

(19) (KR)  
(12) (A)

(51) 。 Int. Cl. 7  
H01L 27/112

(11)  
(43)

2003 - 0014653  
2003 02 19

(21) 10 - 2002 - 0046850  
(22) 2002 08 08

(30) 09/924,577 2001 08 09 (US)

(71) - ( )  
( 94304) 3000

(72) 95070 가 5085  
94087 1161  
94306 3234

(74)

:

(54) 가

P 가 (" OTP" ) (700) . OT  
(790) (230,330) (790) (430,530)  
가 (790) , 가 (790)  
가 (280,380) 가 (280,380)가  
, (230,330) 가 (230,330)  
, (790) 가 , 가  
가 .

1a

1a (anti - fuse) (resistance characteristic)

,

1b

,

1c

/

,

1d

-

,

2a

OTP

1

,

2b , 2a

,

(cross - point nature)

,

2c 2d

2a

,

3a

OTP

2

,

3b , 3a

,

,

3c 3f 3a

,

4a

OTP

3

,

4b , 4a

,

,

5a

OTP

4

,

5b , 5a

,

,

5c

5a

,

6a

2

,

6b 6c

3

,

6d

3

,

6e 4d 3 ,  
 7a 2 ,  
 7b 7c , , ,  
 7d (equalized potential  
 sensing method) (current sensor) ,  
 8a 8b , , .

200 : 210 :  
 220 : 1 230 :  
 240 : 250 : 2  
 260 : 280 :

, " VERTICALLY ORIENTED NANO - FUSE AND NANO - RESISTOR CIRCUIT ELEMENTS"  
 \_\_\_\_\_ , " ONE - TIME PROGRAMMABLE FUSE/ANTI - FUSE COMBINATION  
 MEMORY CELL" \_\_\_\_\_ , " ONE - TIME PROGRAMMABLE VERTICA  
 LLY ORIENTED FUSE AND VERTICALLY ORIENTED FUSE/DIODE UNIT MEMORY CELL AND ONE - TIME  
 PROGRAMMABLE MEMORY USING THE SAME" \_\_\_\_\_

가 (programmable memory device) .  
 , (vertically oriented fuse) (fuse and anti - f  
 use combination unit memory cell) 가 (one - time programmable storage de  
 vice) .  
 , 가 가 . 가 , ,  
 , 가 가 .  
 , 가 (non - volatile me  
 mory), .

(one - time programmable; OTP) 가 (re - progra  
 mmable) . , OTP 가 (charge  
 storage)(EPROM), OTP 4) 가 1) (anti - fuse), 2) , 3) (charge  
 (breakdown) 가 - - (metal - insulator - metal)  
 , 가 , 10V (large drive transistor)가  
 , (access transistor)  
 가 (planar fuse)  
 8<sup>2</sup> ( (minimum photolithographic feature size) )  
 , (end) (contact region) , 가  
 , 8<sup>2</sup> , 가 가  
 , 가 .  
 EPROM , (write voltage) - ( (floating gate) )  
 Fowler - Nordheim electron tunneling) . EPROM OTP  
 , 가 .  
 ROM , OTP ROM ( (field programmed) " ,  
 enable) 가 , ROM " , ROM 가  
 , ROM ,  
 OTP , (cross - point memory) 4<sup>2</sup>  
 substrate) , (single plane of memory) , (single crystal silicon  
 (sense and programming electronics) ,  
 OTP 가 .  
 , 가 (OTP)  
 (row direction) (row conductor)  
 (column conductor) (intersection)  
 (cross - point)가 ( (electrical contact) )  
 state element) .

, OTP  
 (ground)  $(V_{WR})$  가 , ,  
 (critical voltage drop)  $(V_c)$  가  
 , OTP  
 $(V_{RD})$  가 , ,  
 가 1 ( ) 가  
 2 ( )  
 가 OTP 가  
 가,  
 OTP  
 가 4 2  
 가  
 가 (OTP)  
 , OTP  
 가 1 가  
 1a  $(t_0)$   $(V_C)$  가 , 가  $(R1_{AF})$   
 $(R2_{AF})$   $(V_C)$  가 ,  $(t_1)$   
 가  
 (insulating material), (conducting material)  
 (multi - layer stack), (dispersed conductive inclusion)  
 (amorphous) (crystalline) , (phase change material), (Si)  
 (silicide - forming metal)  
 (sandwiched) 가 가가 가  
 $(SiO_x)$ ,  $(SiN_x)$ ,  $(SiO_xN_y)$ ,  $(AlO_x)$ ,  $(TaO_x)$ ,  $(TiO$   
 $x)$ ,  $(AlN_x)$  ,  $(Si)$ ,  $(Ge)$ ,  
 ,  $(InTe)$ ,  $(SbTe)$ ,  $(GaAs)$ ,  $(InSe)$ ,  $(InS$   
 b) , , , , ,  $(Sn)$ , , ,  $(Pb)$ ,  
 $(Bi)$  가 , , ,  $(W)$ ,  $(P$   
 $t)$ ,  $(Pd)$ ,  $(Co)$ ,  $(Ni)$ ,  $(Ti)$

n) Quantum mechanical tunneling current)가  
 m 가 (polycrystalline) 0.5 (nm) 50 nm 가 (pre-breakdown conditio (significant q 5 nm 1 nm 100 n

가 가 가 가 가 가

100 (V<sub>C</sub>) - μm<sup>2</sup> 가 (V<sub>C</sub>) (metal migration) 10<sup>7</sup> - μm<sup>2</sup> (current transport) 가 가

