

1/40

FIG 1A

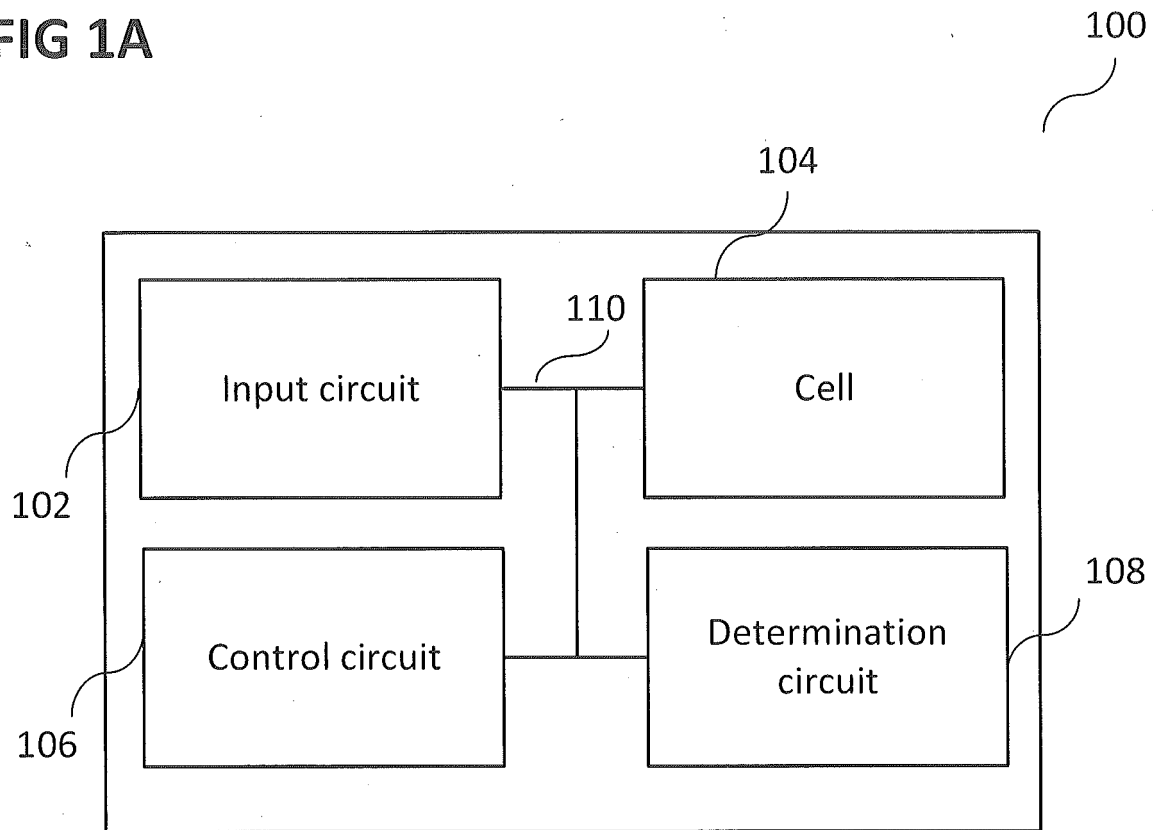
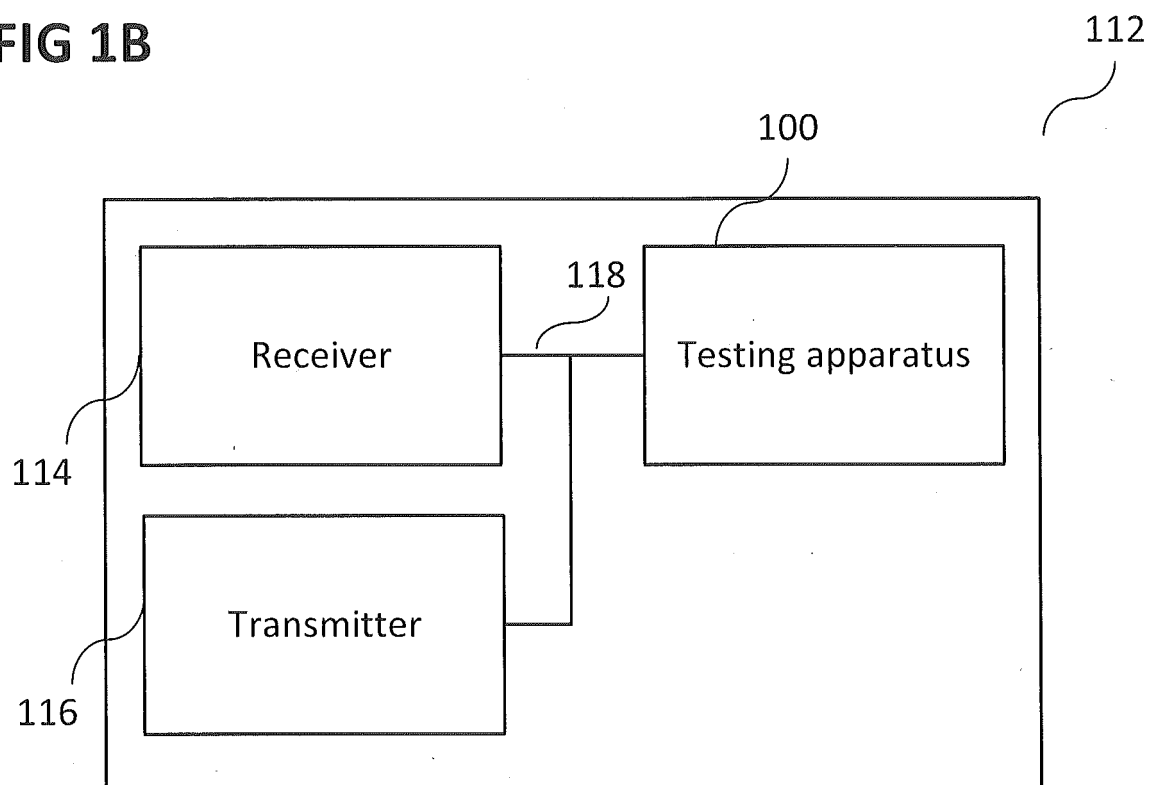


FIG 1B



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FIG 1C

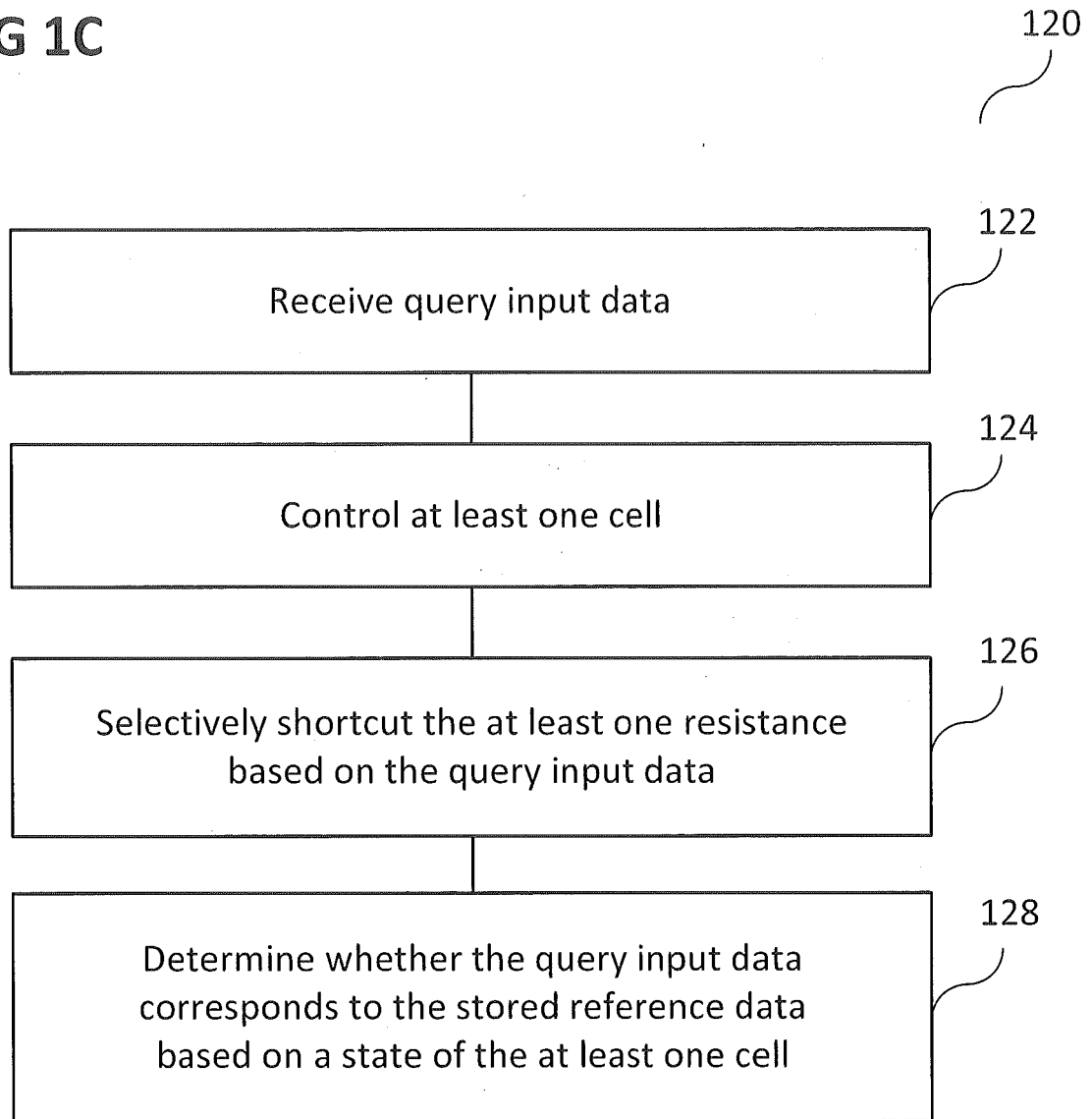
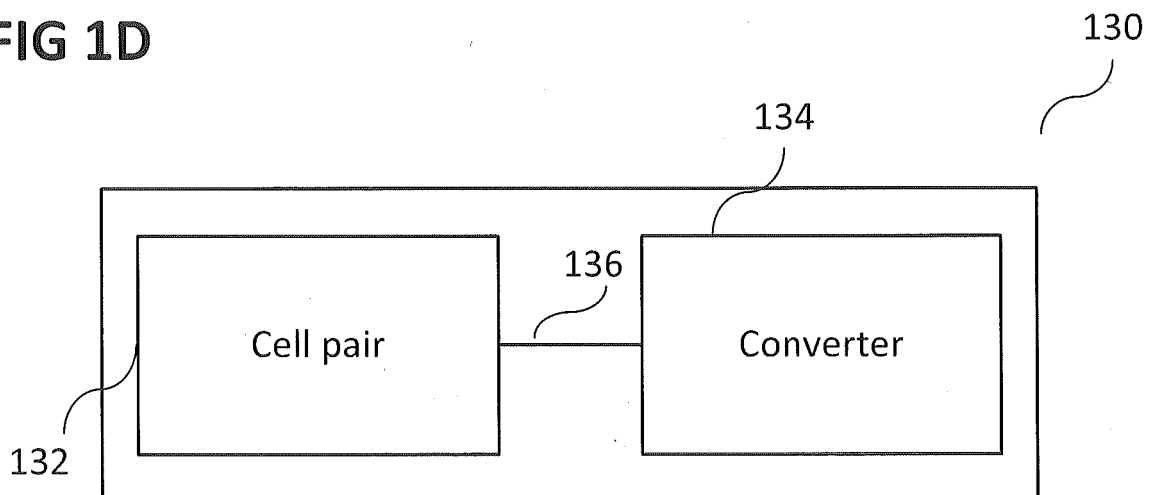


FIG 1D



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FIG 1E

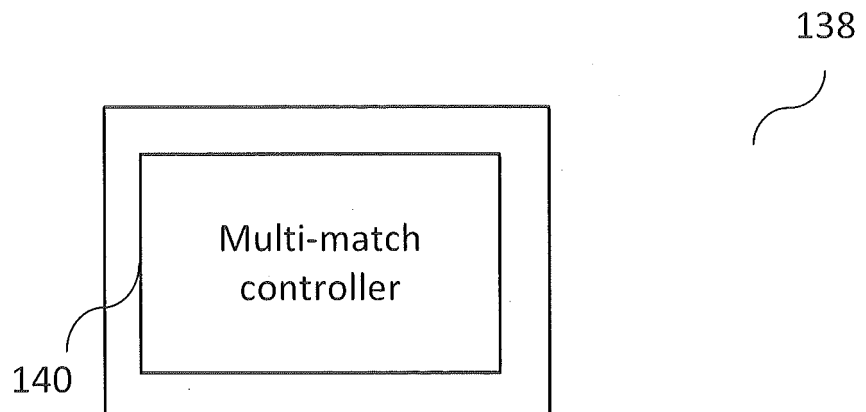


FIG 1F

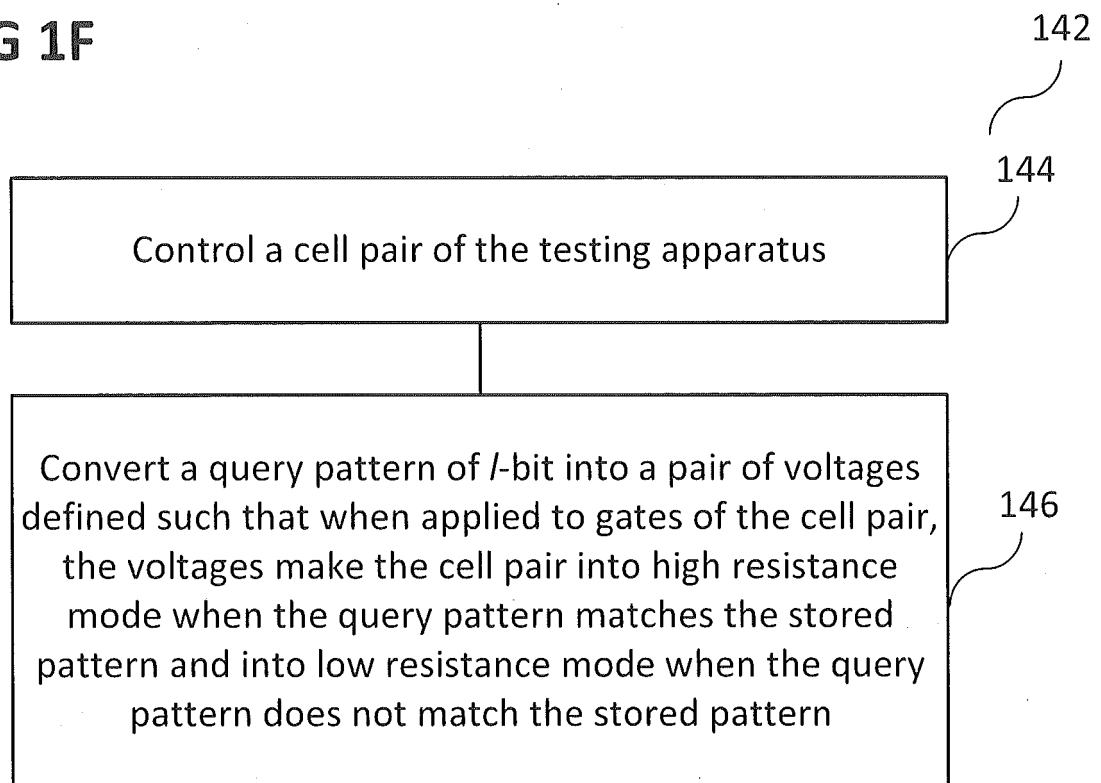
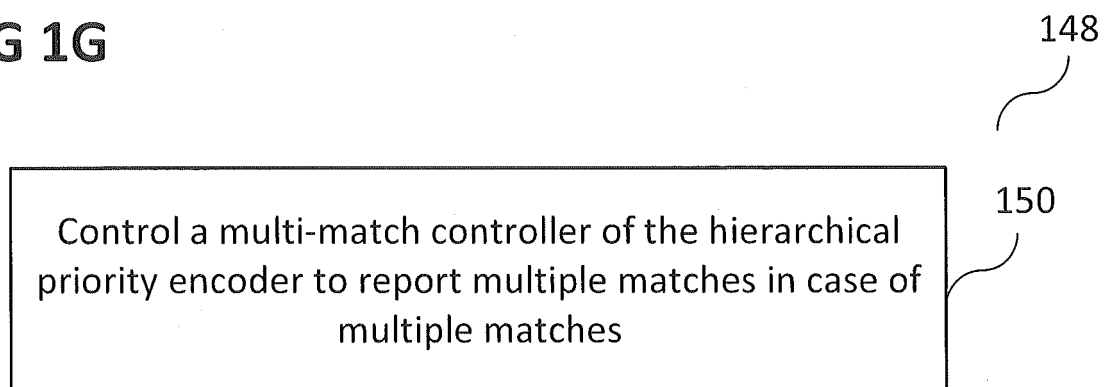


