


FIG.13

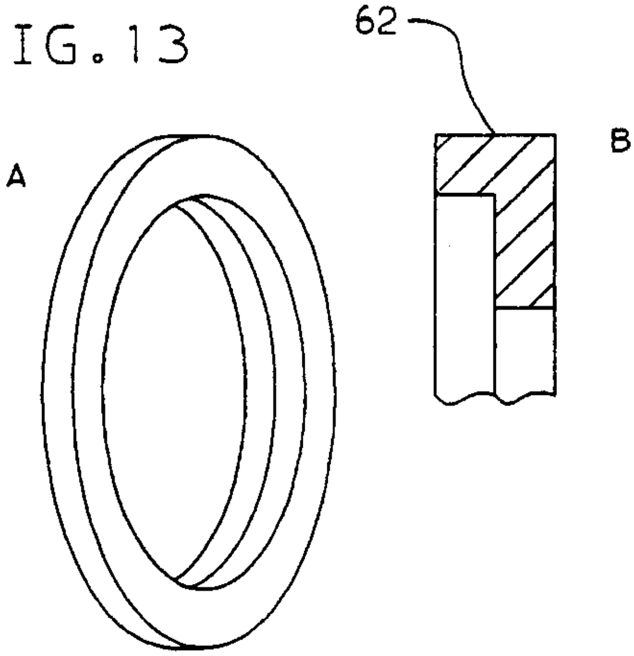


FIG.14

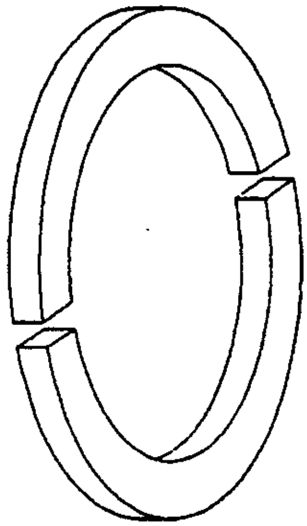


FIG.15

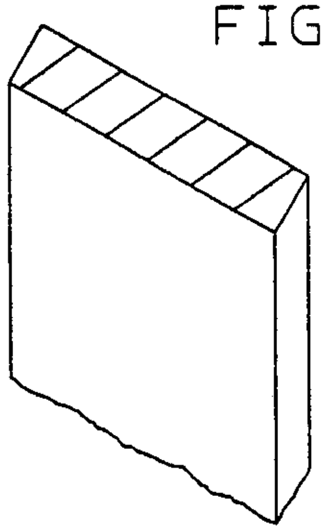


FIG.16

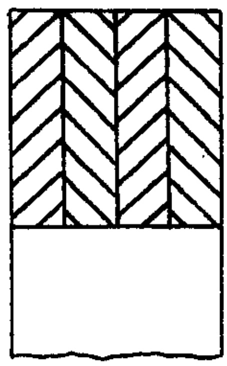
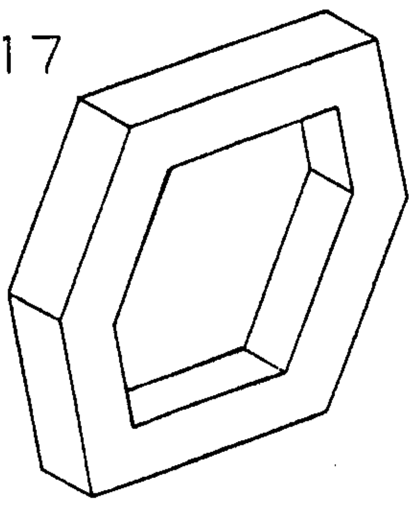


FIG.17



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Title MAGNETIC SHUNT FOR DEFLECTION YOKES.

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H01J G12B

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**** END OF REGISTER ENTRY ****

RENEWAL DETAILS

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PROPRIETOR(S)

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Armonk, N.Y. 10504, United States of America

DATE FILED	29.03.1988
DATE GRANTED	08.06.1994
DATE NEXT RENEWAL DUE	29.03.1995
DATE NOT IN FORCE	
DATE OF LAST RENEWAL	
YEAR OF LAST RENEWAL	00
STATUS	PATENT IN FORCE