(open circuit)가 (thin film resistor) (low melting metal)( refractory metal)( transition metal)(

1b (t<sub>1</sub>) (I<sub>C</sub>)가 (thermal runaway) (R<sub>1F</sub>) (R<sub>2F</sub>)가 (R<sub>1F</sub>) (R<sub>2F</sub>) (I<sup>2</sup>Rt 가 (heating) (dissipation of po (t<sub>2</sub>) 1 2

1 (I<sub>C</sub>) 가 1 가 (V<sub>R</sub>) 가 1 2 1 2

1c, / ( ) ( )  
 (R1<sub>AF</sub>) (t<sub>0</sub>), V<sub>C</sub>가 가 ,  
 (t<sub>1</sub>) (t<sub>1</sub>) /  
 (I<sub>C</sub>)가 가 .  
 (t<sub>2</sub>) 가 (R2<sub>F</sub>) 1c (t<sub>2</sub>) 0 .  
 inite resistance)( R1<sub>AF</sub> ) 1 (f  
 가 2 (infinite resistance)( (R2<sub>F</sub>) ,  
 ( 1c ).  
 2 , (V<sub>C</sub>) 가 1 (t<sub>0</sub>) (t<sub>2</sub>)  
 가 가 가  
 가 가 1d 가 -  
 2 (vertical height) (lat  
 eral thickness) 1 , 1 30 1  
 , 2 가 , 2 (V<sub>C</sub>)(  
 1 ) 가 1 2 (I<sub>C</sub>)( , 1  
 가  
 , 1 2  
 (equipotential method)  
 2a OTP (200) 1  
 280) (230) (200) , 1 (200) 1  
 (230,280)가 (closed region)(285) .

, (230) ( )

, OTP 가

(200) (210) , (210) (closed region)(285)  
1 (220) , (280) (285) (center region) (oc  
copying) (insulating plug)(240) , 2 (250) (260)( 1  
(220), (230) (240) )

(280) , , , , , (low melting  
temperature) , , (230) , , ,

(260,210) , , , , ,  
(220,230) (240) (260,210) . 1 2

(240) , (void)  
(230) (230)

(240) (230) , (280)  
(230)

2a (285) (260)가 (230) ,  
(210)가 (280) 가 , 2a (285)  
(260,210) (conductive path)가  
(210) , (230) , (280) , (260)  
(210) , (230) , (280) , (260)

2b , (260,210) (115) (285) (edge)  
(230) (240) 2a (200)  
(280)( 2b ) (240) (230) 가 ,  
(230) (260,210)  
215) (215)( ) (285) ( )  
(260,210) , (285)

, 1 2 (220,250) 2b , , (230)  
(240)가 (215) . , (260) (spacer)(230)  
(240)

, 2b, (285) (285) (annulus) (230)  
 (285) (240) (cylindrical)  
 ellipse), (285) (enclosed shape), (rectangular), (square), (  
 (240)

2c 2d 2a 1 2c (290) (2  
 00) 2d (290,290b)가  
 (290 / 290b) (280)  
 (230) (280) (290 / 290b)가 (  
 280) (Schottky) (ohmic) (290 / 290b)가 (  
 (230) (290 / 290b) , ,

2c (290)가 (285) (280) (230)  
 (280) 가  
 2d (290b) 2c 1 (290)가 (280) (230) , 2  
 (210) (280)  
 (290 / 290b) (260) (210)  
 가 가 (260)  
 (210)  $I^2Rt$

가 (290 / 290b)  
 tact) (rectifying or ohmic con  
 가 (290 / 290b) (210,260)

가 (260,210) (290 / 290b)

3a OTP (300) 2  
 1 (300) (330) (330)  
 (320) (330)

(300) (bottom) (310) (330) (310)  
 U' (385) 3a (330) 3d  
 (300) 'U' (385)  
 (340) (300) 'U' (385) (380) (360)  
 (320)

, (340)가 , 'U' (385) .

3b 3a (300) , (360)  
 (380) (380)( 3b )  
 (330) (340) (380)  
 (definition insulating) (patterning) (plane of the film)  
 (330) , (340) (310)(  
 3b ) 'U' (385)

3c 3f 3a (300) 3c , (3  
 90)가 (330) (380) , 1  
 (300) (390) 3c  
 (390) 3b (315)

3d , 'U' (385) , 3a (300) 3d  
 , (330)  
 , 3e (390)가 'U' (385) 가  
 (330)가 'U' (385) (330)가 (380)  
 가

3a 3e (330) , (340) , 'U' (385)  
 (310) 2  
 , (330) (360) 1 (330)  
 (360) (inverted) 'U' (385) (340)  
 'U' (385) (300) (310)  
 'U' (385) (380) 가 3f

4a OTP (400) 3  
 2 (400) (430)  
 (430)가 (485)  
 (400) (410) , (410) (385) 1  
 (420) , (385) (440) , 2 (450) (460)(  
 1 (420) (430) )

(440)가  
 1 (460)가 (430)  
 (460,410)

4b (460,410) (415) (430) (485)  
 (440) 4a (400)

5a OTP (500) 4  
 (530) (520) (530)

(500) (510) (530) (510)가  
 U' (585) 3a (530)

40) 5c (500) U' (585) (560) (520) (5)

5b 5a (500) (560)  
 (530) (540) (510) (5)

b ) U' (585) (5)

5a 5c (530) (540) U' (585)  
 (510) 2 (560) 1

6a (600) 2  
 (600) (660,610) (660,610) 2a  
 5c (state e

lement) (692)가 (692) 2a 3e 1  
 4a 5c 2 6a

6b 6c 3 6b (6  
 02) (660) (610) (692) (6  
 60,610)가 (692)가 (602) (699)