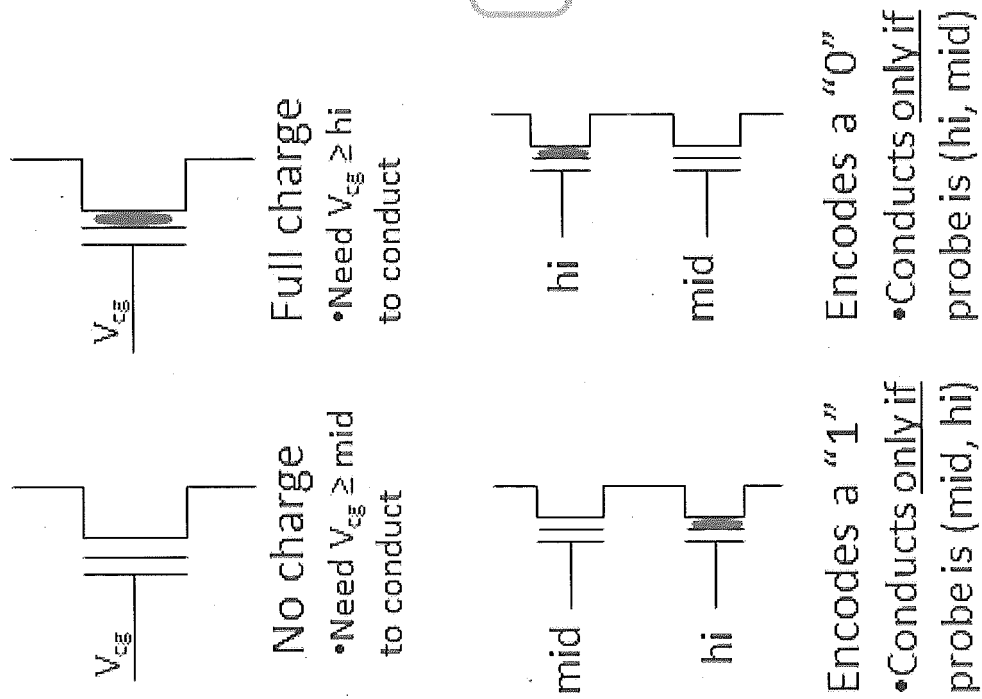
FIG 1G



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FIG 2

200



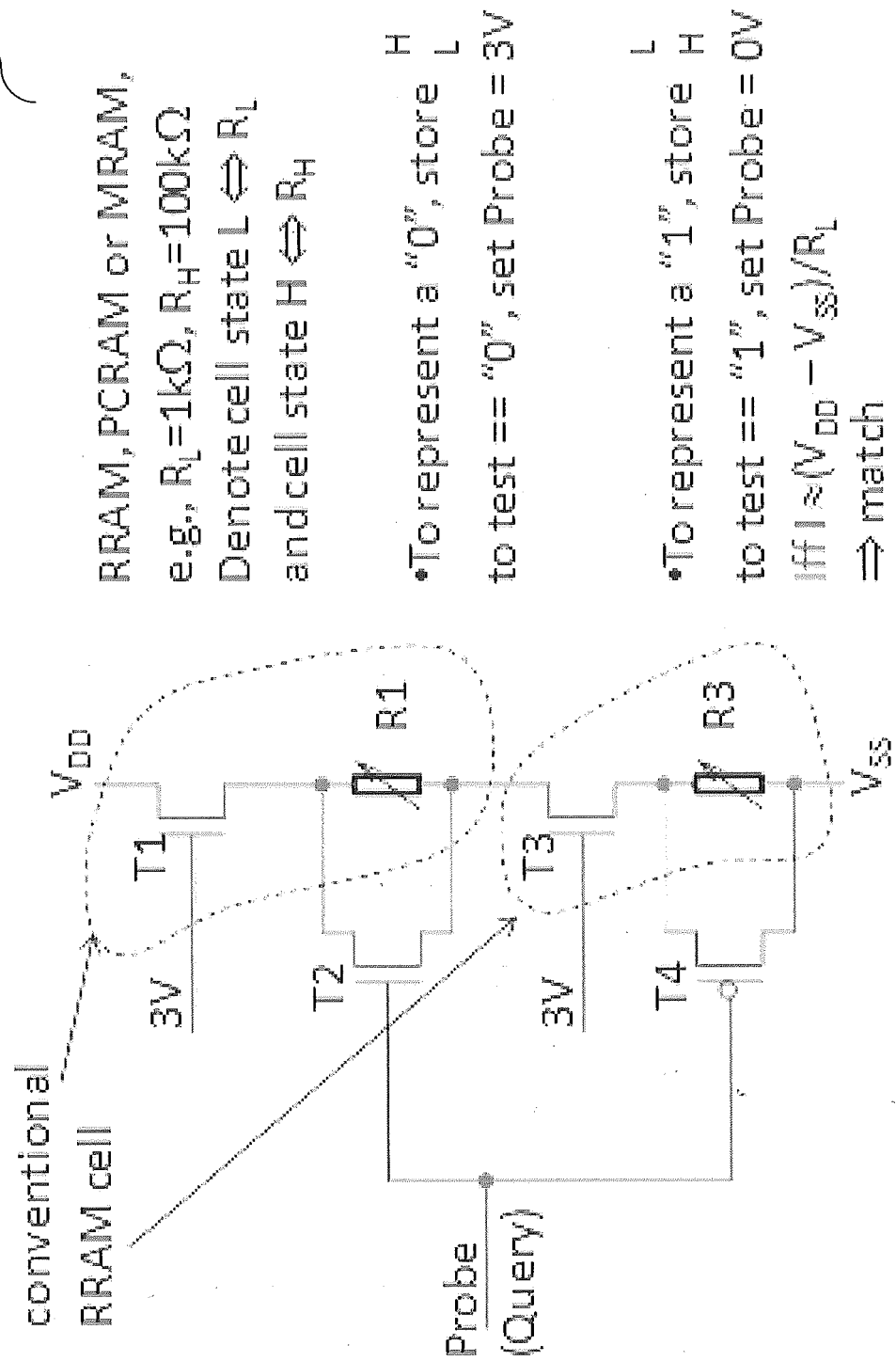
(mid,hi) probe Won't make a "0" conduct

- (mid,mid) and (hi,hi) probes Not allowed by default

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FIG 3

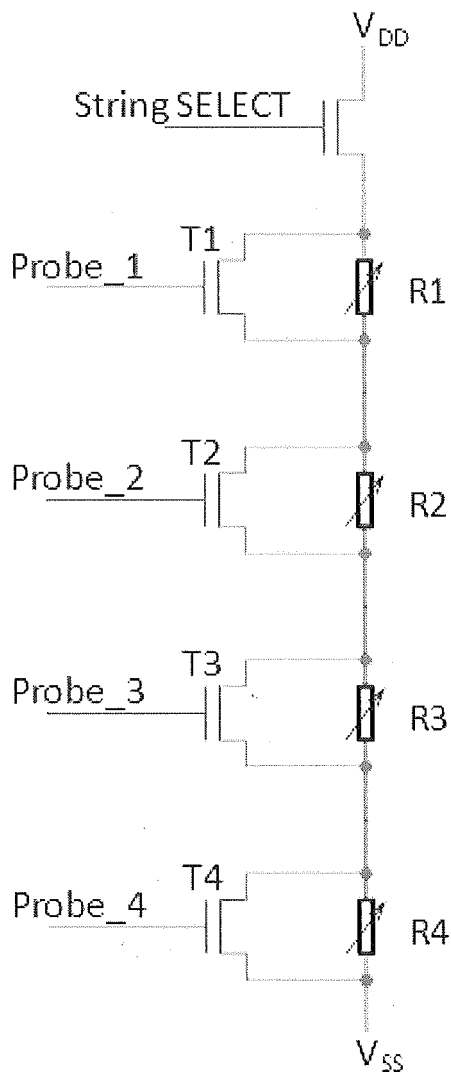
300



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FIG 4

400



•To test == "01", set Probe_1 thru _4 to 3V, 0V, 0V, 3V, respectively;
 Iff $I \approx (V_{DD} - V_{SS}) / (2 * R_L)$
 $\Rightarrow$ Match

•To test == "0x", set Probe_1 thru _4 to 3V, 0V, 3V, 3V, respectively;
 Iff $I \approx (V_{DD} - V_{SS}) / R_L$
 $\Rightarrow$ Match
 $\therefore$ (3V,3V) pair is a weak-bit/
 don't care bit.

•To read a specified row i ,
 use Probe_i = 0V, all others
 Probe = 3V

•To write a specified row i ,
 use Probe_i = 0V, all
 others Probe = 3V

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FIG 5

500

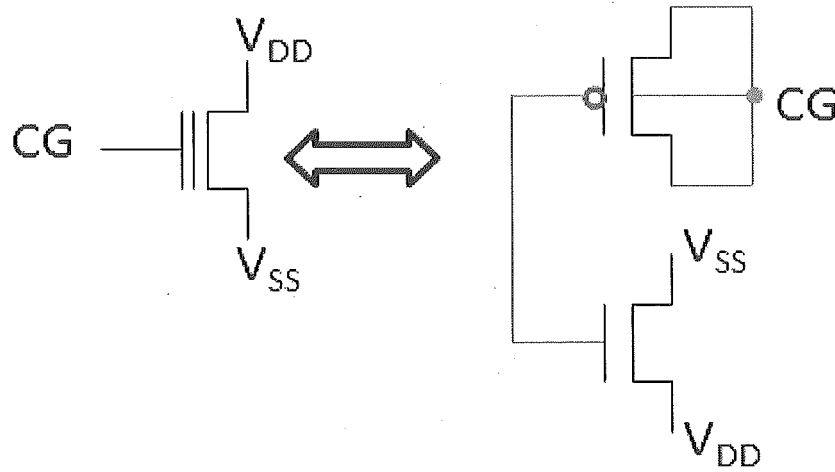
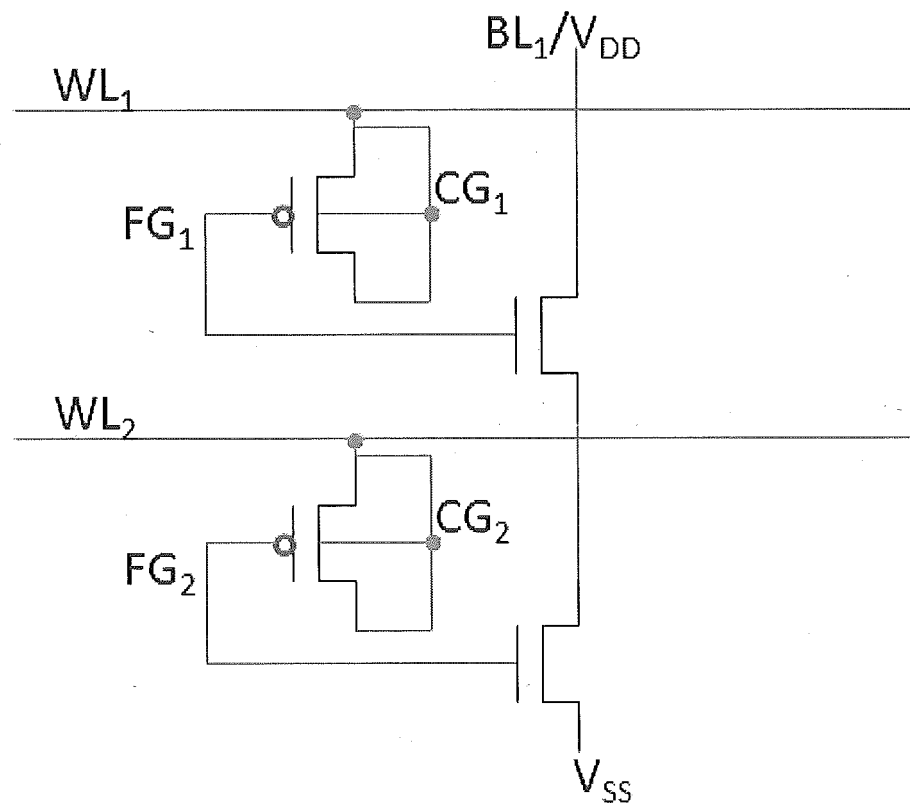


