(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 087 910 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication of patent specification: **06.08.86**

(51) Int. Cl.[4]: **G 11 C 19/08**, H 01 F 10/24, H 01 F 41/28

(21) Application number: **83300919.4**

(22) Date of filing: **22.02.83**

(54) Ion-implanted magnetic bubble memory device.

(30) Priority: **22.02.82 JP 25995/82**
28.04.82 JP 70204/82

(43) Date of publication of application:
07.09.83 Bulletin 83/36

(45) Publication of the grant of the patent:
06.08.86 Bulletin 86/32

(84) Designated Contracting States:
DE FR GB NL

(56) References cited:
EP-A-0 011 137
EP-A-0 032 157
EP-A-0 035 622
WO-A-81/02806
DE-B-2 321 825

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(73) Proprietor: **FUJITSU LIMITED**
1015, Kamikodanaka Nakahara-ku
Kawasaki-shi Kanagawa 211 (JP)

(72) Inventor: **Satoh, Yoshio Sarugaya-haitsu 2-1**
1544-32 Yabe-cho Totsuka-ku
Yokohama-shi Kanagawa 244 (JP)
Inventor: **Ohashi, Makoto**
4-2-6, Masukata Tama-ku
Kawasaki-shi Kanagawa 214 (JP)
Inventor: **Miyashita, Tsutomu**
Hirao-Jutaku 68-301 472-1, Hirao
Inagi-shi Tokyo 206 (JP)
Inventor: **Matsuda, Kazuo**
298, Miyauchi Nakahara-ku
Kawasaki-shi Kanagawa 211 (JP)
Inventor: **Komenou, Kazunari**
7-3-505, Shibokuhoncho 2-chome Miyamae-ku
Kawasaki-shi Kanagawa 213 (JP)

(74) Representative: **Abbott, Leonard Charles et al**
GILL JENNINGS & EVERY 53-64 Chancery Lane
London WC2A 1HN (GB)

EP 0 087 910 B1

Courier Press, Leamington Spa, England.

Description

The present invention relates to a magnetic bubble device and, more particularly, to bubble propagation paths of an ion-implanted bubble device in which the bubble propagation paths are made in a layer of magnetic material by ion-implantation.

In recent years, a number of approaches have been proposed to the realization of a high density storage magnetic bubble memory device in which the bit period is 4 μm or less, and the memory capacity is a 4 Mbits or more. A very promising proposal is the ion-implanted bubble device which is well known in the art.

On the other hand, the most popular bubble propagation organization for the ion-implanted bubble device is a major-minor organization which comprises a plurality of minor loops and one or two major lines (or loops). The bubble is transferred by a transfer gate between the minor loop and the major line. EP—A—11137 discloses a magnetic bubble memory device employing an organization of major and minor loops and with contiguous propagations patterns of successive cusps and bulges formed by ion implantation and with propagation tracks arranged parallel with one of the three easy bubble strip-out directions, such tracks being "good" tracks in that they have good bias field margins.

However, the minor loop of the prior art has a linear formation which is inconvenient from the viewpoint of design as well as performance of the transfer gate so far as a high density device is concerned. Such formation of the minor loop disadvantageously limits an improvement of the storage density too.

To solve these problems, it is preferred to adopt the folded minor loop organization which has usually been employed in conventional permalloy bubble devices. In this folded minor loop organization, the loop has conventionally been folded, for example, in U- or H-shape. However, such folded minor loop must have, as will be described more in detail later, in addition to a plurality of 180° outside turns, at least one 180° inside turn along the bubble propagation path. There has been no 180° inside turn of the bubble propagation path having good performance characteristics and requiring no large space realized by the ion-implantation. Accordingly, it has been impossible to realize an ion-implanted bubble device adopting the folded minor loop organization.

It is, therefore, a principal object of the present invention to provide an ion-implanted device having the folded minor loop organization with an improved bubble propagation path.

The present invention consists in a magnetic bubble memory device comprising a magnetic layer having bubble propagation patterns of the contiguous type formed in regions of the magnetic layer by ion-implantation in other regions of the magnetic layer so as to define bubble propagation paths around the bubble propagation patterns, the propagation patterns being so oriented with respect of the crystallographic axes that the bubble propagation paths provide good tracks (i.e. tracks extending parallel to one of the easy axes of magnetisation) characterized in that each of the bubble propagation paths is of folded form and has substantially U-shaped turns interconnecting the good tracks, at least one of the substantially U-shaped turns being an inside turn having at least one cusp and, in which a tip is provided in the bubble propagation pattern between the said turn cusp and each of the neighbouring cusps on the bubble transfer-in side and on the bubble transfer-out side, so as to prevent a direct bubble propagation path between the summit of the turn cusp and the summit of a neighbouring cusp and in which the summit of the turn cusp is offset in the direction of bubble propagation with respect to a centre line of this cusp extending parallel to the easy axis of strip out and passing through a middle point on a line connecting the tips.

The present invention will now be described in detail based on preferred embodiments and in contrast with the prior art, with reference to the accompanying drawings, in which:—

Fig. 1 is a partial plan view of an ion-implanted magnetic bubble propagation pattern;

Fig. 2 is a sectional view taken along line II—II in Fig. 1;

Fig. 3 illustrates the relationship between the easy axis of magnetization of the magnetic layer and the bubble propagation pattern;

Fig. 4 illustrates a construction of the ion-implanted bubble device employing a folded minor loop organization;

Fig. 5 illustrates different shapes of the folded minor loop;

Fig. 6 illustrates an embodiment of the turn in the conventional bubble propagation path;

Fig. 7 illustrates another embodiment of the turn in the conventional bubble propagation path;

Fig. 8 illustrates an embodiment of the turn in a bubble propagation path according to the present invention;

Figs. 9 and 10 illustrate the performance characteristics of the embodiment shown by Fig. 8;

Fig. 11 illustrates a variation of the embodiment shown by Fig. 8;

Fig. 12 illustrates another embodiment of the present invention;

Fig. 13 illustrates a variation of the embodiment shown by Fig. 12;

Fig. 14 illustrates the performance characteristics of the embodiment shown by Fig. 12 or Fig. 13;

Fig. 15 illustrates a preferred embodiment of the inside turn of the bubble propagation path;

Fig. 16 illustrates an embodiment of the inside turn of the bubble propagation path according to the present invention;

Figs. 17 and 18 illustrate the performance characteristics of the embodiment shown by Fig. 16;

Fig. 19 illustrates another embodiment of the present invention;

Fig. 20 illustrates still another embodiment of the present invention;

Fig. 21 illustrates the performance characteristics of the embodiments shown by Figs. 19 and 20;

Fig. 22 illustrates further another embodiment of the present invention;

Fig. 23 illustrates a variation of the embodiment shown by Fig. 22; and

Fig. 24 illustrates the performance characteristics of the embodiments shown by Figs. 22 and 23.

First, prior art will be described with reference to Figs. 1 through 3.

Figures 1 and 2 illustrate a bubble propagation pattern made by ion-implantation. A reference numeral 1 designates a substrate of gadolinium gallium garnet, on which a thin layer 2 of magnetic garnet is deposited by the method of liquid-phase epitaxial growth. The magnetic layer 2 has a first region 3, and a second remainder region 4 in which an ion, such as H, Ne or He is implanted. The second ion-implanted region 4 has the easy axis of magnetization which is in the plane of the layer 2 as shown by an arrow X, and the first nonimplanted region 3 has the easy axis of magnetization which is normal to the plane of the layer 2 as shown by an arrow Y. A bubble 5 is moved along the periphery of the first region 3 by means of a magnetic field rotating in the plane of the layer 2. Therefore, the first region 3 defines a bubble propagation pattern. Such bubble propagation pattern as mentioned above is a contiguous pattern, which may be composed of a plurality of overlapping disk or square patterns and therefore requires no gap unlike a conventional permalloy pattern. This fact makes it possible to relax the pattern in precision and, accordingly, to provide a smaller pattern and a higher density.

In the magnetic layer 2, there are six easy axes of magnetization K_1 in the directions $(\bar{1}\,\bar{1}\,2)$, $(\bar{1}\,2\,\bar{1})$, $(2\,\bar{1}\,\bar{1})$, $(1\,1\,\bar{2})$, $(1\,\bar{2}\,1)$ and $(\bar{2}\,1\,1)$ which are 60° apart from each other, as illustrated in Fig. 3. These axes are classified into two groups: that is, a group including the axes I, II and III; and the other group including the axes IV, V and VI. The axes I, II and III are easy axes of stripe out.

Depending on what direction the patterns composing the bubble propagation pattern are linearly arranged in with respect to the easy axes of magnetization K_1 there are three kinds of bubble propagation path; that is, a super track "s", a bad track "b" and a good track "g". The good track "g" is a propagation path in which the operating margin in the bubble propagation is moderate and is obtained when the propagation direction of the path is parallel to an easy axis of magnetization. A super track "s" is a propagation path in which the bias field margin is large and the bubble can be easily propagated; such a propagation track is obtained when one of the easy axes of magnetization (i.e. easy stripe-out directions) is perpendicular to the propagation direction and is directed into a cusp. A bad track "b" is a propagation path in which the bias field margin is small and the bubble cannot be easily propagated; such a track is obtained when one of the easy axes of magnetization is perpendicular to the propagation direction and is directed out of the cusp. As illustrated in Figure 3, the path opposite to the super track "s" is the bad track "b". Both of the paths of the contiguous disk pattern 3' arranged along the axis K_1 are good tracks "g". This feature is due to a peculiarity of bubble propagation which is caused by the cubic anisotropy of garnet film.