가 6b 3 가 (660,610)  
 (692)

6b 3 가 4 , N+1  
 N , 2  
 4 가 6c N 가 2N  
 , 6b (692) , 6c (694) (604)  
 6d , 3a 3e (300)( (601) ) 3  
 , (601) (662,612) , (632) , (642)  
 , (632) (682) (662,612) (696)  
 (682)가 , 3d 5a 5c (500) 3 가  
 , (696) 6d  
 6e 3 6e ,  
 (606) (662) , (612) , (632) , (642)  
 , (606) (696) (682)  
 (606) (699) 가 6e , 3 가 ,  
 , 가 6e , N 2N 가  
 N+1 N  
 7a (700) 2 ,  
 (760) (710) (760,710)  
 ( ) , (790)가 (790) 1 2  
 , (790)가 (760) (710)  
 (790)  
 7b 7c , , (700)  
 7b (700) (row addressing circuit)(715)  
 (735) (715) (725)  
 (760) (725)  
 (735) (745) (710)  
 (745) , 7c , (745) (75)  
 5) (710) (755)  
 1 2 ,  
 7d (755) , (755)  
 (790), , 1 2 ,  
 (790)

7c 가 , ( )가 (710)  
 가 . (745) 가 가 . ,가 (virt  
 ual ground potential)가 (755) 가 . , (710)  
 (755) (I<sub>S</sub>) 가 . ,  
 (710) (710) 가 가 .  
 (I<sub>S</sub>) , 가 .  
 , (I<sub>S</sub>) , (V<sub>R</sub>) 가 .  
 / 가  
 가 가 , 가 가 ( 1d ). ,  
 가 가 가/ 가/ 가  
 . (700) .  
 /  
 가 가  
 가 .  
 가, (700)  
 가 . CMOS (support circu  
 it) (715,735) ,  
 ) . (700) .

8a 8b , , (800)  
 . 8a , 7b  
 , (790)가 ( 810)). (790) (760)  
 (V<sub>WR</sub>) 가( 820)) (710) ( 830)) .  
 (820,830)

7b (800) 7b , 3  
 (790)가 (790) 가 가 . (V  
 (790) 가 가 가 (V<sub>WR</sub>)  
 (I<sub>S</sub>) , (760) 3 (710) .  
 (parallel writing) 가 , , (790) ,  
 (760) 가 가 ( 7b ). , 3 (V<sub>WR</sub>) 1  
 (710) 가 가 , 1 3 4 (710) , 4  
 (790)가

가 . /  
 ,  
 가 ,  
 .

8b (790)가 (850) , (840) 7c (790) (790) (710) , (760) (860) (V<sub>R</sub>) 가(

(790)가 (805) 가 7c (790) 가 3 가 , 3 가 , (790)가 (790)가 , ( ) ( )

, 가 , , (790)가 ,

, 가 , " " " " 가 , " " " " 가 , " " " "

, " " , (horizontal) 가 , , "

가 가

OTP

가,

OTP

4<sup>2</sup>

가

(57)

1.

가 (one - time programmable memory array) (700) ,

(row direction) (row conductor) (760) ,

(column direction) (710) - (760)

(intersection) (cross - point)가 - ,

(fuse) (230,330) (710) (state element) (790) - (anti - fuse) (280,380) (790) (760)

가 (700).

2.

1 , (790) (230,330) (280,380) (thin conductor) (290,390)

가 (700).

3.

가 (700) , (760) , (710) - (760)

가 - , (790) - (790) (790) (vertically orient (710)

ed fuse) (430,530) , (790) (790) (760) (710)

- 가 (700).

4.

1 3 , (790) (insulator) (220,320,420,520)

가 (700).

5.

1 3 , (790) (230,330,430,530)

가 (700).

6.

1 3 ,  
 (790) (230,330,430,530) (230,330,430,530)  
 (void)  
 가 (700).  
 7.  
 가 ,  
 (760) ,  
 가 - , (710) - (760)  
 (760) (230,330) (710) (280,380) (790) - (790) (430,530) (790)  
 (combination) ,  
 (760) (700) ,  
 (700) (700) (760) (row addressing circuit) (715) ,  
 (700) (710) (735)  
 가 .  
 8.  
 7 ,  
 가 (700) (715) (735)  
 (700)  
 가 .  
 9.  
 7 ,  
 (760) (row transistor) (725) - (760)  
 가 (725)가 - ,  
 (710) (column transistor) (745) - (745)  
 (715) (equalized potential) 가 - ,

(710) (current sensor) (755) - (755)  
 (790) , (755) (710)  
 가 (virtual potential) 가 -

가 .

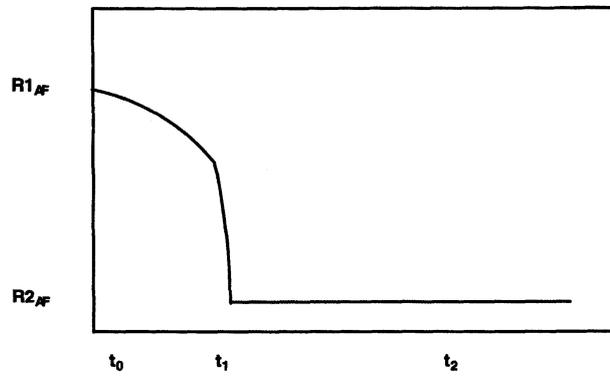
10.