FIG 6

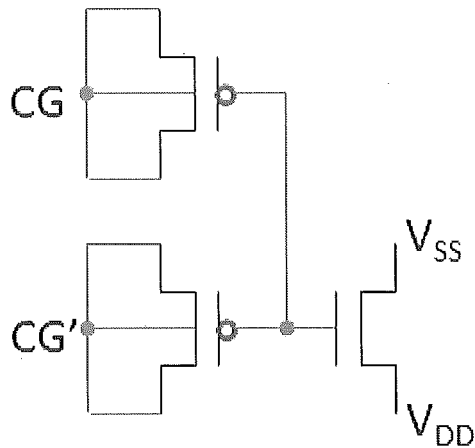
600



8/40

FIG 7A

700



•Example configuration:

$$C_{gp} = C_{gn}; \quad C_{gp}' = 4 \cdot C_{gp}$$

$$V_{prog} = 10V; \quad V_{erase} = 10V; \quad V_{read} = 2V$$

•For NFN write,

$$CG = CG' = V_{prog}, \quad \alpha = (C_{gp} + C_{gp}')/C_{gn}$$

$$\Rightarrow \text{initial FG} = \alpha/(1+\alpha) \cdot V_{prog} = 8.33V$$

•For PFN erase

$$CG = V_{erase}, \quad CG' = 0V, \quad \alpha = C_{gp}/(C_{gp}' + C_{gn})$$

$$\Rightarrow \text{initial FG} = \alpha/(1+\alpha) \cdot V_{prog} = 1.67V$$

•For read,

$$CG = CG' = V_{read}, \quad \alpha = (C_{gp} + C_{gp}')/C_{gn}$$

FIG 7B

702

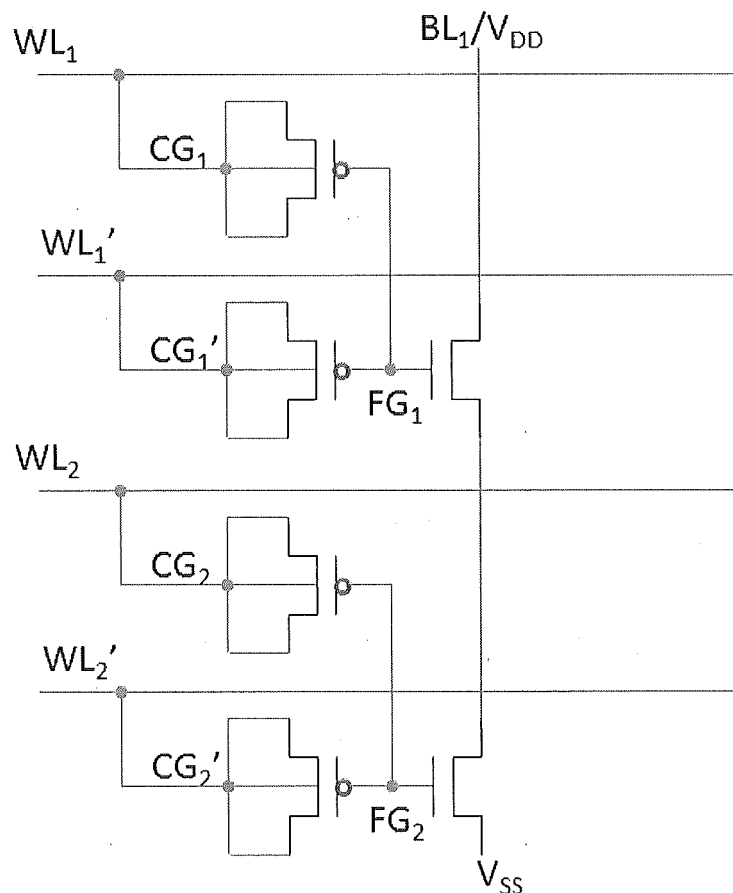
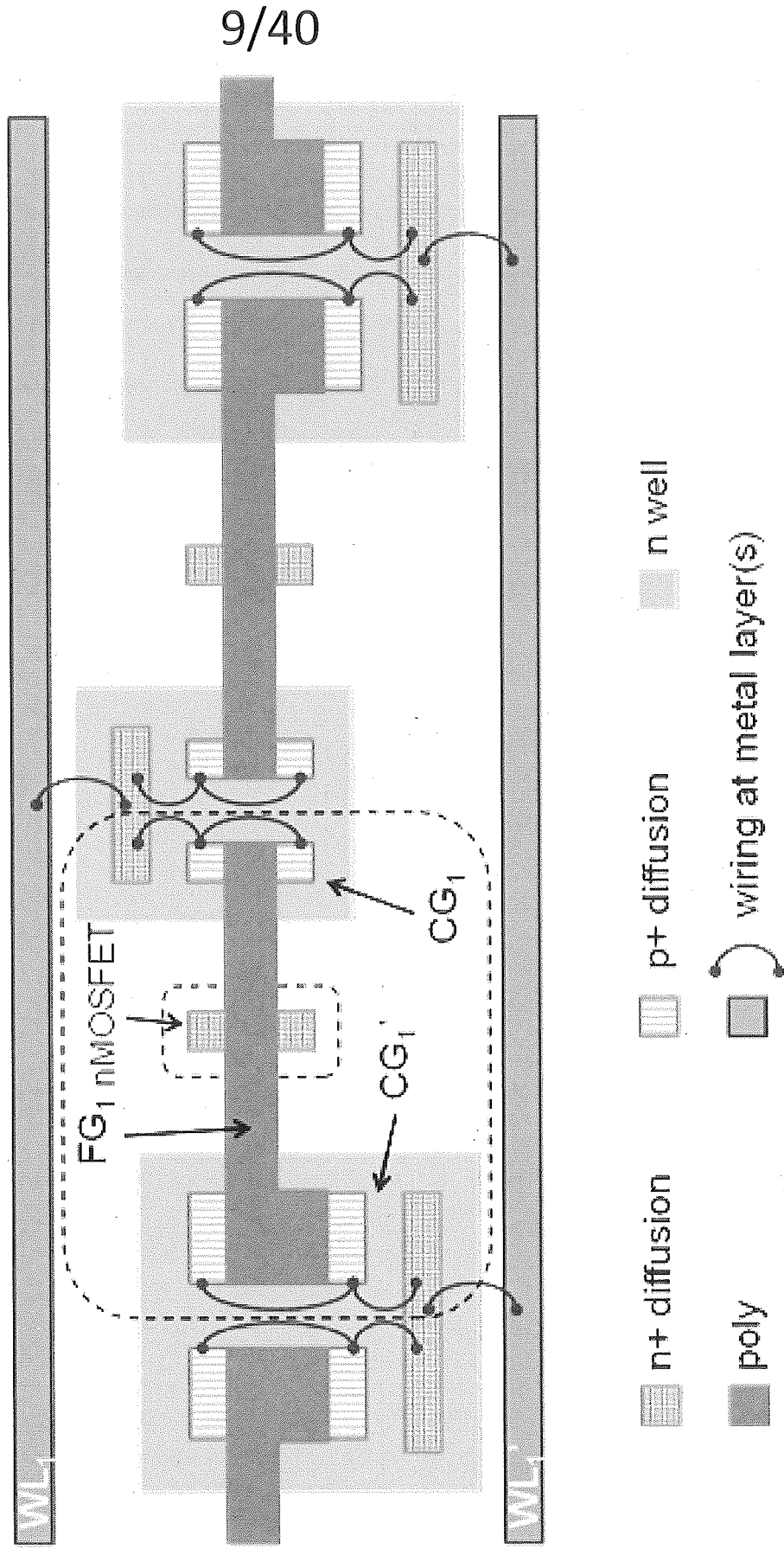


FIG 8

800



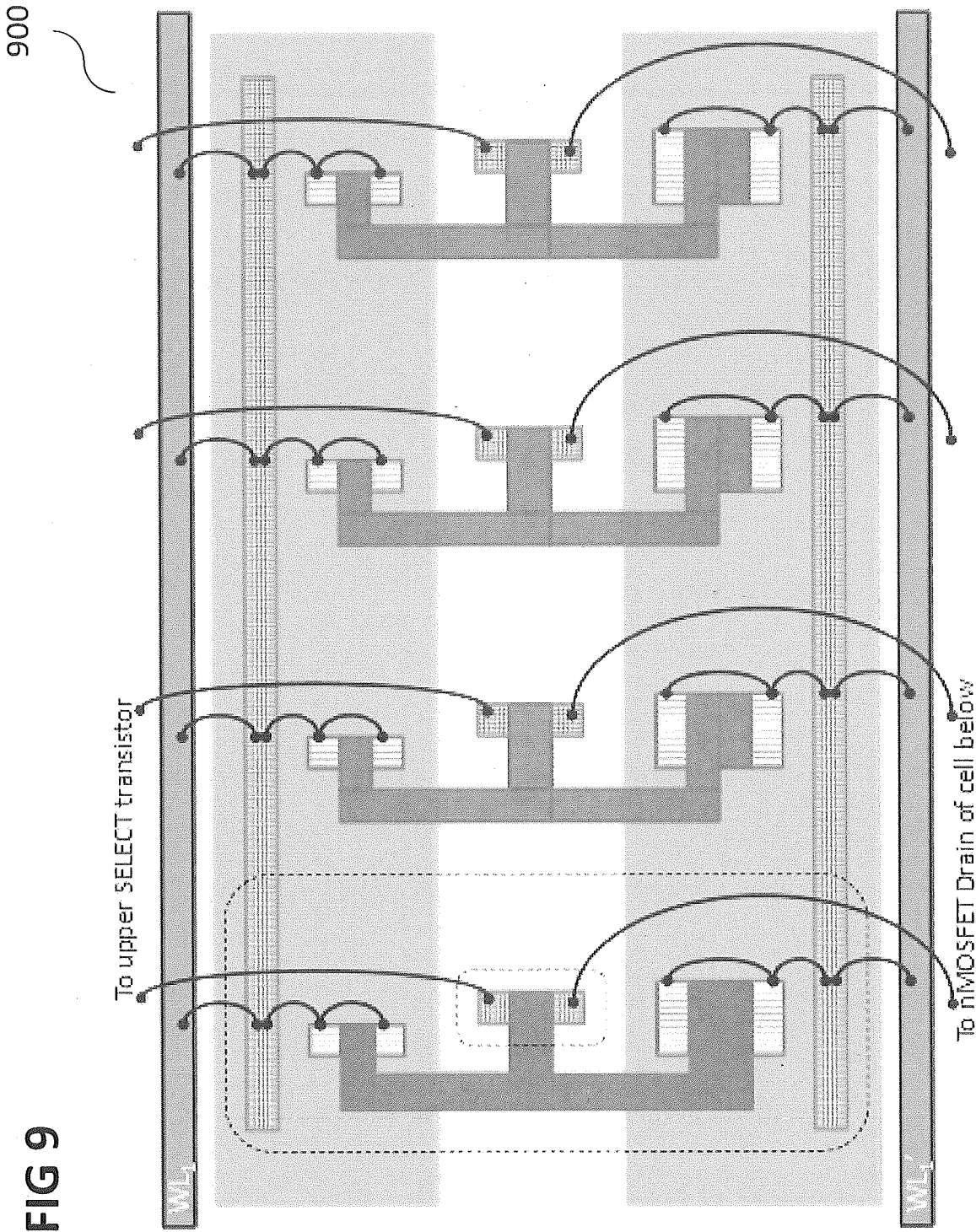


FIG 10A

1000

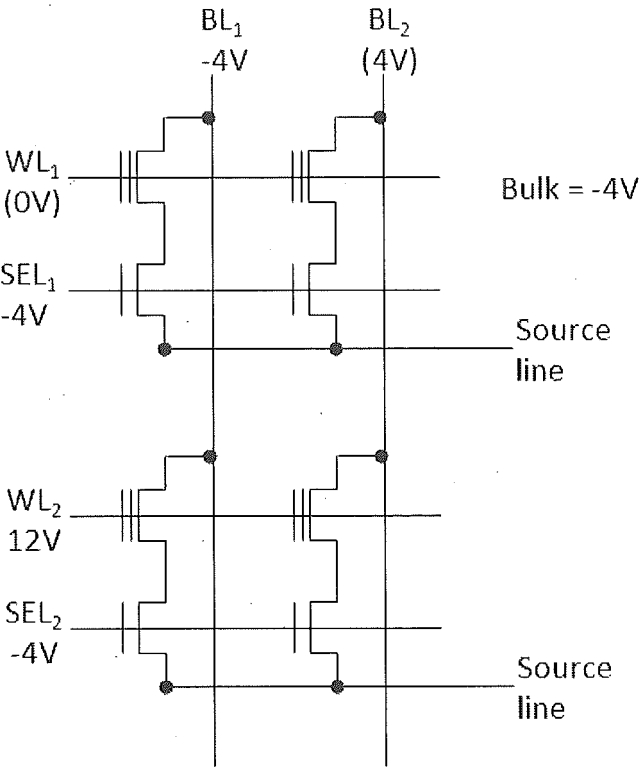
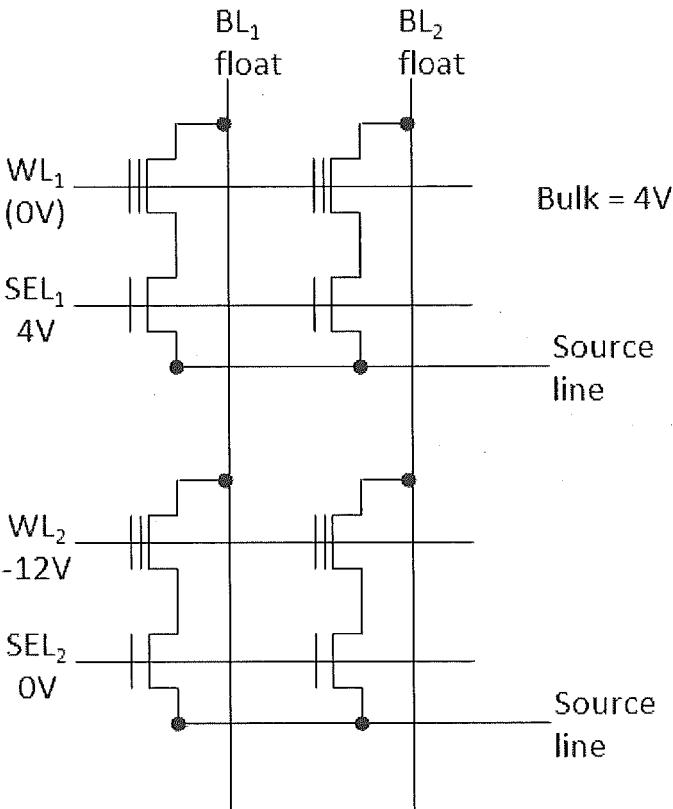