Figure 4 illustrates the construction of the major-minor loop organized ion-implanted bubble memory device adopting the folded minor loop configuration. Reference symbol GE designates a bubble generator, DE a bubble detector, ML a major line, ml a minor loop, and T a bidirectional transfer gate. The minor loop ml is U-folded so that its principal path directions are parallel to one $(\bar{1}\,2\,\bar{1})$ of the easy axes of striping out, i.e. in the direction of the good track, and has four portions at which it turns through 180°, resulting in two outside turns OB along the bad track, an outside turn OS along the super track and an inside turn IB along the bad track. It should be understood that folded minor loops as illustrated in Figure 5 are also useful. A minor loop ml_1 is inverse U-shaped and has four turns inclusive of an inside turn. A minor loop ml_2 is H-shaped and has six turns inclusive of two inside turns. A minor loop ml_3 is C-shaped and has six turns inclusive of two inside turns. Thus, the folded minor loops must have at least one 180° inside turn.

Figure 6 illustrates an embodiment of the conventional 180° turn of the bubble propagation path. The inside turn of this propagation path presents a curve too gentle to realize a higher density. Figure 7 illustrates a pattern so designed that the inside turn has the minimum dimension. However, such a pattern has a problem that a bubble (not shown) propagated from a tip A to a cusp B and then to a cusp C by means of a counterclockwise rotating field returns back to the cusp B as the rotating field continues to rotate, finally resulting in oscillation of the bubble between the cusps B and C.

The present invention is made to eliminate the above-mentioned problems in conventional devices. The preferred embodiments of the present invention will now be described with reference to Figs. 8 through 24.

Fig. 8 illustrates a 180° turn of the bubble propagation path according to the present invention. Reference numeral 15 designates a bubble propagation pattern composed of a non-implanted region and having an inside turn of the bubble propagation pattern along its bad track. This inside turn is provided with a substantially V-shaped cusp 6. There are tips 10 and 11 formed between the cusp 6 and the cusps 8 and 9, respectively, so that summits of the cusps 8 and 9 cannot be linearly seen through from a summit of the cusp 6 (Fig. 7 corresponds to the case wherein said summits of the cusps 8 and 9 can be linearly seen through from the summit of the cusp 6). The summit of the cusp 6 is arranged a little toward a direction P of bubble propagation with respect to a center line CL of the cusp 6. The cusp center line CL is a line passing the middle point on the line connecting the tips 10 and 11 and extending in parallel to the easy axis $(\bar{1}2\bar{1})$ of striping out. The deviation of the cusp summit is based on the fact that the nearer the side, along which the bubble is transferred out from the cusp, to the perpendicular to the easy axis of striping out, the better the margin is as reported by C. C. Shir(IBM) in J.A.P. 52(3) 2 388 (1981). To realize such deviation, the present invention provides an arrangement that the side along which the bubble is transferred from the cusp 6 is inclined by 90° to 140° with respect to the easy axis of striping out. When a rotating field H_R rotates counterclockwise while the bubble is propagated in the direction of the arrow P as shown, an angle θ of the side 7 along which the bubble is transferred out with respect to the easy axis $(2\bar{1}\bar{1})$ of striping out is 90° to 140° as measured counterclockwise around the cusp summit. When the field H_R rotates clockwise while the bubble is propagated in the direction opposite to that indicated by the arrow P, on the other hand, an angle θ' of the side 7′ of bubble transfer-out (the cusp summit deviates rightward with respect to the cusp center line CL, in this case) with respect to the easy axis $(\bar{1}\bar{1}2)$ of striping out is 90° to 140° as measured clockwise. Said angles θ and θ' are between −30° to +20° when measured from the easy axis $(\bar{1}2\bar{1})$ of striping out.

Fig. 9 is a diagram illustrating the relationship between the bias field H_B and the driving field H_R which was experimentally determined by varying said angle θ in Fig. 8. Referring to Fig. 9, a curve A corresponds to a case of $\theta=140°$, a curve B corresponds to a case of $\theta=120°$, a curve D corresponds to a case of $\theta=90°$, and a curve C corresponds to a case wherein the cusp summit is placed on the cusp center line. It will be obvious that the angle $\theta=90°$ to 140° established according to the present invention effectively enlarges the margin relative to said case wherein the cusp summit is placed just on the cusp center line.

Fig. 10 is a diagram illustrating the relationship established between the angle and the bias margin H_B when the driving field $H_R=40 \cdot 10^2$ A/m. It will be seen that the margin is enlarged as the angle θ decreases toward 90°, i.e., the side of bubble transfer-out approaches the perpendicular to the easy axis of striping out. As the angle θ decreases from 90°, the pattern formation becomes difficult from the viewpoint of the photolithographic technique and at the same time said side of bubble transfer-out deviates again off the direction normal to the easy axis of striping out. Accordingly, the angle lies preferably between 90° and 140°.

Fig. 11 illustrates a variation of the embodiment shown by Fig. 8. This variation is different from the embodiment of Fig. 8 in that all the corners of the pattern are formed as curves but provides the same effect as in the case of the embodiment shown by Fig. 8.

Fig. 12 illustrates another embodiment of the 180° inside turn along the bad track according to the present invention, which has two cusps 20. A summit 21 of the cusp 20 is formed as a horizontal side to facilitate the pattern formation but deviates toward the direction P of bubble propagation with respect to the cusp center line (not shown). A side 22 along which the bubble is transferred out is substantially normal to the easy axis $(2\bar{1}\bar{1})$ of striping out. A side 23 along which the bubble is transferred in is so arranged that the cusp has an opening angle sufficient to assure a preferable margin and said side 23 is rather smoothly connected to the neighbouring side of the cusp. A pattern established when the bubble is propagated in the direction opposed to that in the case of Fig. 12 is illustrated by Fig. 13. This pattern is just reverse to the pattern illustrated by Fig. 12. Fig. 14 illustrates the performance characteristics of the propagation path illustrated by Fig. 12 or Fig. 13 (bias-driving magnetic margin at a frequency of 1 Hz) and indicates that a large margin is assured.

The 180° inside turn of the propagation path formed along the super track of the propagation pattern will be now described. Fig. 15 illustrates an embodiment of such inside turn. This inside turn has a substantially V-shaped cusp 30 and tips D and G formed between this cusp 30 and neighbouring cusps 31 and 32 of bubble transfer-in side and of bubble transfer-out, respectively. Summits of the cusps neighbouring each other cannot be linearly seen through from each other. A cusp center line CL passing a middle point M on the line connecting the tips D and G and extending in parallel to the easy axis $(\bar{1}2\bar{1})$ of striping out passes a middle point of a side EF which defines the cusp summit. Thus, the summit of the cusp 30 lines on the cusp center line and has no deviation toward the direction of bubble propagation. This is true also for the cusps 31 and 32 which neighbour said cusp 30.

Fig. 16 illustrates a variation of the embodiment illustrated by Fig. 15. In this embodiment, a middle point N on the side EF of the cusp 30′ deviates from the cusp center line CL toward the direction P of bubble propagation, and a line connecting the points M and N is clockwise inclined by an angle α with respect to the cusp center line. The neighbouring cusps 31′ and 32′ also deviate away from or toward the direction P of bubble propagation, sides AB and IJ are substantially normal to the easy axis $(\bar{1}2\bar{1})$ of striping out while sides CD and GH are substantially normal to the easy axes $(2\bar{1}\bar{1})$ and $(\bar{1}\bar{1}2)$ of striping out, respectively.

Fig. 17 illustrates the performance characteristics of the embodiment illustrated by Fig. 16, in which curves A, B, C and D correspond to the cases of $\alpha=0°$, $17°$, $8°$ and $-10°$, respectively. Curve E in Fig. 18 represents the dependency of the margin upon the angle α. Referring to Fig. 18, $\alpha=0°$ corresponds to the case wherein the cusp has no deviation as illustrated in Fig. 15, $\alpha>0$ corresponds to the case wherein the cusp deviates toward the direction of bubble propagation, and $\alpha<0$ corresponds to the case wherein the cusp deviates away from the direction of bubble propagation. It will be apparent from Figs. 17 and 18 that a preferably large margin can be obtained when $\alpha=5°$ to $17°$.

Fig. 19 illustrates a U-folded minor loop pattern of an ion-implanted bubble device embodying to the present invention. Referring to Fig. 19, reference numeral 40 designates an ion-implanted region while reference numeral 41 designates a minor loop pattern defined by non-implanted region, i.e., a hatched area. The super track side and the bad track side in the folded portion of the pattern 41 are formed with the outside turn and the inside turn of the minor loop, respectively. In such a pattern, it is forced by a geometric requirement of its formation that the folded portion of the pattern should include relatively large regions 42 and 43, and, for example, a bubble 44 propagated along the outside turn as shown by an arrow P is sometimes erroneously transferred from a tip 45 to a tip 47 of a neighbouring minor loop 46.

Another embodiment of the present invention made to solve this problem will be described in reference with Fig. 20. In the embodiment illustrated by Fig. 20, a pattern 51 is similar to the pattern 41 in Fig. 19 except that ion-implanted regions 52 and 53 are formed in the folded portion. The region 52 is independent of the bubble path around the pattern 51. The other region 53 is connected by a gap 54, which is similarly formed by an ion-implanted region, to the outside turn cusp. However, the gap 54 has a width substantially equal to the bubble diameter, so that no bubble can enter the region 53. The gap 54 contributes to reduction of any nucleation current during bubble transfer.

Fig. 21 illustrates the performance characteristics of the outside turn in the embodiment shown by Figs. 19 and 20, by curves B, B′ and curves A, A′, respectively. In the embodiment of Fig. 20, the erroneous operation as above-mentioned is avoided by the presence of the ion-implanted regions 52 and 53 and the lower limit (curve A′) of the bias field is improved approximately by $4.8 \cdot 10^2$ A/m relative to the bias field lower limit (curve B′) in the embodiment shown by Fig. 19.

