



iant magnetoresistive : GMR) (magnetic tunnel junction : MTJ)  
(magnetic random access memory : MRAM)

9

1a - 1b

MRAM

2

가

3

가

4 3

5

6 5

7

(super - imposed indicia)

가 가

5

8 7

3

9

10a - e

1

11a - e

2

12a - c

3

13a - c

4

109 : 120 :

122 : 124 :

130<sub>1</sub>, 130<sub>2</sub> :

(Defense Advanced Research Projects Agency)

MDA972 - 96 - C - 0030

1996 11 27 MAGNETIC TUNNEL JUNCTION DEVICE WITH NONFERROMAGNETIC INTERFACE LAYER FOR IMPROVED MAGNETIC FIELD RESPONSE 7  
 58,614 1998 6 9 5,764,567 (a continuation - in - part)

1. 'MAGNETIC MEMORY ARRAY USING MAGNETIC TUNNEL JUNCTION DEVICES IN THE MEMORY CELLS' 1997 6 17 5,640,343

2. 'MAGNETIC TUNNEL JUNCTIONS WITH CONTROLLED MAGNETIC RESPONSE' 1997 7 22 5,650,958

1. MAGNETIC MEMORY DEVICES HAVING MULTIPLE MAGNETIC TUNNEL JUNCTIONS THEREIN 09/021,342

2. INTENTIONAL ASYMMETRY IMPOSED DURING FABRICATION AND/OR ACCESS OF MAGNETIC TUNNEL JUNCTION DEVICES 09/021,515

3. LIMITING MAGNETIC WRITING FIELDS TO A PREFERRED PORTION OF A CHANGEABLE MAGNETIC REGION IN MAGNETIC DEVICES 09/021,569 (1999 8 31 5,946,228)

(a magnetic random access memory : 'MRAM')  
 (access)

(wordlines) (1, 2, 3) 1a - 1b ('MARM')  
 (bitlines) (4, 5, 6)  
 (9) (a magnetic tunnel junction : 'MTJ') (8)  
 가 (free) (24) (20)  
 가 (the easy axis : 'EA')

MRAM (reference region) 가 (refe  
 (+EA - EA) 가  
 (+EA) 가 (+EA/+EA) (- EA/

가 EA (50) 가 (hysteresis) 2  
 가 +/- H<sub>c</sub> 가 (sensitivity)가  
 ( 가 +/- H<sub>c</sub> ) ( )

vortex) (a magnetic  
 reference m<sub>free</sub> m  
 uctures) (complex micromagnetic str

3 EA (59) 가  
 +700 Oe -700 Oe +700 Oe (bias)가 가  
 가 +700 Oe -280 Oe 4  
 (50) (non - square) 가  
 가 가

INTENTIONAL ASYMMETRY IMPOSED DU  
 RING FABRICATION AND/OR ACCESS OF MAGNETIC TUNNEL JUNCTION DEVICES  
 MRAM

가 6

(giant magnetoresistive : 'GMR' )

가 (parametric window)  
가 . ,

가 가  
가 가 .

가 . ,  
가 . ,

1

( ,

) 1  
1

1  
가  
. 1  
.

, 1  
1

1 50%

1  
relationship)

1

1  
1

(a conductive re  
1

1

(an insulating relationship)

가

가 1

1

1  
1

가

가

1

1

1

, 1  
.

