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(24) 2001 06 19

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(22) 1998 01 08 (43) 1999 01 25

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(30) 97 - 161488 1997 06 18 (JP)

(73) 가 가  
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(72) 2 2 - 3 가 가  
2 2 - 3 가 가

(74)

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(54)

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/ (10) (2) (10) (2) / (10) (2) n (12)  
, Co (11) , / (10) (3) (11) PN (4) (11) (5)  
(2) 가 / (10) (3) 가 .  
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3 : P  
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9 : n  
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17 :

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31 : N

41 :

51 : p

52 : n

61 :

71 :

91 : p

100 :

111 : Co

121 : p

181 :

101 :

102 :

103 : P

104 :

105 :

106 :

107 :

108 :

109 : n

200 :

1010 : /

1011 :

1016 :

1017 :

1018 :

, 가

LSI , 가 가  
 가 , / (Self - Align  
 ed silicide) 가

55 , 102 , 103 P , 104 , 105 , 106 , 107 , 108 , 109 n , 1010 / , 1011 , 1016 , 1  
 017 (1017) / (1010) (1011) ,  
 Co, Ni, Ti, W, Pt

, 56  
 (1011) , (102) / (1010) (102)  
 (潛入) 가 . , Co Ni

가 , / (1010) P (103) (1011) / (1010) (1011) (1011)  
 (101) P (103), (104) (105)  
 가 .

, 57 , (102) 가 .

(102) 가 , (102) P (103) (101) (101)  
 (1011) (1011) / (1010) P (103) PN , (104)  
 (1011) 가 .  
 (1011) Co Ni 가 , 58 (1011) , 59  
 PN , (1018) (1011) 가 , / (1010) P (103)  
 10) (104) (105) (1011) (101) (1011) / (10  
 /  
 가 .  
 , / PN 가 .  
 가 .  
 60 n (1091) 가 .  
 4,949,136  
 , (102) (1011) n n  
 (1091) (1091) 가 .  
 , (108, 1081) 가 , / (1010)  
 / PN , ,  
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1	1			1	1	2		
, 3	P	, 4	, 5	, 6	, 7	, 8	, 9	n
, 10	/	, 11	Co	, 12	n	.	.	.
$1 \times 10^{21}$		$1 \times 10^{17}$	$1 \times 10^{18} / \text{cm}^3$	$1 \times 10^{18}$	$1 \times 10^{17}$	$1 \times 10^{18} / \text{cm}^3$	$1 \times 10^{17}$	$1 \times 10^1$
$8 / \text{cm}^3$	, n	(9)	,	,	(5)	,	(10)	.
$1 \times 10^{22} / \text{cm}^3$	,	n		(12)	$1 \times 10^{19} / \text{cm}^3$	,	$1 \times 10^{19} / \text{cm}^3$	.
2	1					2	7	
, 100	, 120	.	, 200	.	.	(120)	(100)	.
(200)		.	1	n	.	(120)	.	(7)

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(7)		/	(10)		,		,	P (3)
가		/		가	.	,	n	(12) P (3)
Co			Co		.	.	n	.
			(11)		.	.		.
					.	.		.

,	Co	Ni, Ti, W, Pt	,	n	,		,	,
(12)		.	/	(10)	n	n	(9)	n
가	n	(12)				가	.	.

, 3 PMOS , 31 N , 91 p , 121 p . N (31)  
 $1 \times 10^{17}$   $1 \times 10^{18} / \text{cm}^3$  , (4)  $1 \times 10^{17}$   $1 \times 10^{18} / \text{cm}^3$  , p (91)  $1 \times 10^{17}$   $1 \times 10^{18} / \text{cm}^3$   
 , (5) / (10)  $1 \times 10^{19} / \text{cm}^3$  , /  $1 \times 10^{19} / \text{cm}^3$  , p (12)  
 $10^{18}$   $1 \times 10^{18}$  ,  
 1) .

, Co Ni, Ti, W, Pt , p ,  
 .

PMOS NMOS 가 가 /  
 , , p (121) N (31) /  
 , p (121) Co , Co (11)  
 .

n (12) p / (10) (2) , / (10)  
 (2) (121) (2) Co (11)  
 (4) (5) , / (10) (3) (11)  
 (11) 가 , / PN 가  
 .

4, 5, 6, 7 8 1 13 , 14 , 111 Co , 61 4,  
 5, 6, 7 8

, 4 (1) 200 (61) 3000  
 (14) 3000 5000 (2)

, (61) (14) (SiON) (61) , (61) (1)  
 1000 , , , (2)

5 , p (61) (14) , (2)  
 250keV ,  $1 \times 10^{13}$   $1 \times 10^{14} / \text{cm}^2$  P (3)  
 100keV ,  $1 \times 10^{12}$   $1 \times 10^{13} / \text{cm}^2$  (4)  
 $1 \times 10^{12}$  , (5)

, (6) (7) , 10 40keV ,  $1 \times 10^{13}$   $1 \times 10^{14} / \text{cm}^2$   
 , 45° n (9) , 20 60keV ,  $1 \times 10^{15}$   $1 \times 10^{16} / \text{cm}^2$  RIE (reactive ion  
 etching) (8) , (10)

, 6 , 1000 (13) (7) / (10)  
 (facet) n (12) , 6

,	10	40keV	, $1 \times 10^{13}$	$1 \times 10^{14} / \text{cm}^2$	n	45 °	.	,	(13)
.	.	(7)	.	.	.	(12)	.	.	.
.	/	(10)	.	.	.	.	.	.	.
7		(13)	300	.	.	(13)	/	.	.
(13)	/	(10)	가	,	(7)	(13)	가	.	.
,	8		CVD		50	200	Co	(111)	
	RTA	(rapid thermal anneal)		400	500	, 30	2		
	(7)	/	(10)	Co	(11)	.	Co	N	
i, Ti, W, Pt	.	.	.	.	.	.	.	.	.
,	Co	(mixed acid peroxyhydrate) (HNO <sub>3</sub> /CH <sub>3</sub> COOH /P <sub>4</sub> O <sub>10</sub> /H <sub>2</sub> O <sub>2</sub> )		.	.	.	.	.	(h)
hydrochloric acid peroxyhydrate) (HCl/H <sub>2</sub> O <sub>2</sub> )			,	700	900	, 30	2		
RTA	1		(2)	n	(12)	.	.	.	.
,	PMOS	NMOS	가	3000	5000	.	.	.	(2)
n		1.2MeV	, $1 \times 10^{13}$	$1 \times 10^{14} / \text{cm}^2$	.	.	.	.	N (31)
,		350keV	, $1 \times 10^{12}$	$1 \times 10^{13} / \text{cm}^2$	.	.	.	.	(4)
,		40keV	200keV	, $1 \times 10^{12}$	$1 \times 10^{13} / \text{cm}^2$	.	.	.	( )
5)	.	.	.	.	.	.	.	.	.
$1 \times 10^{15} / \text{cm}^2$	(6)	7 °	(7)	p	(91)	5keV	40keV	$1 \times 10^{-14}$	
(8)	.	.	10keV	50keV	$1 \times 10^{-15}$	$1 \times 10^{16} / \text{cm}^2$	,	NMOS	가
/	(10)	.	.	.	.	.	.	.	.
,	NMOS	가	.	(13)	.	5keV	40keV	$1 \times 10^{-14}$	
$1 \times 10^{15} / \text{cm}^2$	.	.	,	.	.	(7)	.	.	.
p	(121)	.	,	(13)	.	.	.	.	.
,	NMOS	가	Co	(11)	.	3	.	.	가
(13)	/	(10)	.	.	NMOS	.	.	.	.
PMOS, NMOS	.	.	.	.	.	.	.	.	.
,	PMOS, NMOS	.	(5)	.	(4)	.	.	.	.
,	.	.	,	(5)	(4)	.	.	.	.
,	.	.	,	(5)	(4)	.	.	.	.
,	.	.	,	.	.	0.15μm	.	.	.
PMOS	NMOS	가	.	.	.	.	.	.	.
10)	n	(12)	p	(121)	(7)	/	.	.	( )
(2)	.	(13)	.	가	가	.	.	.	.
.	.	,	.	.	.	.	.	.	.
(2)	(2)	.	.	.	.	.	.	.	.

, / (10) (2) Co , / (10) (11) n (12)  
 p (121) (121) (11) (2) 가 / (10) (3) (11) PN (2)  
 (4) (5) / (10) / (11) PN  
 (11) 가 ,  
 ,  
 9, 10, 11, 12 13 1 14 , 71  
 . 9, 10, 11, 12 13  
 .  
 , (1) 3000 200 (61) 1000 (14)  
 . 5000 (2)  
 .  
 9 (2) (14) p  
 300keV  $1 \times 10^{13}$   $1 \times 10^{14} / \text{cm}^2$   
 100keV  $1 \times 10^{12}$   $1 \times 10^{13} / \text{cm}^2$   
 60keV 110keV ,  $1 \times 10^{12}$   $1 \times 10^{13} / \text{cm}^2$   
 (4) (5)  
 (14)  
 (boron range distance) (2) 3 4 , , (5)  
 (14)  
 , 10 (61) (6)  
 (14) (71)  
 .  
 , 11 (15) (15) (7)  
 .  
 , 12 10keV 40keV ,  $1 \times 10^{13}$   $1 \times 10^{14} / \text{cm}^2$  n 45° (12)  
 . (14)  
 .  
 , 10keV 40keV  $1 \times 10^{13}$   $1 \times 10^{14} / \text{cm}^2$  45° n  
 (9) . , CVD RIE (reactive ion etching)  
 (8) 20keV 60keV  $1 \times 10^{15}$   $1 \times 10^{16} / \text{cm}^2$   
 (10)  
 .  
 , 13 CVD 50 200 Co (111)  
 RTA (rapid thermal anneal) , 400 500 , 30 2 Co N  
 (7) / (10) Co  
 i, Ti, W, Pt  
 , Co (HNO<sub>3</sub>/CH<sub>3</sub>COOH/P<sub>4</sub>O<sub>10</sub>/H<sub>2</sub>O<sub>2</sub>) 1 (HCl/H<sub>2</sub>O<sub>2</sub>) (2)  
 , 700 900 , 30 2 RTA 1  
 n (12)  
 .  
 , PMOS NMOS 가 , 200 1000  
 3000 5000

$1 \times 10^{14} / \text{cm}^2$	N (31)	n	350keV	$1.3 \text{MeV}$	$1 \times 10^{13} / \text{cm}^2$
$\text{cm}^2$	(4)	,	200keV	$1 \times 10^{12} / \text{cm}^2$	$1 \times 10^{13} / \text{cm}^2$
	(5)	.			
$0^{15} / \text{cm}^2$	(6)	(7)	5keV	40keV	$1 \times 10^{14} / \text{cm}^2$
	,	,			p
(121)		(14)		(7)	
$0^{15}$	5keV	40keV	$1 \times 10^{14} / \text{cm}^2$	$1 \times 10^{15} / \text{cm}^2$	$7^\circ$
(91)	, NMOS	가	(8)	.	10keV
$1 \times 10^{16} / \text{cm}^2$		/	(10)	.	50keV
,	NMOS	가	Co	(11)	3
PMOS, NMOS	(5)	(4)		.	가
,	14	PMOS, NMOS	(5)	(7)	.
(14)	(61)		(6)	.	.
NMOS	,	50keV	$1 \times 10^{12} / \text{cm}^2$	$1 \times 10^{13} / \text{cm}^2, 7^\circ$	, PMOS
100	180keV	,	$1 \times 10^{12} / \text{cm}^2$	$1 \times 10^{13} / \text{cm}^2, 7^\circ$	PMOS
10keV	20keV	,	$1 \times 10^{12} / \text{cm}^2$	$1 \times 10^{13} / \text{cm}^2, 7^\circ$	.
,	(5)	/	(10)	,	(7)
,			가	,	가
, PMOS, NMOS	(5)	(4)		.	.
,		(5)	.	0.15 $\mu\text{m}$	.
,	n	(12)	p	(121)	(2)
(14)		(2)		(1)	.
,	/	(10)	(2)	,	n
p	(121)		, Co	/	(12)
(4)		(2)	가	(10)	(2)
11)		(5)	,	(11)	.
가		가	/	PN	.
,		,	(10)	,	(
1	,	가	(3)	가	).
,		가			.



, / (10) (2) , / (10) (11) n (12)  
 p (121) , Co (11) (11) PN ,  
 (4) (5) 가 , / (10) (3) 가  
 (11) 가 , /

, , ,  
 17 18 2

, 1 가 (14) (2) 17 200  
 61) 3000 NMOS 100keV ,  $1 \times 10^{-12}$   
 $1 \times 10^{13} / \text{cm}^2$  (41)

, 1 (14) 가 (2) 가 P (3) 1000  
 , 1 가 (15) (7) (5)

, 18 , 1 가 (6) (71) (14)  
 (61) , (15) (7)

(15) n 1 가 (12) (14) (7)

, 1 가 , n (9), (8), / (10) Co (11)

, PMOS  $1 \times 10^{13} / \text{cm}^2$  NMOS 가 , , PMOS 350keV ,  $1 \times 10^{-12}$   
 (41)

PMOS, NMOS , (5) 0.15 $\mu\text{m}$

, 1 가 PMOS, NMOS (6) (5) (7)

NMOS 50keV ,  $1 \times 10^{-12}$   $1 \times 10^{13} / \text{cm}^2$ , 7° , PMOS  
 100keV 180keV ,  $1 \times 10^{-12}$   $1 \times 10^{13} / \text{cm}^2$ , 7° , PMOS  
 10keV 20keV ,  $1 \times 10^{-12}$   $1 \times 10^{13} / \text{cm}^2$ , 7°

, (5) / (10) 가 가 (7)

, n (12) p (121) (1) (2)

, / (10) (2) , / (10) (12) (2)  
 p (121) , Co (11) n  
 (4) (5) (2) 가 / (10) (3) (11) PN (1)  
 11) 가 / .  
 , , ,  
 2 가 ,  
 가 .  
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 19 20 3 . 19 20  
 18  
 19 NMOS , P (3) ,  $1 \times 10^{17}$   $1 \times 10^{18} / \text{cm}^3$  , (5)  $1 \times 10^{17}$   $1 \times 10^{18} / \text{cm}^3$  , (4)  
 , n (9)  $1 \times 10^{18}$  ,  $1 \times 10^{19} / \text{cm}^3$  , /  $1 \times 10^{17}$   $1 \times 10^{18} / \text{cm}^3$   $1 \times 10^{18} / \text{cm}^3$   
 $10^{21}$   $1 \times 10^{22} / \text{cm}^3$  , n (12)  $1 \times 10^{18}$   $1 \times 10^{19} / \text{cm}^3$  .  
 가 , / (10) , , , , P (3) (12) P (3)  
 , Co (11) . n  
 Co (11) .  
 , Co Ni, Ti, W, Pt , n , / (10) n , (9)  
 n (12) . , / (10) n , (9)  
 가 , n (12) .  
 , 20 PMOS , N (31) ,  $1 \times 10^{17}$   $1 \times 10^{18} / \text{cm}^3$  ,  $1 \times 10^{18} / \text{cm}^3$  , (5)  $1 \times 10^{17}$   $1 \times 10^{18} / \text{cm}^3$  ,  
 (4)  $10^{18} / \text{cm}^3$  , p (91)  $1 \times 10^{21}$   $1 \times 10^{22} / \text{cm}^3$  , p (121)  $1 \times 10^{18}$   $1 \times 10^{19} / \text{cm}^3$  , /  $1 \times 10^{17}$   $1 \times 10^{19} / \text{cm}^3$  .  
 , Co Ni, Ti, W, Pt , p ,  
 PMOS NMOS 가 , 가 , /  
 , , p (121) N (31) , , Co , Co (11) 가  
 1) , p (121) .

21, 22 23 3

, 21	(1)	300	(61)	2000
(14)			(14),	(61)
	(1)		3000	

22 TEOS (181) 7000 CMP(Chemical Mechanical Polishing) (18) .

, 23 , 1 가 P (3), (5), (6),  
 (7), n (9), (8), / (10) 1000 (13) ,  
 (7) / (10) (12) . , (13) Co (11)

(10) (18) , n (12) (13) , p (121) (7) /  
(18) (18) (1) 가 가 .

, / (10) (18) / (10) n (12)  
 p (121) , Co (11) (18)  
 (18) 가 (11) (11) (18)  
 5) , / (10) PN (11) 가  
 / 가

24, 25, 26 27 3

, 24 , (1) 300 (61) 2000  
 (14) , (1) , (14), (61)  
 , , , 3000  
 . , TEOS (181) 7000

25 CMP(Chemical Mechanical Polishing) (14)  
 , P (3) 300keV ,  $1 \times 10^{13}$   $1 \times 10^{14} / \text{cm}^2$   
 (4) 100keV ,  $1 \times 10^{12}$   $1 \times 10^{13} / \text{cm}^2$ ,  
 60 110keV ,  $1 \times 10^{12}$   $1 \times 10^{13} / \text{cm}^2$ , (5)  
 TEOS (181) .

, 26 , 1 가 (61) (14) (15)  
 (6) , (71) , (15) , (15)

, 27 0keV 40keV ,  $1 \times 10^{13}$   $1 \times 10^{14} / \text{cm}^2$  45° , , 1  
 (7) n (12) , (14) ,  
 (61) TEOS (181)

, 1 , Co 가 (11) (6), (7), n (9), (8), /  
 (10) .

PMOS eV NMOS 가 , p (121) 5keV 10k  
 ,  $1 \times 10^{12}$   $1 \times 10^{13} / \text{cm}^2$  45° .

PMOS, NMOS (5) (4)  
 , , (5) 0.15 $\mu\text{m}$

, 1 (61) PMOS, NMOS (5) (7)  
 (14) .

NMOS , 50keV ,  $1 \times 10^{12}$   $1 \times 10^{13} / \text{cm}^2$ , 7° , PMOS  
 100keV 180keV  $1 \times 10^{12}$   $1 \times 10^{13} / \text{cm}^2$ , 7° , PMOS  
 10keV 20keV ,  $1 \times 10^{12}$   $1 \times 10^{13} / \text{cm}^2$ , 7° .

, (5) / (10) 가 , (7)  
 , , , 가 .

, , , n (12) p (121) (18) (18)  
 (14) (61) (18) (1) .

, / (10) (18) / (10)  
 p (121) , Co (11) (10)  
 , (18) 가 (14)

(5) / (10) PN (11) 가

, / .

3 , 가 , .

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28 4 .

28 NMOS , 19 (41) (18) 1  
 $\times 10^{17}$   $1 \times 10^{18} / \text{cm}^3$  .

PMOS 3 , (41) (41) ,  $1 \times 10^{17}$  (18) 1  
 $1 \times 10^{18} / \text{cm}^3$  .

n (12) , / (10) (18) (10) , / (18) (11) (10)  
(18) p (121) (5) , / (10) 가 , Co (11) (11)  
(18) (10) , / (10) PN , 가 .

, (18) , , .

29 30 4 .

, 3 , 가 , (14) (1) 300 (61) 2000  
, , (1) (14), (61)  
, 3000 .

29 , , NMOS (41) 5keV 10keV ,  $1 \times 10^{-12}$   $1 \times 10^{13} / \text{cm}^2$   
, , 3 , 3 , 가 .

, 30 3 , (9), (8), / (10) P (3), (5), (6),  
(7), n (10) (12) , , (13) (13) Co (11) .



$$, \quad 3 \quad \text{가} \quad , \text{PMOS, NMOS} \quad (5) \quad (7)$$

$$(14) \quad (61) \quad , \quad (6)$$

NMOS , 50keV  $1 \times 10^{12}$   $1 \times 10^{13} /cm^2$ , 7 ° , PMOS  
 100keV 180keV ,  $1 \times 10^{12}$   $1 \times 10^{13} /cm^2$ , 7 ° , PMOS  
 10keV 20keV ,  $1 \times 10^{12}$   $1 \times 10^{13} /cm^2$ , 7 ° .