Fig. 22 illustrates still another embodiment of the present invention, which is also made to avoid the above-mentioned erroneous operation and Fig. 23 illustrates a variation of this embodiment. Referring to Figs. 22 and 23, the minor loop patterns 60 and 70 are similar to each other except that the outside turn of the pattern 60 includes two cusps while the outside turn of the pattern 70 includes a single cusp. The outside turns of the patterns 60 and 70 respectively have along opposite sides tips 61 and 62 which are set back with respect to the other tips 63 at least by the bubble diameter so that a distance L between the tips 61 and 62 of neighbouring patterns is longer than a distance L_0 between the other tips 63. It is also possible to achieve the desired distance L by forming only one of said tips 61 and 62 as a tip set back with respect to the other tips 63. Such pattern formation reduces the previously mentioned erroneous transfer of bubble to the neighbouring pattern and improves the performance characteristics, since the distance L between the tips is adequately long. The performance characteristics are illustrated by Fig. 24, in which a curve A corresponds to the case of $l=20$ µm, $L_o=5$ µm and $L=L_o+3$ µm$=8$ µm in the embodiment of Fig. 23, and a curve B corresponds to the case of $l=20$ µm and $L_o=L=5$ µm also in the embodiment of Fig. 23. The diagram indicates noticeably improved lower limits of the bias field and of the driving field.

As will be obviously understood from the foregoing description, the present invention permits a folded minor loop organization of good performance characteristics and of higher density and, therefore, allows an ion-implanted bubble device of higher density and of small size to be realized.

Claims

1. A magnetic bubble memory device comprising a magnetic layer having bubble propagation patterns of the contiguous type formed in regions of the magnetic layer by ion-implantation in other regions of the magnetic layer so as to define bubble propagation paths around the bubble propagation patterns, the propagation patterns being so oriented with respect of the crystallographic axes that the bubble propagation paths provide good tracks (i.e. tracks extending parallel to one of the easy axes of magnetisation) characterized in that each of the bubble propagation paths is of folded form and has substantially U-shaped turns (OB, IB Figure 4) interconnecting the good tracks, at least one of the substantially U-shaped turns being an inside turn (IB) having at least one cusp (6, Figure 8), and in which a tip (10, 11) is provided in the bubble propagation pattern between the said turn cusp (6) and each of the neighbouring cusps (8, 9) on the bubble transfer-in side and on the bubble transfer-out side, so as to prevent a direct bubble propagation path between the summit of the turn cusp and the summit of a neighbouring cusp and in which the summit of the turn cusp is offset in the direction of bubble propagation with respect to a centre line (CL) of this cusp extending parallel to the easy axis of strip out and passing through a middle point on a line connecting the tips.

2. A magnetic bubble memory device according to claim 1, wherein the inside turn of the bubble propagation path is formed along a bad track of the bubble propagation pattern (i.e. a propagation

track such that one of the easy axes of magnetisation is perpendicular to the propagation direction of the track and points out of the cusp) and the bubble transfer-out side of the turn cusp is inclined with respect to the said easy axis by an angle of −30° to +20° counter-clockwise or clockwise around the cusp summit, depending on the direction of bubble propagation.

3. A magnetic bubble memory device according to claim 1, wherein the inside turn of the bubble propagation path is formed along a super track of the bubble propagation pattern (i.e. a propagation track such that one of the easy axes of magnetisation is perpendicular to the propagation direction of the track and points into the cusp), and a line connecting the turn cusp summit and the middle point of the tips extends at an angle of 5° to 17° with respect to the cusp centre line measured clockwise or counter-clockwise depending on the direction of bubble propagation.

4. A magnetic bubble memory device according to claim 1, wherein a region of the non-implanted bubble propagation pattern (51), forming a bubble propagation path, and which defines a substantially U-shaped turn, contains an ion-implanted region (52 or 53), the normal bubble propagation path around the non-implanted propagation pattern being unaffected by the ion-implanted region contained therein.

5. A magnetic bubble memory device according to claim 1, comprising two adjacent bubble propagation patterns defining propagation paths with substantially U-shaped outside turns each constituting a super track (i.e. a propagation track such that one of the easy axes of magnetisation is perpendicular to the propagation direction of the track and points into the cusp), adjacent sides of the two patterns defining parallel good tracks, the distance (L) between the tips of neighbouring portions of the two outside turns being greater by at least one bubble diameter than the distance (Lo) between two adjacent tips on respective adjacent good tracks.

Patentansprüche

1. Magnetblasenspeicher mit einer magnetischen Schicht, die Blasenausbreitungsmuster vom Zusammenhängenden Typ hat, die in Bereichen der magnetischen Schicht durch Ionenimplantation in anderen Bereichen der magnetischen Schicht gebildet sind, um so Blasenausbreitungswege um die Blasenausbreitungsmuster herum zu bilden, wobei die Ausbreitungsmuster bezüglich der kristallographischen Achsen so ausgerichtet sind, daß die Blasenausbreitungswege gute Spuren bilden (d.h. Spuren, die sich parallel zu einer der leichten Achsen der Magnetisierung erstrecken), dadurch gekennzeichnet, daß jeder Blasenausbreitungsweg von gefalteter Form ist und im wesentlichen U-förmige Windungen (OB, IB, Fig. 4) umfaßt, die die guten Spuren miteinander verbinden, wenigstens eine der im wesentlichen U-förmigen Windungen eine innere Windung (IB) ist, die wenigstens einen Windungsinnenwinkel (6, Figur 8) umfaßt, und bei welcher eine Zacke (10, 11) in dem Blasenausbreitungsmuster zwischen dem genannten Windungsinnenwinkel (6) und jedem der benachbarten Innenwinkel (8, 9) der Blasen-Einwärtstransfer-Seite und auf der Blasen-Auswärtstransfer-Seite umfaßt, um so einen direkten Blasenausbreitungsweg zwischen der Spitze des Windungsinnenwinkels und der Spitze des benachbarten Innenwinkels zu verhindern, und bei welcher die Spitze des Innenwinkels in Richtung der Blasenausbreitung in Bezug auf eine zentrale Linie (CL) dieses Innenwinkels versetzt ist, die sich parallel zu der leichten Achse des Ausstreifens erstreckt und durch einen mittleren Punkt auf einer die Zacken verbindenden Linie hindurchgeht.

2. Magnetischer Blasenspeicher nach Anspruch 1, bei welchem die innere Windung des Blasenausbreitungsweges längs einer schlechten Spur des Blasenausbreitungsmusters gebildet ist (d.h. einer Ausbreitungsspur, so daß eine der leichten Achsen der Magnetisierung senkrecht zu der Ausbreitungsrichtung der Spur ist und aus dem Innenwinkel herauszeigt) und die Blasen-Auswärtstransfer-Seite des Windungsinnenwinkels in Bezug auf die genannte leichte Achse um einen Winkel von −30° bis +20° gegen den Uhrzeigersinn oder im Uhrzeigersinn um die Spitze des Innenwinkels geneigt ist, abhängig von der Richtung der Blasenausbreitung.

3. Magnetischer Blasenspeicher nach Anspruch 1, bei welchem die innere Windung des Blasenausbreitungsweges längs einer Superspur von dem Blasenausbreitungsmuster (d.h. eine Ausbreitungsspur derart, daß eine der leichten Achsen der Magnetisierung senkrecht zu der Ausbreitungsrichtung der Spur ist und in den Innenwinkel hineinzeigt) gebildet ist, und eine Leitung, die die Spitzen der Innenwinkel und den mittleren Punkt der Zacken verbindet, sich um einen Winkel von 5° bis 17° in Bezug auf die Innenwinkelmittellinie erstreckt, gemessen im Uhrzeigersinn oder gegen den Uhrzeigersinn, abhängig von der Richtung der Blasenausbreitung.

4. Magnetischer Blasenspeicher nach Anspruch 1, bei welchem ein Bereich von nicht-implantierten Blasenausbreitungsmustern (51), der einen Blasenausbreitungsweg bildet und der eine im wesentlichen U-förmige Windung definiert, einen ionenimplantierten Bereich (52 oder 53) umfaßt, wobei der normale Blasenausbreitungsweg um das nicht-implantierte Ausbreitungsmuster von dem darin enthaltenen ionenimplantierten Bereich unbeeinflußt ist.

5. Magnetische Blasenspeichervorrichtung nach Anspruch 1, mit zwei benachbarten Blasenausbreitungsmustern, die Ausbreitungswege mit im wesentlichen U-förmigen Außenwindungen definieren, die jeweils eine Superspur (d.h. eine Ausbreitungsspur derart, daß eine der leichten Achsen der Magnetisierung senkrecht zu der Ausbreitungsrichtung der spur ist und in den

Innenwinkel zeigt) bilden, wobei benachbarte Seiten der beiden Muster parallele, gute Spuren definieren und der Abstand (L) zwischen den Zacken von benachbarten Abschnitten der beiden Außenwindungen um wenigstens einen Blasendurchmesser größer als der Abstand (Lo) zwischen zwei benachbarten Zacken von entsprechenden benachbarten guten Spuren ist.

Revendications

1. Dispositif de mémoire à bulles magnétiques comprenant une couche magnétique qui possède des motifs de propagation de bulles du type contigu formés dans des régions de la couche magnétique par implantation ionique dans d'autres régions de la couche magnétique afin de définir des trajets de propagation de bulles autour des motifs de propagation de bulles, les motifs de propagation étant orientés vis-à-vis des axes cristallographiques de telle manière que les trajets de propagation des bulles fournissent de bons chemins (c'est-à-dire des chemins s'étendant parallèlement à l'un des axes d'aimantation faciles), caractérisé en ce que chacun des trajets de propagation des bulles est de la forme pliée et possède des coudes sensiblement en forme de U (OB, IB, figure 4) reliant entre eux les bons chemins, au moins l'un des coudes en forme de U étant un coude intérieur (IB) qui possède au moins l'entaille (6, figure 8), dans lequel une pointe saillante (10, 11) est ménagée dans le motif de propagation des bulles entre l'entaille (6) dudit coude et chacune des entailles voisines (8, 9) se trouvant du côté transfert d'entrée et du côté transfer de sortie des bulles, afin d'empêcher l'existence d'un trajet de propagation directe des bulles entre le sommet de l'entaille du coude et le sommet d'une entaille voisine, et dans lequel le sommet de l'entaille du coude est décalé dans le sens de propagation des bulles par rapport à la ligne centrale (CL) de cette entaille qui s'étend parallèlement à l'axe d'enlèvement facile et qui passe par le milieu d'une ligne reliant les pointes saillantes.