FIG 10B

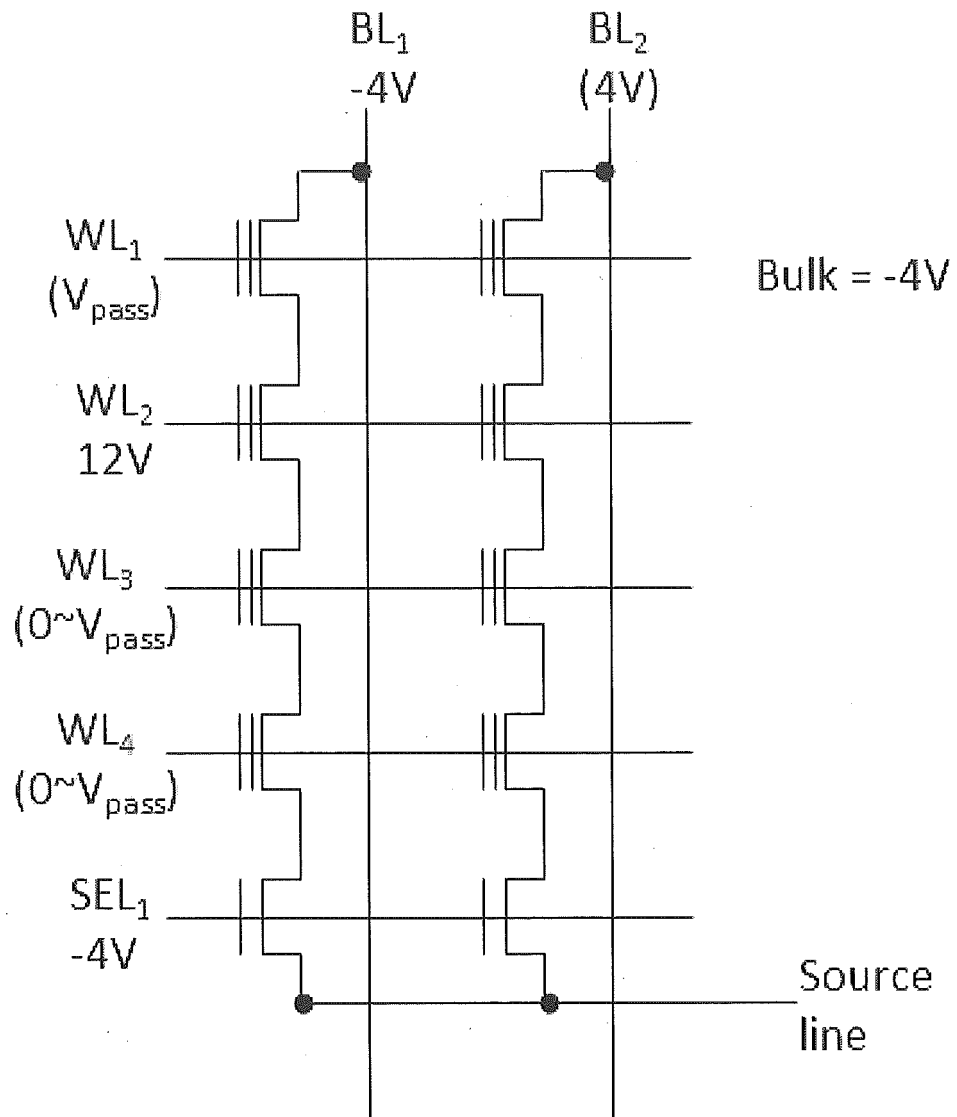
1002



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FIG 11A

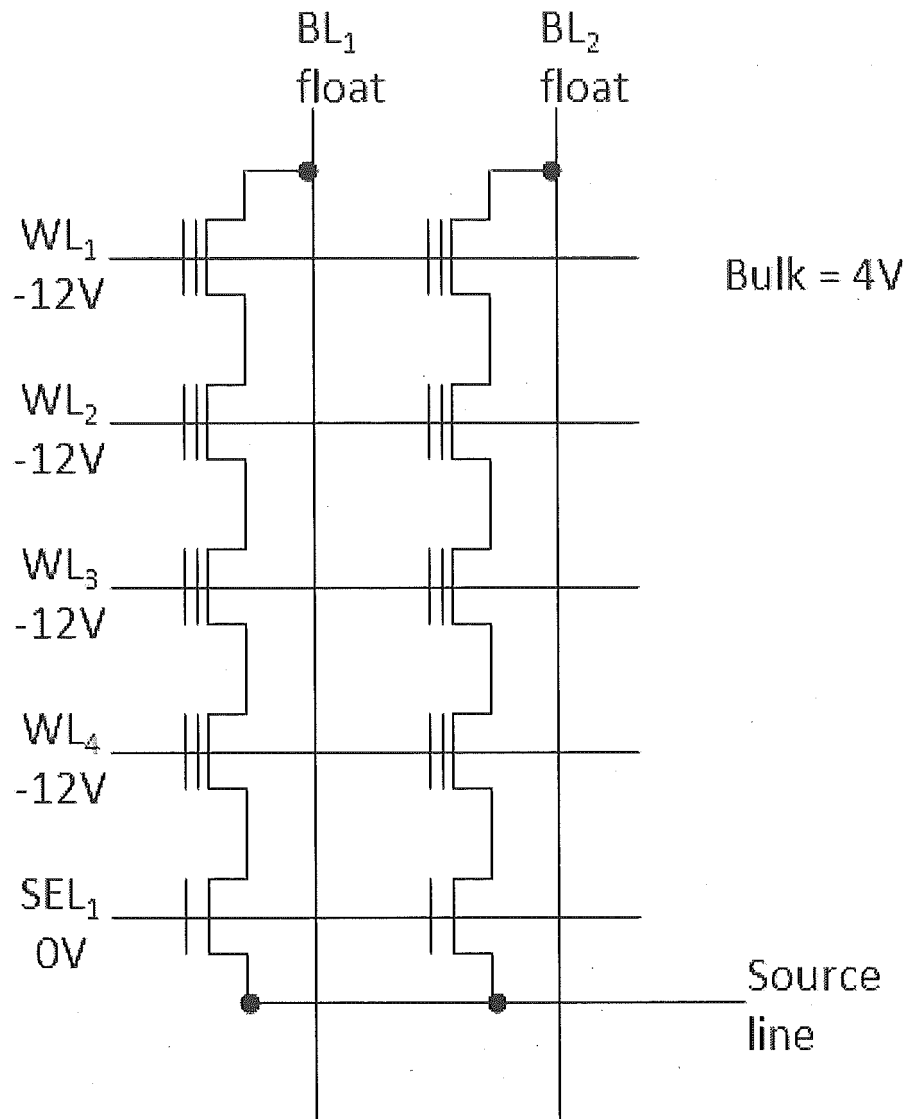
1100



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FIG 11B

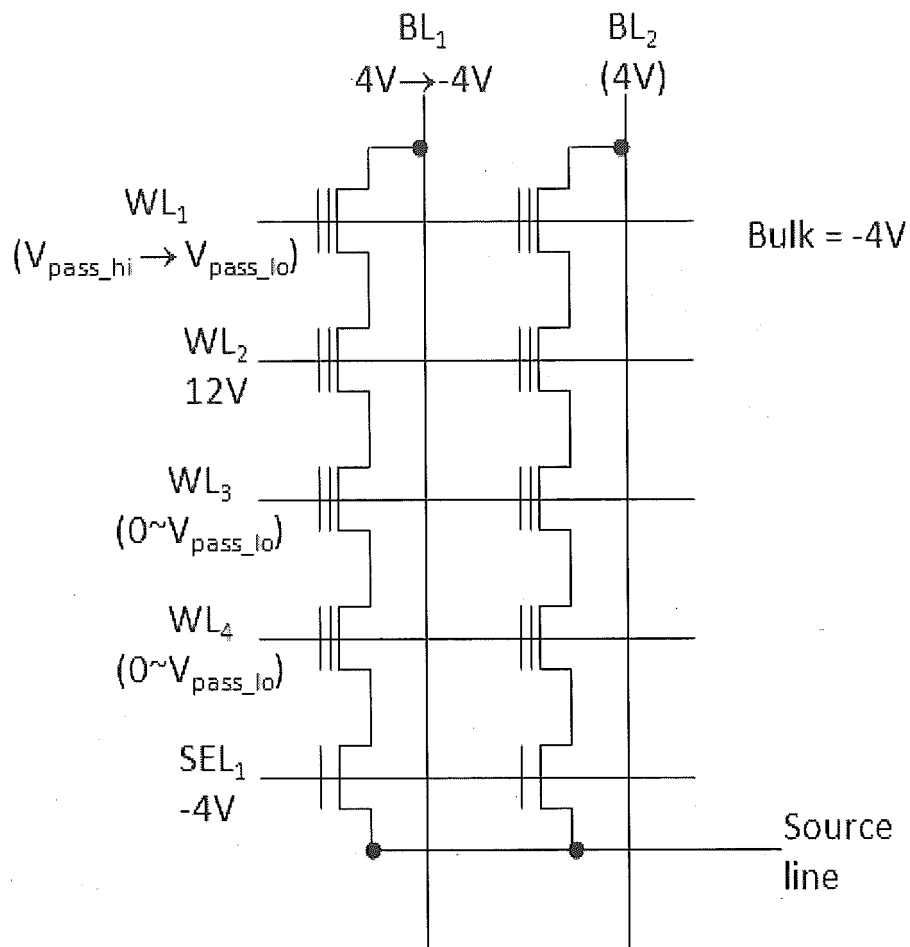
1102



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FIG 12

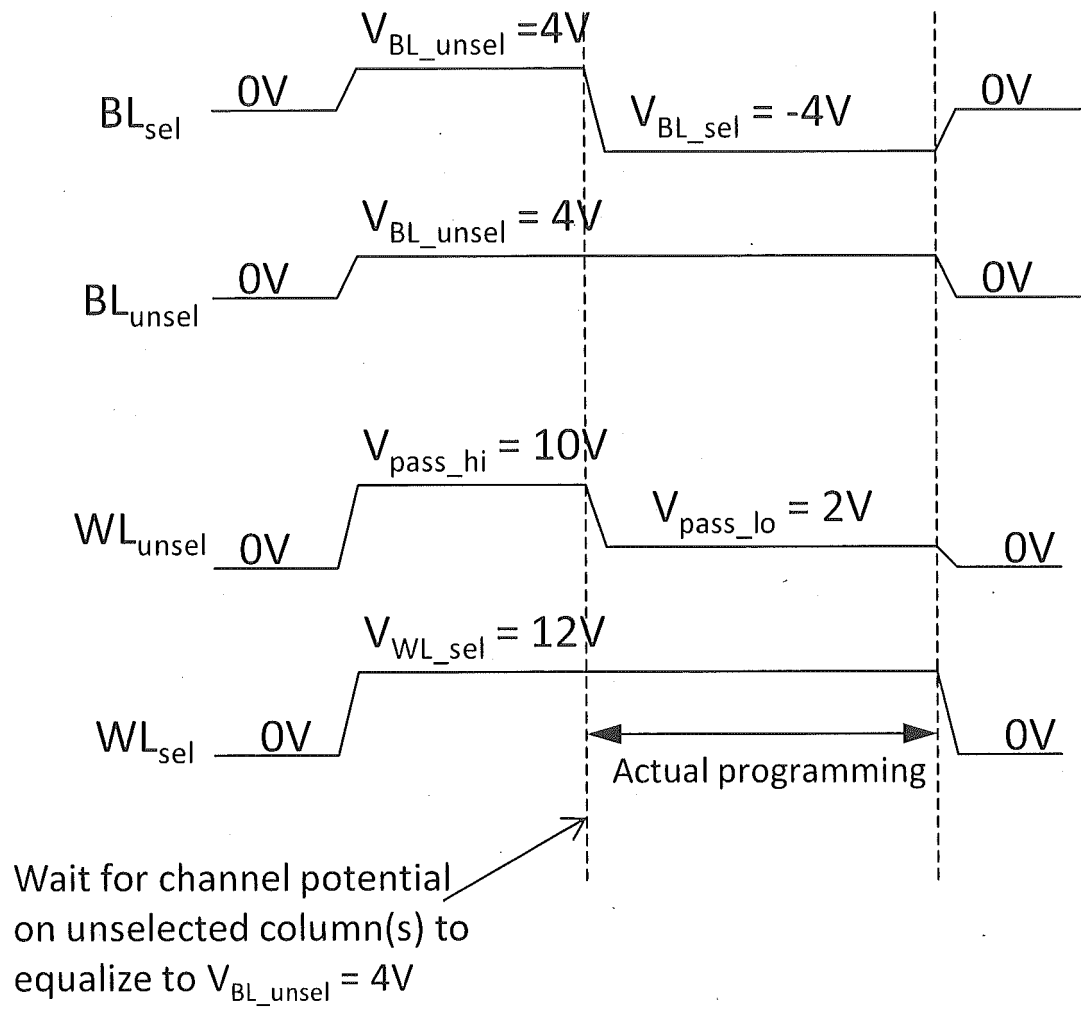
1200



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FIG 13

1300



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FIG 14

1400

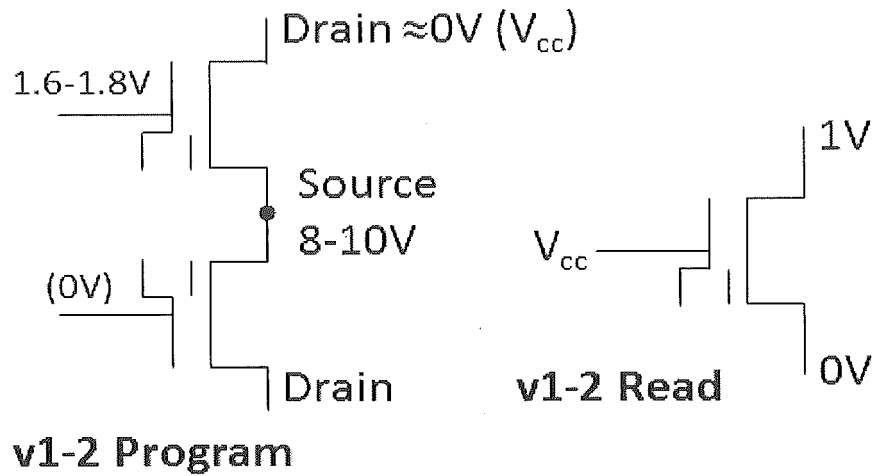
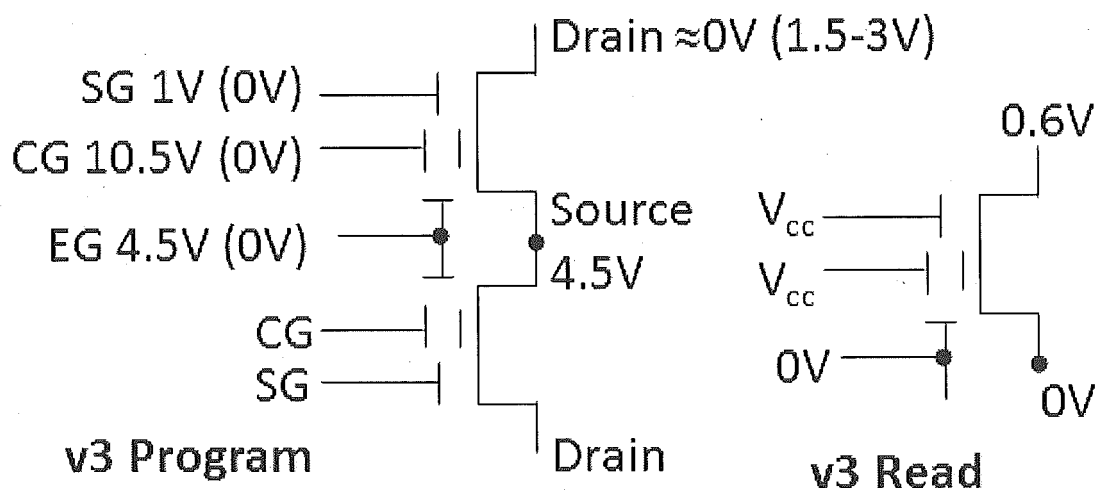