, (5) / (10) 가 , 가 (7) 가

, n	(12)	p	(121)
(14)	(18)	(1)	(18)

, / (10) (18) Co, / (10) (11) (10) (12) (18)  
 p (121) (18) 가 PN (11) (11) (11) (11) (12)  
 (5) / (10) 가

4 , 가  
      가 .

< 5 >

33 34 5 . 33 34  
51 p , 52 n .

$$\begin{array}{ccccccccc}
 33 & \text{NMOS} & & , P & (3) & & 1 \times 10^{17} & 1 \times 10^{18} / \text{cm}^3 & , \\
 & & 1 \times 10^{17} & 1 \times 10^{18} / \text{cm}^3 & , p & & (51) & 1 \times 10^{17} & 1 \times 10^{18} / \text{cm}^3 \\
 , n & & (9) & & 1 \times 10^{18} & 1 \times 10^{19} / \text{cm}^3 & , & / & (10) \\
 21 & & 1 \times 10^{22} / \text{cm}^3 & , n & (12) & 1 \times 10^{18} & 1 \times 10^{19} / \text{cm}^3 & . & 1 \times 10
 \end{array} \quad (4)$$

(7) 가 / (10) , Co (11) , Co (11) , . (11) . (12) n , P (3) (12) P (3) .





, PMOS NMOS 가 , 39 , 1 가  
 (2) N (31) , (6), (7), p (91) 5keV  
 60keV ,  $1 \times 10^{13}$   $1 \times 10^{14} / \text{cm}^2$  , 7° , n (52) , (52)  
 8), / (10) . , n (52) p (91) .

NMOS, PMOS 1 1 (5) (4)

, n (12) p (121) (2)  
 (14) (2) (1)

, / (10) (2) , / (10) (11) (12)  
 p (121) Co (11) (2)  
 (4) , / (2) 가 PN (11) (11) (12)  
 / 가

5 , 가 가

< 6 >

40 6

$$40 \quad \text{NMOS} \quad (41) \quad 10^{17} \quad 1 \times 10^{18} \text{ /cm}^3 \quad 33 \quad . \quad (41) \quad 1 \times$$

$$\text{PMOS} \quad (41) \quad , \quad (2) \\ 1 \quad , \quad (41) \quad 1 \times 10^{17} \quad 1 \times 10^{18} / \text{cm}^3$$

NMOS, PMOS 1

n (12) / (10) (2) , / (10)  
n (2) p (121) (2) Co (11)  
n (2) (4) / (10) 가 PN  
n 가 / 가

(2)

,	p	(51)	n	(52)	n	(9)	p	(91)
,	,	,	가	,	가	가	,	가
41	42	6	,	,	,	,	,	,
,	5	(2)	가	, 200	(61)	1000	(14)	
				41		NMOS	100keV	, $1 \times 10^{-12}$
					(41)	.	.	.
,	(61)		(14)		5	가	P (3),	(6),
	(7), n		(9), p		(51),	(8), /	(10)	.
,	42	(10)	5	가	1000	(13)	Co	(11)
/		(12)	.	,	(13)	.	.	.
n								.
,	PMOS	$\times 10^{13} / \text{cm}^2$	NMOS	가	.	, PMOS	350keV	, $1 \times 10^{-12}$
					(41)	.	.	.
5	가	,	/	(10)	(13)	,	/	,
(13)	300	,	,	(13)	(13)	(13)	/	(10)
								.
(7)				(13)		가	/	(10)
MOS, PMOS	1	,	(5)	(4)	1	.	.	.
								.
0)	n	(12)	p	(121)	(7)	/	(	(
?)	(2)	(13)	(1)	가	가	,	가	,
								.
,	/	(10)	(2)	,	/	(10)	n	(12)
p	(121)		가	, Co	(11)		(2)	.
								.
4)								.
,	/	(2)	가	PN	,	(11)	(11)	가
		(10)						.
	/							.

, p (51) n (52) n (9) p (91)  
, 가 . 가 . 가 .

43 6

, 5 가 (2) 200 (61) 3000  
 (14) , NMOS 100keV ,  $1 \times 10^{12}$   $1 \times 10^{13} / \text{cm}^2$   
 (41) .

, (14) 가 , 1000  
5 가 (2) P (3) .

$$, \quad 43 \quad , \quad 1 \quad \text{가} \quad , \quad (14) \\ (61) \quad , \quad (15) \quad (6) \quad (71) \quad (7) \quad .$$

, 5 가 n (9), p (51), (8), / (10) Co  
(11) .

, PMOS  
 $1 \times 10^{13} / \text{cm}^2$       NMOS       $\text{g}$       .      , PMOS  
 $(41)$       .      .      .  
 NMOS, PMOS      1      1      .  
 $(5)$       (4)      (5)

	n	(12)	p	(121)	(2)
(14)		(2)		(1)	

, / (10) (2), / (10) (11) n (12)  
 p (121) , Co (11) (2)  
 (4) (2) 가 (11) (11) (11) 가  
 / (10) PN  
 / 가

6 , 가  
      가 .

< 7 >

44 45 7

$$\begin{aligned}
 & 44 \quad \text{NMOS} \quad , \quad P \quad (3) \quad 1 \times 10^{17} \quad 1 \times 10^{18} / \text{cm}^3 \quad , \quad 1 \times 10^{17} \quad 1 \times 10^{18} / \text{cm}^3 \quad (4) \\
 & , \quad n \quad 1 \times 10^{17} \quad 1 \times 10^{18} / \text{cm}^3 \quad , \quad p \quad (51) \quad 1 \times 10^{19} / \text{cm}^3 \quad , \quad / \quad 1 \times 10^{17} \quad 1 \times 10^{18} / \text{cm}^3 \\
 & 21 \quad 1 \times 10^{22} / \text{cm}^3 \quad , \quad n \quad (9) \quad 1 \times 10^{18} \quad 1 \times 10^{19} / \text{cm}^3 \quad , \quad / \quad 1 \times 10^{19} / \text{cm}^3 \quad (10) \quad 1 \times 10^{10}
 \end{aligned}$$

(7) 가 / (10) 가 . , , n , P (3)  
 , Co (11) .  
 , Co (11) .

Co Ni Ti W Pt P

PMOS NMOS p 가 , (121) N 가 , / , Co , Co (11) (11)

NMOS PMOS 1

n (12) , / (10) (18) , Co (11) (11)





, p	(51)	n	(52)	n	(9)	p	(91)
,	,	가	,	가	가	가	가
7		가		가		,	
< 8	>						
50	8						
50	NMOS			(41)		,	(18)
$\times 10^{17}$	$1 \times 10^{18} / \text{cm}^3$	44				(41)	1
PMOS		(41)			,	(18)	
7		(41)			$1 \times 10^{17}$	$1 \times 10^{18} / \text{cm}^3$	
NMOS, PMOS	1						
n	(12)	,	/	(10)	(18)	,	(10)
(18)	p	(121)			, Co	(11)	
,	/	(10)		(18)	가	(11)	
/					PN		가
				가			
,		(18)					
, p	(51)	n	(52)	n	(9)	p	(91)
,	,	가	,	가	가	가	가
51	52	8					
,	3	가	,	(1)		300	(61) 2000
,	(14)		,	(1)	,	(14),	(61)
						3000	
51		,	NMOS		5keV	10keV	$1 \times 10^{-12}$ $1 \times 10^{13} / \text{cm}^2$
	,	,	(41)		,	3	(18)

7 , 3 가 P (3), (6), (7), n (9),  
1) n 가 p (51) (8), / (10) . p (5)  
(9)

, 52 3 가 (7)  
/ (10) 1000 (13)  
n (12) . , (13) Co (11)

, PMOS NMOS 가 (6), (7), P (91)  
 5 60keV ,  $1 \times 10^{13}$   $1 \times 10^{14} / \text{cm}^2$  , 7 ° , n (52)  
 (8), / (10) . n (52) p (91)

$$\text{NMOS, PMOS} \quad 1 \quad , \quad (5) \quad 1 \quad (4) \quad (5)$$

(10) (18), n (12) (13), p (1), (121) 가 (7) / 가 , , (18) , (1) ,

, / (10) (18), / (10) n (12)  
p (121), Co (11) (18) 가 (11) (11) 가 /  
/ (10) PN (11) (11) 가 /  
가



, 1 4 2 3 , 가 . 가 가 , 가

, 1 가 / 가 ,

1

(57)