2. Dispositif de mémoire à bulles magnétiques selon la revendication 1, où le coude intérieur du trajet de propagation des bulles est formé le long d'un mauvais chemin du motif de propagation de bulles (c'est-à-dire un chemin de propagation tel que l'un des axes d'aimantation faciles est perpendiculaire à la direction de propagation du chemin et pointe extérieurement par rapport à l'entaille), et le côté transfert de sortie des bulles de l'entaille du coude est incliné par rapport audit axe facile d'un angle de −30° à +20° mesuré dans le sens antihoraire ou le sens horaire autour du sommet de l'entaille, selon le sens de propagation des bulles.

3. Dispositif de mémoire à bulles magnétiques selon la revendication 1, où le coude intérieur du trajet de propagation des bulles est formé le long d'un super-chemin du motif de propagation de bulles (c'est-à-dire un chemin de propagation tel que l'un des axes d'aimantation faciles est perpendiculaire à la direction de propagation du chemin et pointe vers l'intérieur de l'entaille), et une ligne reliant le sommet de l'entaille du coude et le milieu des pointes saillantes s'étend suivant un angle de 5° à 17° par rapport à la ligne centrale de l'entaille, mesuré dans le sens horaire ou le sens antihoraire selon la direction de propagation des bulles.

4. Dispositif de mémoire à bulles magnétiques selon la revendication 1, où une région du motif de propagation de bulles non implanté (51), qui forme un trajet de propagation de bulles et qui définit un coude sensiblement en forme de U, contient une région d'implantation ionique (52 ou 53), le trajet de propagation de bulles normal autour du motif de propagation non implanté n'étant pas affecté par la région d'implantation ionique qu'il contient.

5. Dispositif de mémoire à bulles magnétiques selon la revendication 1, comprenant deux motifs de propagation de bulles adjacents qui définissent des trajets de propagation ayant des coudes extérieures sensiblement en forme de U constituant chacun un super-chemin (c'-est-à-dire un chemin de propagation tel que l'un des axes d'aimantation faciles est perpendiculaire à la direction de propagation du chemin et pointe vers l'intérieur de l'entaille), des côtés adjacents des deux motifs définissant de bons chemins parallèles, la distance (L) entre les pointes saillantes de parties voisines des deux coudes extérieurs étant plus grande d'au moins un diamètre de bulle que la distance (L_o) entre deux pointes saillantes adjacentes se trouvant sur des bons chemins adjacents respectifs.

Fig. 1

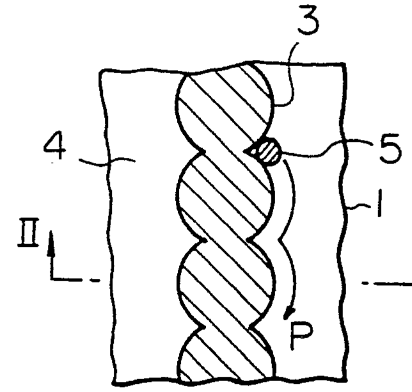
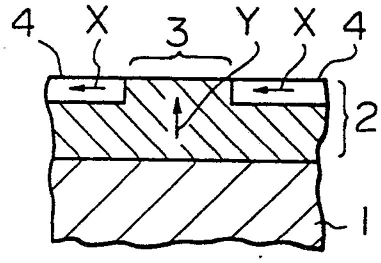


Fig. 2



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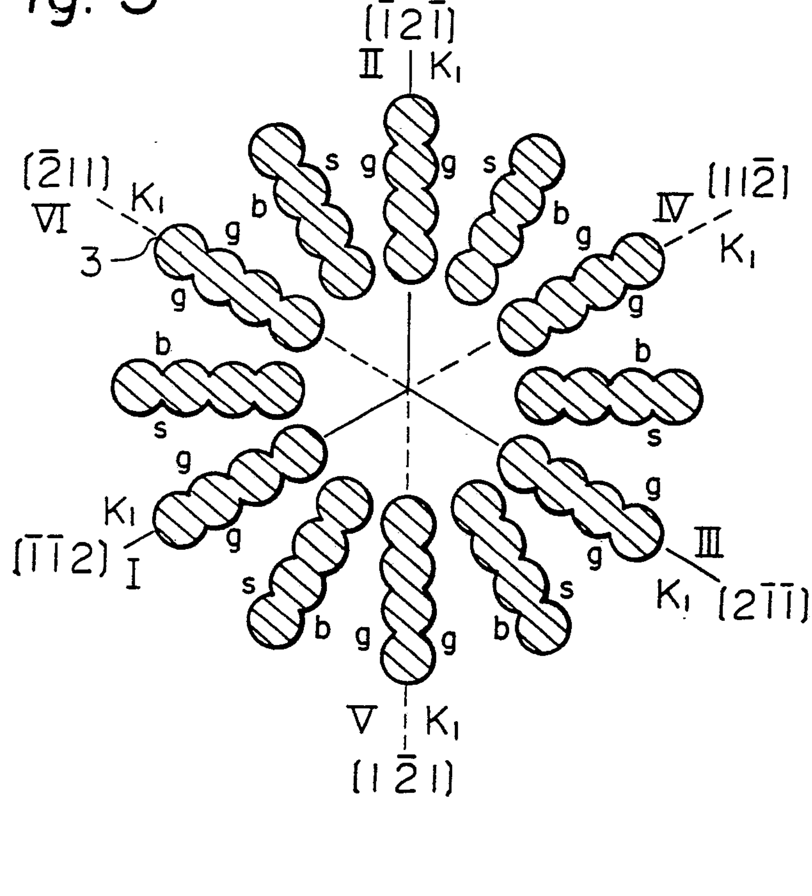
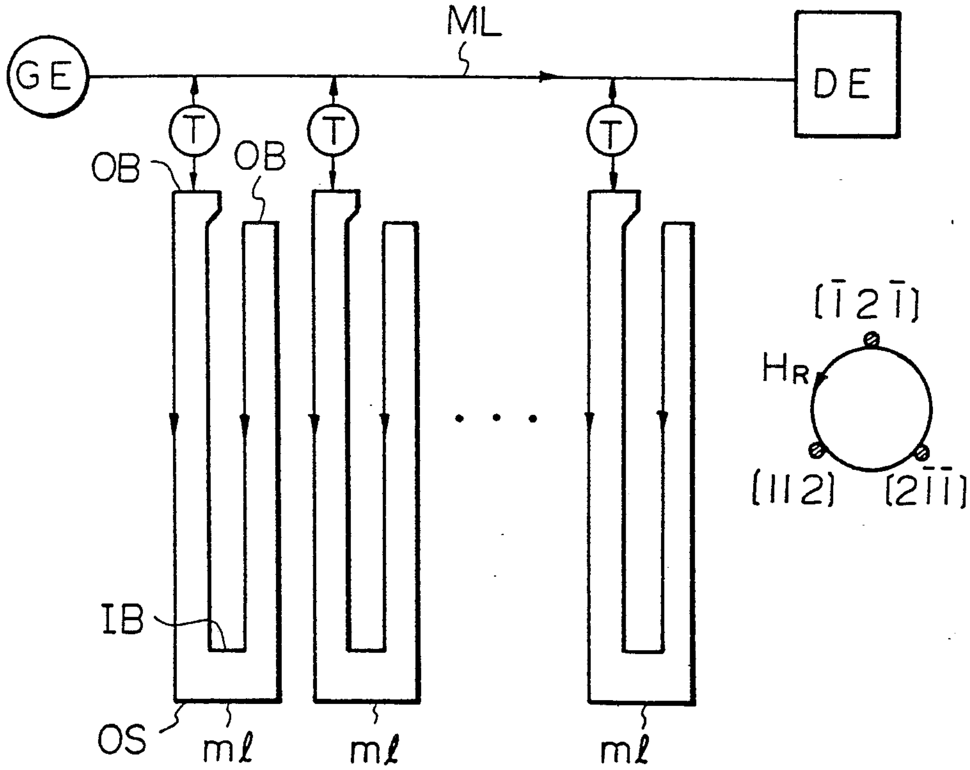


Fig. 4



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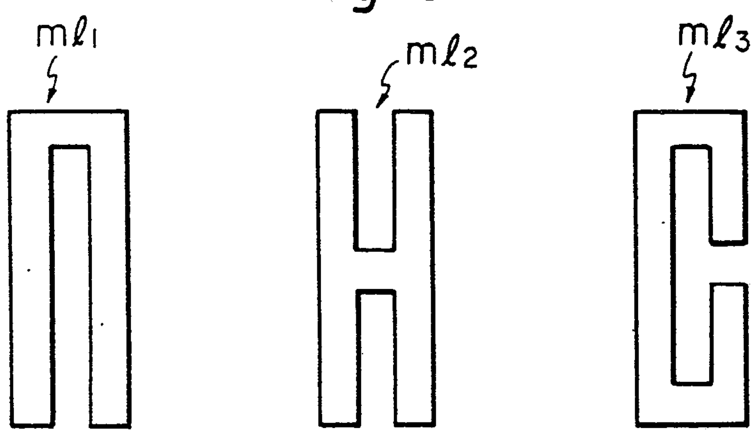

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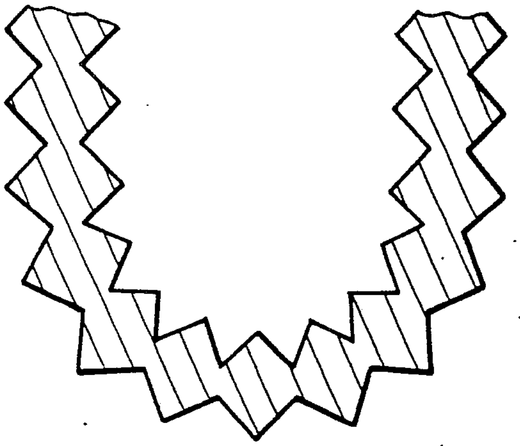