1

가  
,  
1

가  
1

1

가

가

7 13  
5,650,958

1a - 1b

5,640,343

가

1a , MRAM

(1, 2, 3)

(4, 5, 6)

1b

(9)

1a  
(7)

(a magnetic tunnel junction : MTJ)(8)

3  
(9)

3  
(stack)

MRAM

가

가

(9)

(9)

가

(9)

, MTJ,

1a

, MRAM

가

MRAM

1b

(9)

(9)

(3)( 1a )

(3)

(9)

,

(7)

MTJ(8)

(7) n

(10) p

(11)

(7) p

(11)

(stud)(12)

MTJ(8)

(7) n (10) (3)

MTJ(8) 1b MTJ(8) Pt ( (

型板) (template layer)(15) , (permalloy)(Ni - Fe) (ferromagnetic layer)(1

6) , Mn - Fe (an antiferromagnetic layer)(AF)(18) , Co, Fe

(FMF)(20) , (Al<sub>2</sub>O<sub>3</sub>) (22) ,

Co - Fe (軟質) 가 ' (free) ' (FMS)(24) , Pt (25)

(24) ('EA') (優向軸, preferred axis)

(24) 가 가 가

(20) (24)

(unidirectional anisotropy direction)

strain - induced) (24) MTJ (intrinsic anisotropy), (

(24) 가 L (shape anisotropy) MTJ(8)

(24) L W , L W ( 1b).

AF (18) Pt, Cu Ta (15) (16) 111 (16) Fe - Mn

(blocking temperature)

AF (15) 가 ,

(16) 가 (magnetic anisotropy) (magnetostriction)

가 .

AF (exchange coupling) , 가

가 . MTJ 가

MRAM

MRAM 가 , 가 MRAM , MTJ  
 ing field) . 가 (the switch  
 . MTJ  
 ( ) (7) MTJ(8)  
 . Al<sub>2</sub>O<sub>3</sub> (22) Al<sub>2</sub>O<sub>3</sub> 가 Al<sub>2</sub>O<sub>3</sub> (22) ,  
 (22) 가 Al<sub>2</sub>O<sub>3</sub> 가 가  
 가 MTJ(8)  
 가 (spin polarized)  
 (spin up) (spin down)).  
 (interface) (a spin filter) 2  
 1 2 가 1 2 가  
 1 2 1 2 , 1 2  
 가 1 2 가 (0 1)  
 (100%) 7 , (69)  
 25% 50% 가 가  
 가 (가 , ) ,가  
 가 가  
 7 100%( 74) 50%( 72) 25%( 70) , 8  
 (compatibility) (tolerance)가  
 9 , 9 (122) (124)  
 (109)가 (120) (124)  
 (124) 가 (124)  
 (122) (120) ) 9 (130<sub>1</sub>, 130<sub>2</sub>)(  
 (124) 가

10 13 ,  
 ( , (7))  
 10 13 . ( , , )  
 가 .)

10a 10e (209) 1 가 10a  
 , (220') ( , MnFe, NiFe, ) , (222') ( ,  
 Al, Al<sub>2</sub>O<sub>3</sub>, Al, SiO<sub>2</sub>) , (224') ( , NiFe  
 ) (200) ( )가 10b  
 (200)  
 10c (230<sub>1</sub>' , 230<sub>2</sub>' ) 가 10d  
 (200) 가 (220' , 222' , 224' ) (230  
 1' , 230<sub>2</sub>' ) ( , Al<sub>2</sub>O<sub>3</sub> SiO<sub>2</sub>)  
 10e (224) ( )  
 224) (222) (230<sub>1</sub>' , 230<sub>2</sub>' ) (224)

11a 11e (309) 2 가 11a  
 (320' ) , (322' ) , (300)가 11b  
 (320' , 322' , 300) (300) . 11c  
 , (320' , 322' ) (330<sub>1</sub>' , 330<sub>2</sub>' ) 가  
 11d (300) , (322' ) (32  
 0' ) 가 (330<sub>1</sub>' , 330<sub>2</sub>' ) ,  
 11e (324) (320' ) ( )  
 322' ) (309)가 (324)  
 (330<sub>1</sub>' , 330<sub>2</sub>' )

12a 12c (409) 3 가 12a  
 (420' ) , (422' ) ,  
 (200) (430' , 430<sub>2</sub>' ) (422' )  
 (430<sub>1</sub>' , 430<sub>2</sub>' ) , (422' )  
 12b (200)가 가  
 , 12c (200)가 (424) (422)  
 (424)  
 (430<sub>1</sub>' , 430<sub>2</sub>' )