FIG 15

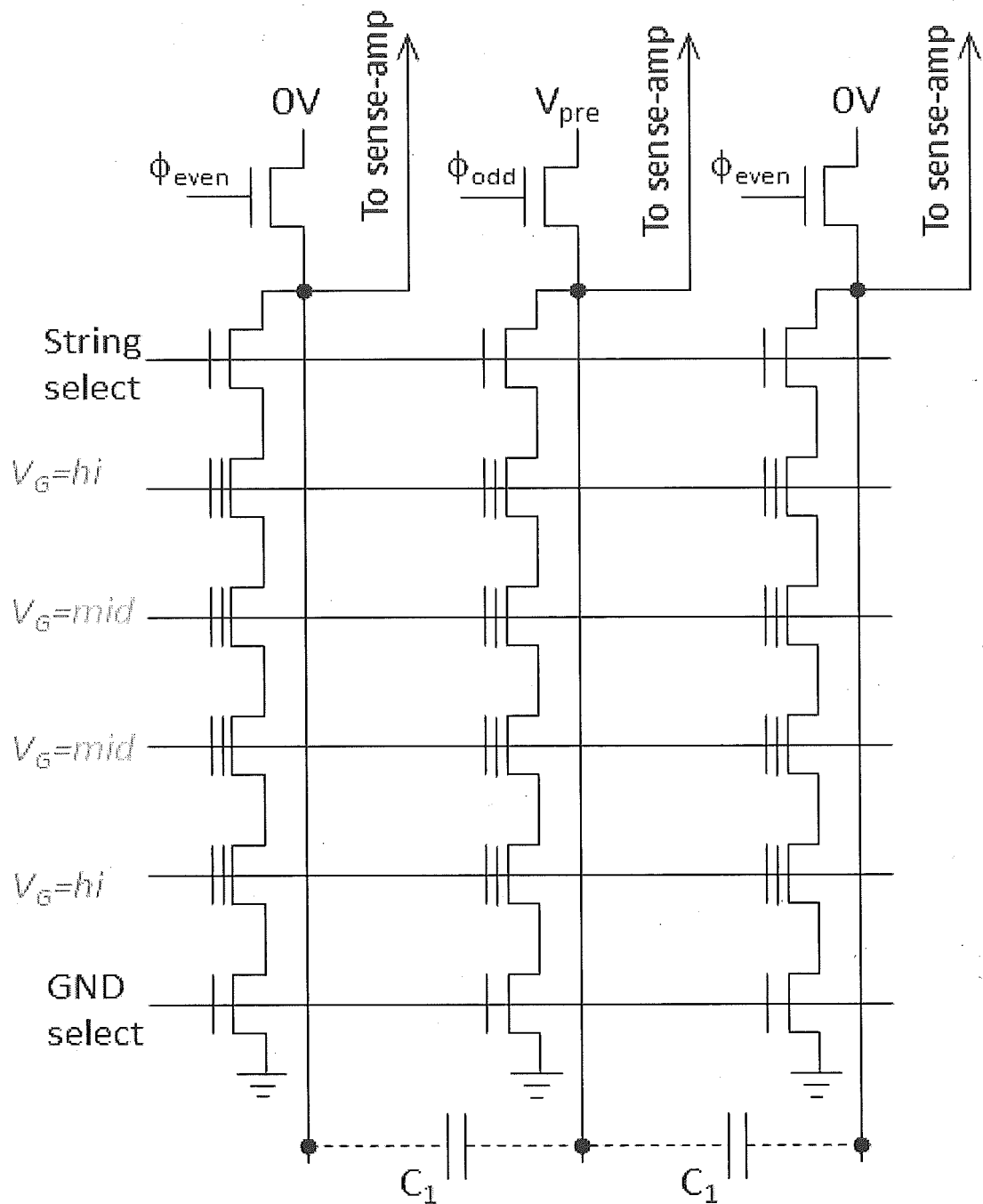
1500



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FIG 16

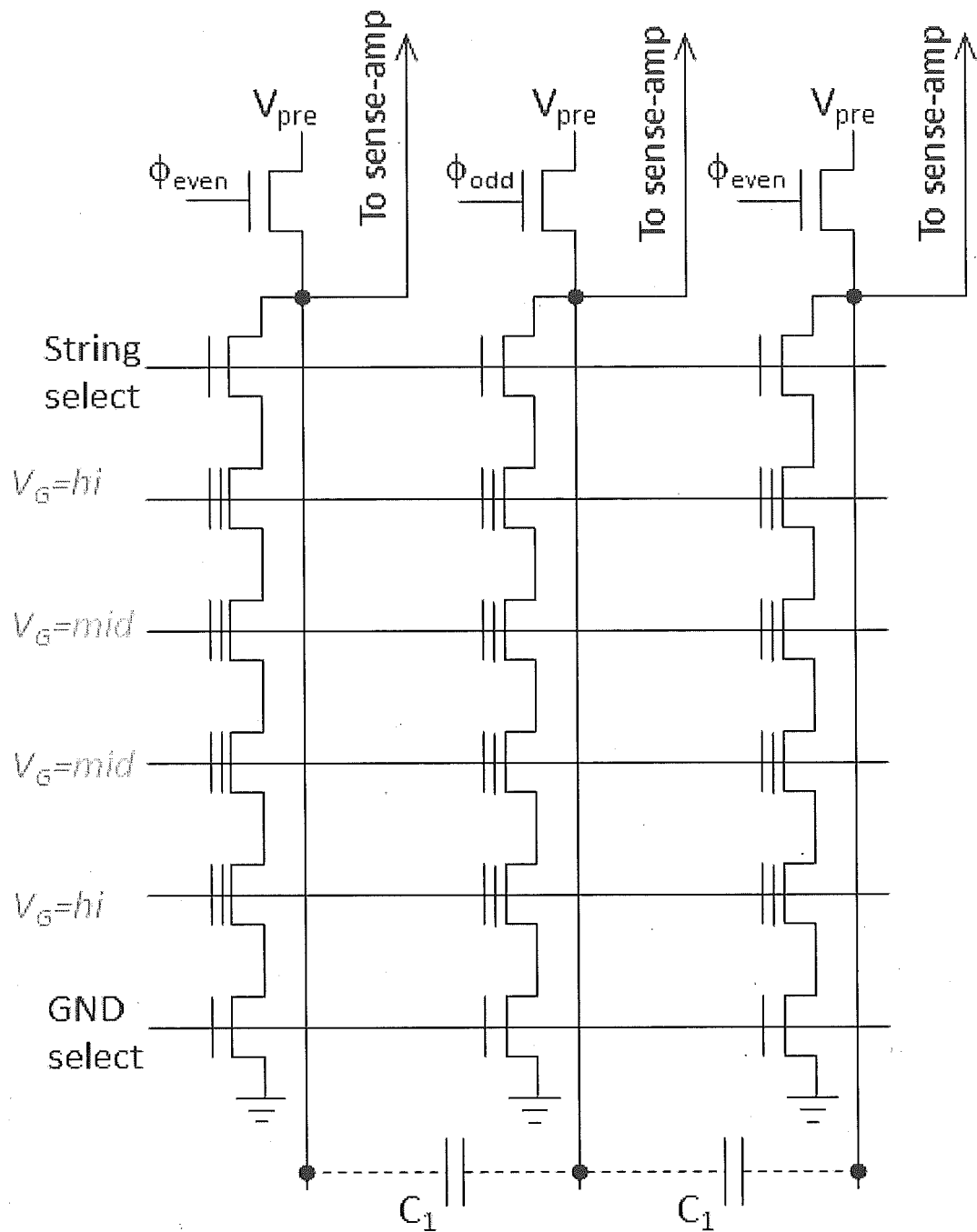
1600



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FIG 17

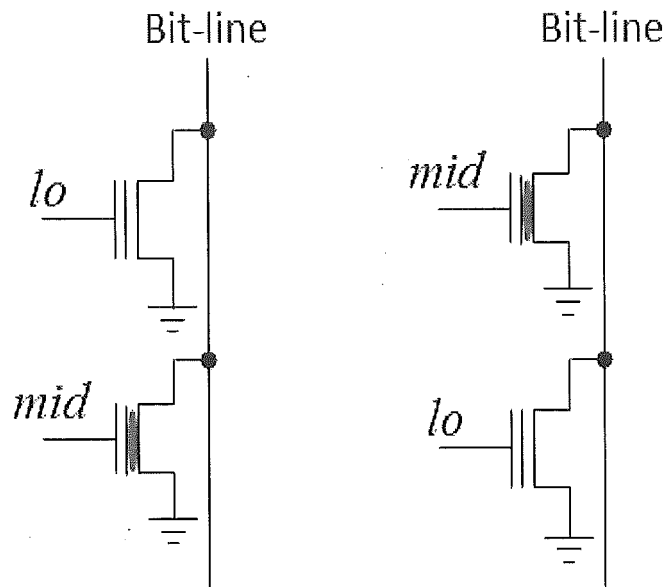
1700



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FIG 18A

1800



Encodes a "1"

• Does NOT draw current
only if probe is (*lo*, *mid*)

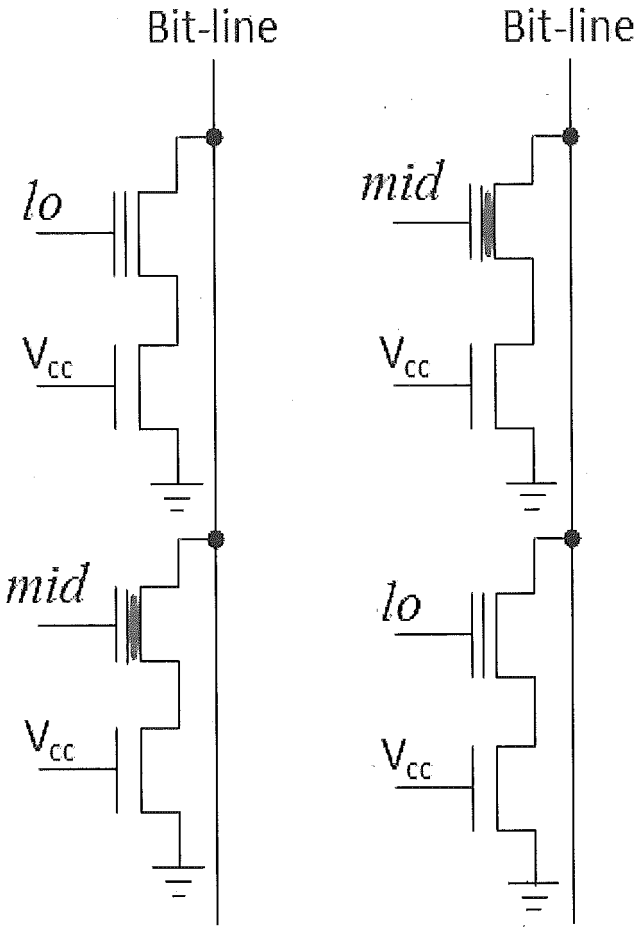
Encodes a "0"

• Does NOT draw current
only if probe is (*mid*, *lo*)

- (*lo*, *lo*) and (*mid*, *mid*)
probes Not allowed

FIG 18B

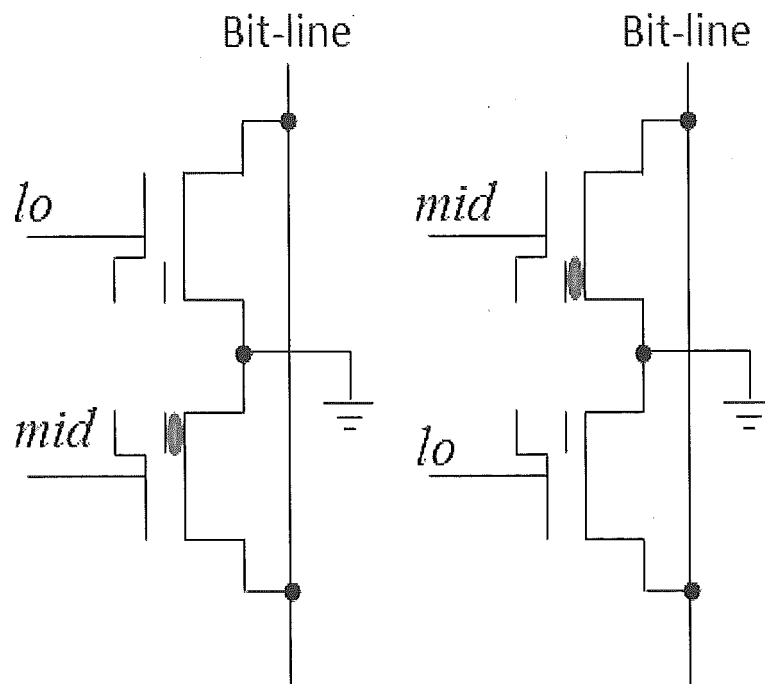
1802



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FIG 18C

1804



- $mid = V_{ref1}$
- *lo* should cause an erased cell to *not* conduct

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FIG 18D

1806

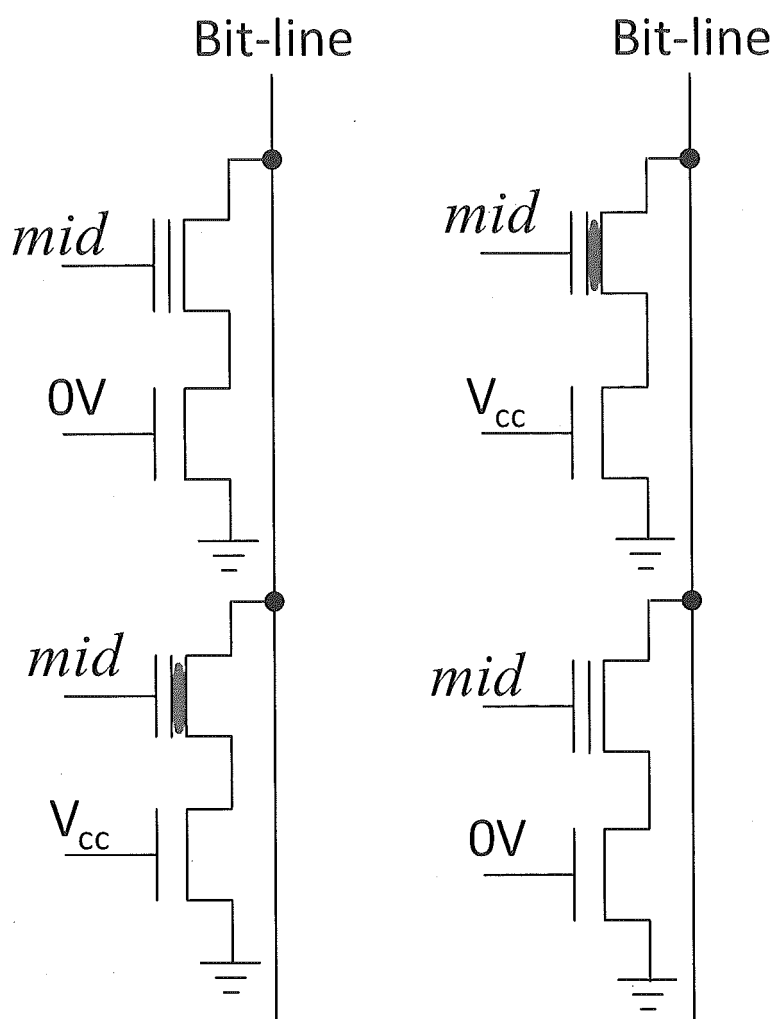
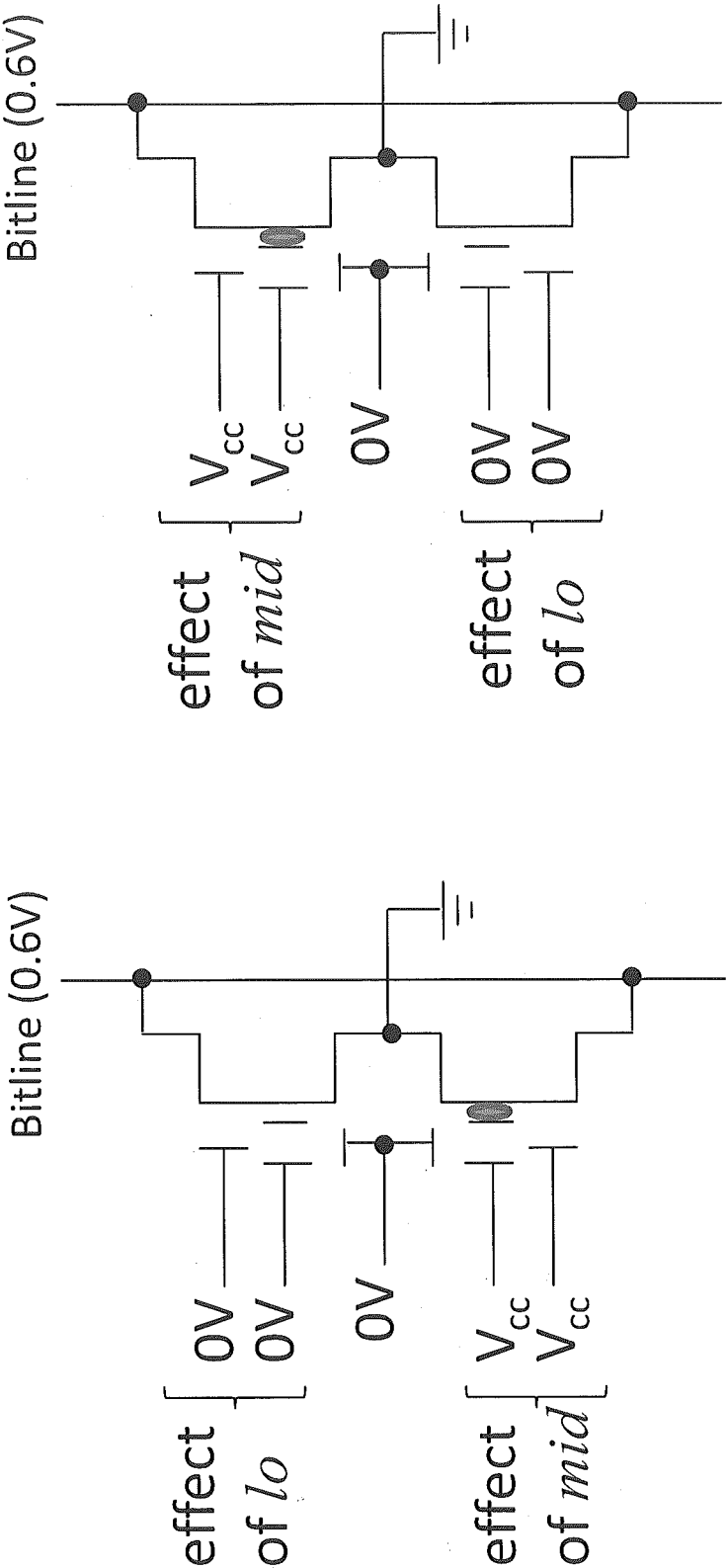