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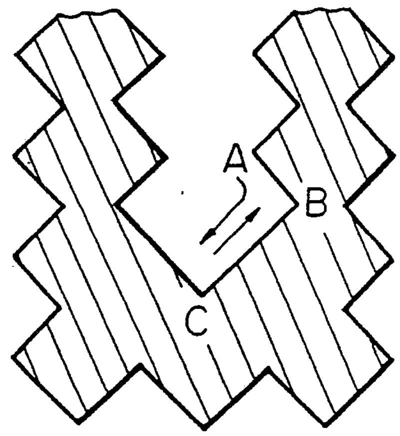

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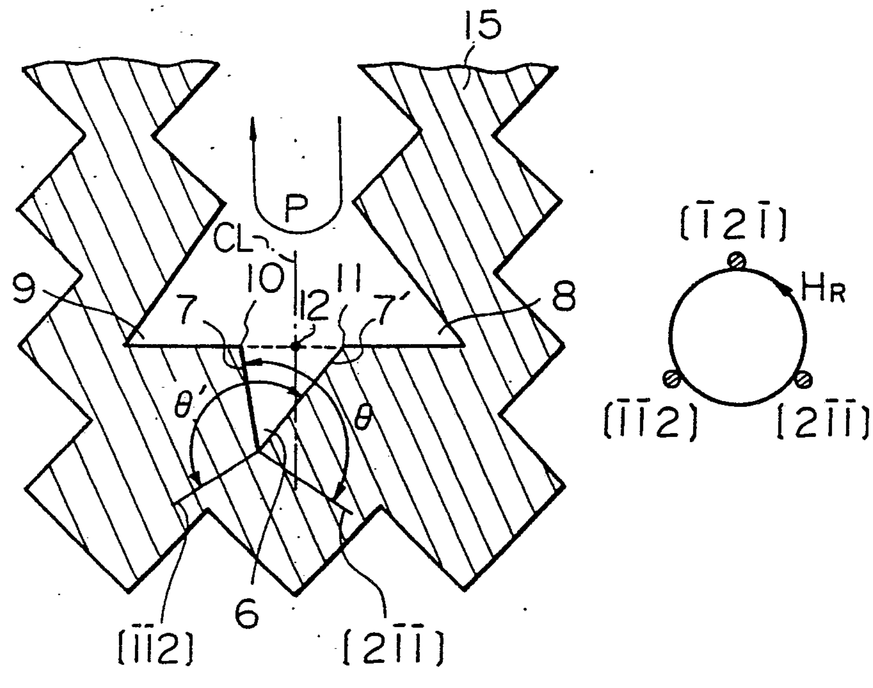

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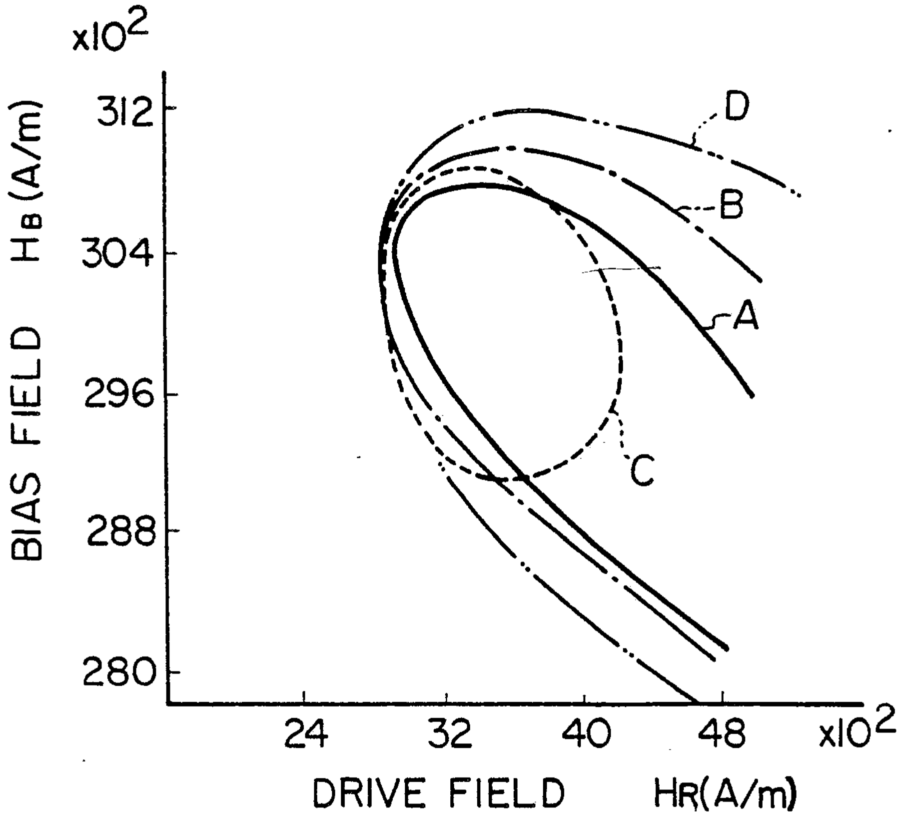
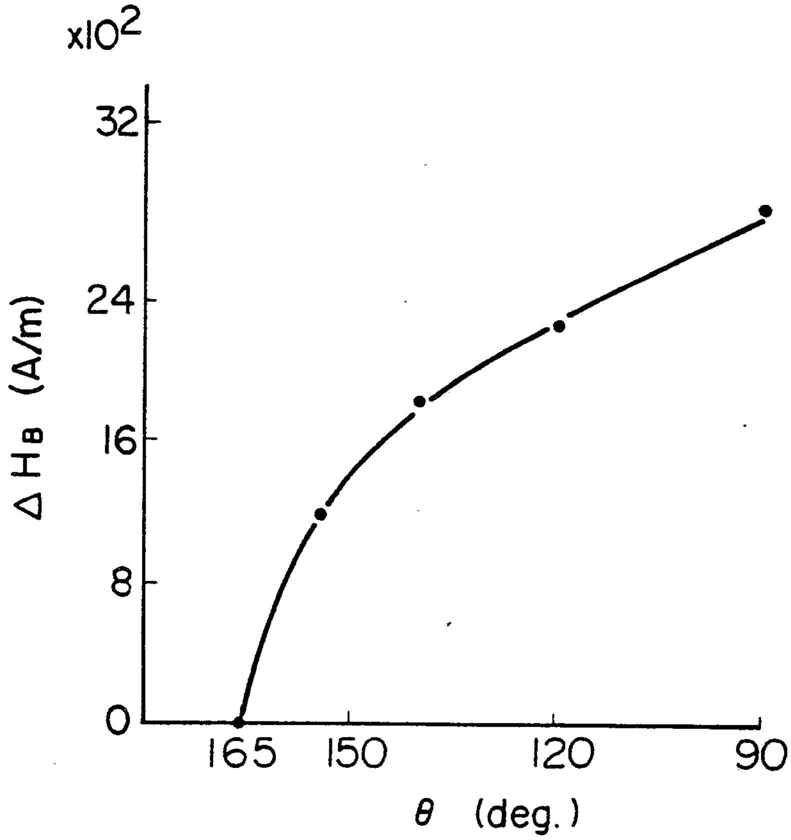

x10^2
312
304
296
288
280
BIAS FIELD HB (A/m)
D
B
A
C
24
32
40
48
x10^2
DRIVE FIELD HR(A/m)

Fig. 10



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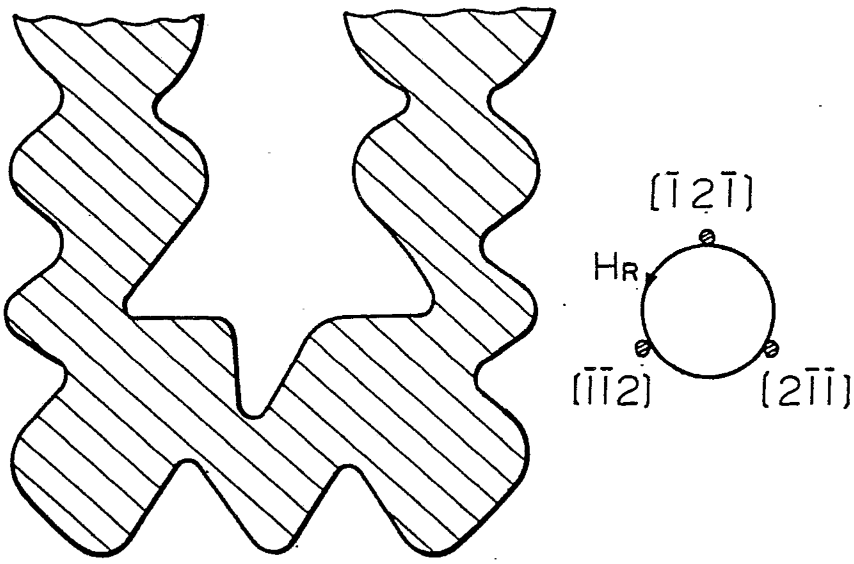

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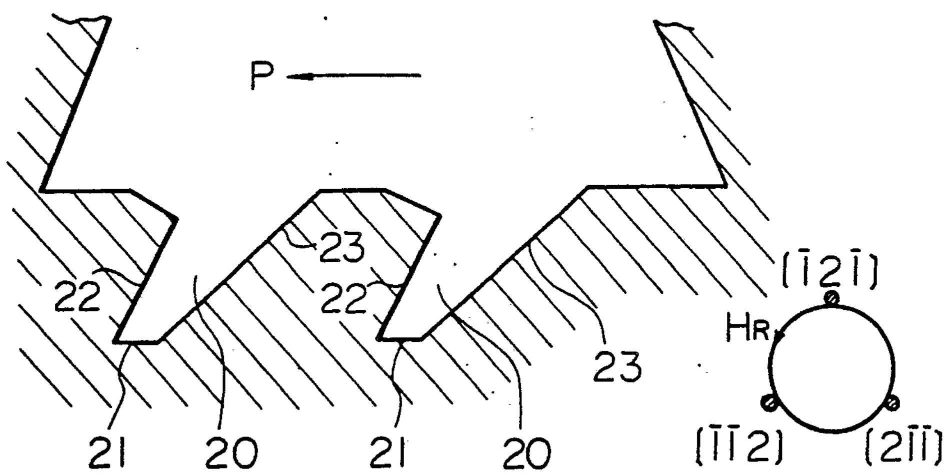