13a 13c (509) 4 가 13a  
 (520' ) , (Al) (521' )  
 , (522' ) ( Al  
 (522' ) ) , (524' ) (500)가  
 , (O<sub>2</sub>) (501' ) , (an anneal step)  
 (530<sub>1</sub>' , 530<sub>2</sub>' ) Al<sub>2</sub>O<sub>3</sub> (500)가 13c (500)  
 (521) (522' ) (509)가 (524) (522' )  
 , (530<sub>1</sub>' , 530<sub>2</sub>' ) , /  
 (524)

implantation) (irradiation) 가 가 (additive process) (subtractive approach) 가 . (가 , (

(self - masking structure)

(MTJ)

(current scattering effect)

(GMR)

MRAM

가

가

가

(stimulus) 가 가

LIMITING MAGNETIC WRITING FIELDS TO A PREFERRED PORTION OF A CHANGABLE MAGNETIC REGION IN MAGNETIC DEVICES

가 , 'MAGNETIC MEMORY DEVICES HAVING MULTIPLE MAGNETIC TUNNEL JUNCTIONS THEREIN' 가 ( , )

'INTENTIONAL ASYMMETRY IMPOSED DURING FABRICATION AND/OR ACCESS OF MAGNETIC TUNNEL JUNCTION DEVICES'

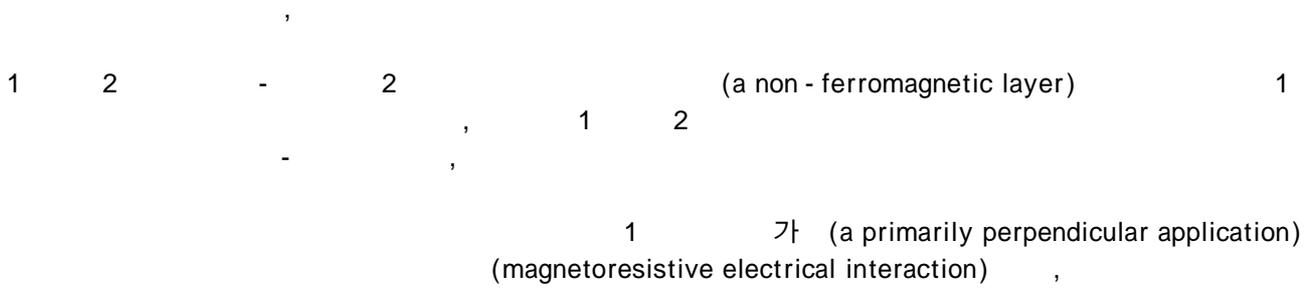
가

가

(a magnetic random access memory : 'MRAM')  
(access)

(57)

1.



1

7.



8.



11.

가 가 1 ,  
 1 2 ,  
 가 1 , 1  
 가 1 1 1 1

14.

11 ,  
 1

15.

2 가 가 1 ,  
 가 1 , 1 ,  
 1 1 ,  
 1 2 ,

16.

11 ,

19.

가 2 가 1 1 ,  
1 가

23.

가 가 1 1 -

24.