FIG 18E

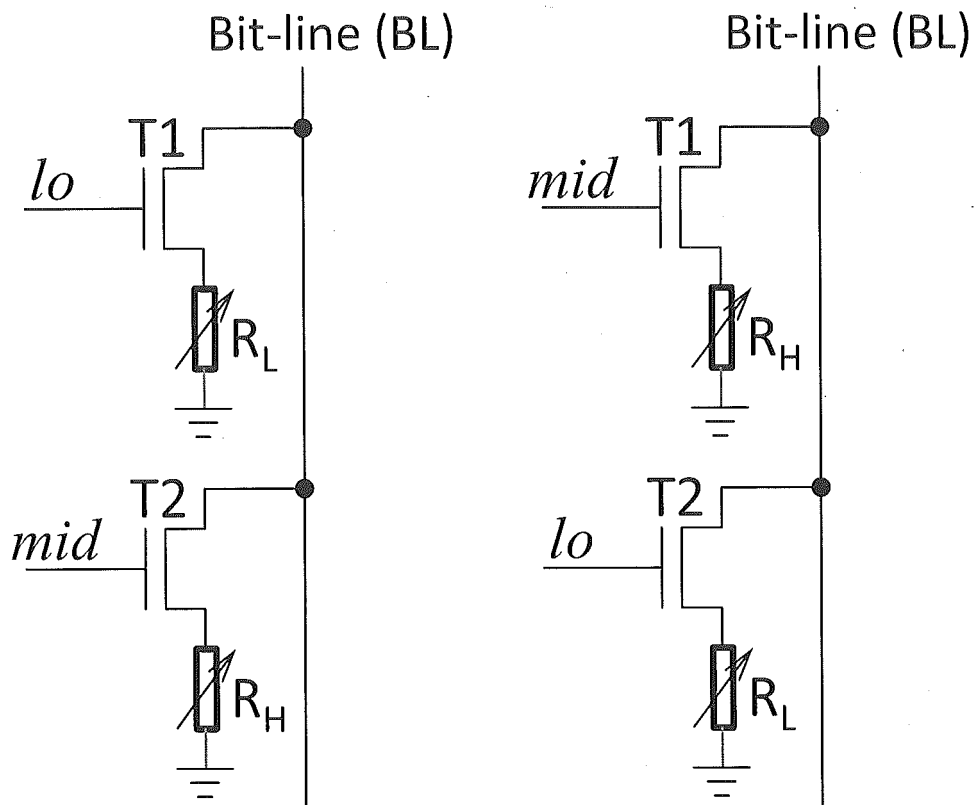
1808



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FIG 19

1900



Encodes a "1"

- Draws small current (V_{BL}/R_H) if probe is (*lo*, *mid*)
- Draws large current (V_{BL}/R_L) if probe is (*mid*, *lo*)

Encodes a "0"

- Draws small current (V_{BL}/R_H) if probe is (*mid*, *lo*)
- Draws large current (V_{BL}/R_L) if probe is (*lo*, *mid*)

FIG 20

2000

Range query description in cell state pair		Tests for	Meaning	Illustration
Query- side	Reference- side			
$(x, 2^{l'-y-1})$	$(a, 2^{l'-b-1})$	$x \leq a \ \& \ 2^{l'-y-1} \leq 2^{l'-b-1}$ $\Leftrightarrow x \leq a \ \& \ y \geq b$	$[a, b] \subseteq [x, y]$	
$x \leq y$	$a \leq b$		Anti-match (always false)	$y \geq b \geq a \geq x$ conflicts with $x < y$
$x > y$	$a > b$		$[y, x] \subseteq [b, a]$	
$x \leq y$	$a > b$		$[x, y] \cap [b, a] \neq \emptyset$ (most often used)	

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FIG 21B

2102

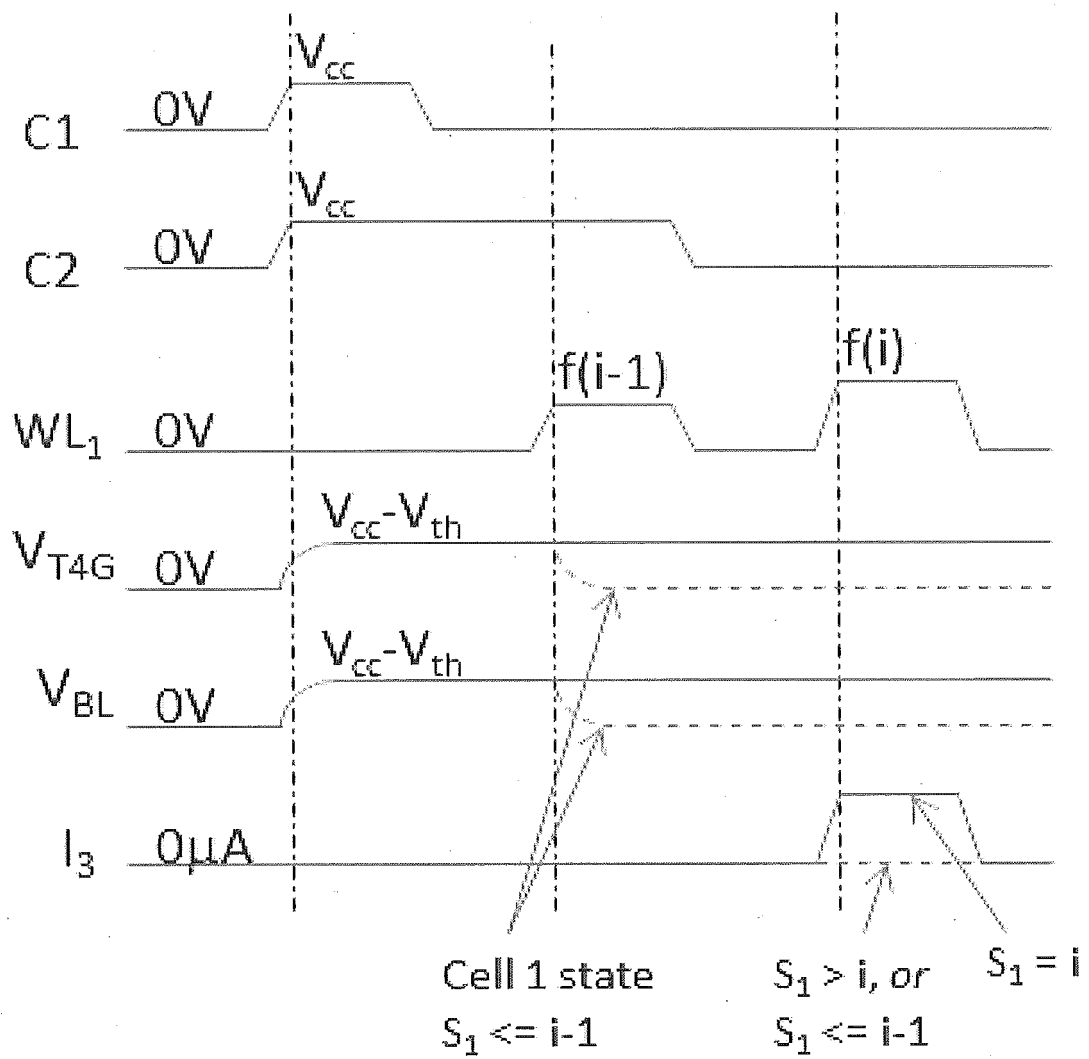
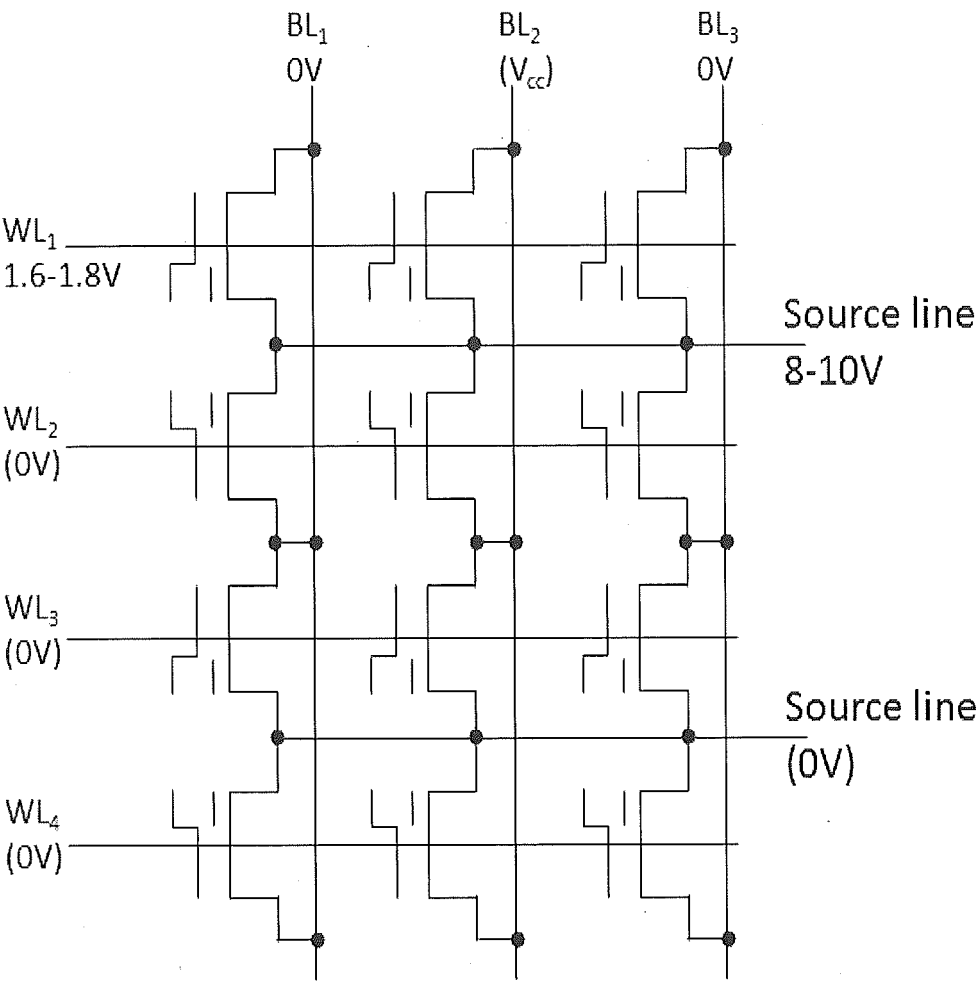