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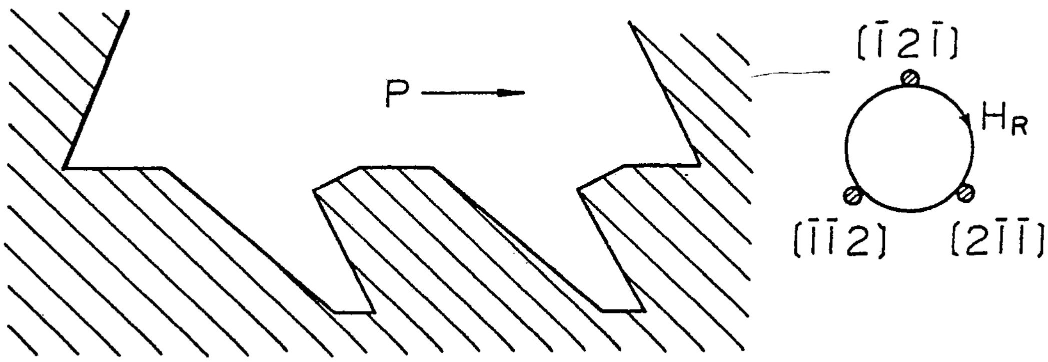

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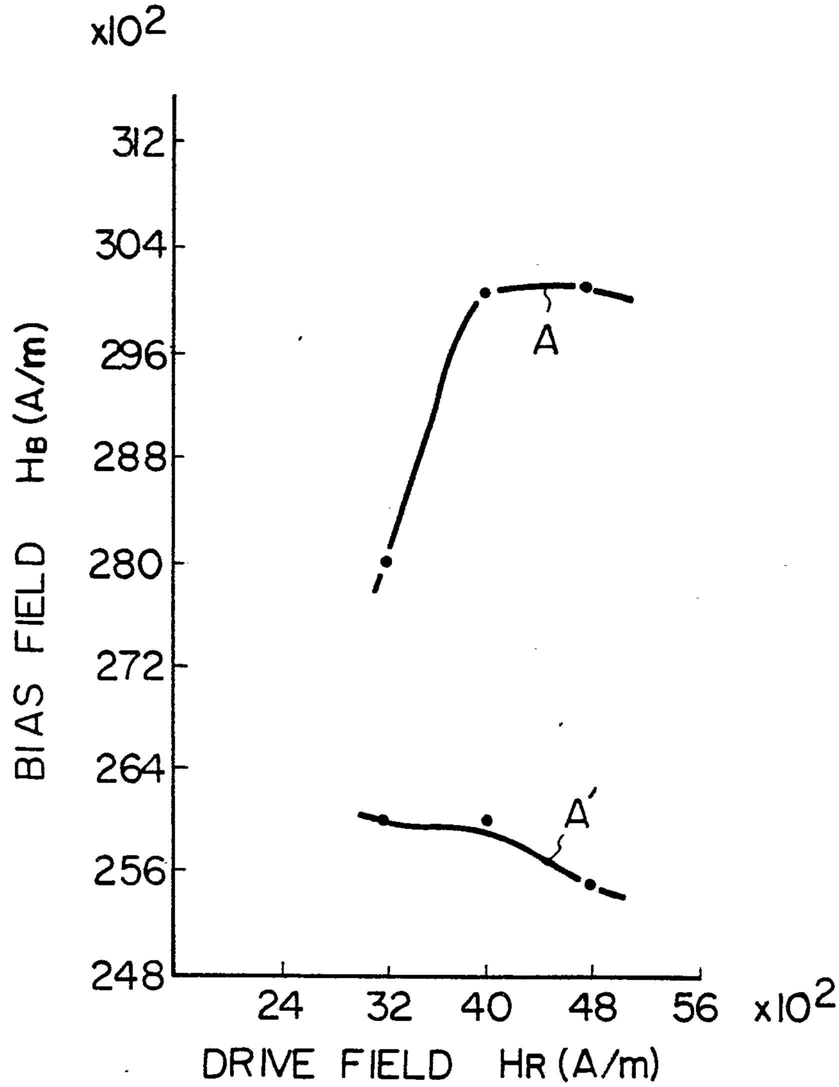

x10²
312
304
296
288
280
272
264
256
248
BIAS FIELD HB (A/m)
A
A'
24
32
40
48
56
x10²
DRIVE FIELD HR (A/m)