1 7 ,

(280,380) 가 (280,380)

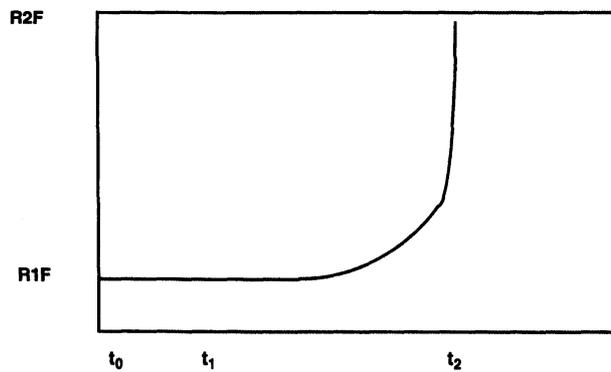
가 (700) .

1a  
 반퓨즈의 저항



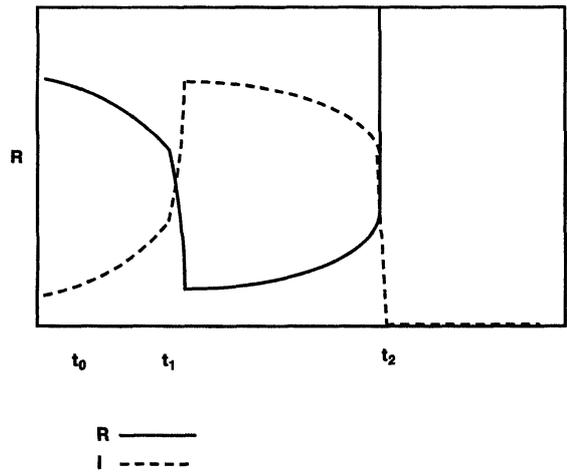
1b

퓨즈의 저항



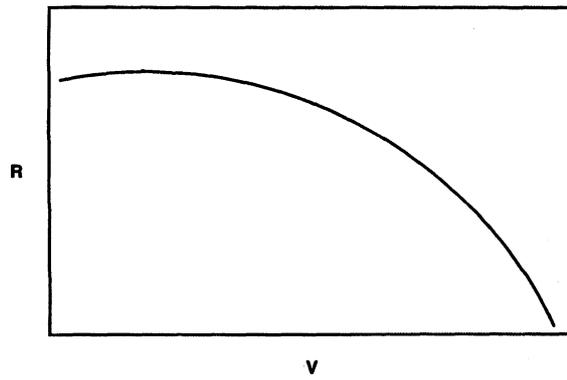
1c

셀의 저항/전류 특성

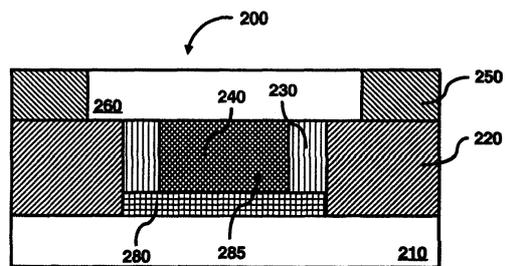


1d

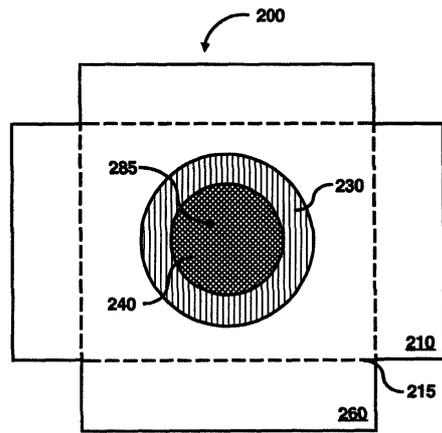