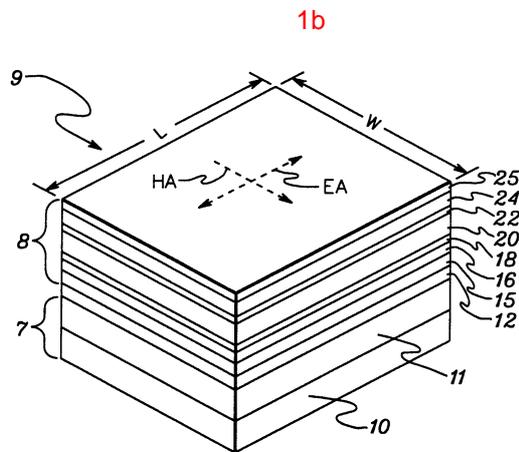
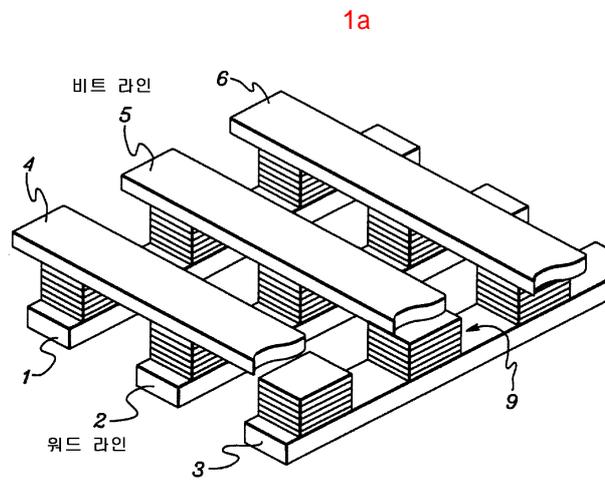
19 ,

26.

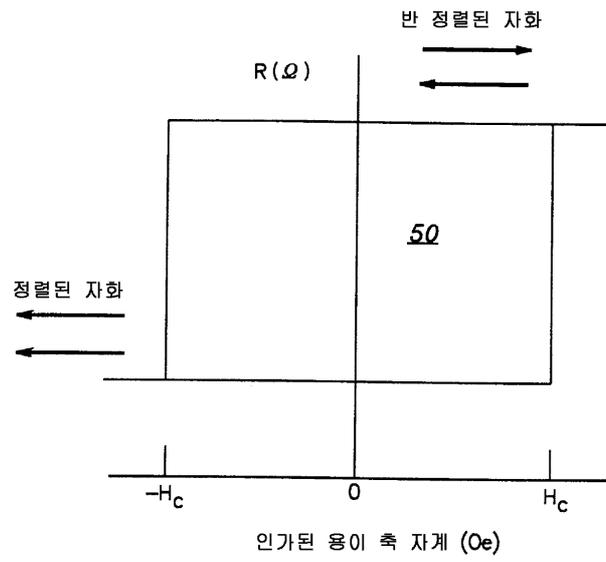
1 가 —  
— , 1 , 가 가 1  
1 1

33.