1

1

1

1

2

3

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3 1 4

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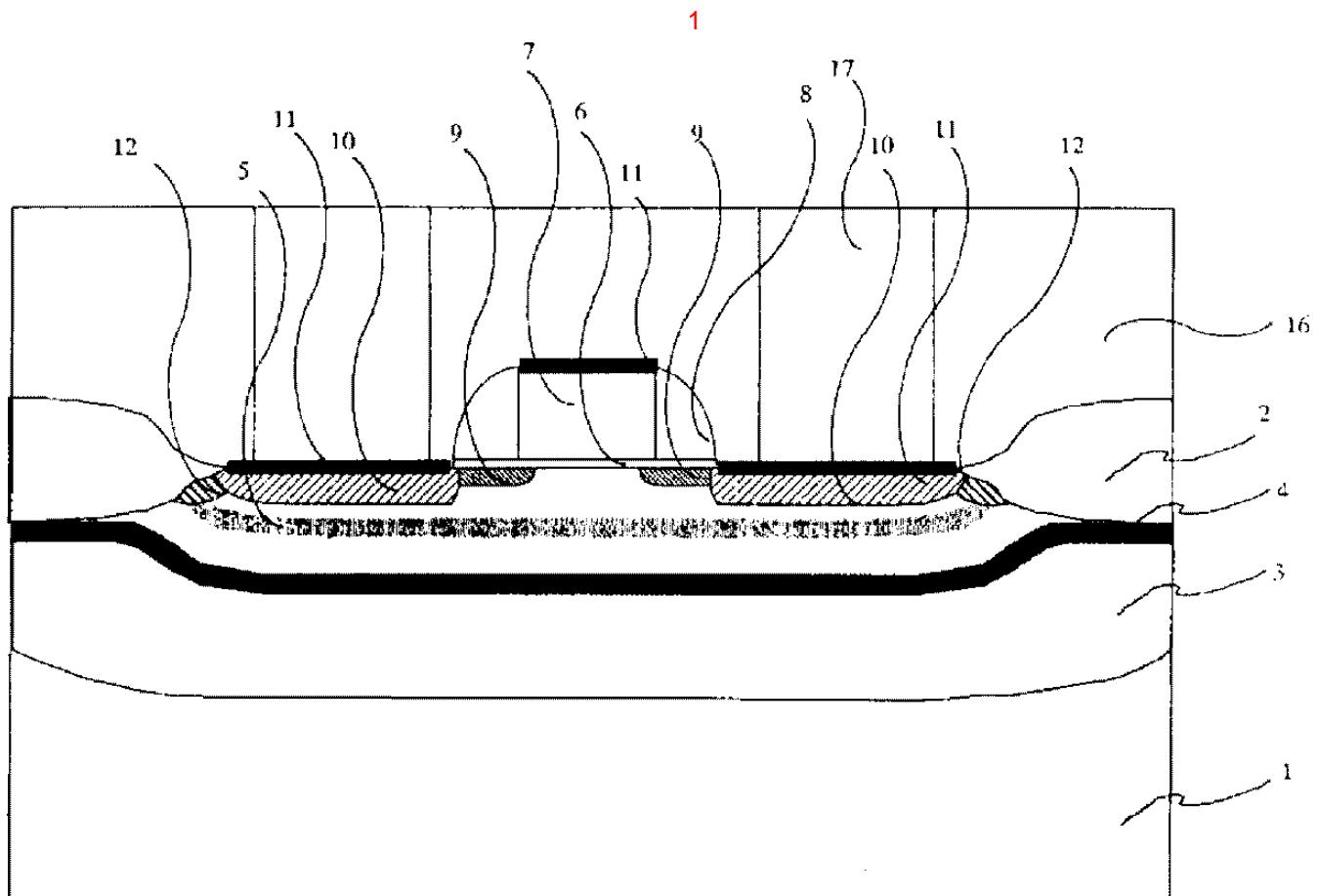
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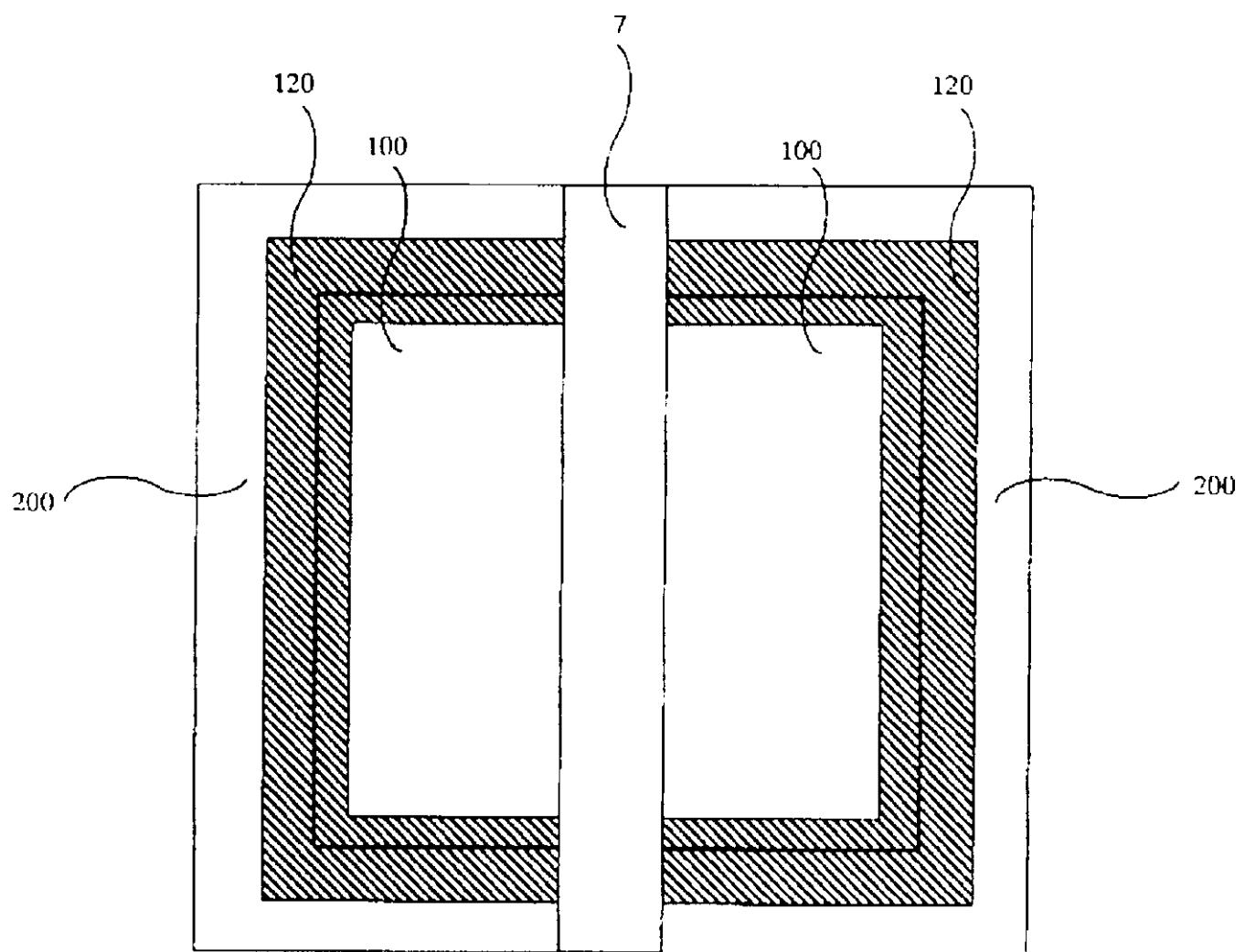
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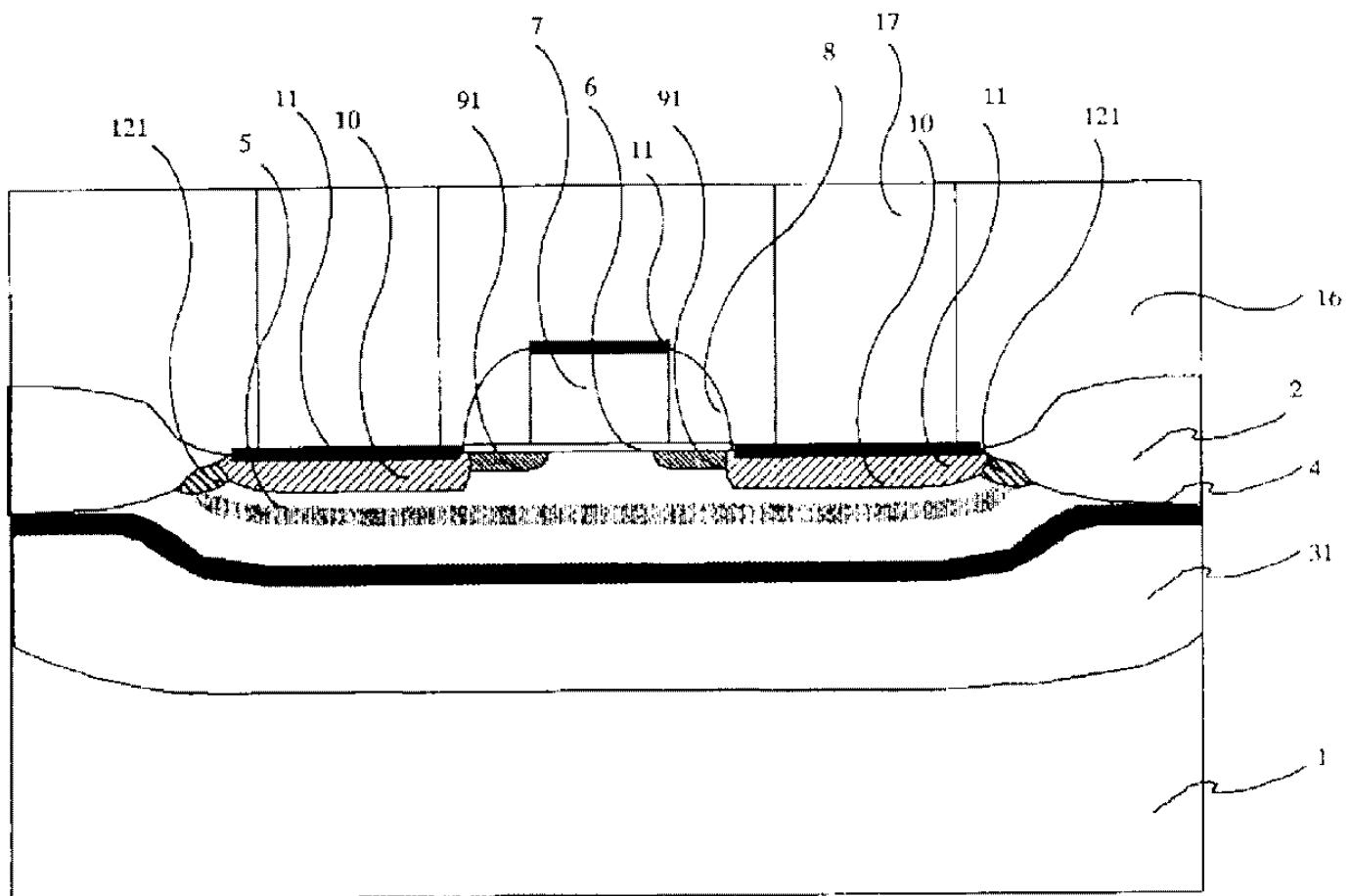
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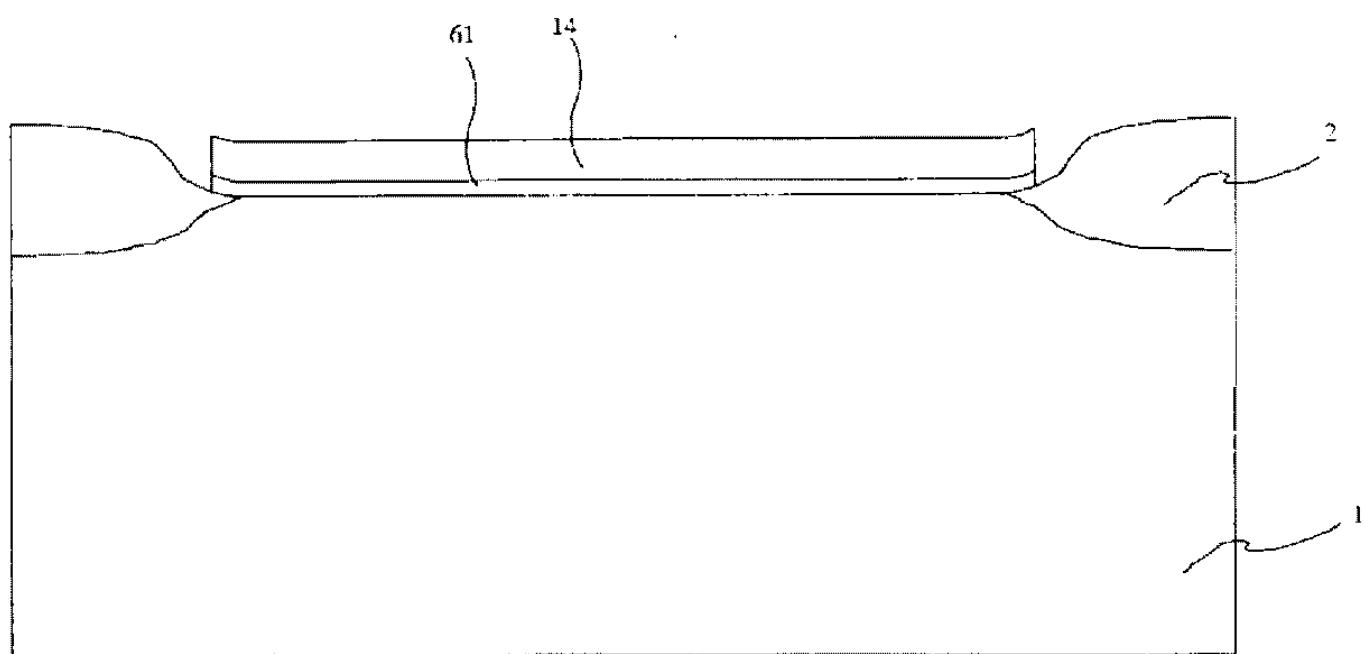
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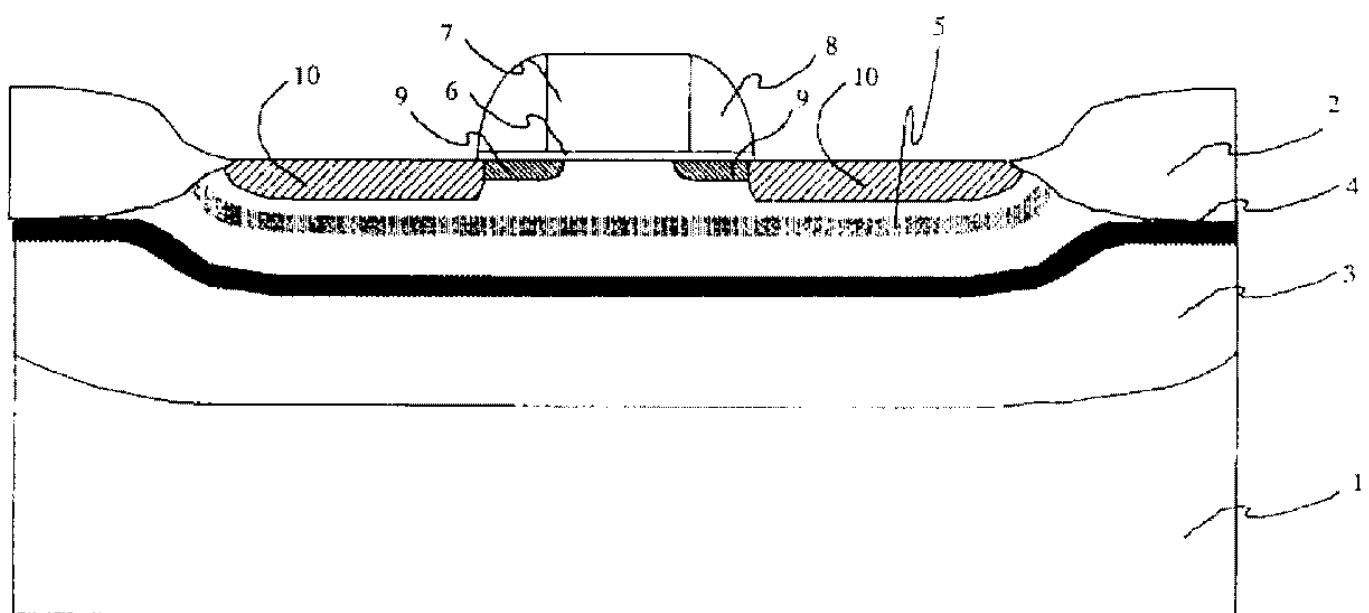
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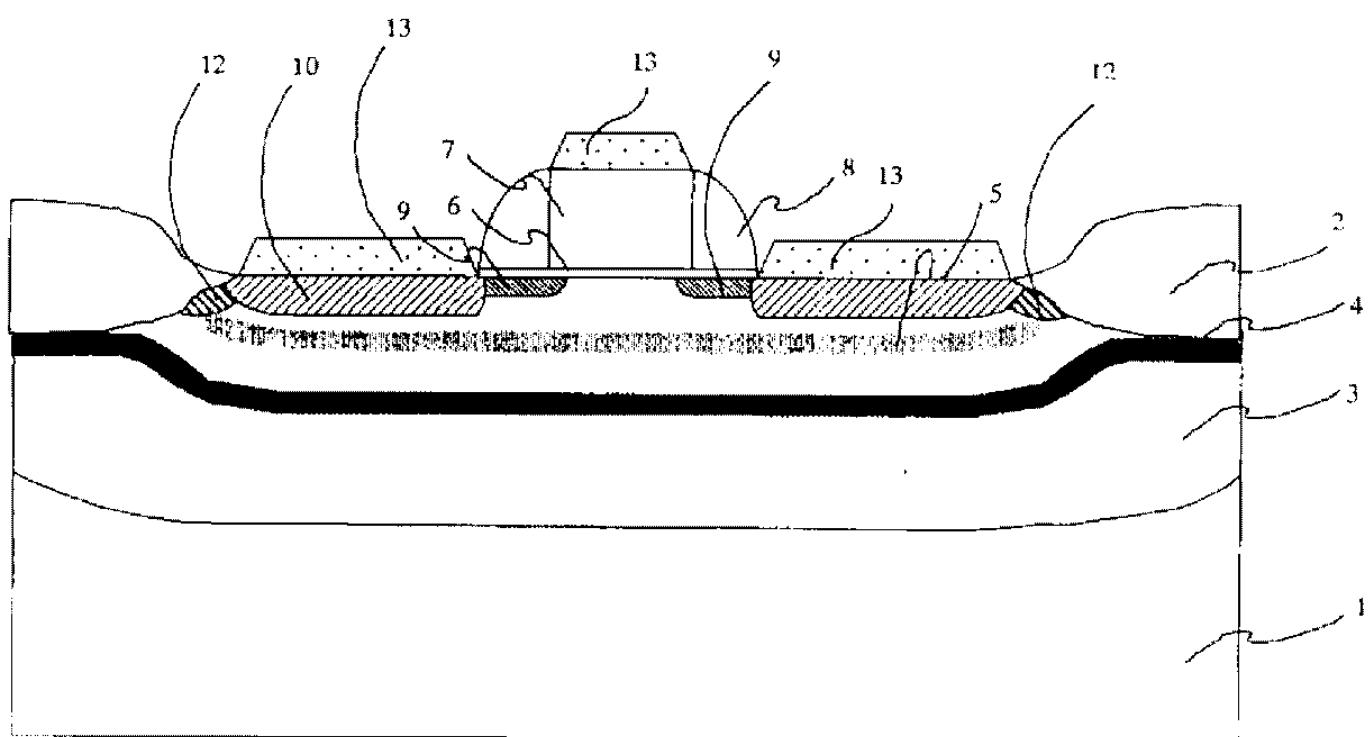
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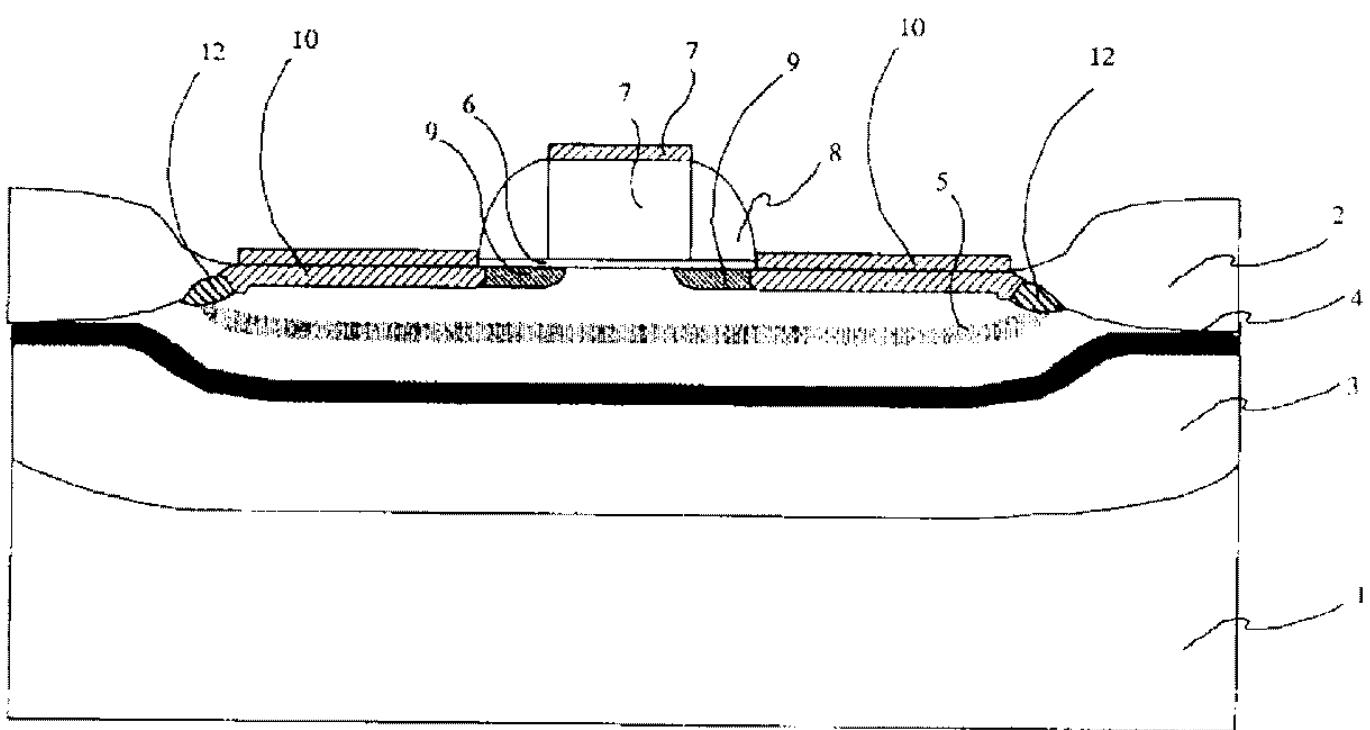
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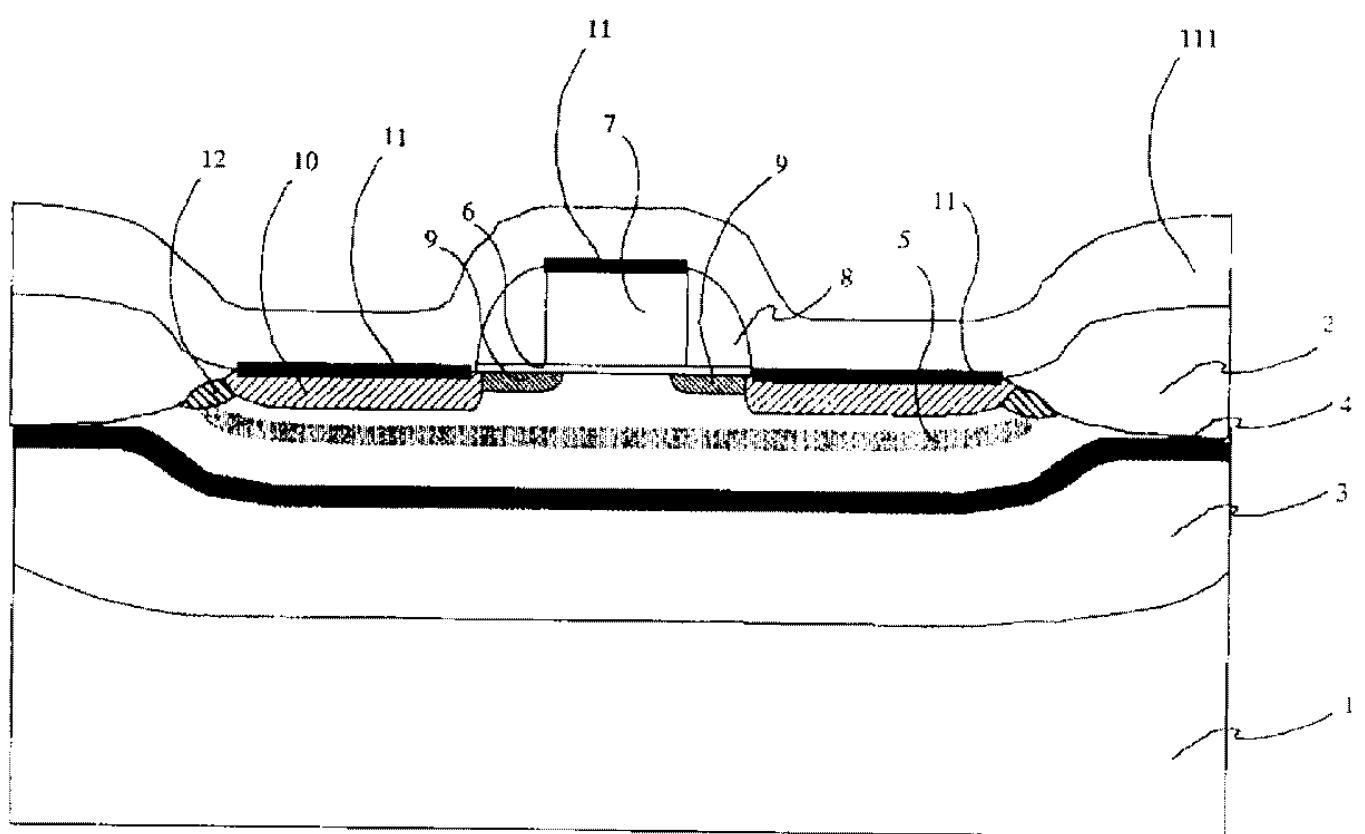
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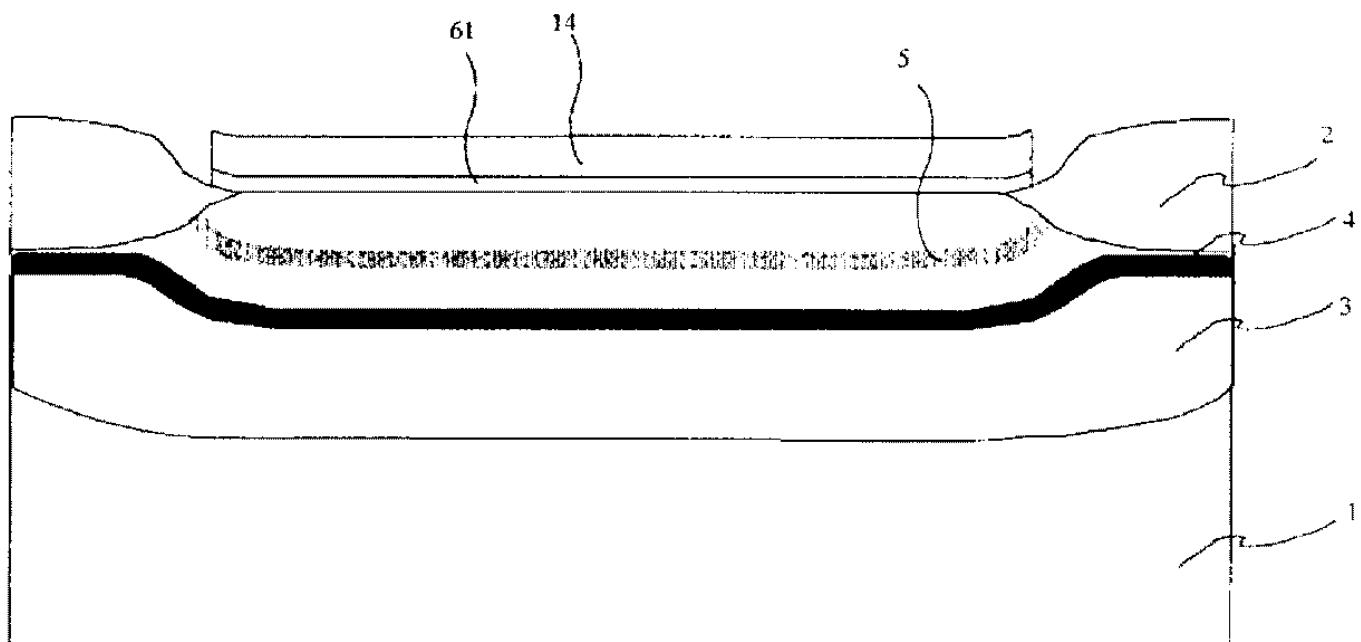
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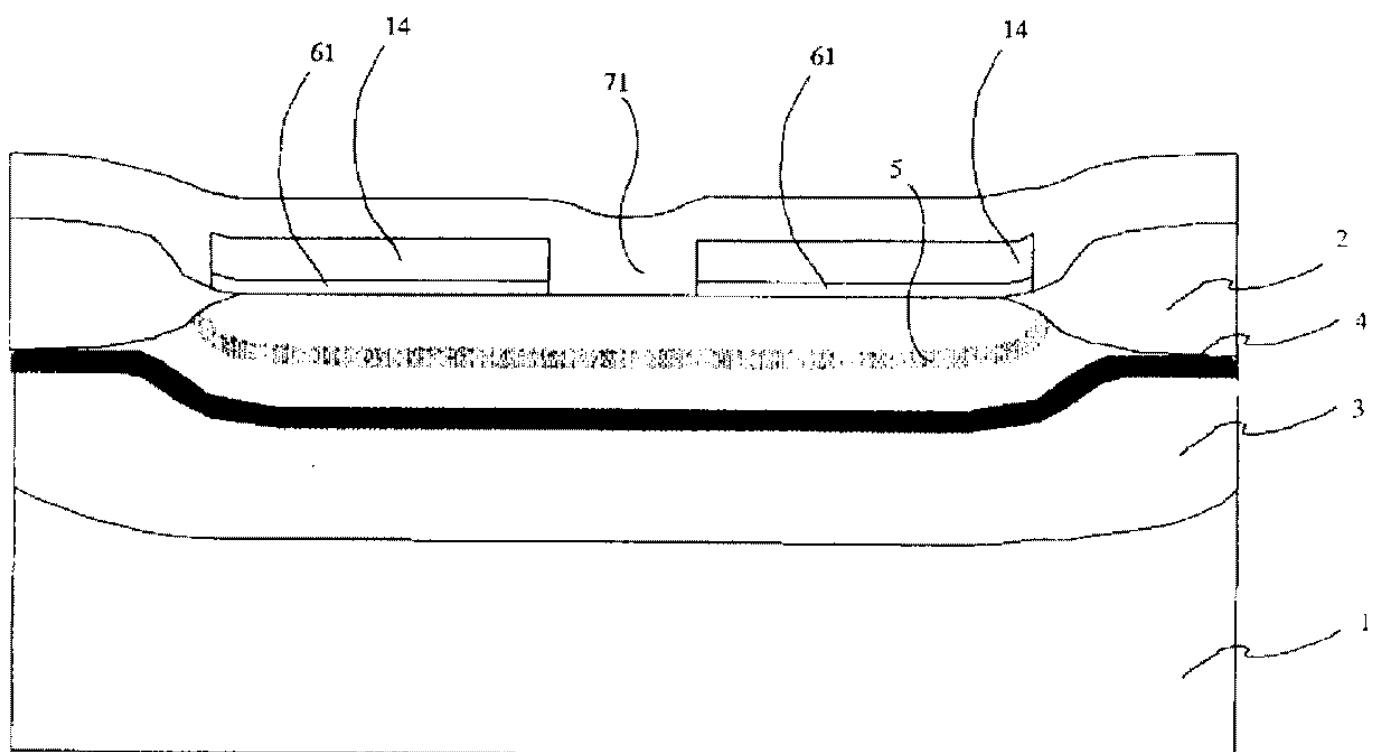
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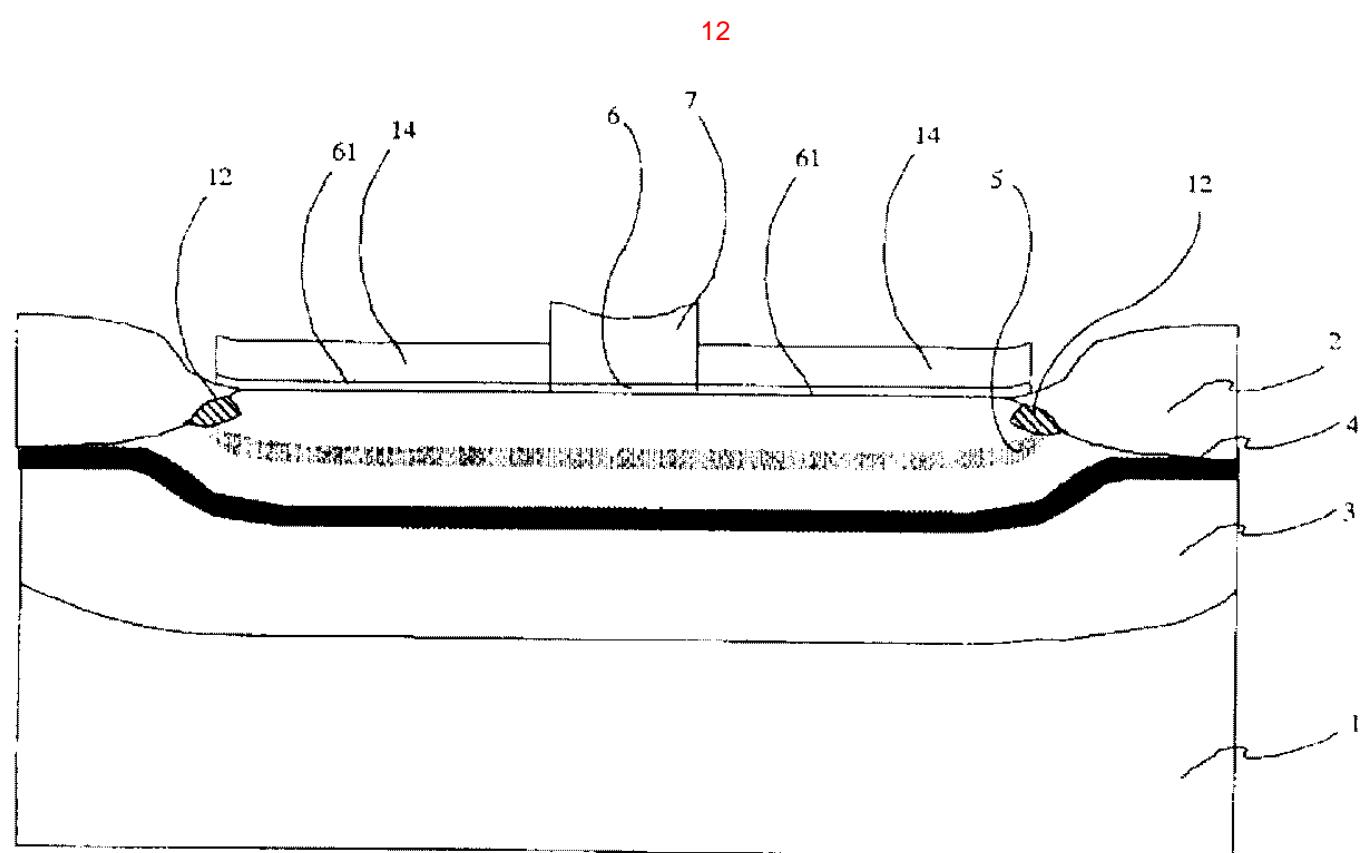
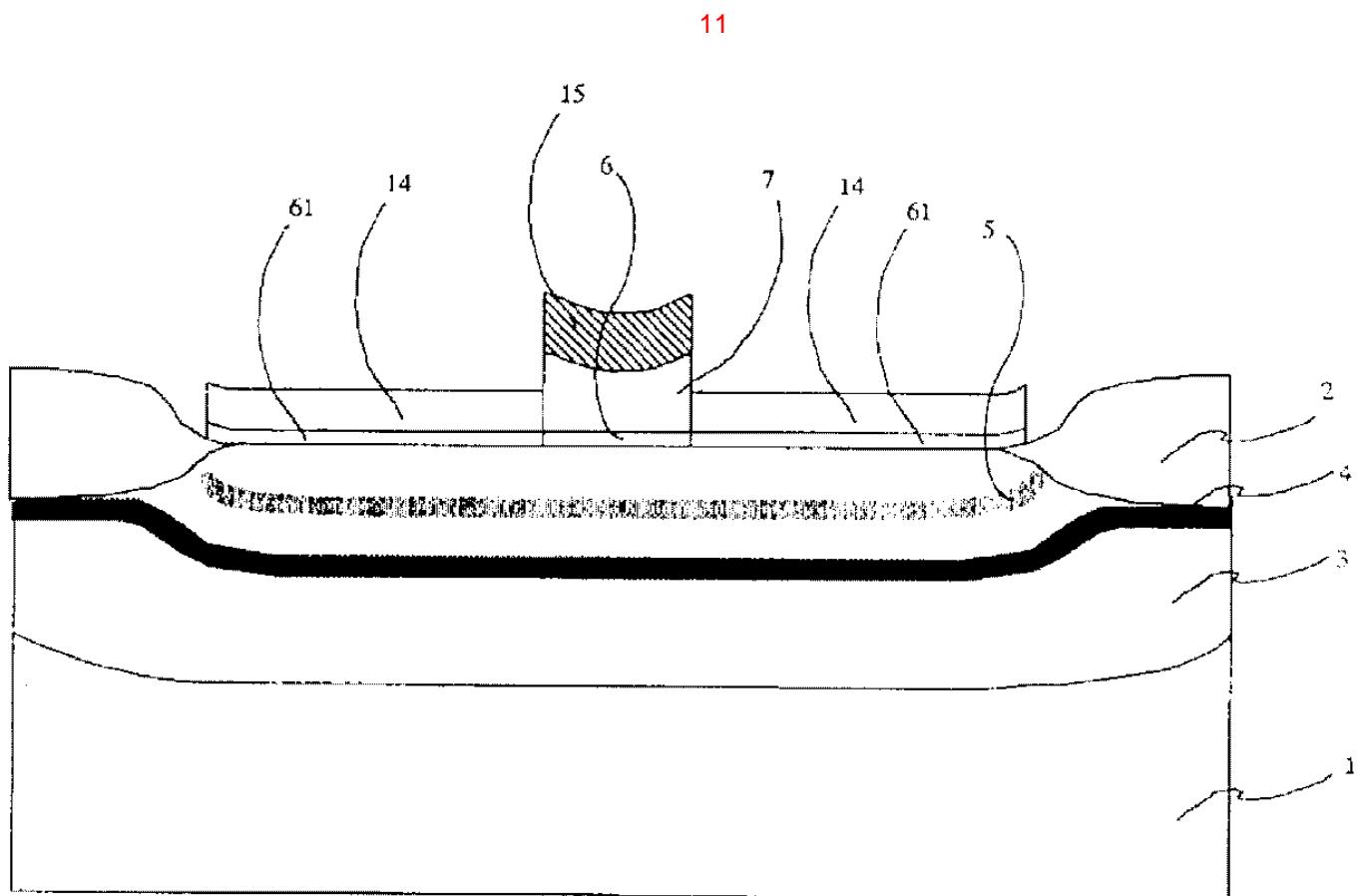