반퓨즈의 전압/저항 특성



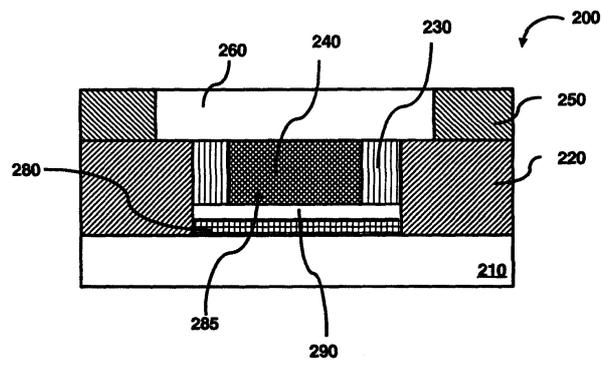
2a



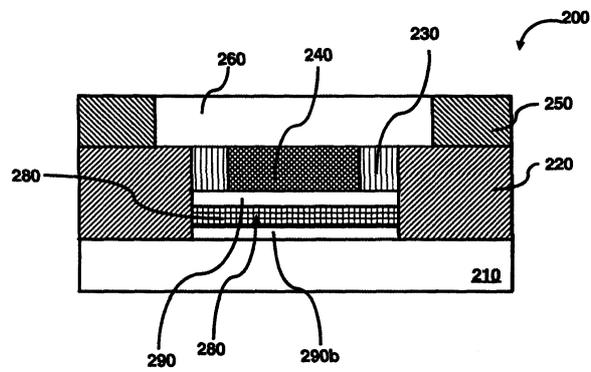
2b



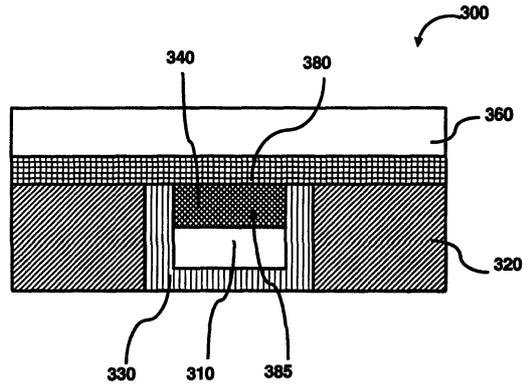
2c



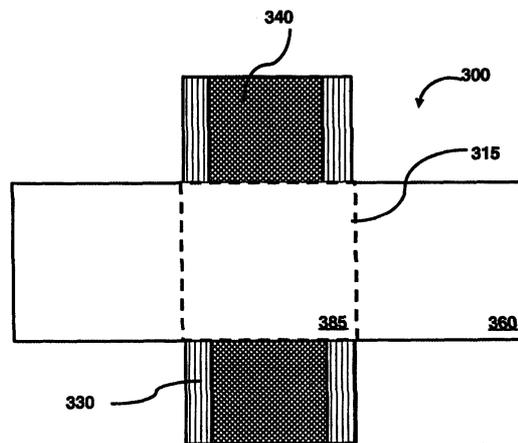
2d



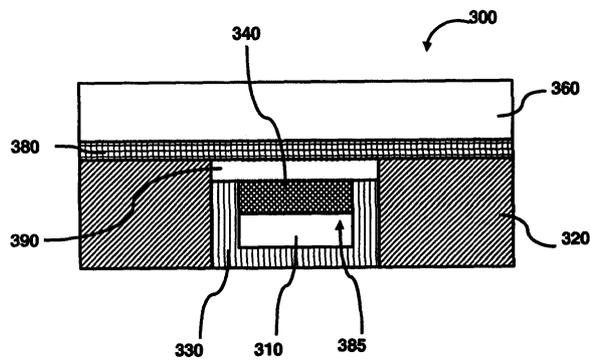
3a