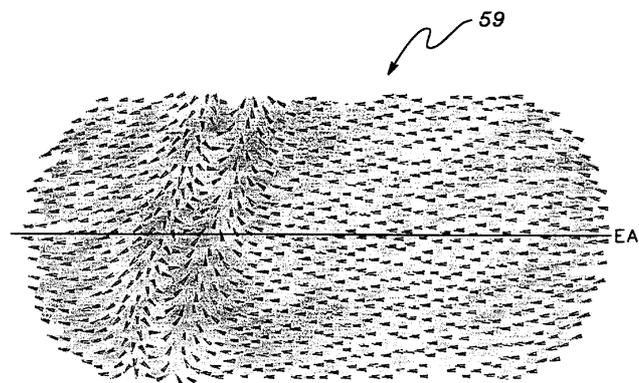
1 가 1 가 1



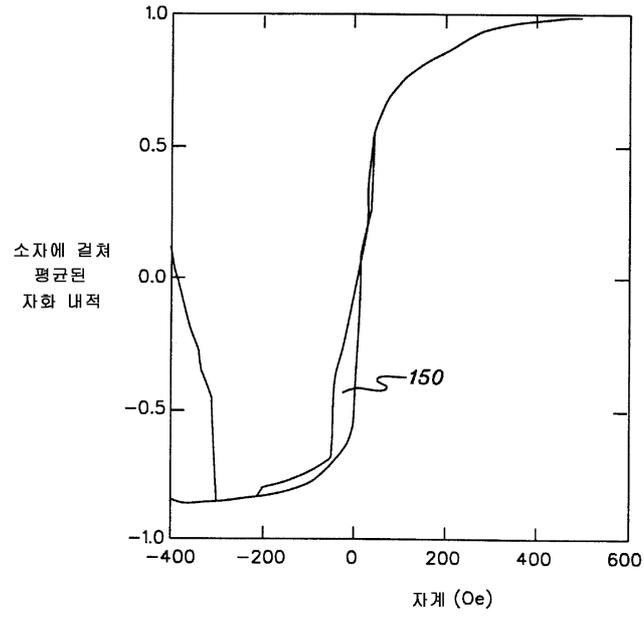
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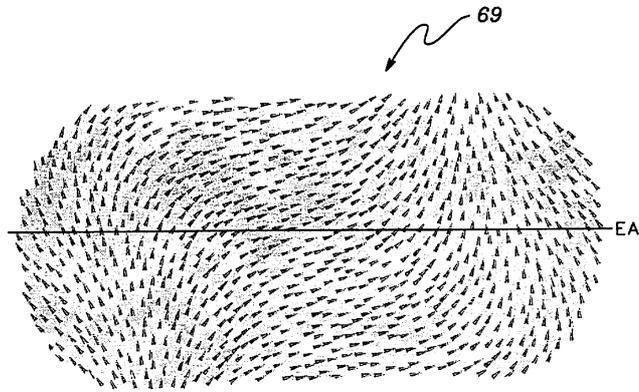
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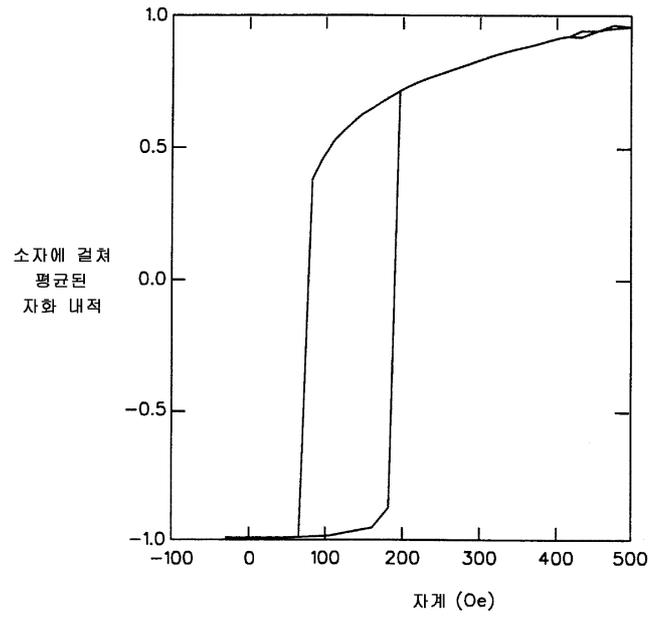
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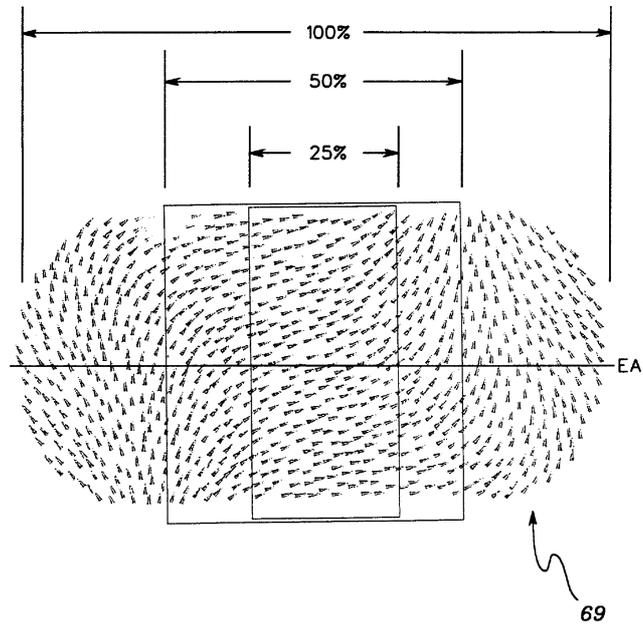
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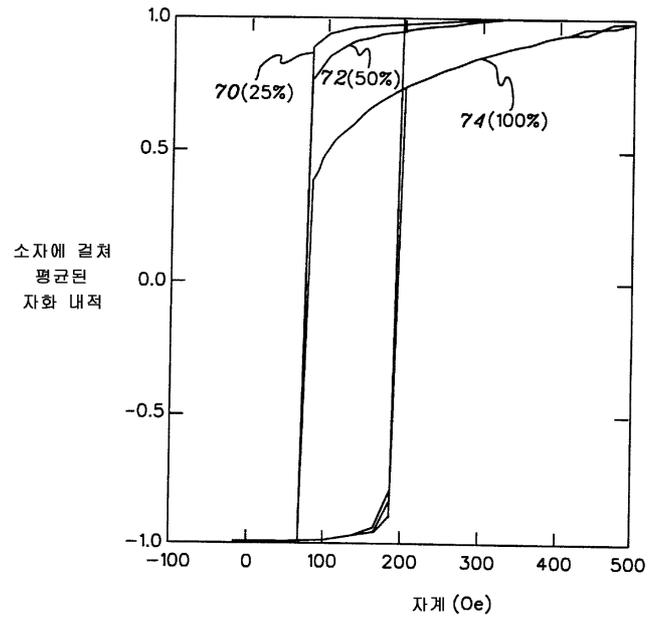