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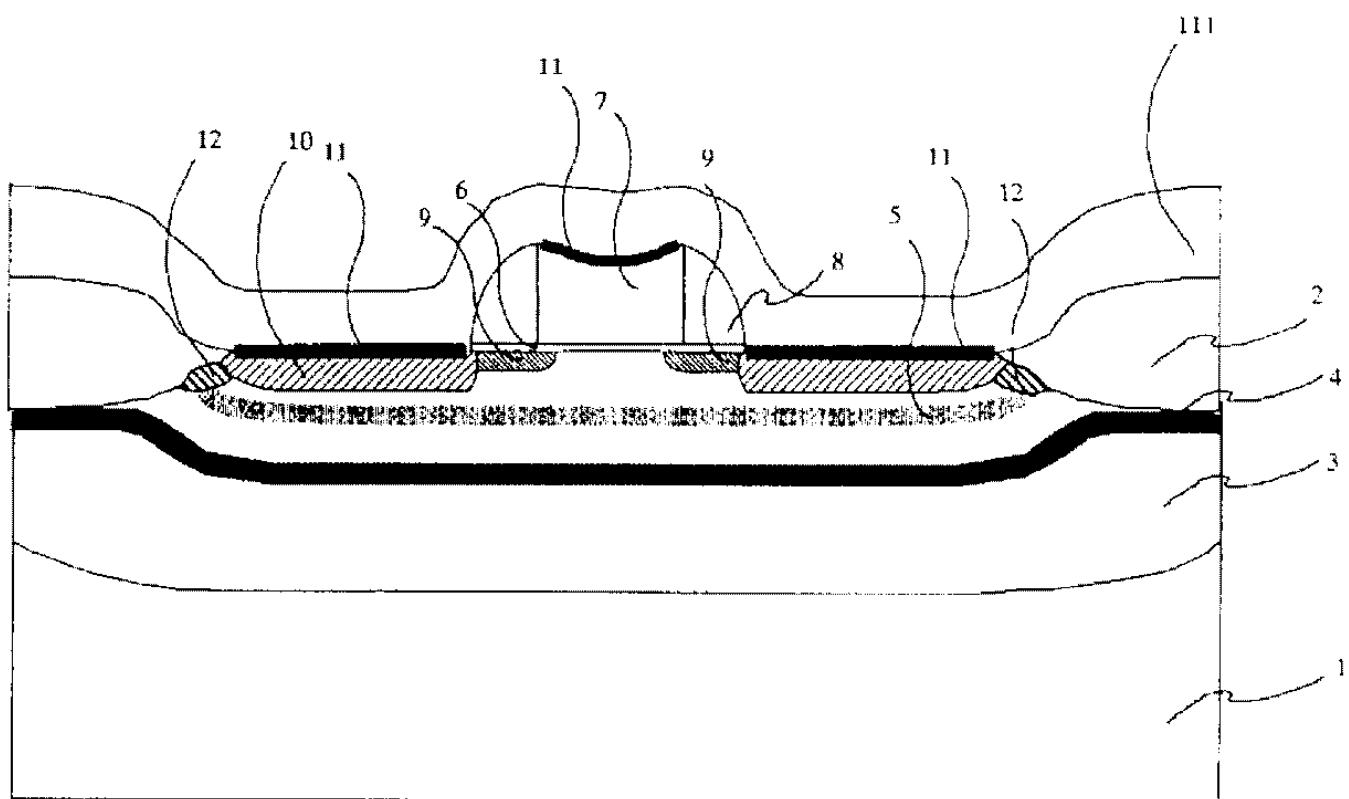


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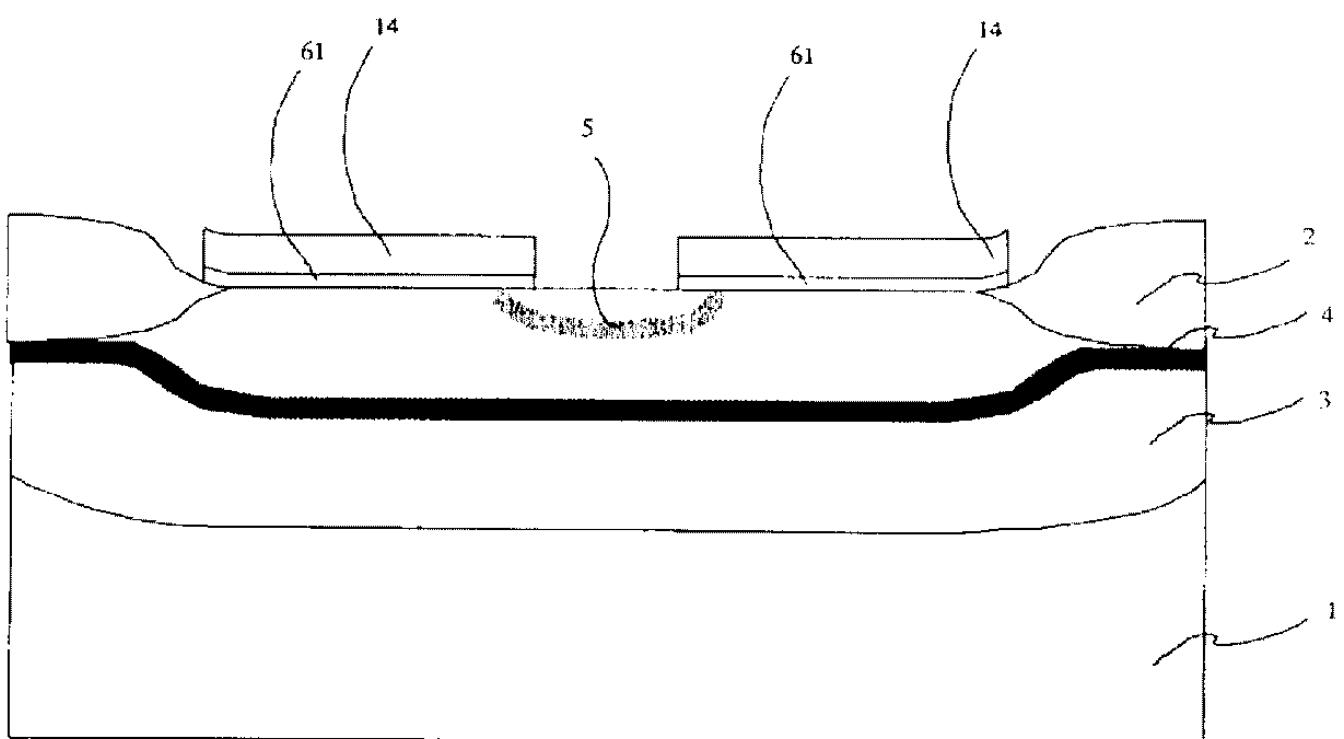


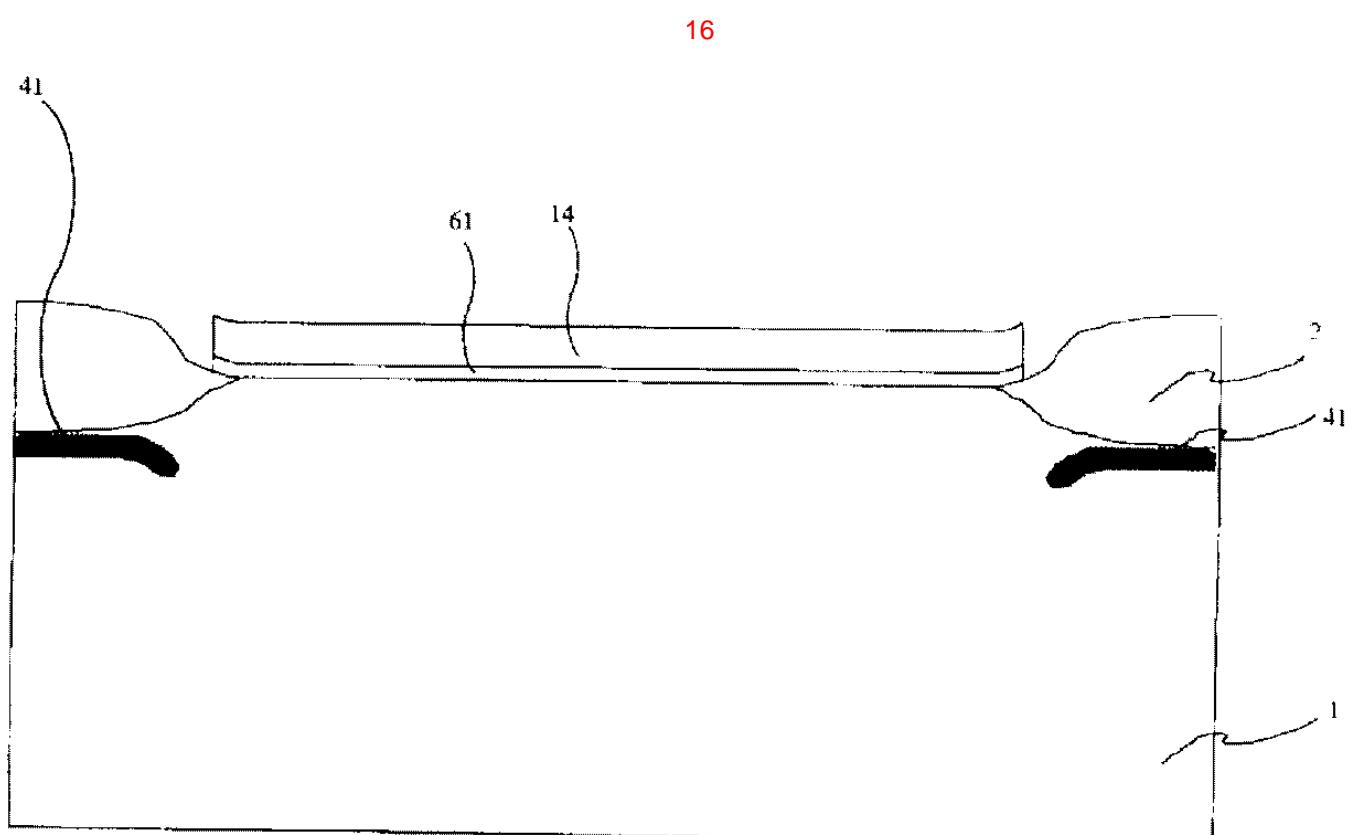
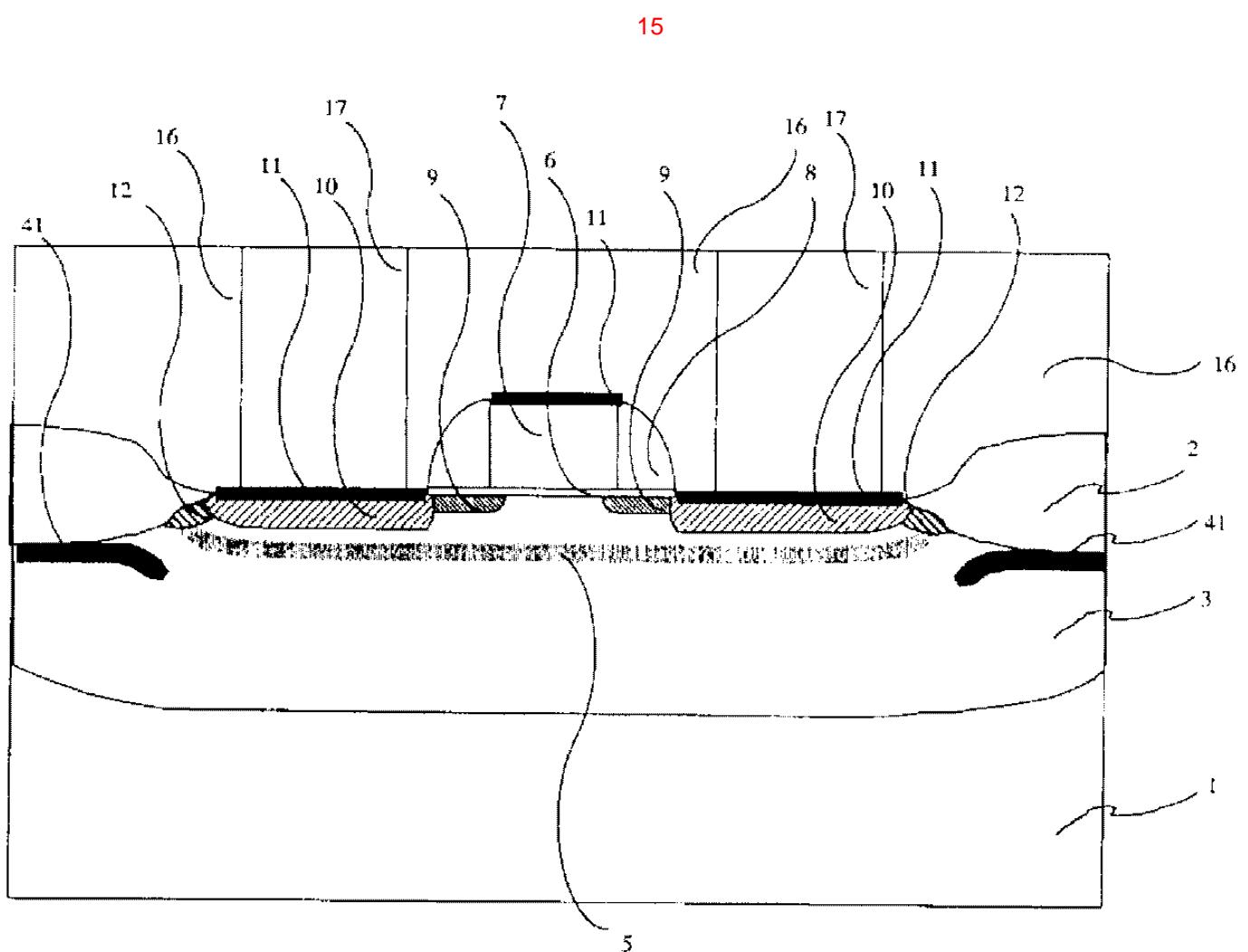