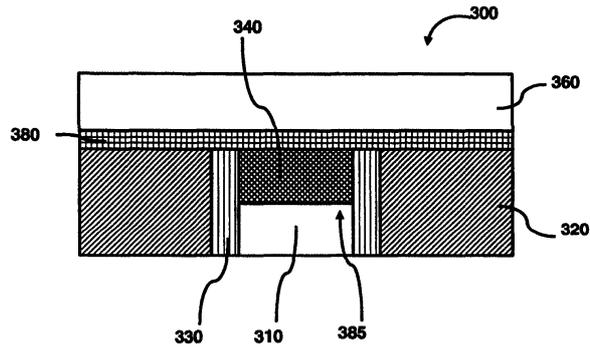
3b



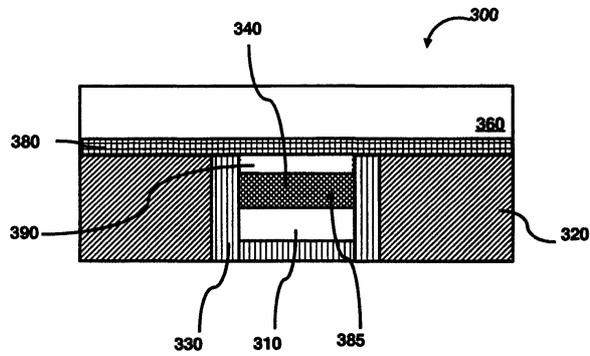
3c



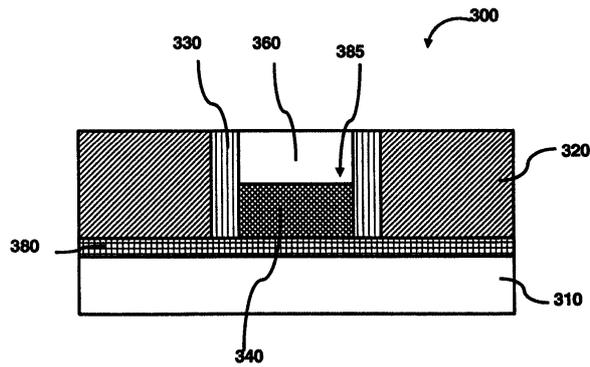
3d



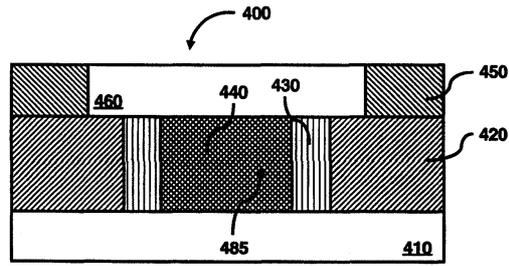
3e



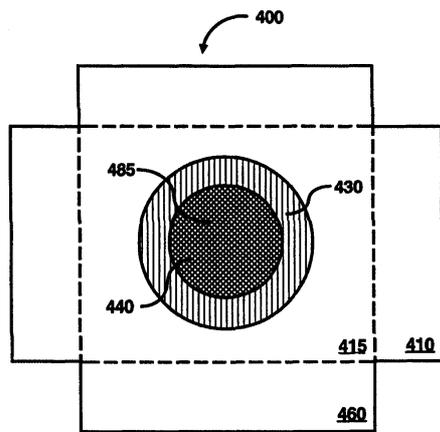
3f



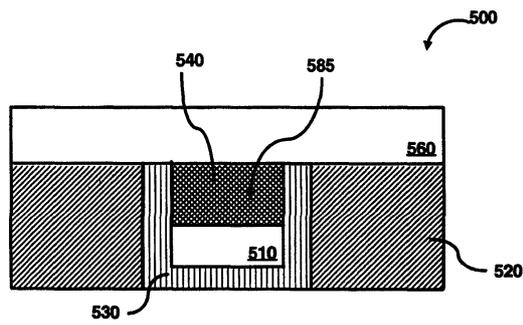
4a