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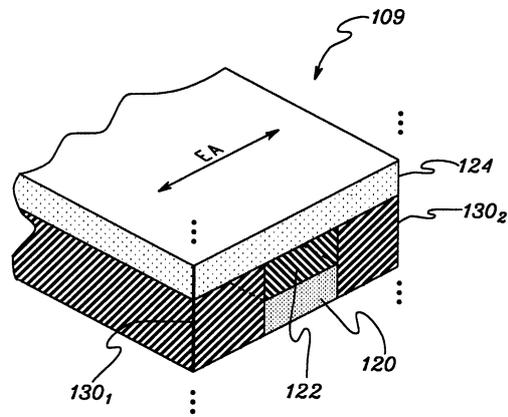
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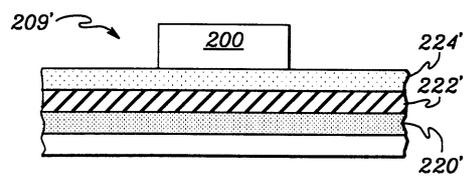
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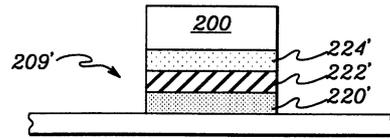
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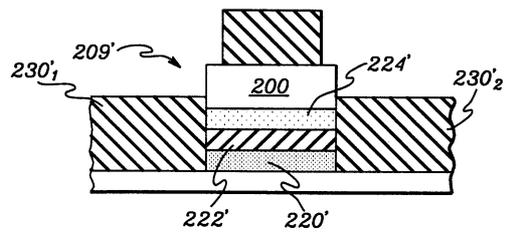
10a