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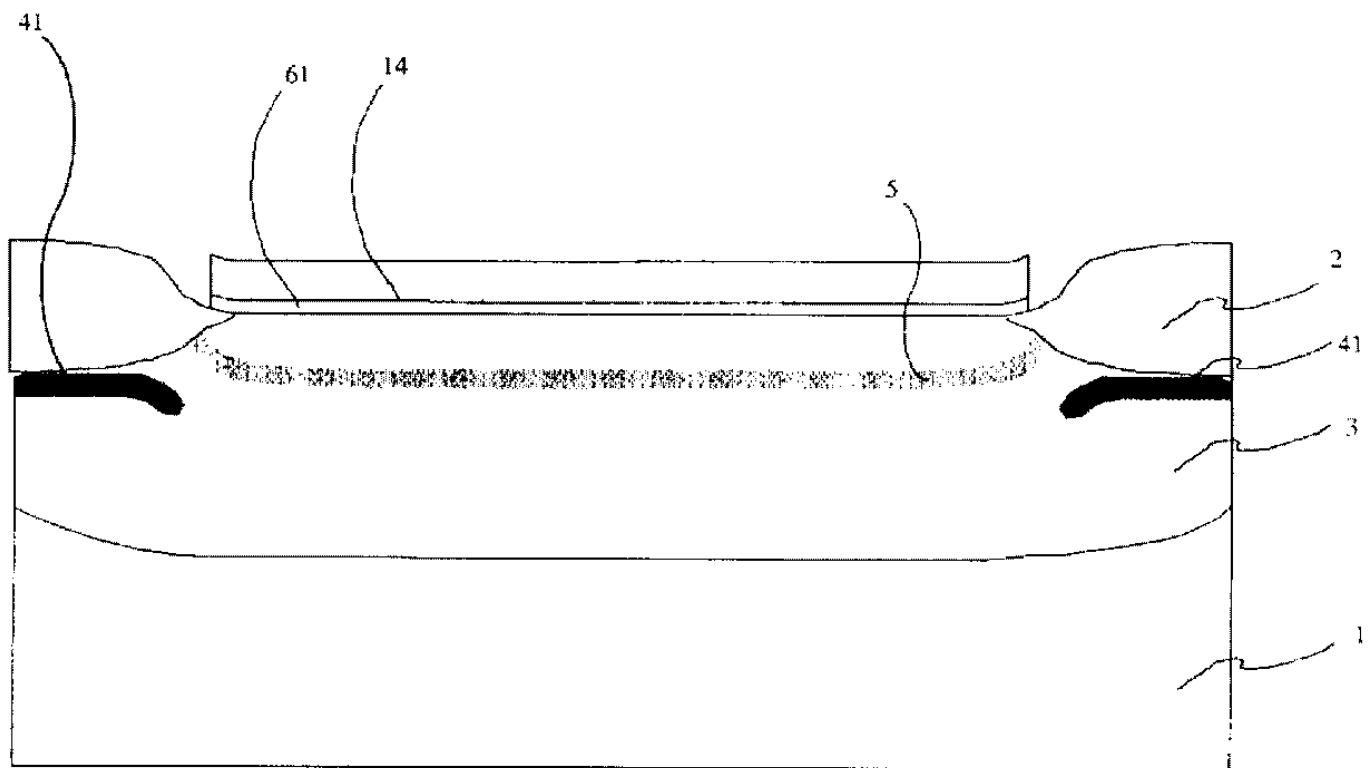


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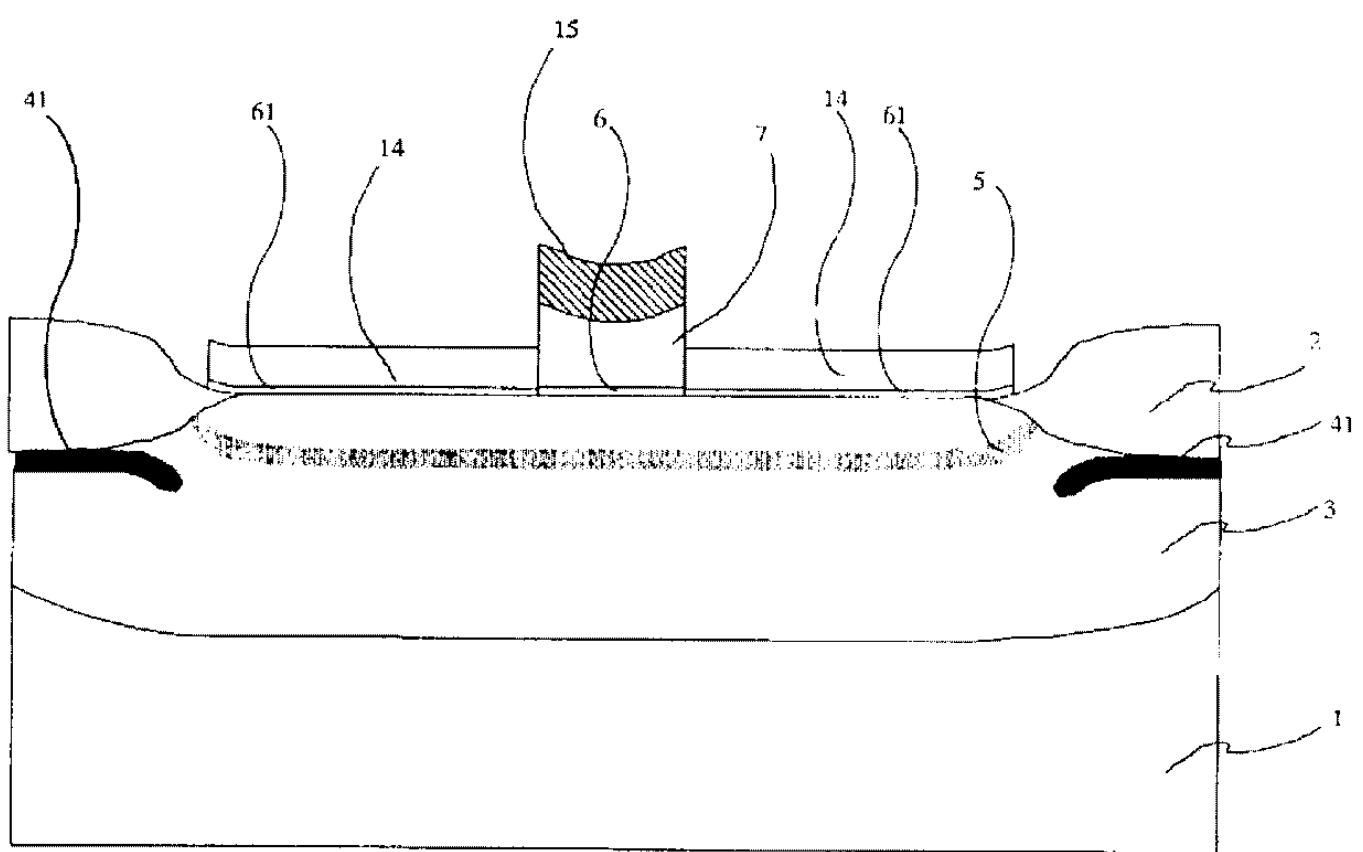