FIG 22A

2200



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FIG 22B

2202

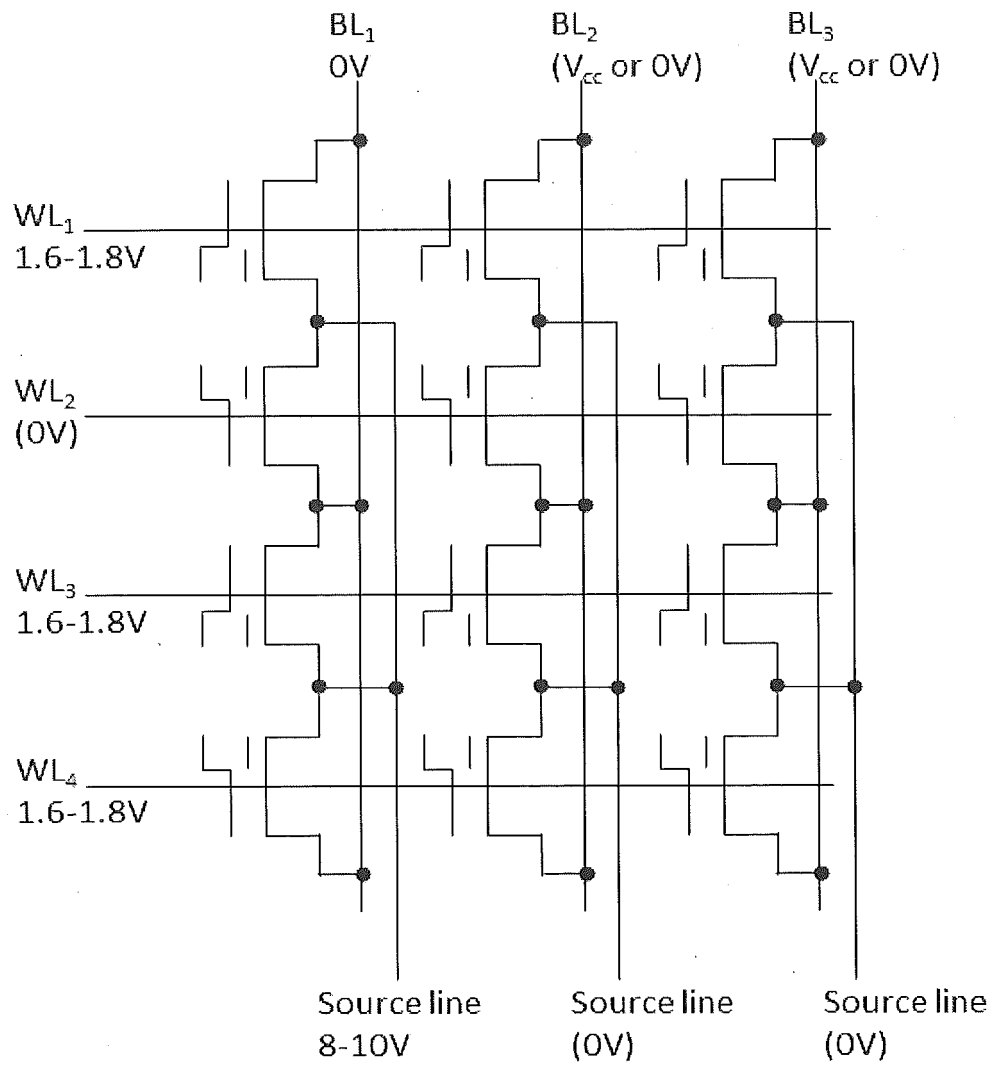


FIG 23A

2300

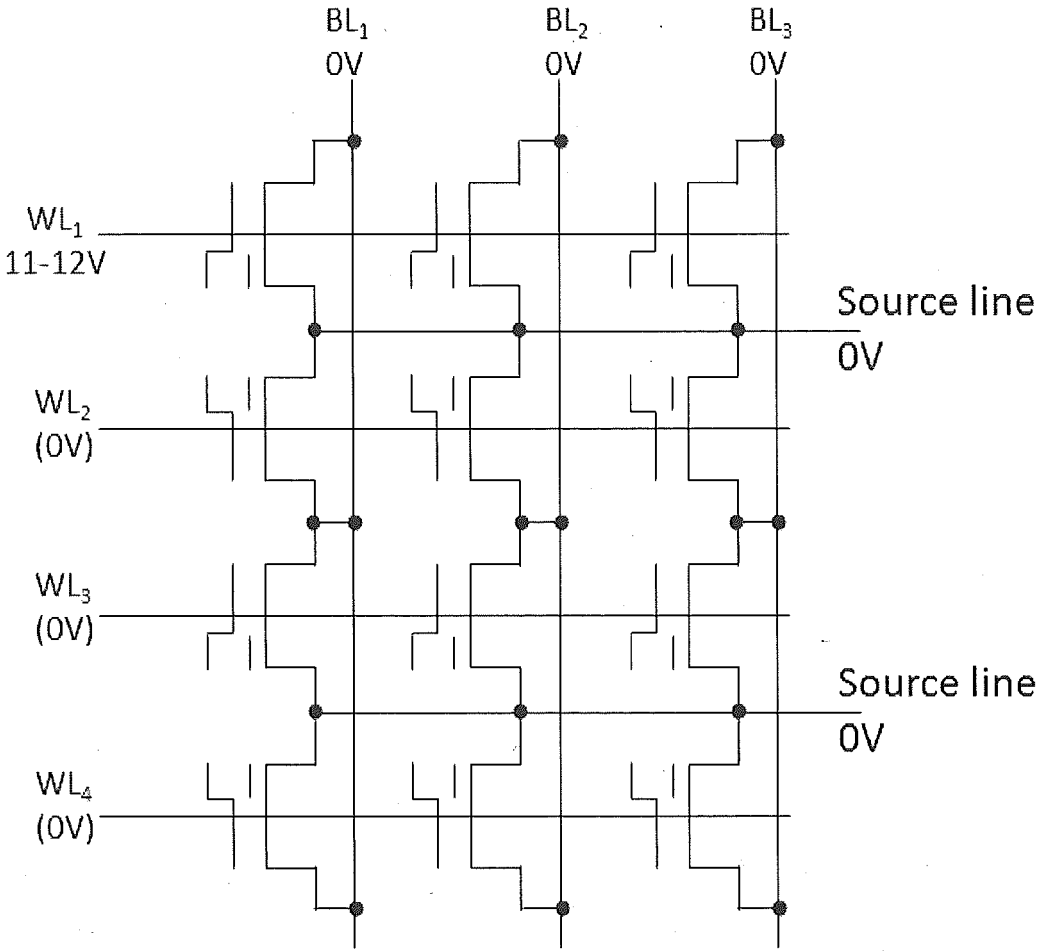
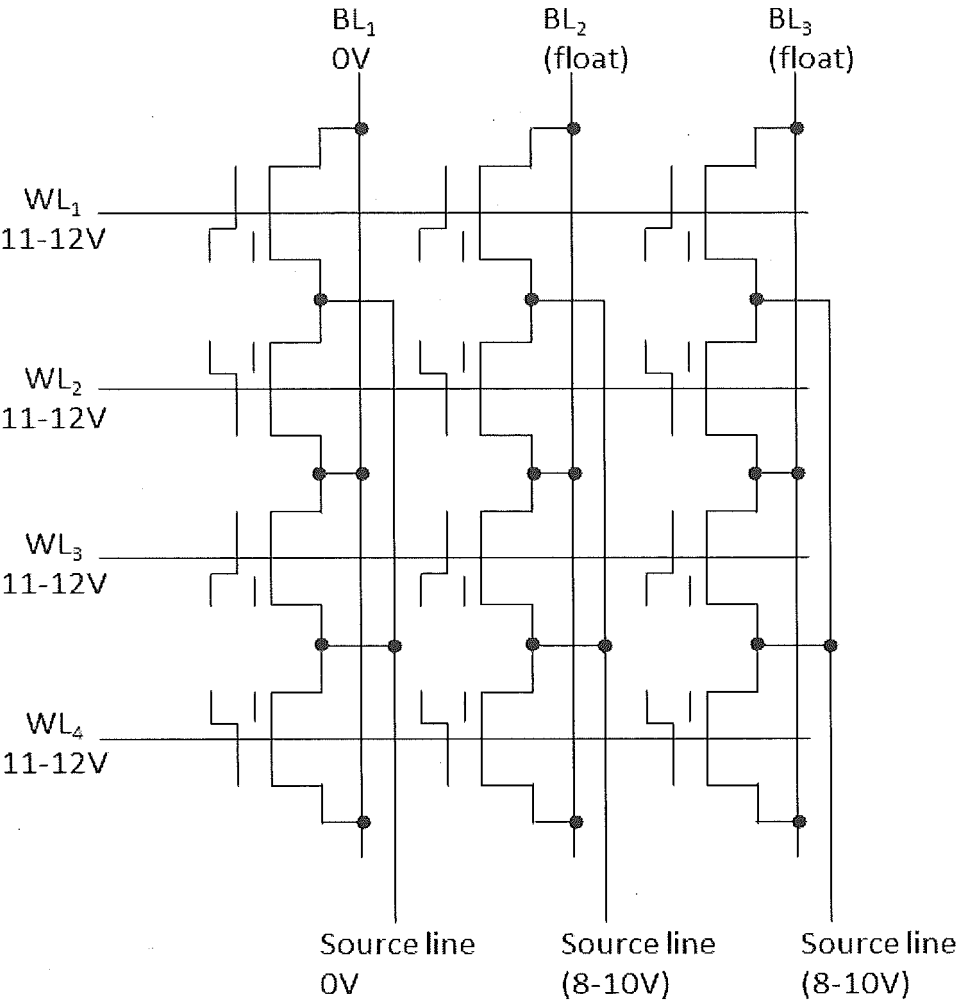


FIG 23B

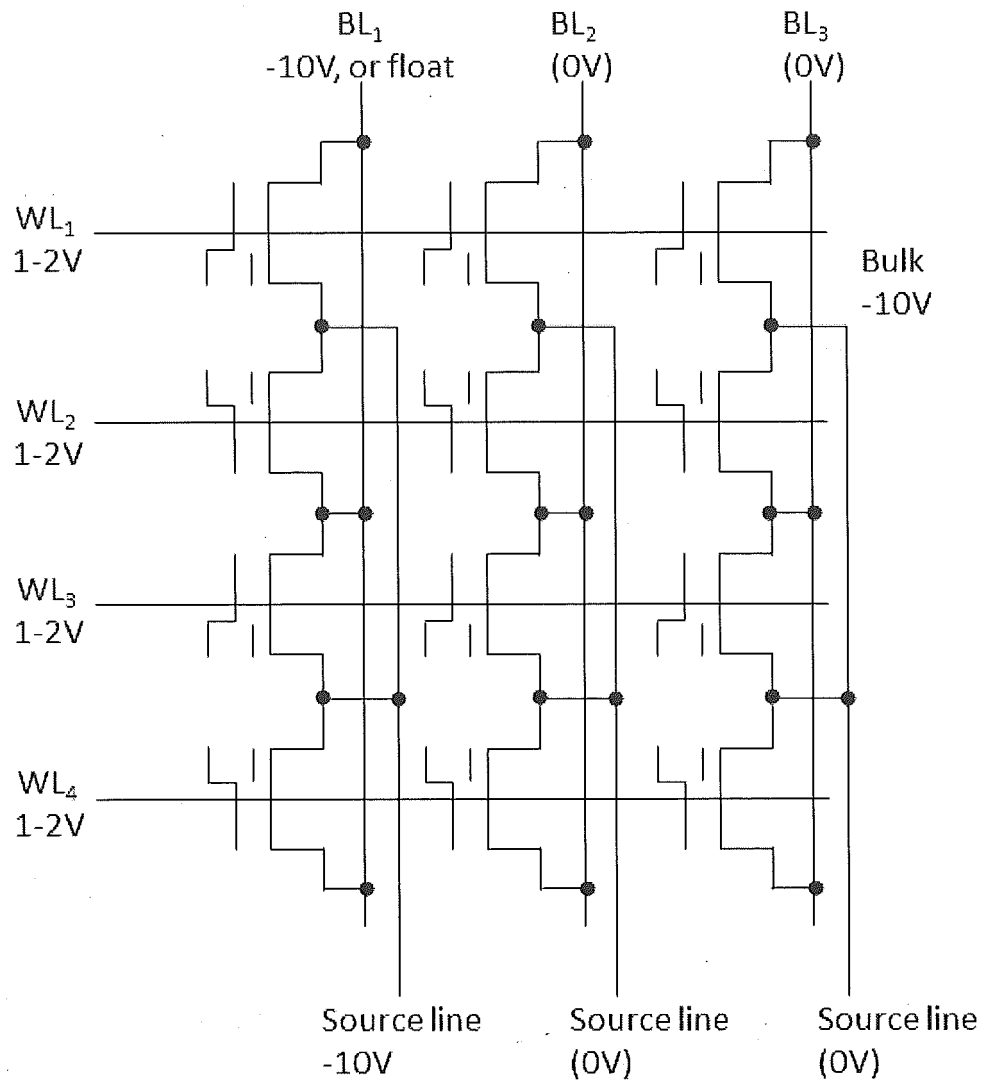
2302



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FIG 23C

2304



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FIG 24A

2400

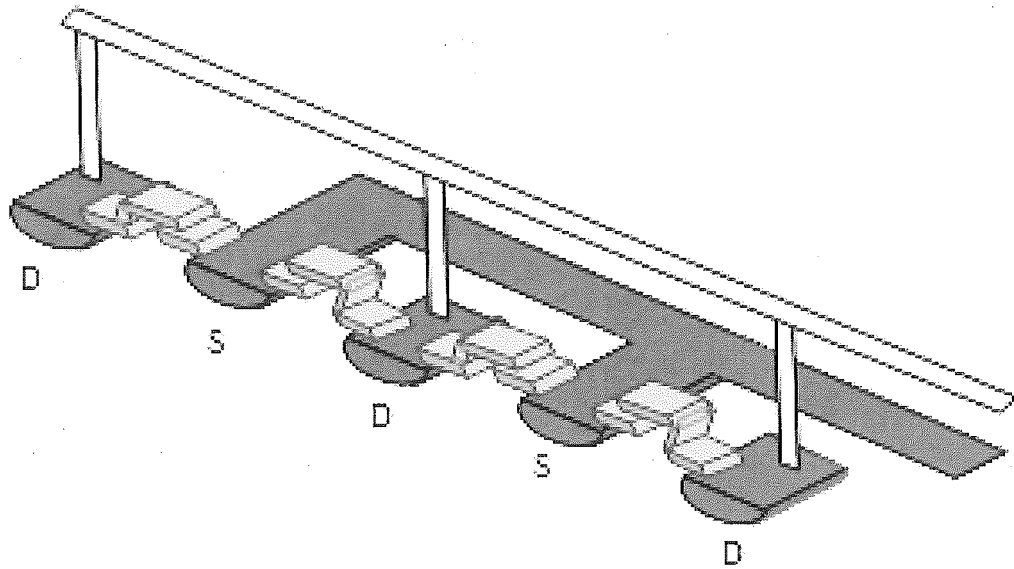
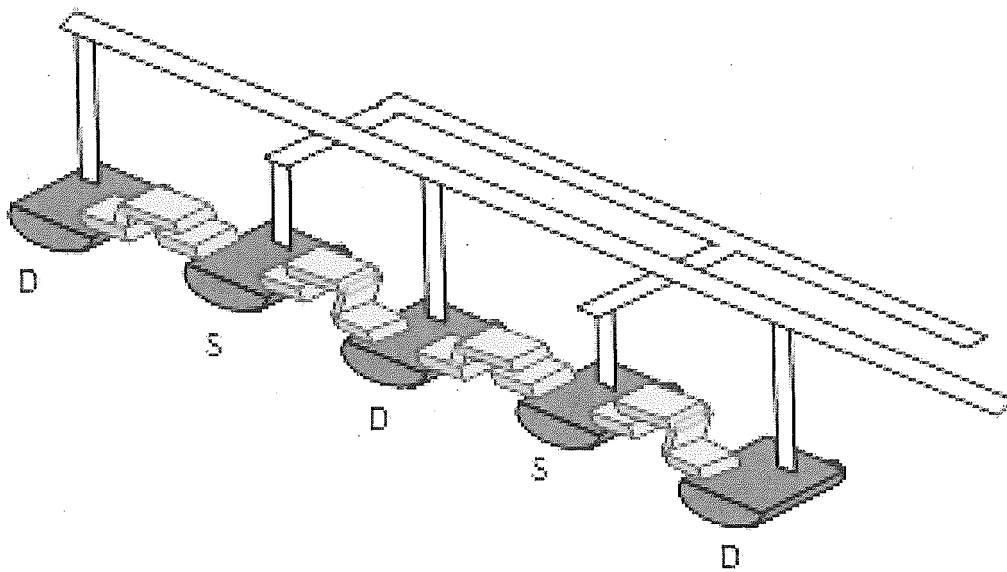