Fig. 15

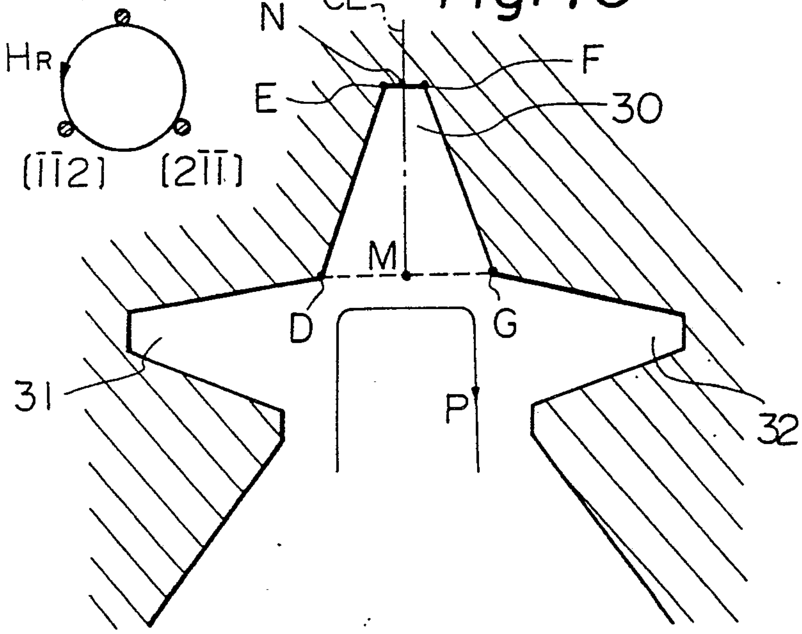

[1̄21̄]
HR
[1̄1̄2]
[21̄1̄]
CL
N
E
F
30
M
D
G
31
P
32

Fig. 16

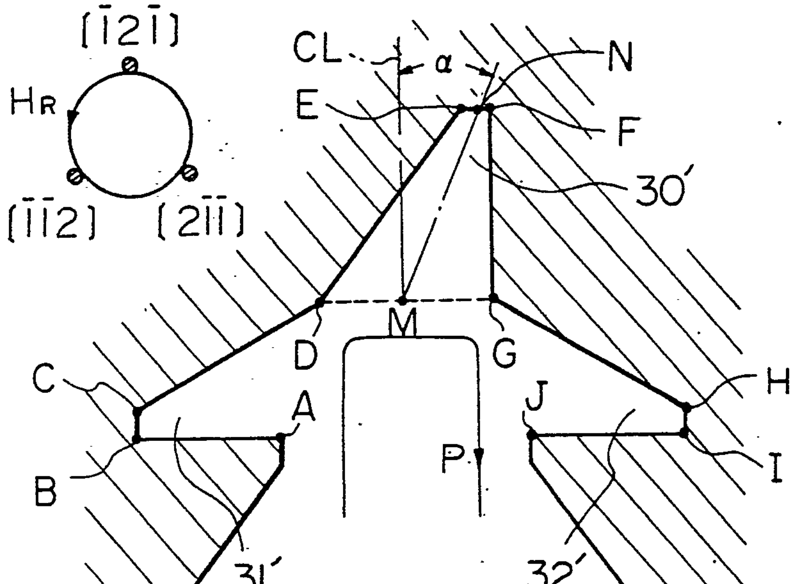

[1̄21̄]
HR
[1̄1̄2]
[21̄1̄]
CL
α
N
E
F
30′
M
D
G
C
A
J
H
B
P
I
31′
32′

Fig. 17

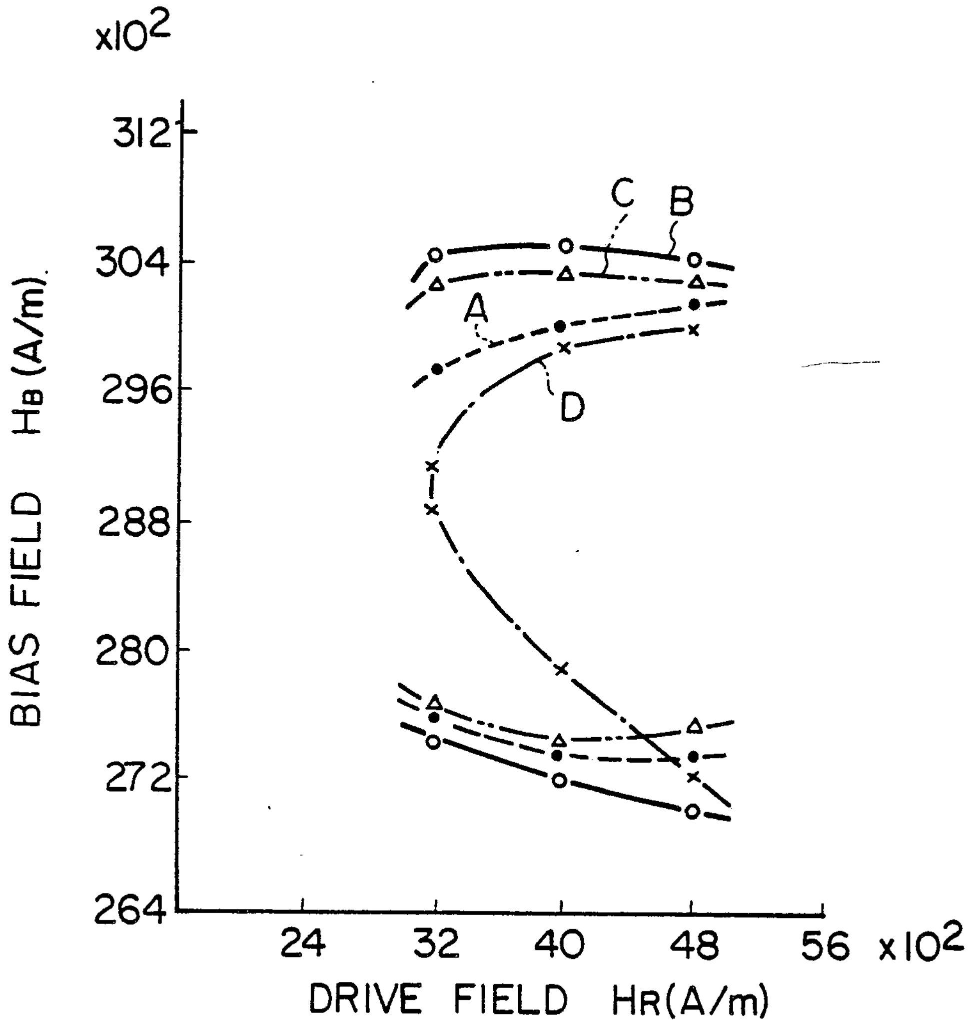

x10²
312
304
296
288
280
272
264
BIAS FIELD HB (A/m)
C
B
A
D
24
32
40
48
56
x10²
DRIVE FIELD HR(A/m)

Fig. 18

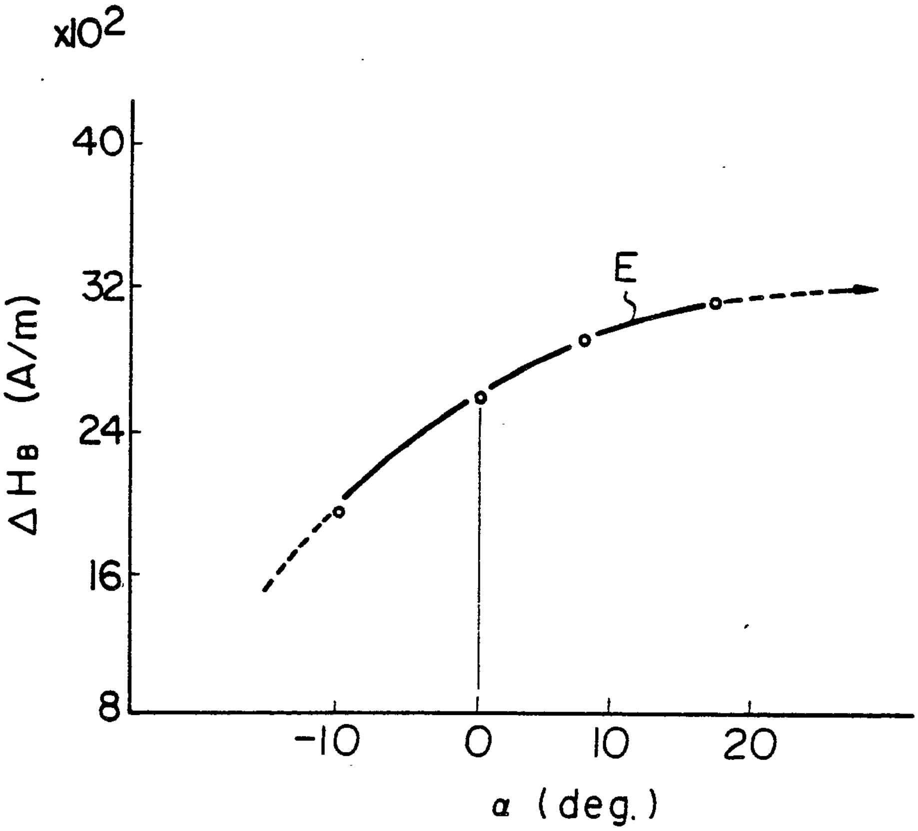
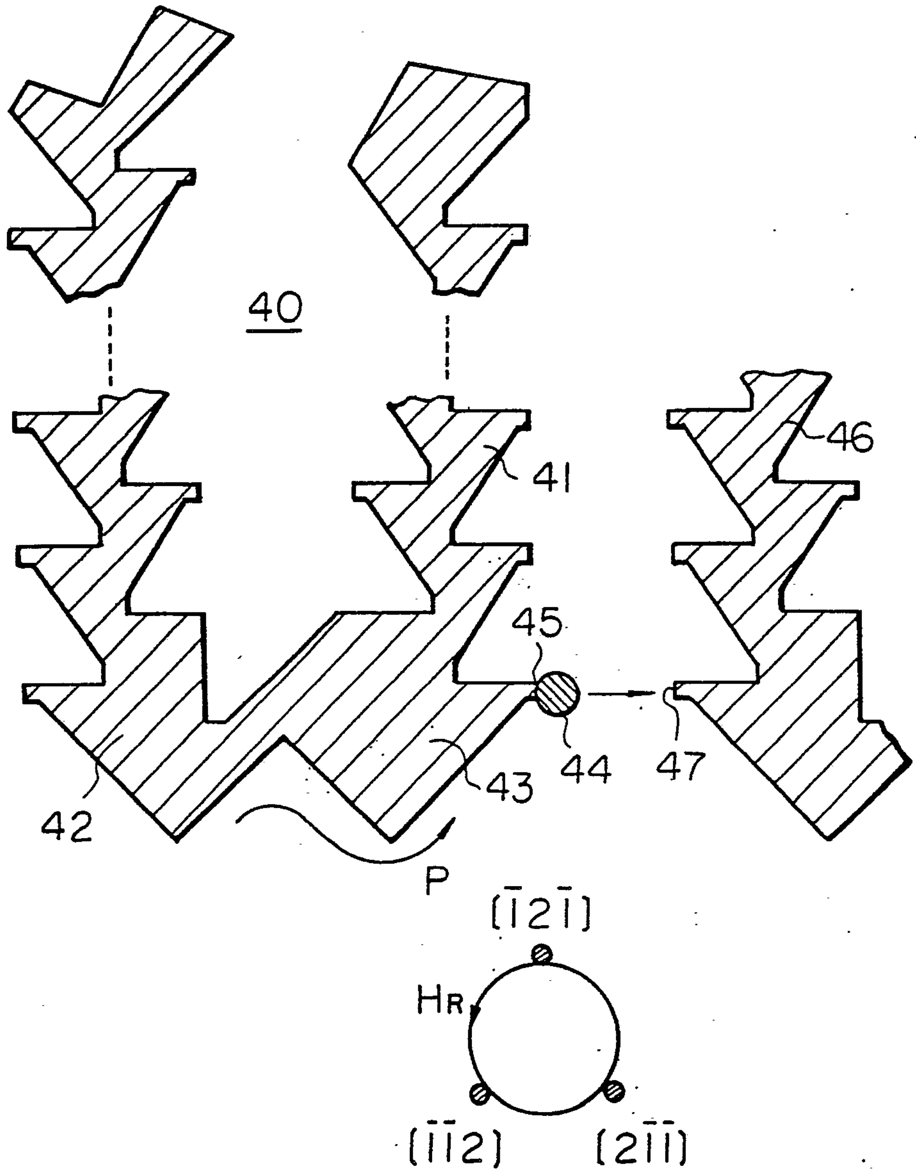


Fig. 19



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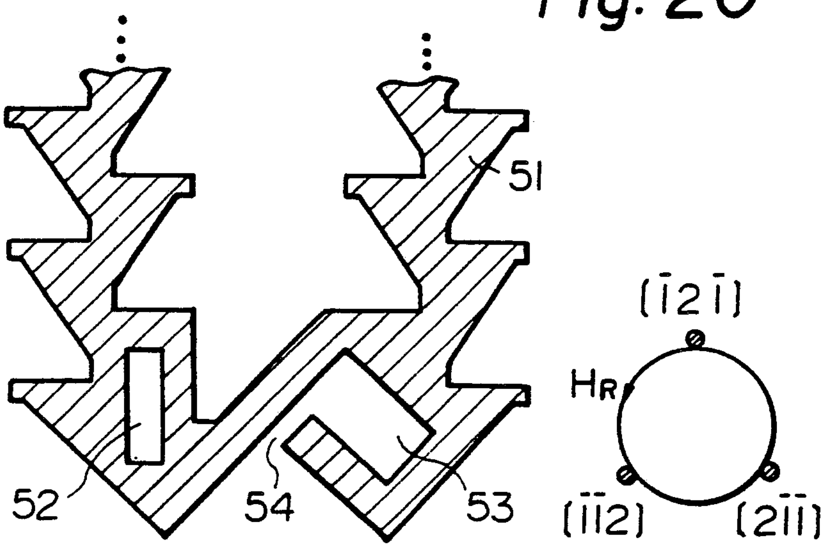

51
52
54
53
HR
[1̄21̄]
[1̄1̄2]
[21̄1̄]