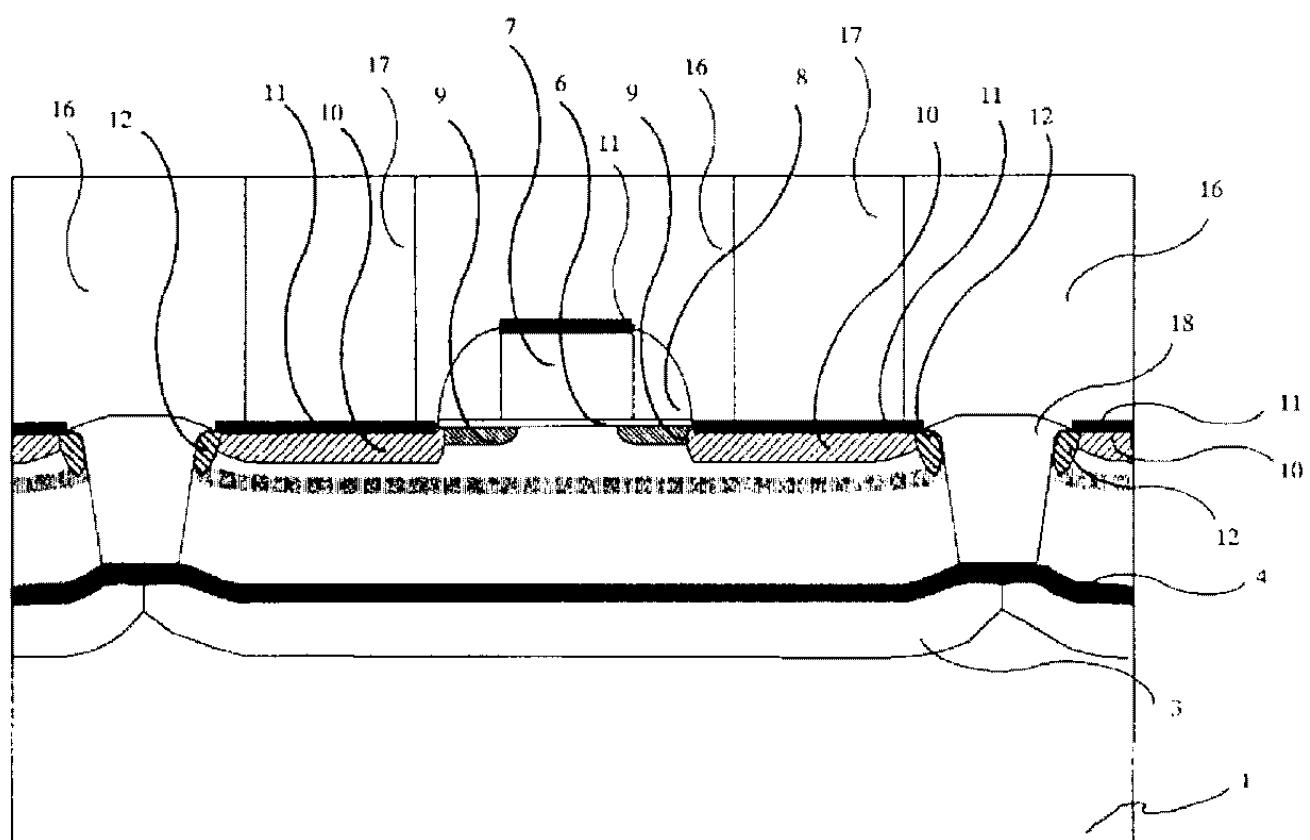
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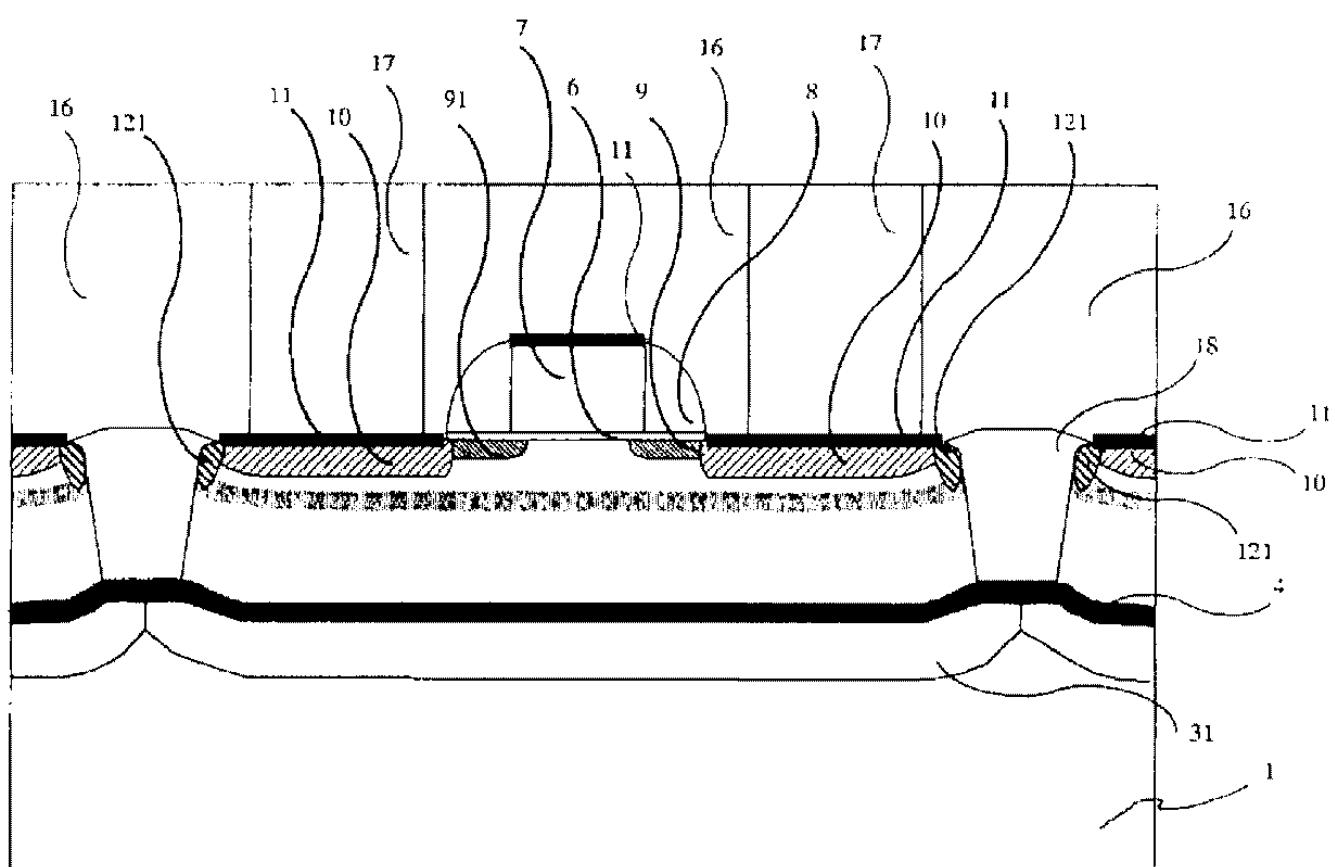
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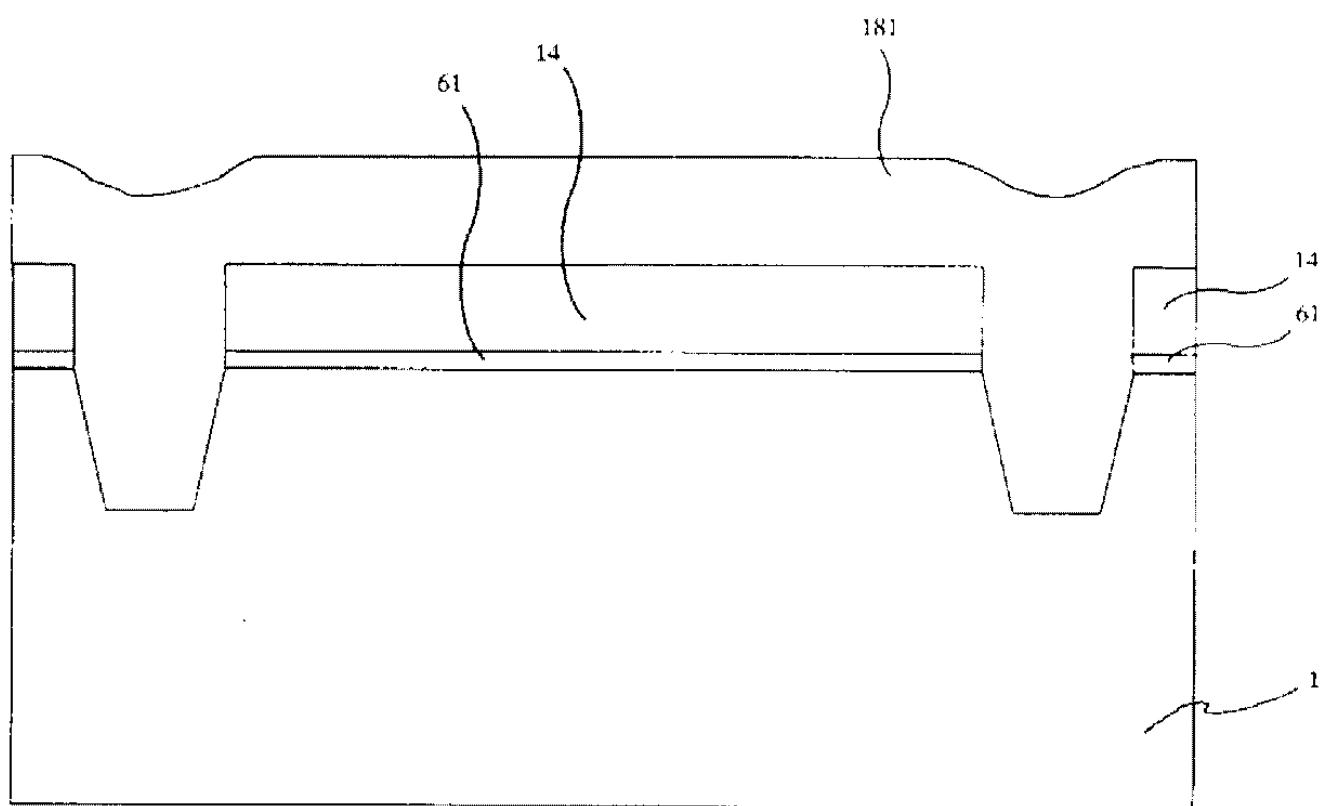
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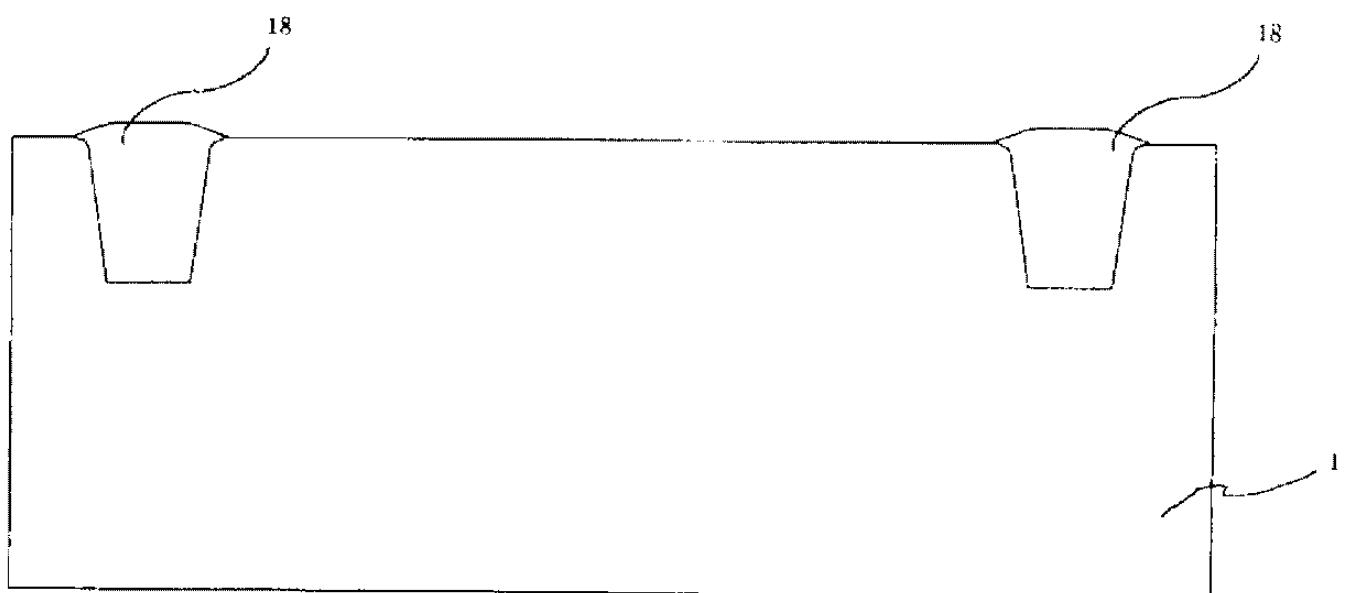
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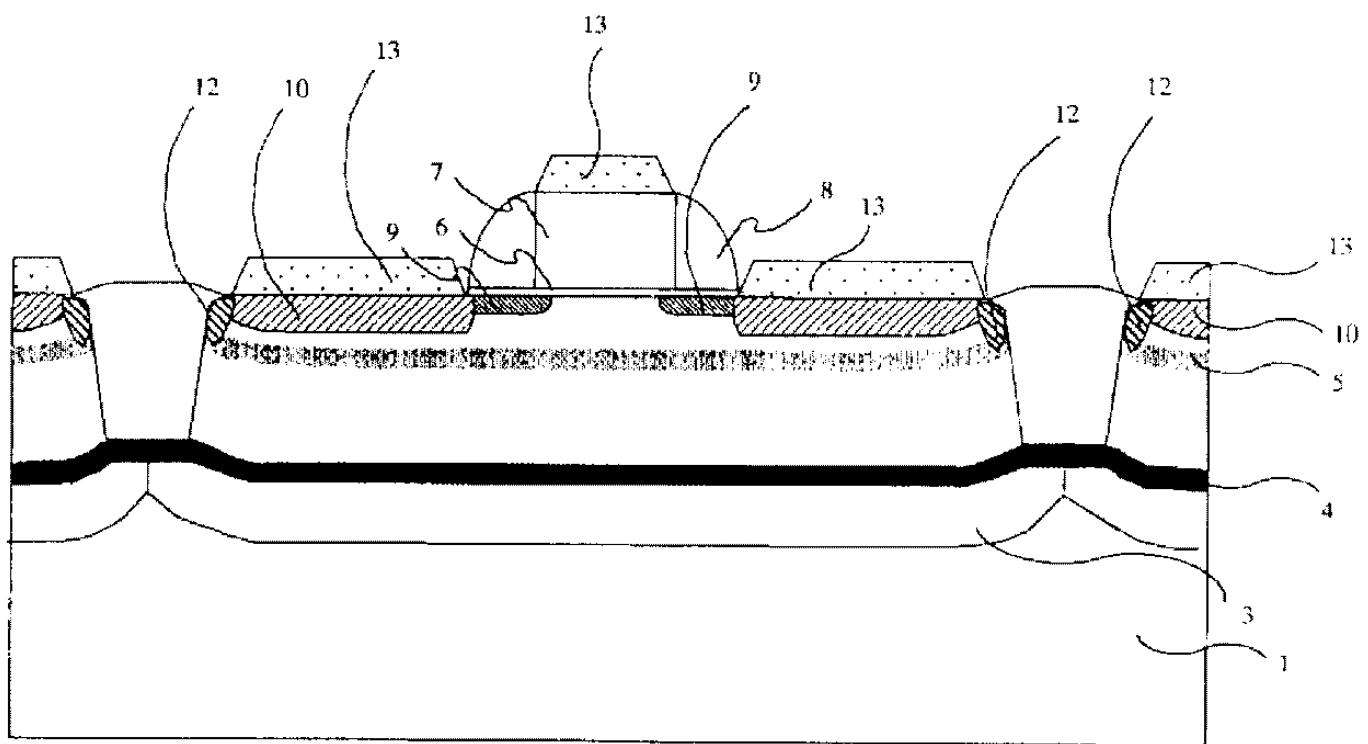
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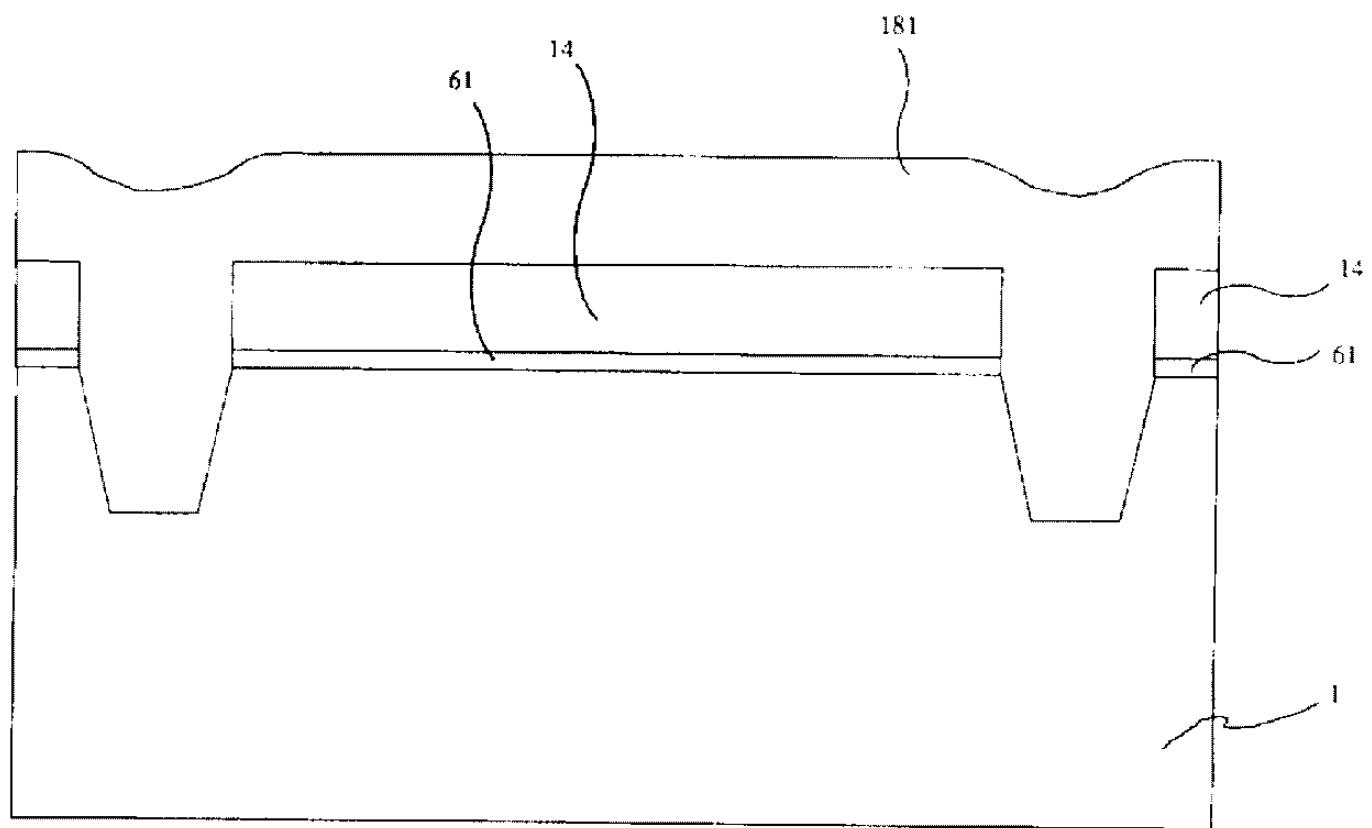
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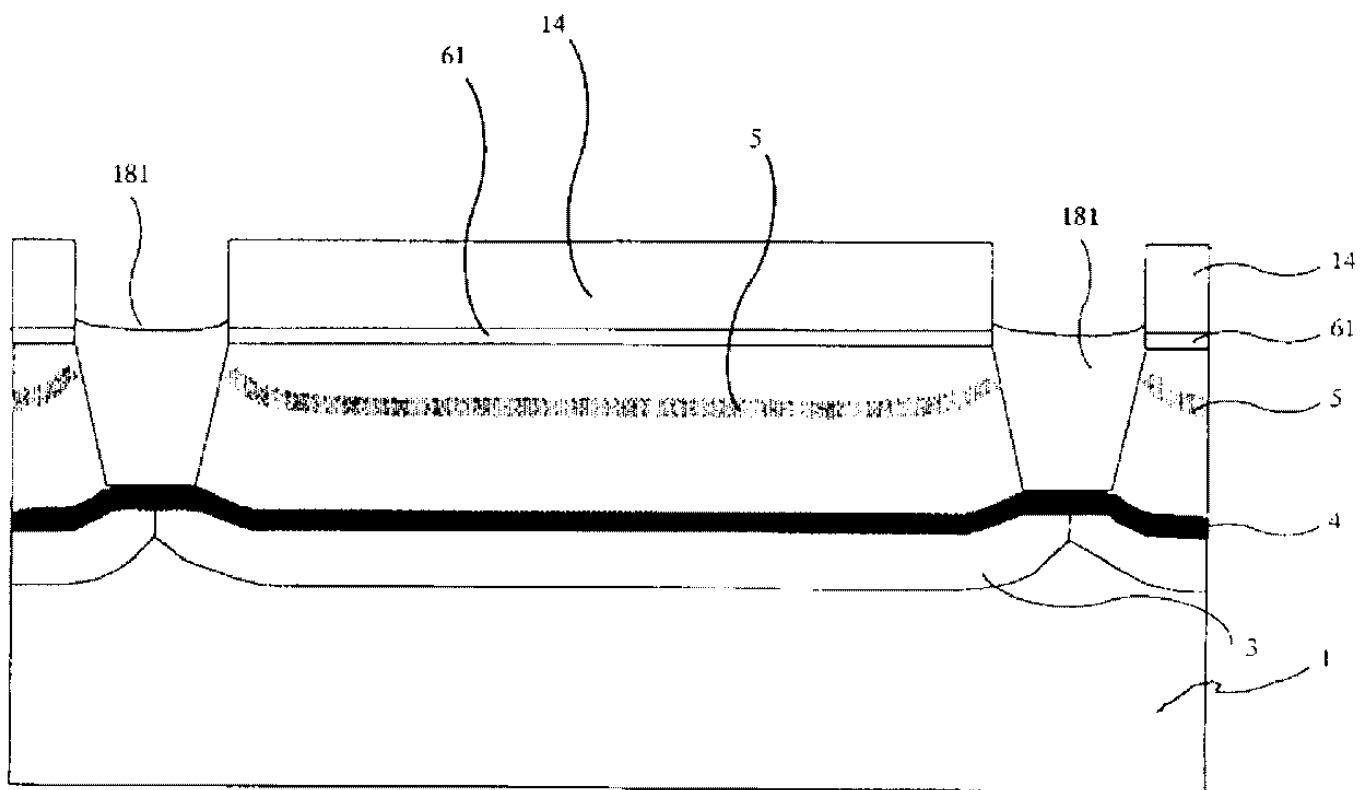