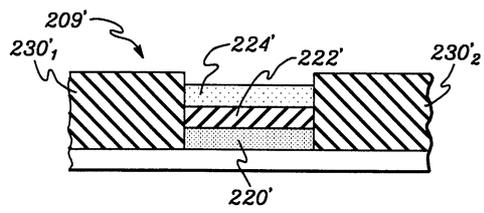
10b



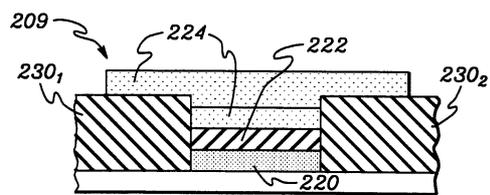
10c



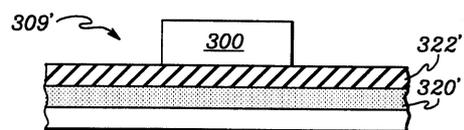
10d



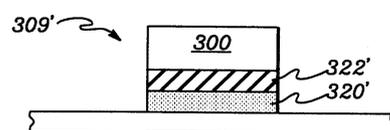
10e



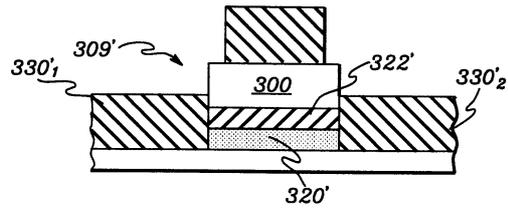
11a



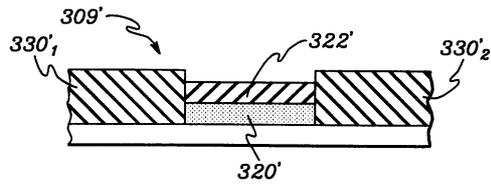
11b



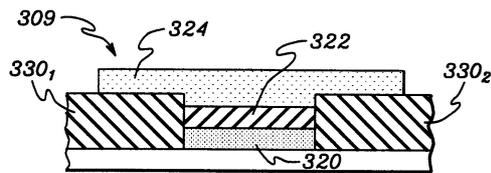
11c



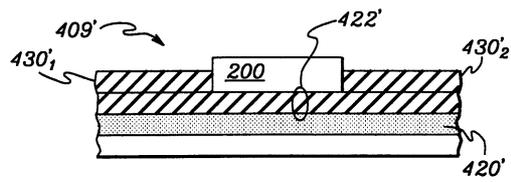
11d



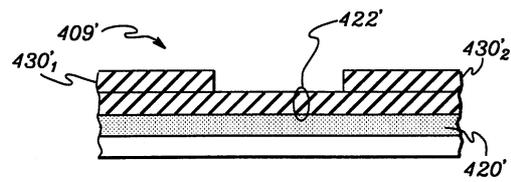
11e



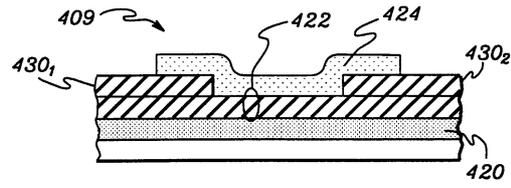
12a



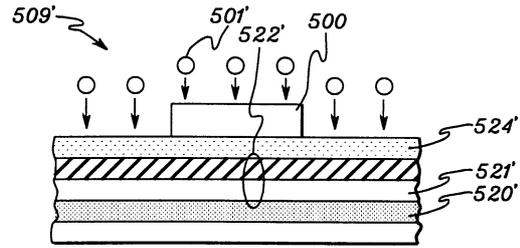
12b



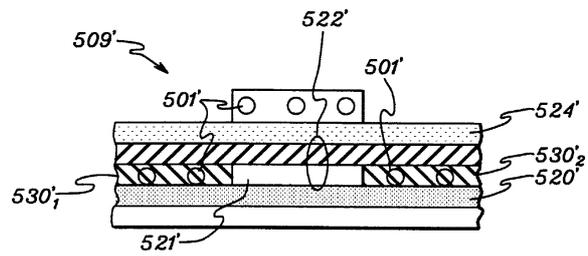
12c



13a



13b



13c