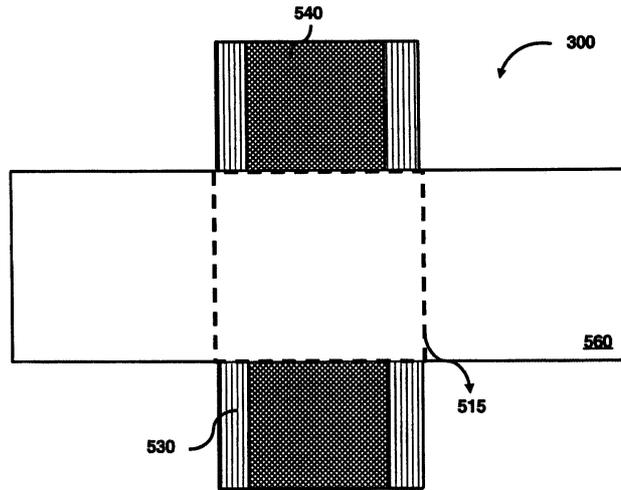
4b



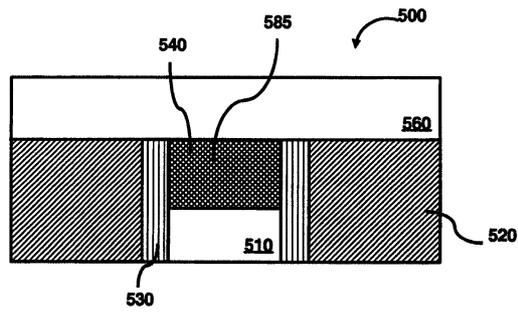
5a



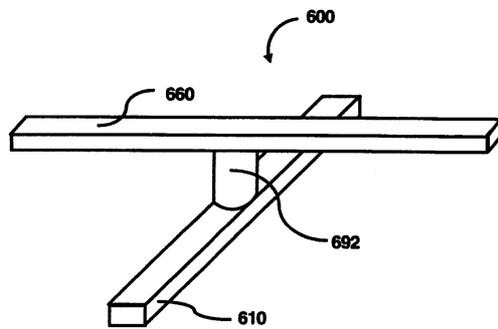
5b



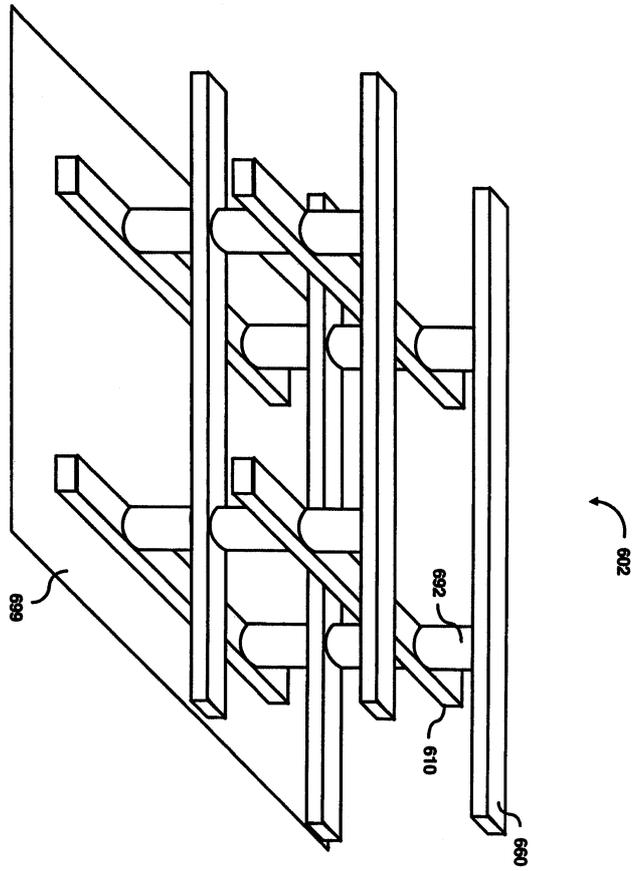
5c



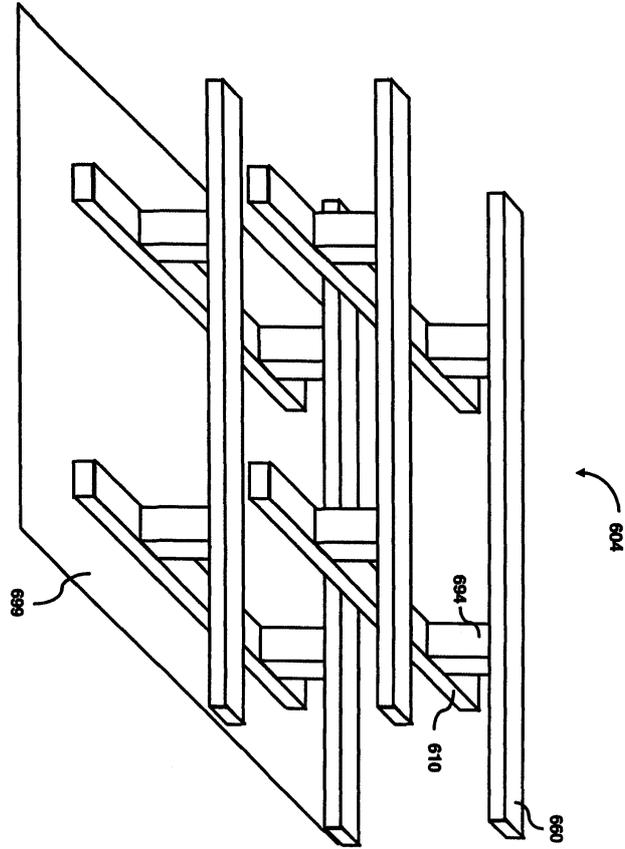
6a



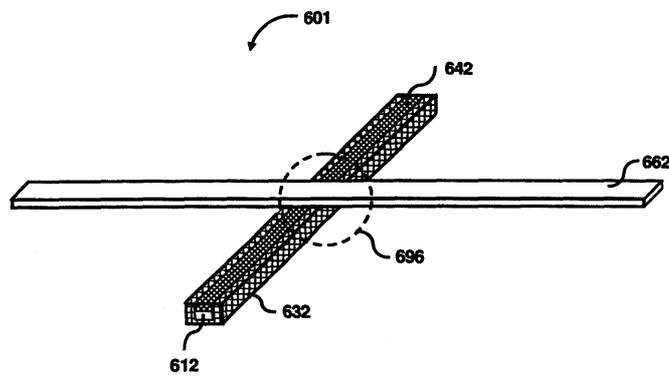
6b