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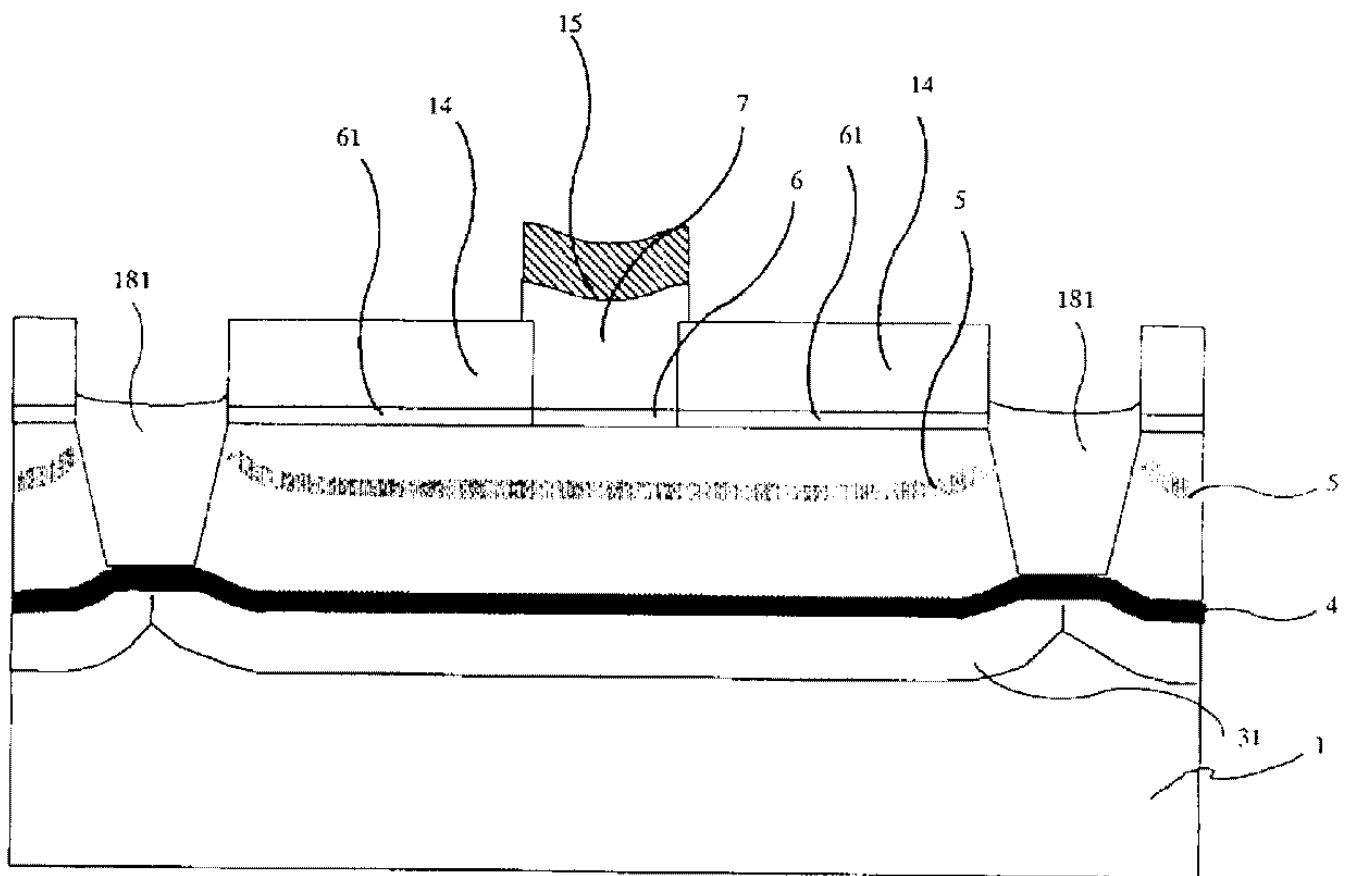
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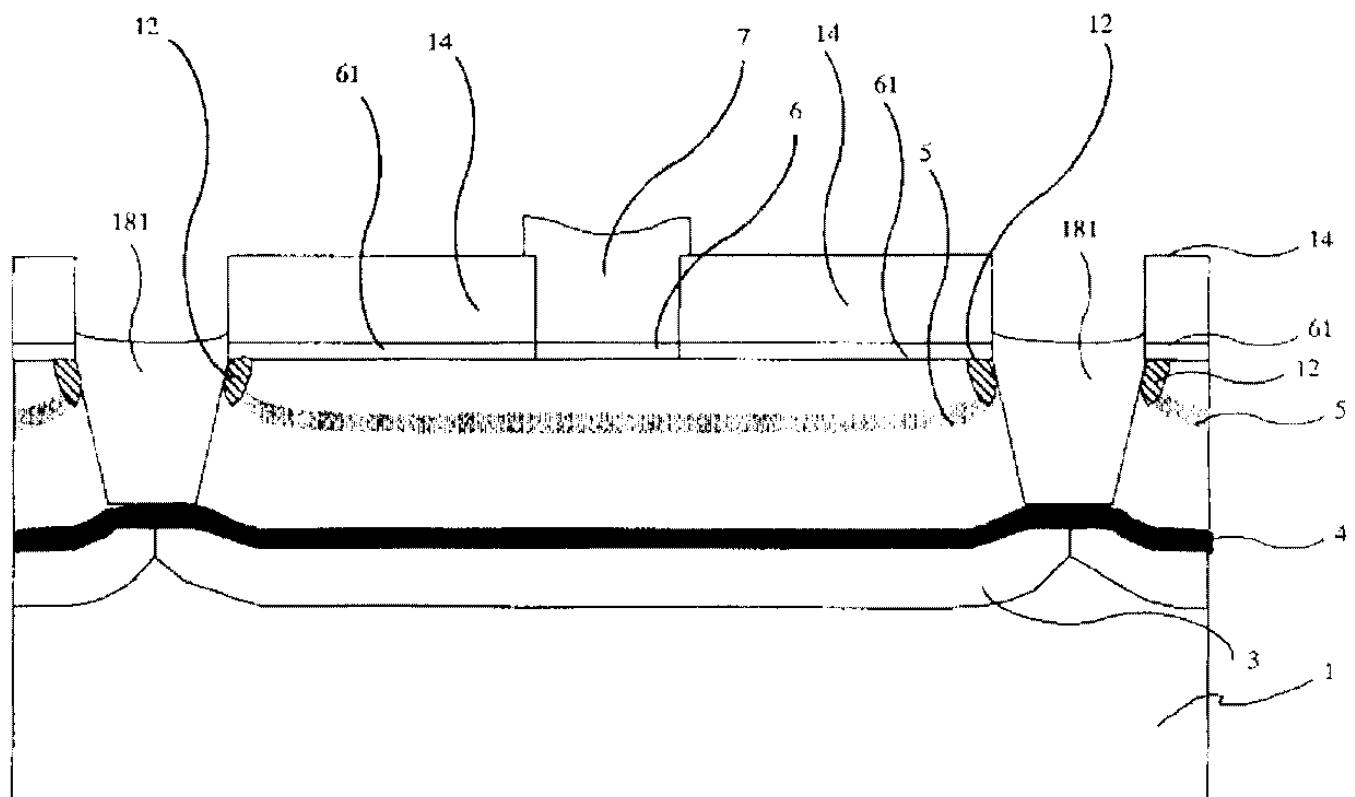
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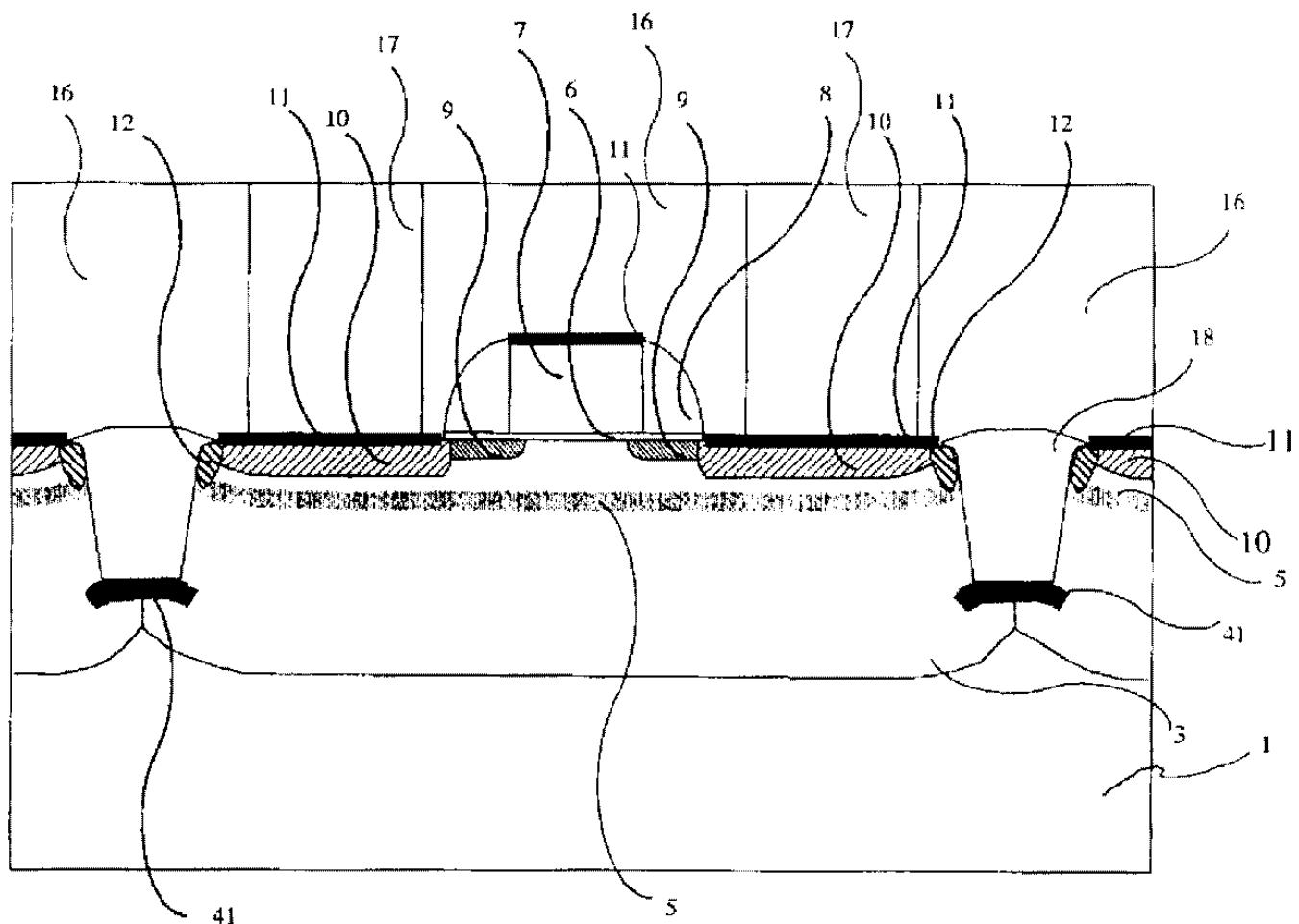
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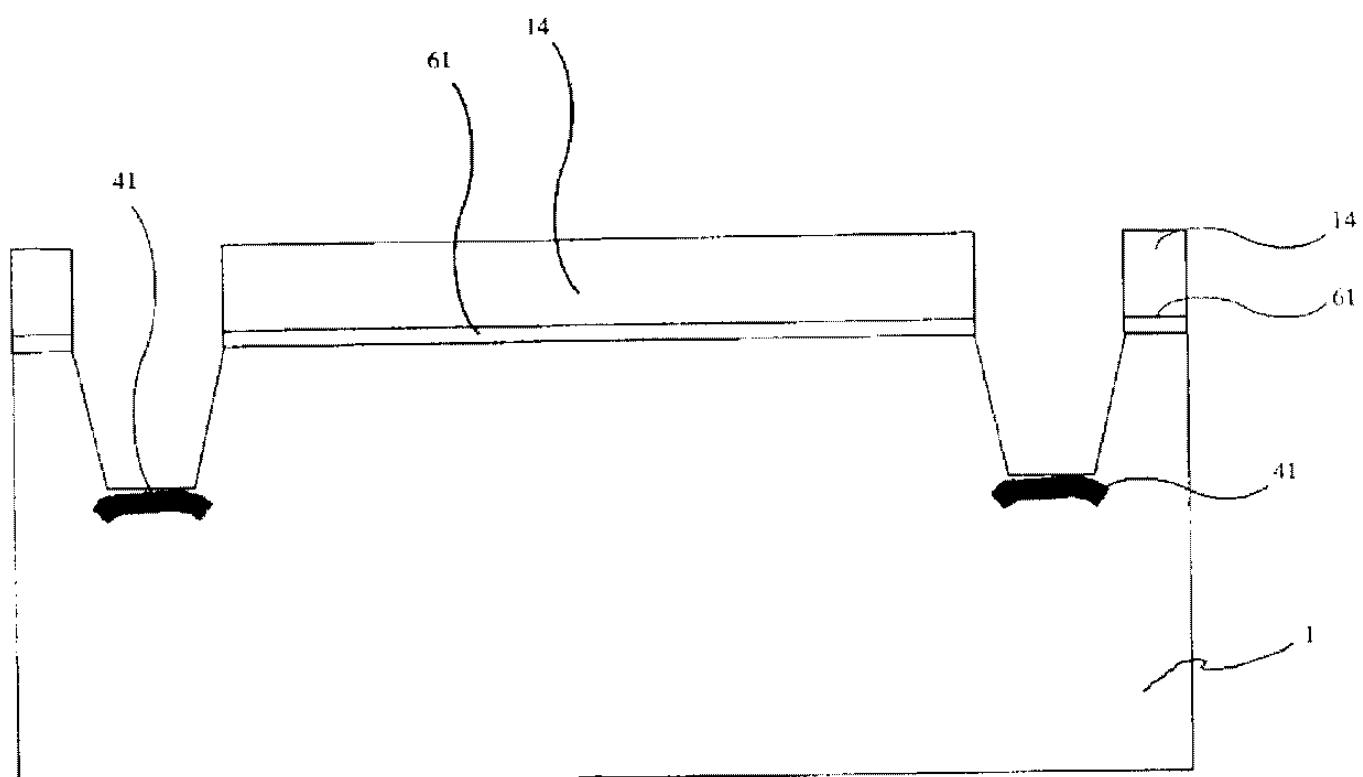
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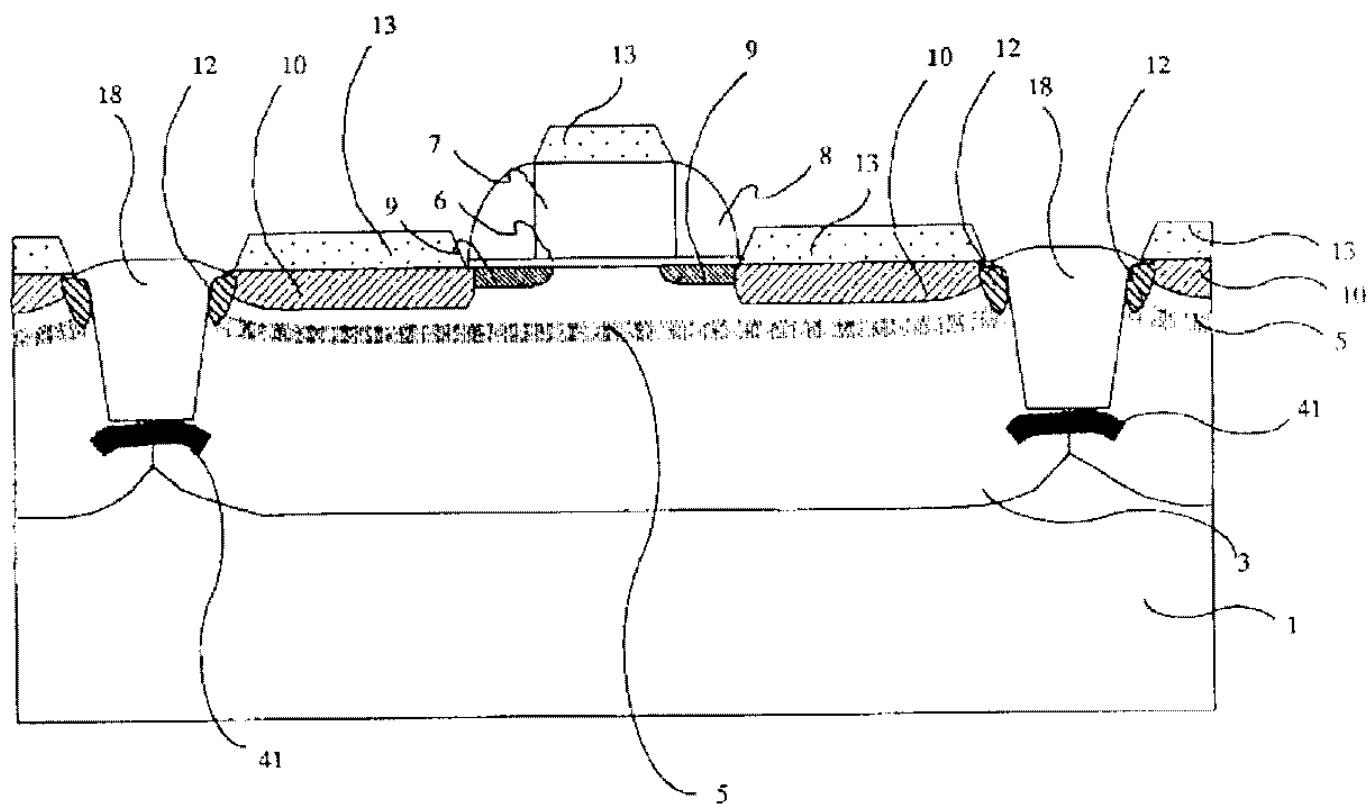
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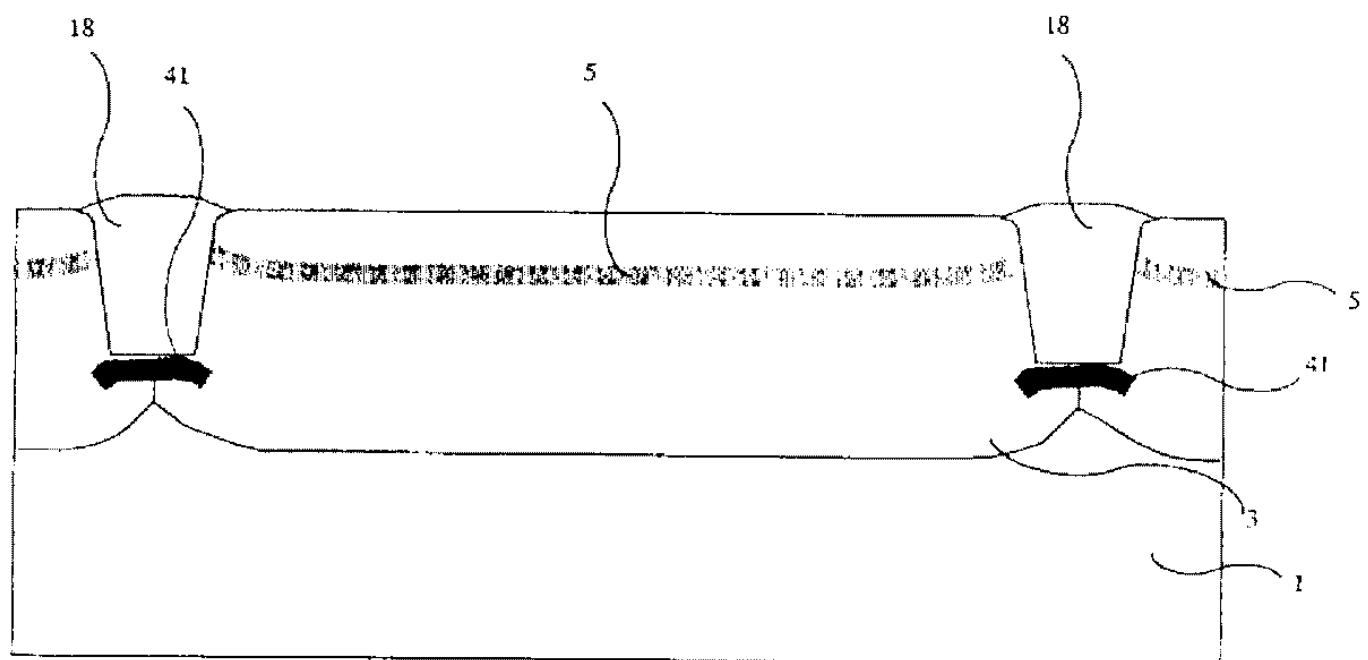
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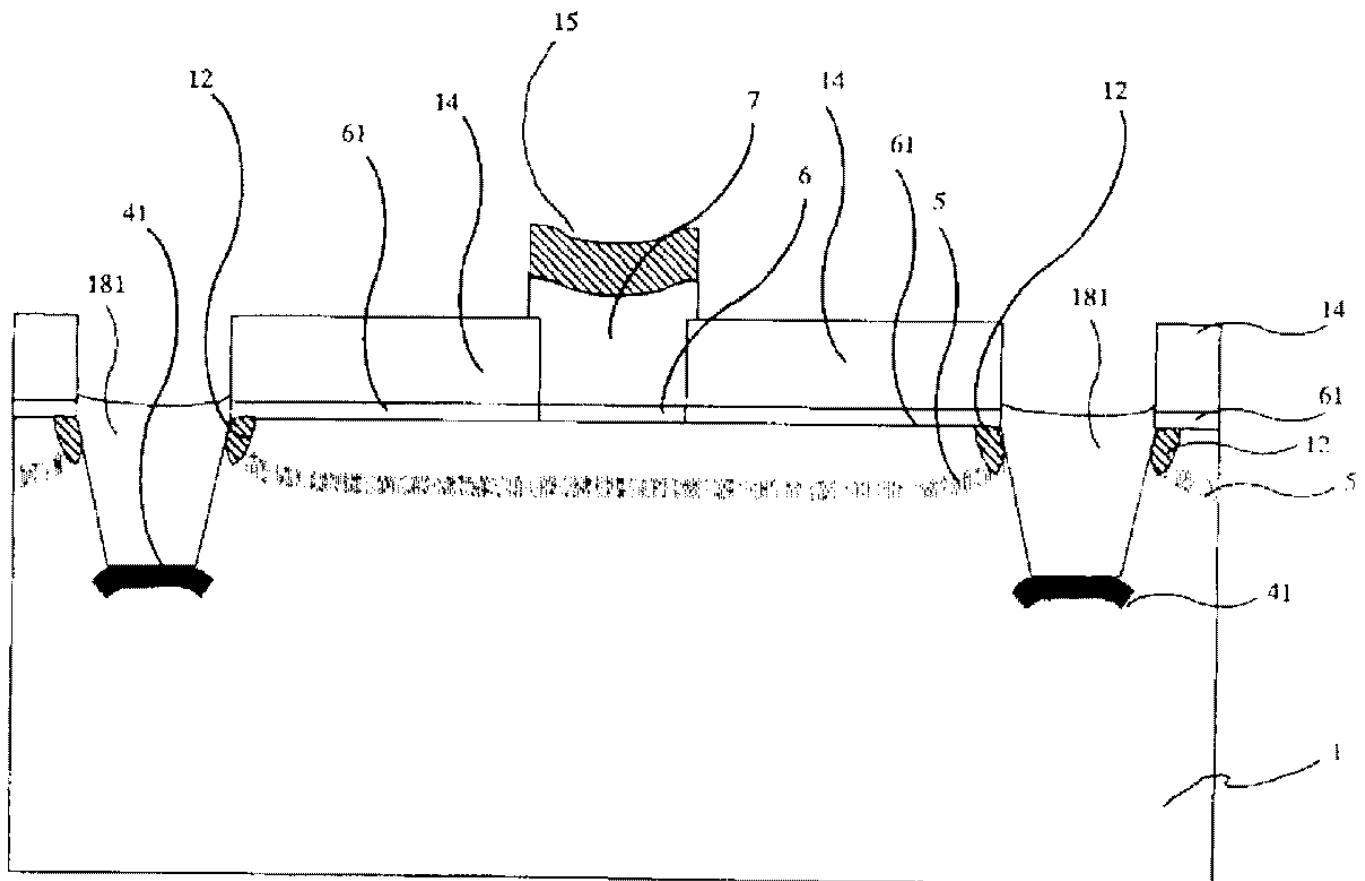