Fig. 21

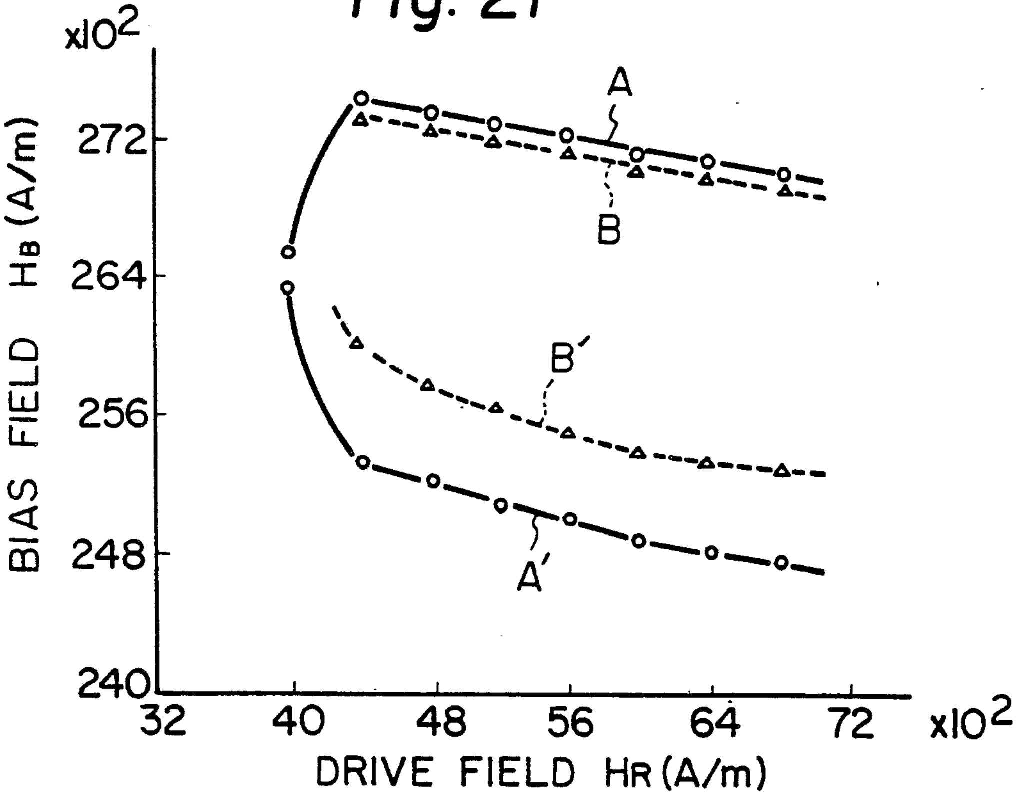
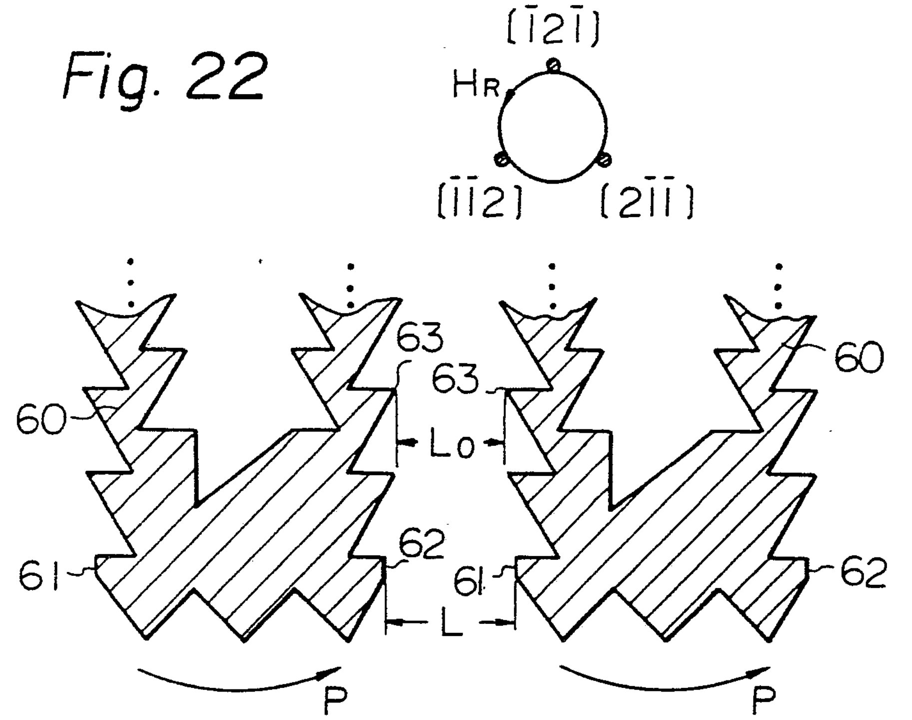
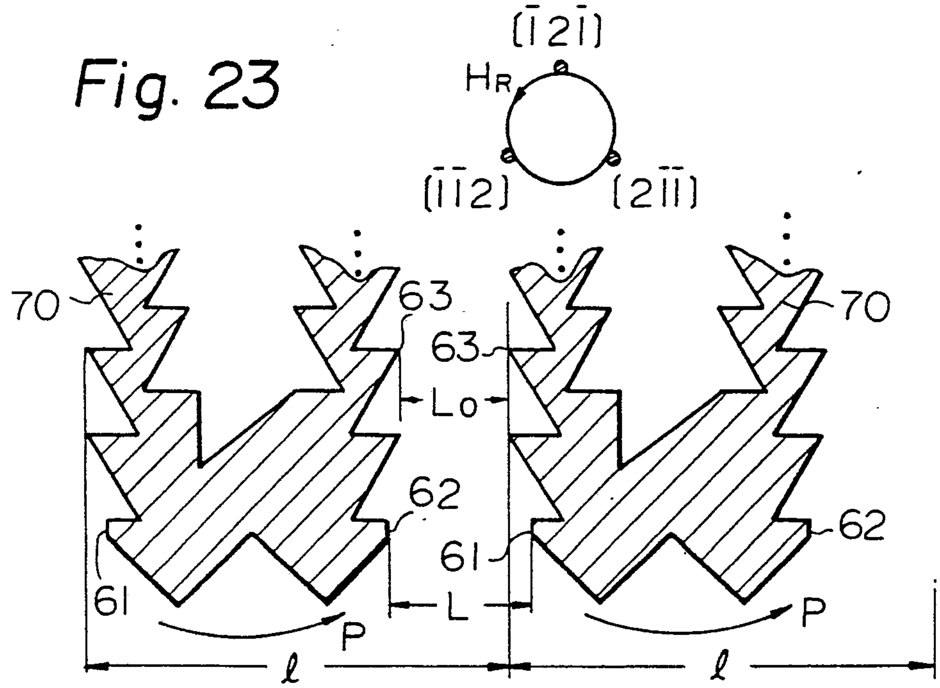

x10²
BIAS FIELD HB (A/m)
272
264
256
248
240
32
40
48
56
64
72
x10²
DRIVE FIELD HR (A/m)
A
B
B'
A'

Fig. 22



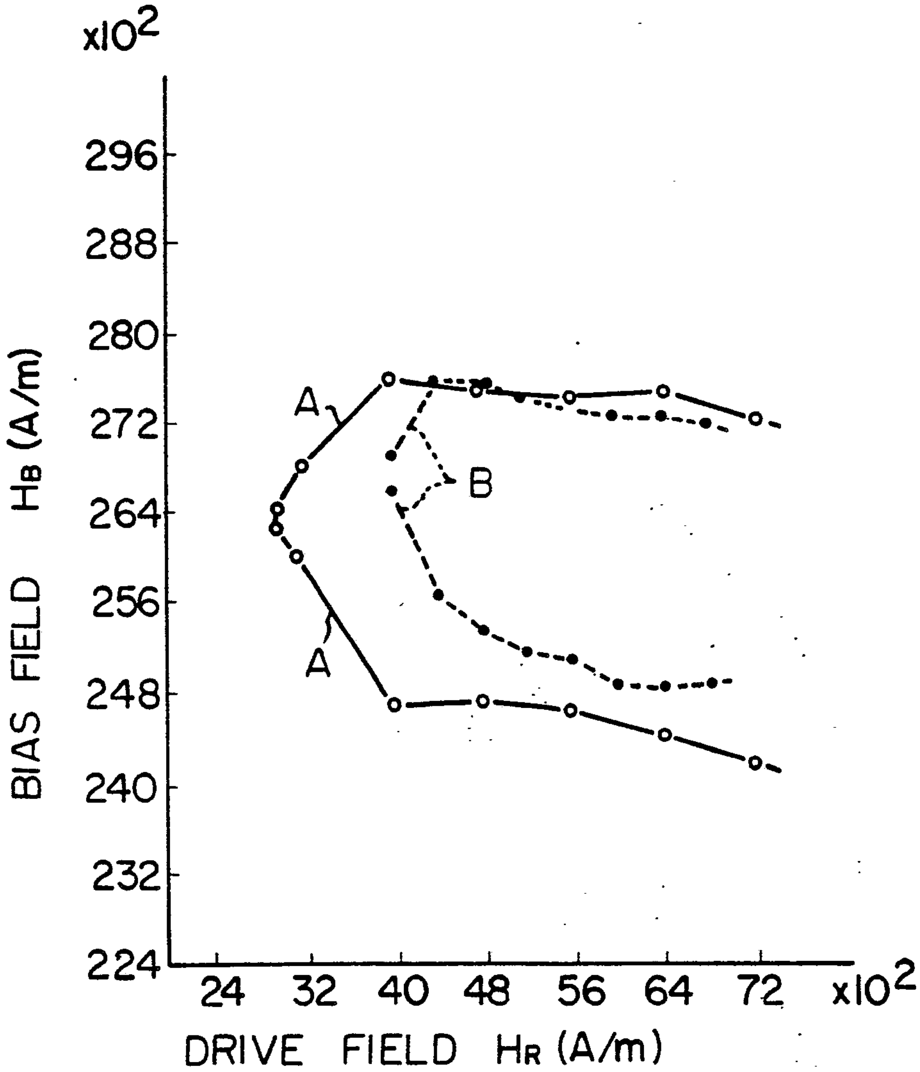
[$\bar{1}2\bar{1}$]
H_R
[$1\bar{1}2$]
[$2\bar{1}\bar{1}$]
63
63
60
60
Lo
62
61
61
62
L
P
P

Fig. 23



[$\bar{1}2\bar{1}$]
H_R
[$\bar{1}\bar{1}2$]
[$2\bar{1}\bar{1}$]
70
63
70
63
Lo
62
62
61
61
L
P
P
ℓ
ℓ

Fig. 24


x10^2
296
288
280
272
264
256
248
240
232
224
BIAS FIELD HB (A/m)
A
A
B
24
32
40
48
56
64
72
x10^2
DRIVE FIELD HR (A/m)