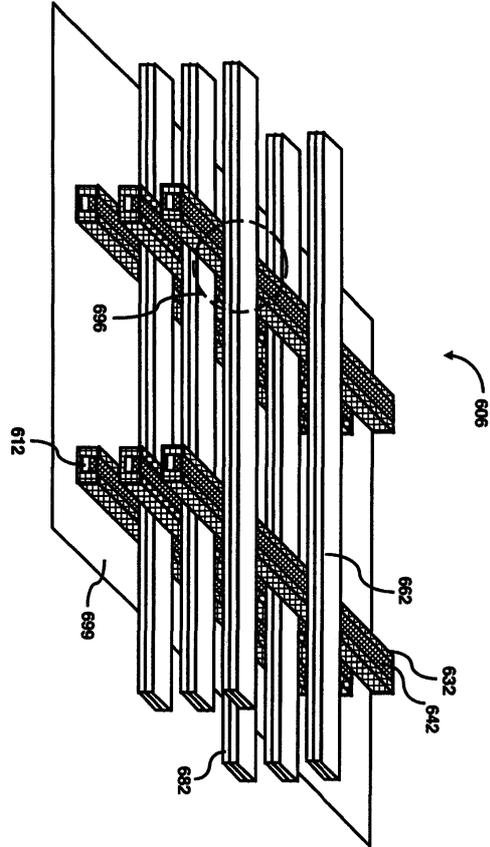
6c

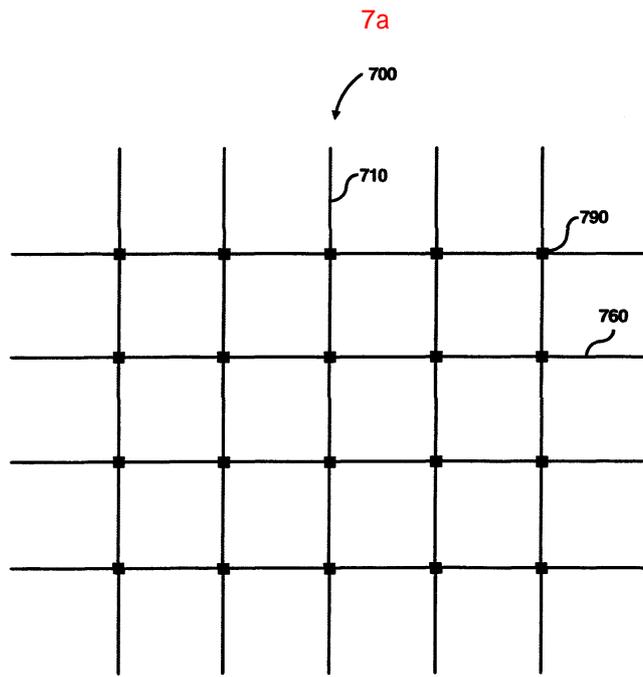


6d

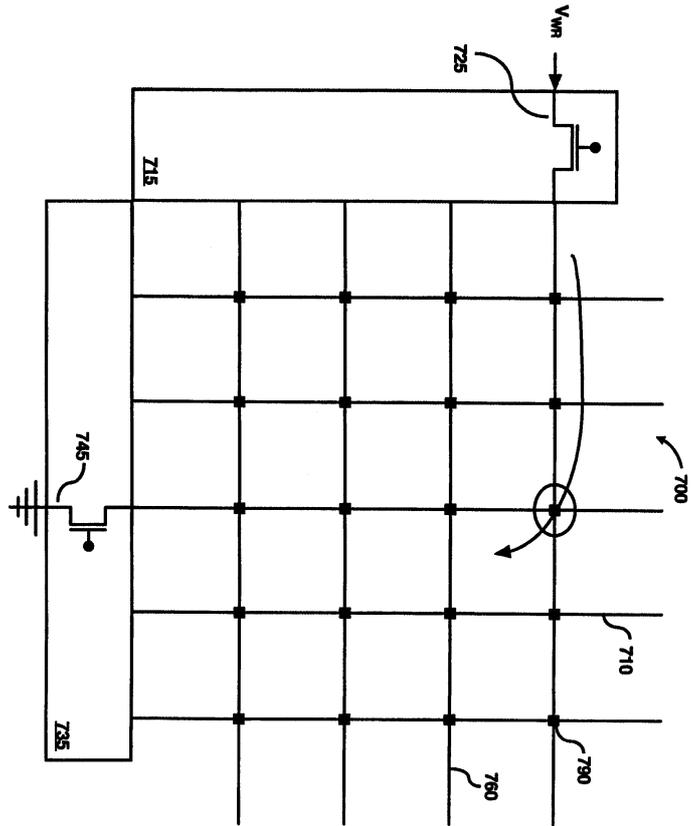


6e

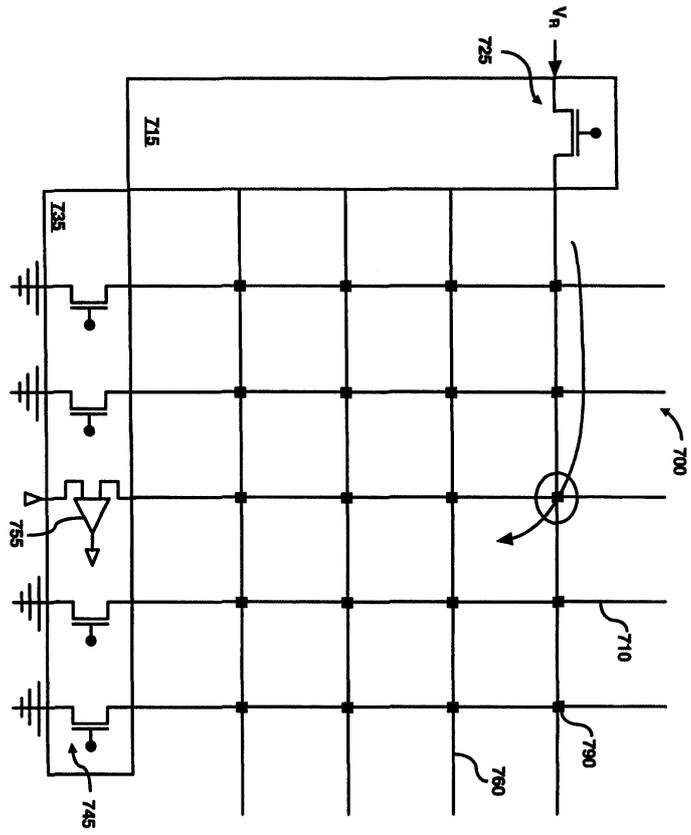


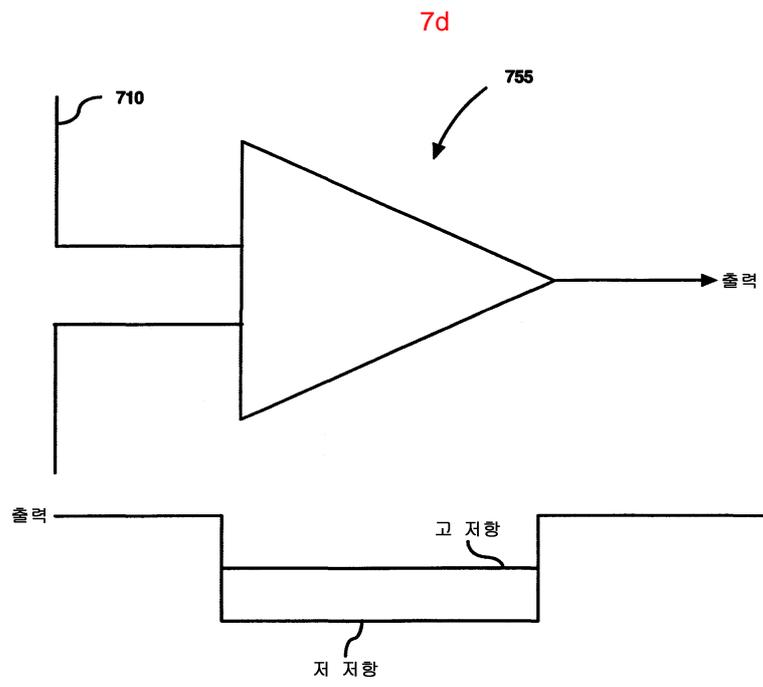


7b

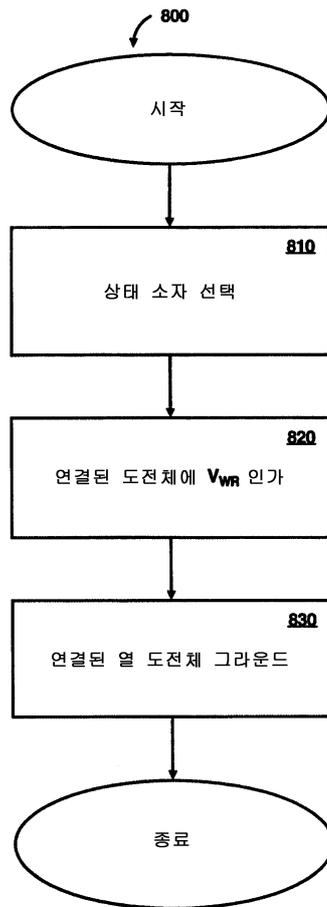


7c





8a



8b