FIG 24B

2402



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FIG 25A

2500

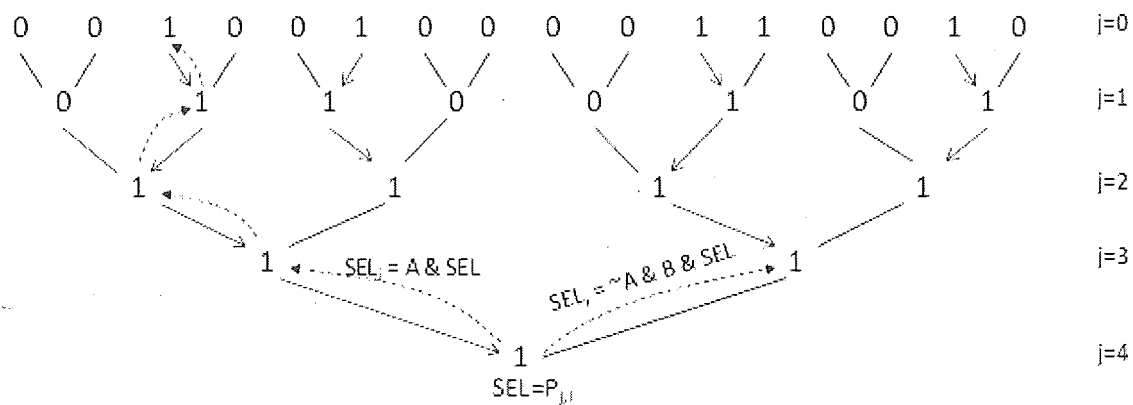
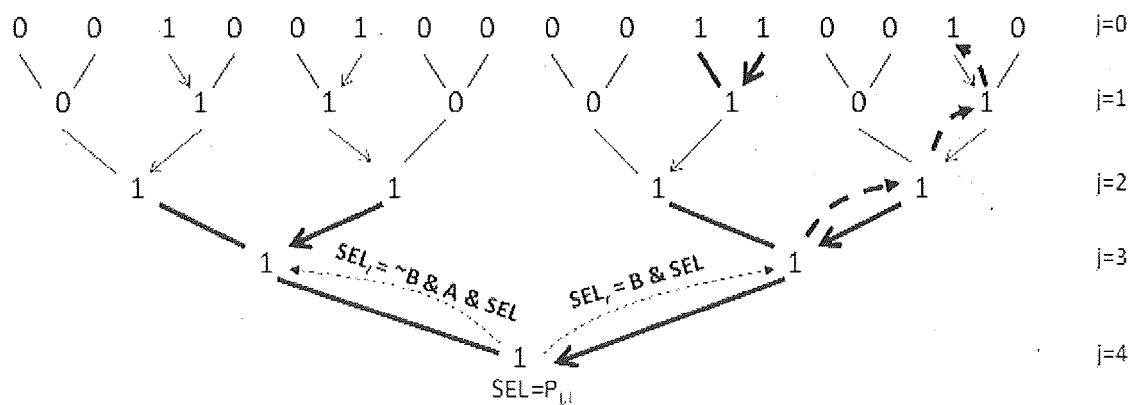


FIG 25B

2502



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FIG 26A

2600

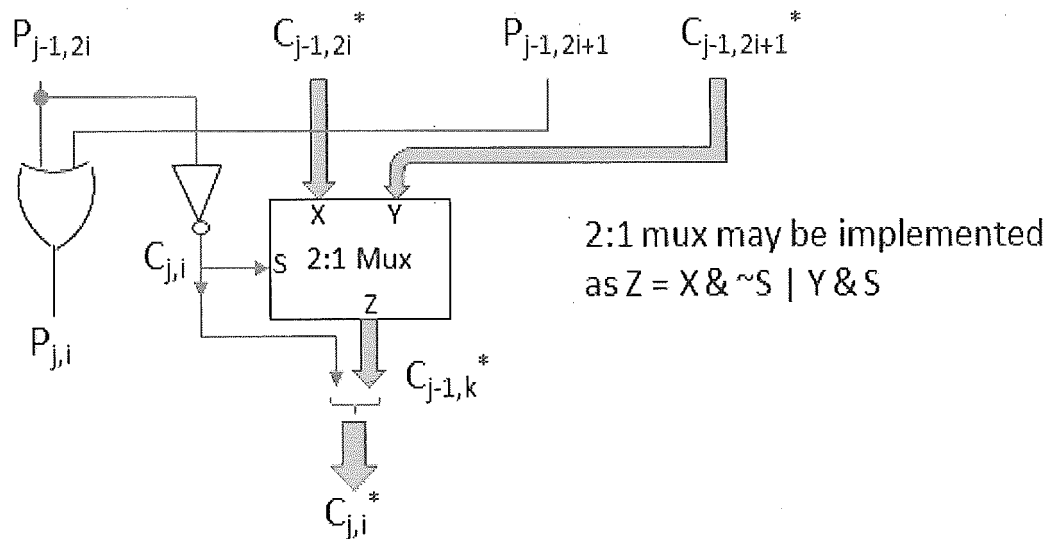
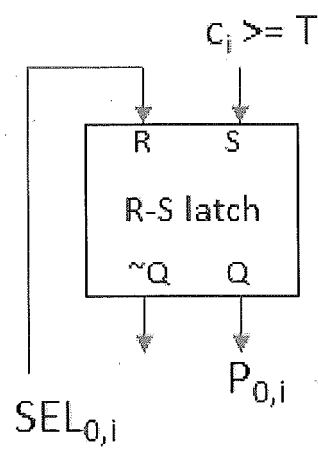


FIG 26B

2602



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FIG 26C

2604

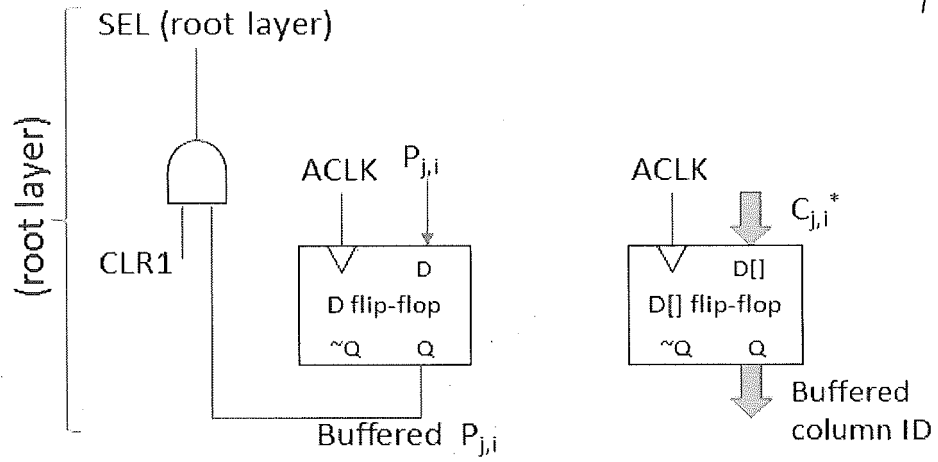


FIG 26D

2606

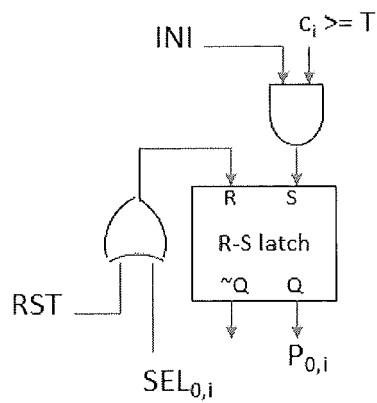
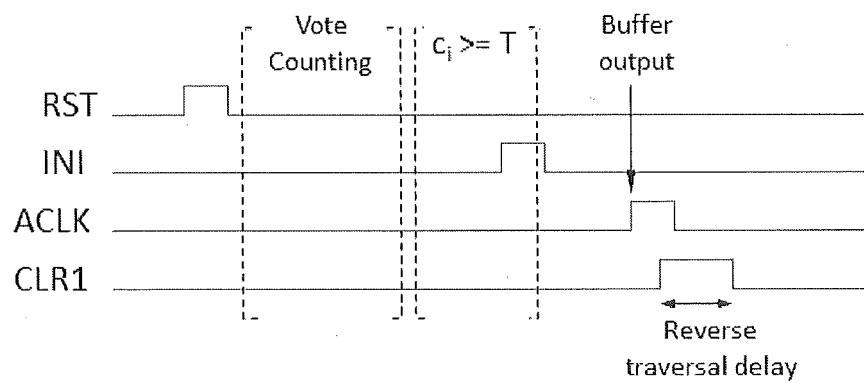


FIG 26E

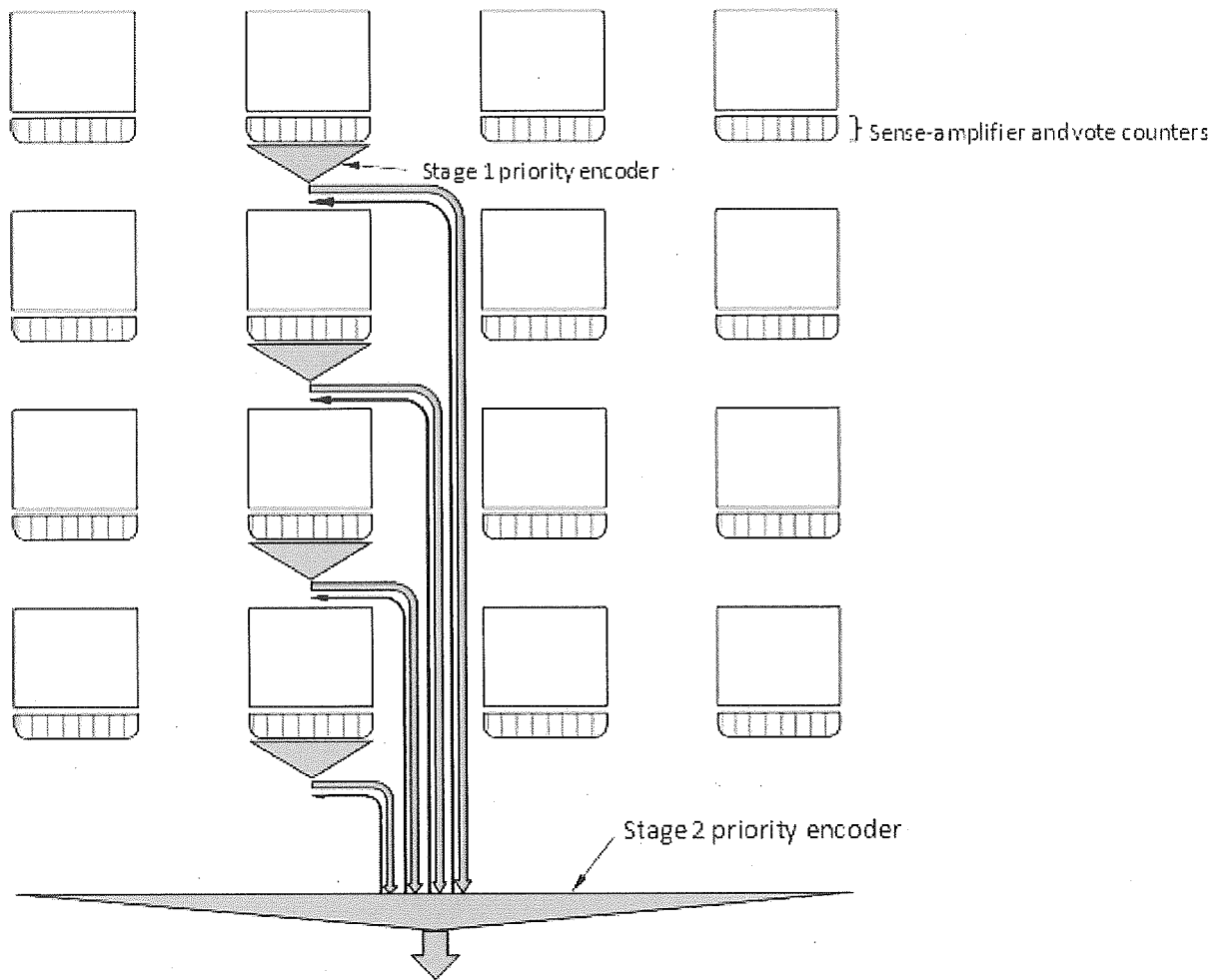
2608



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FIG 27

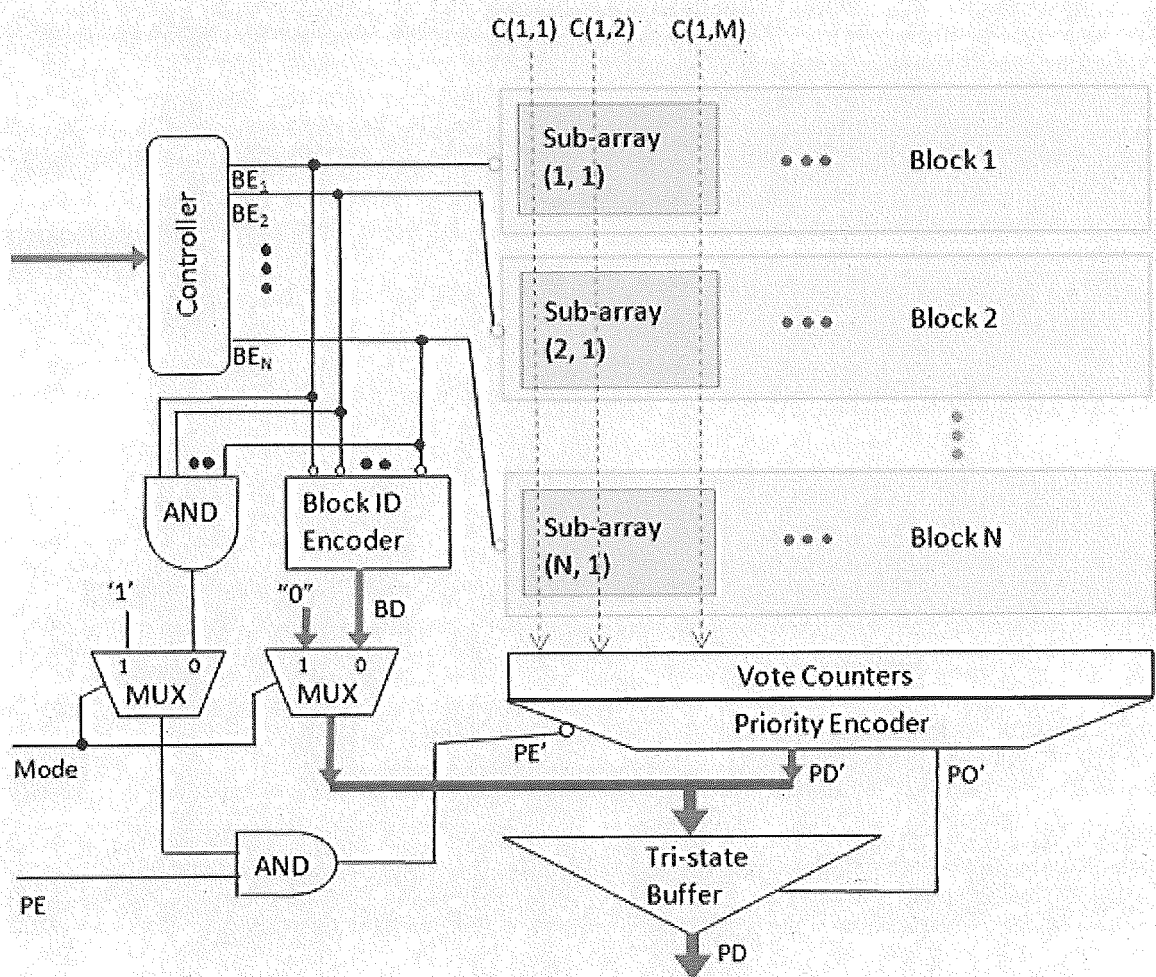
2700



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FIG 28

2800



2900

FIG 29