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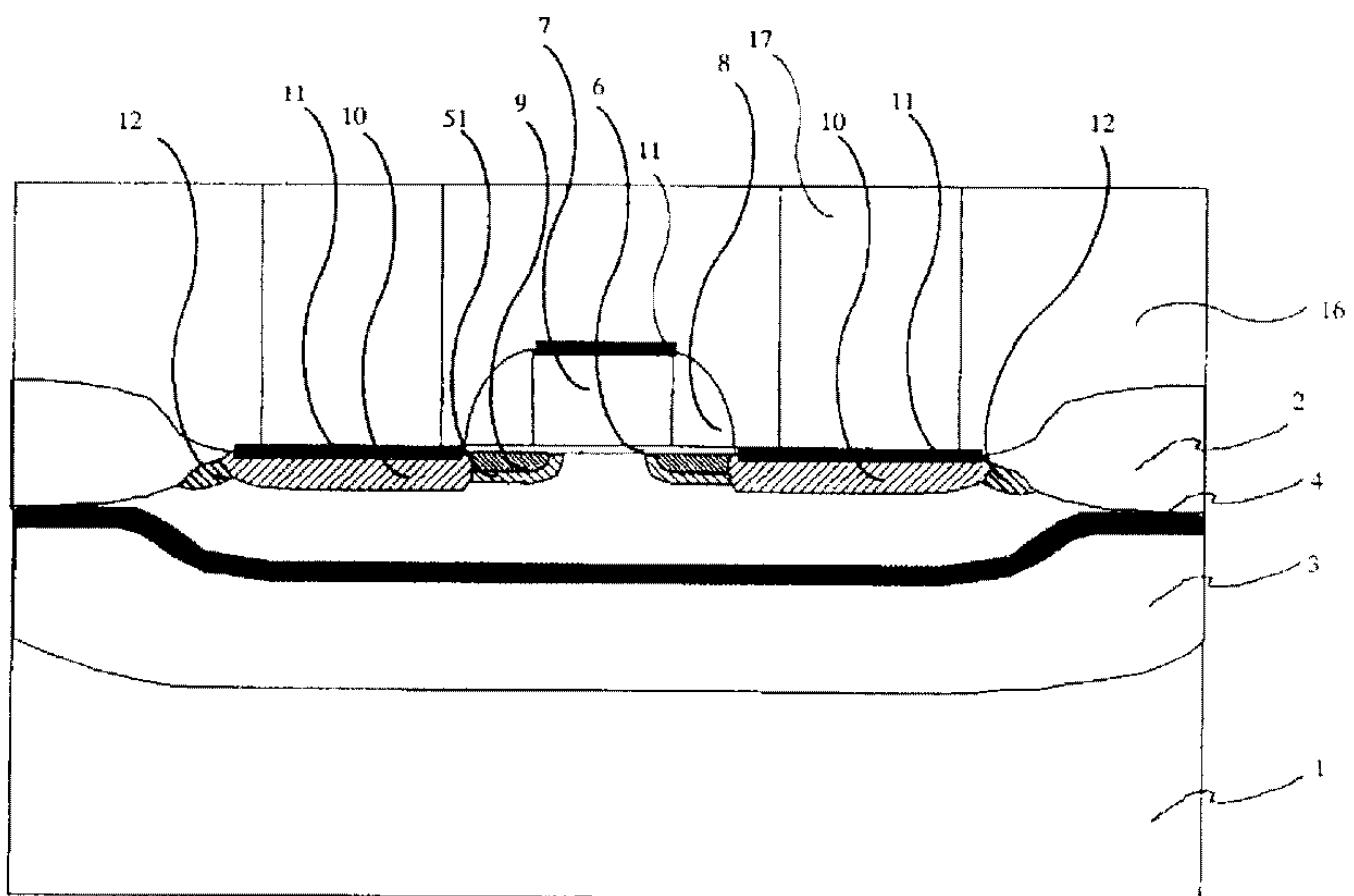
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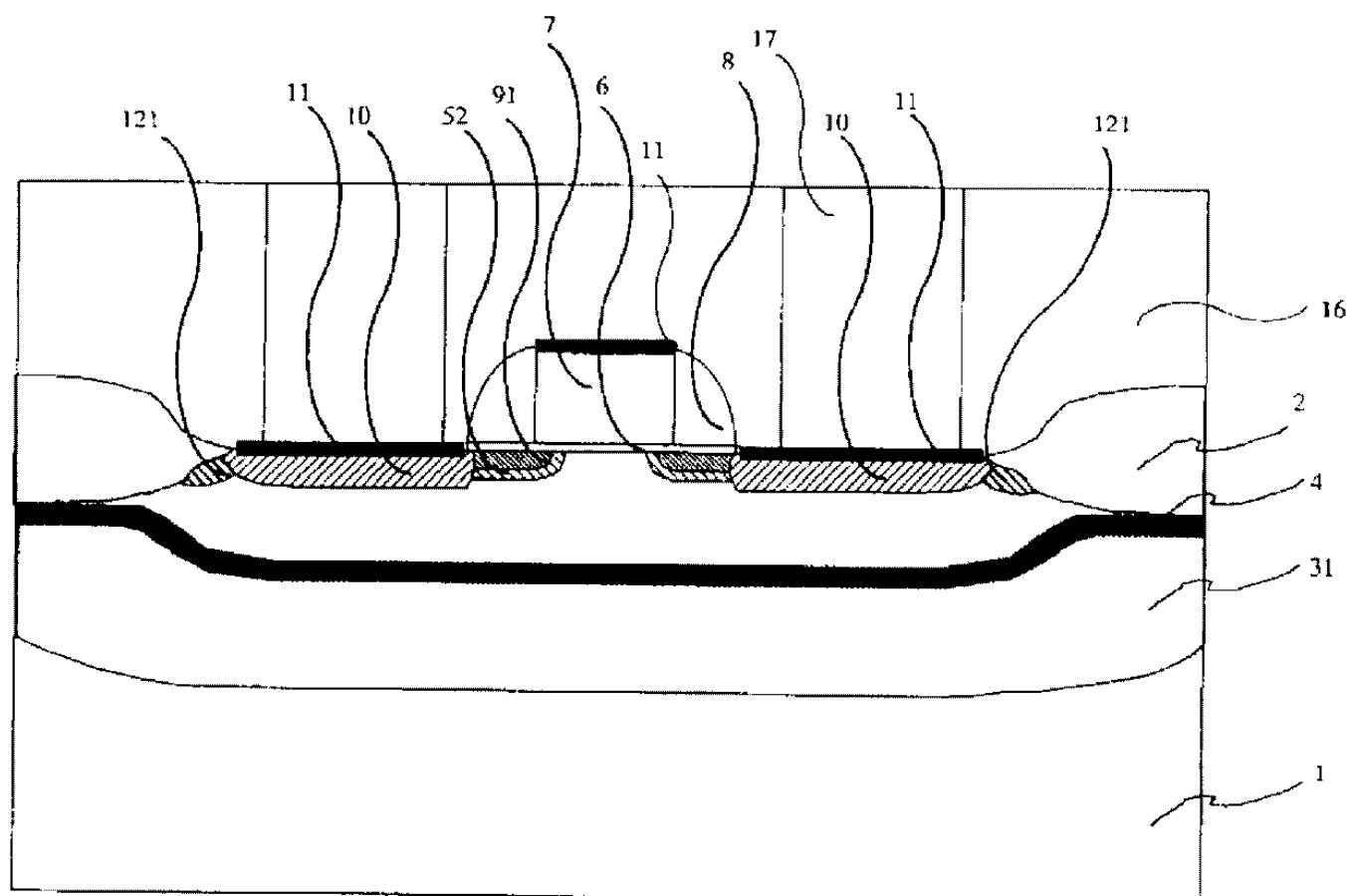
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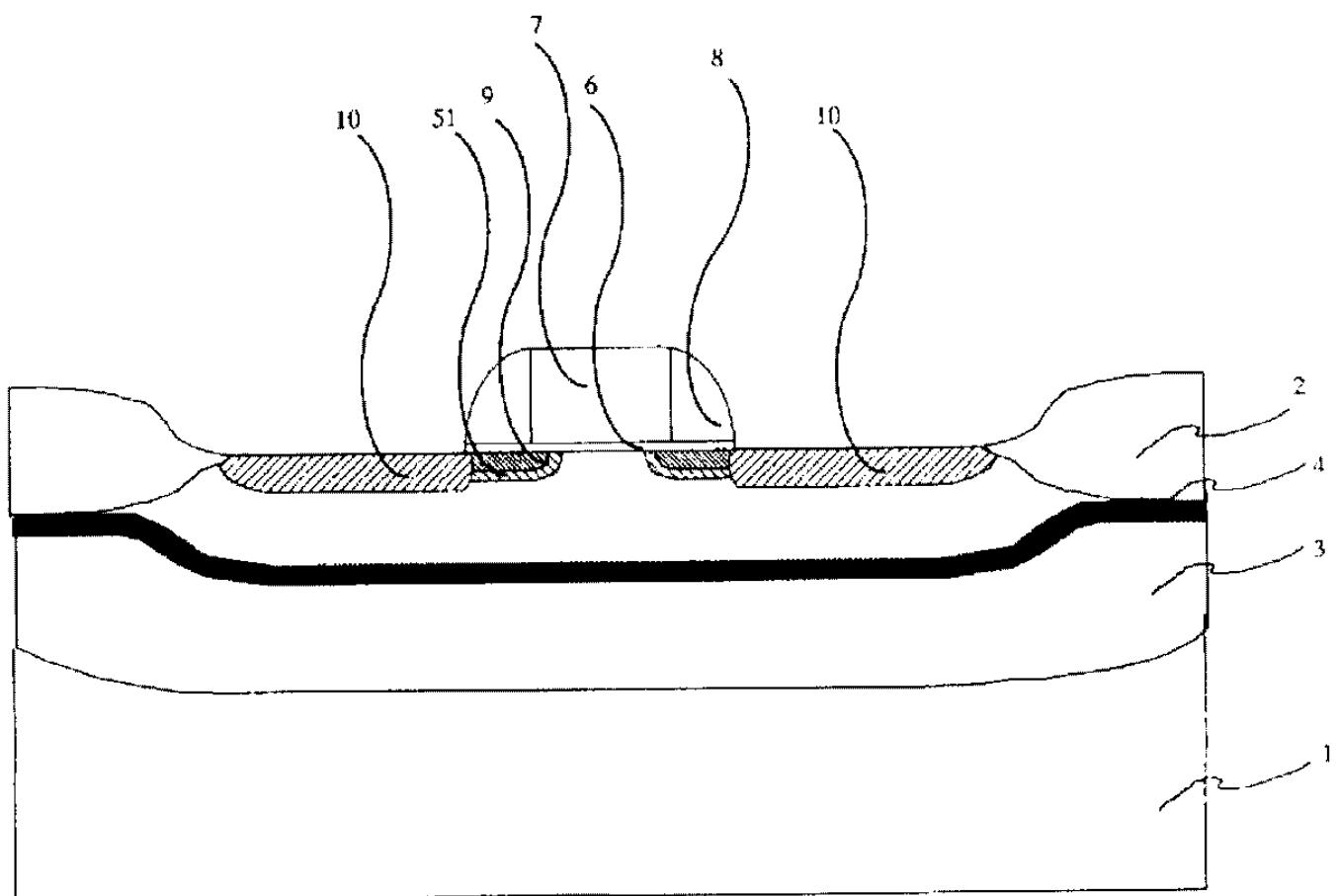
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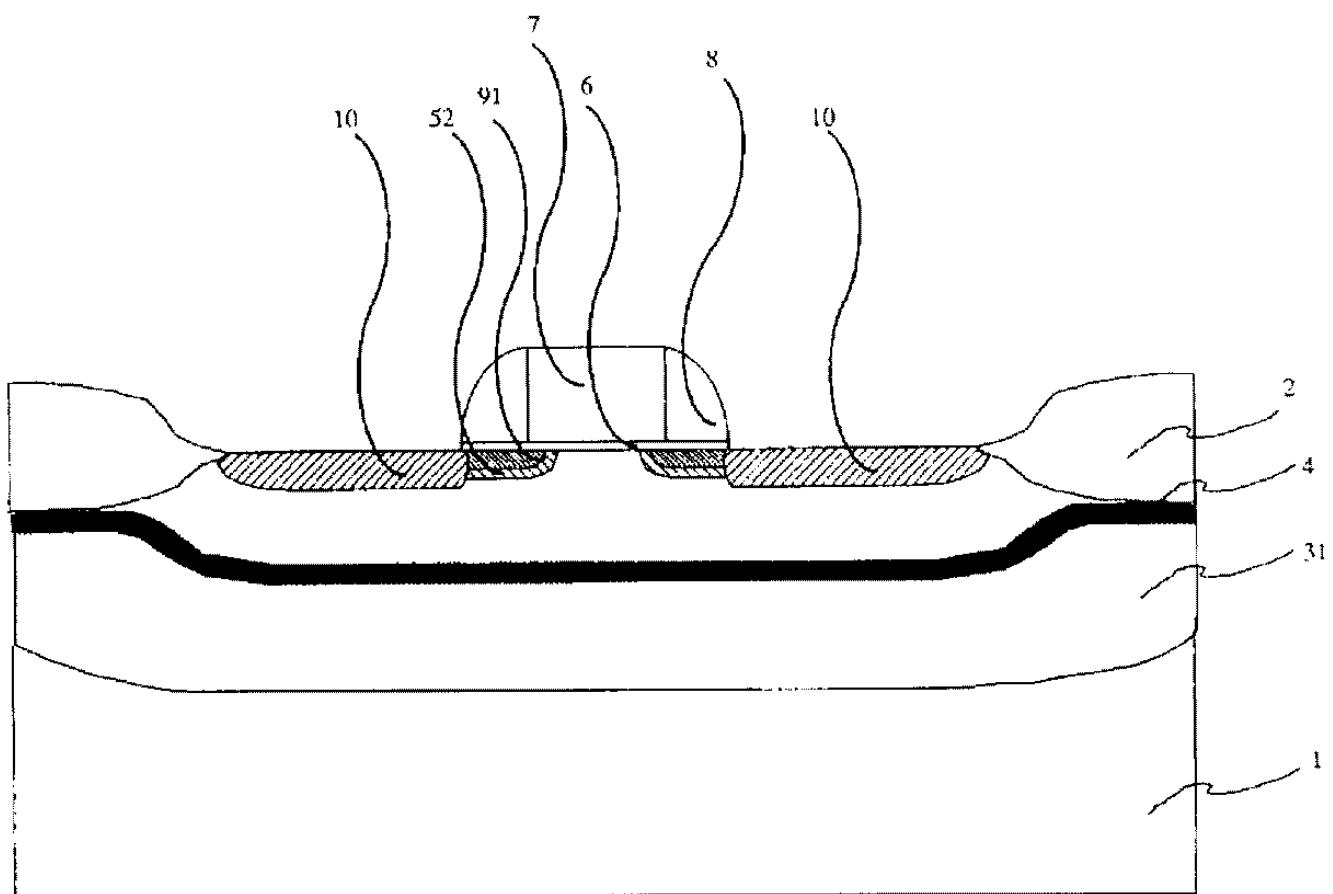
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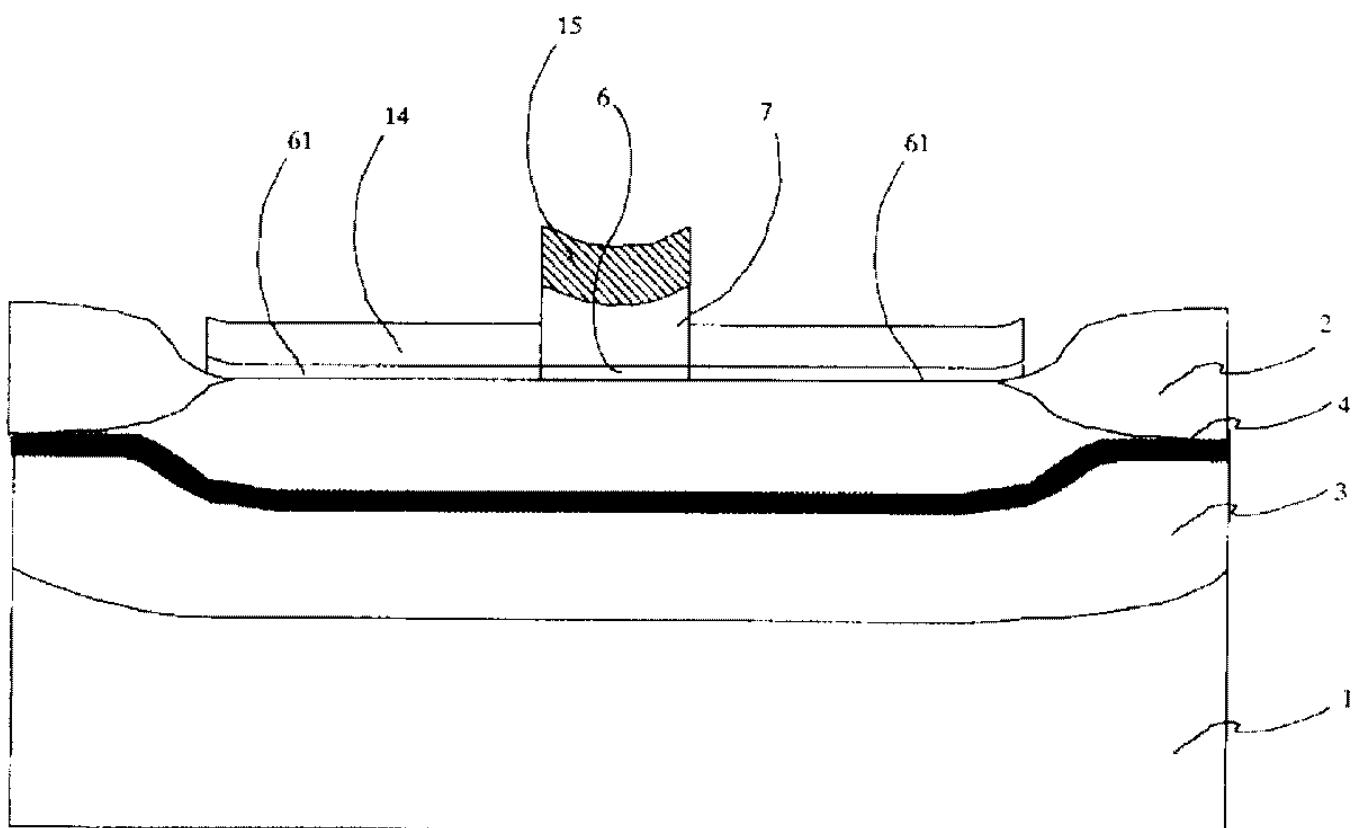
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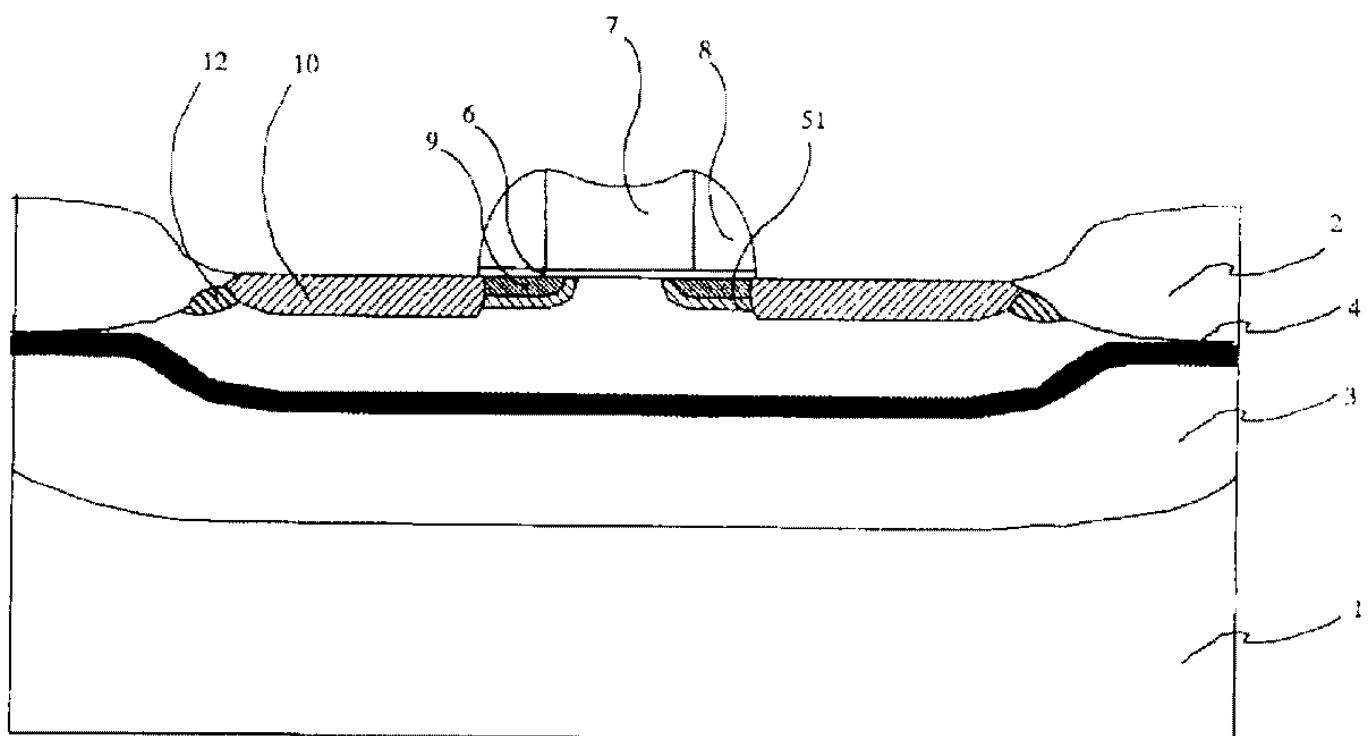
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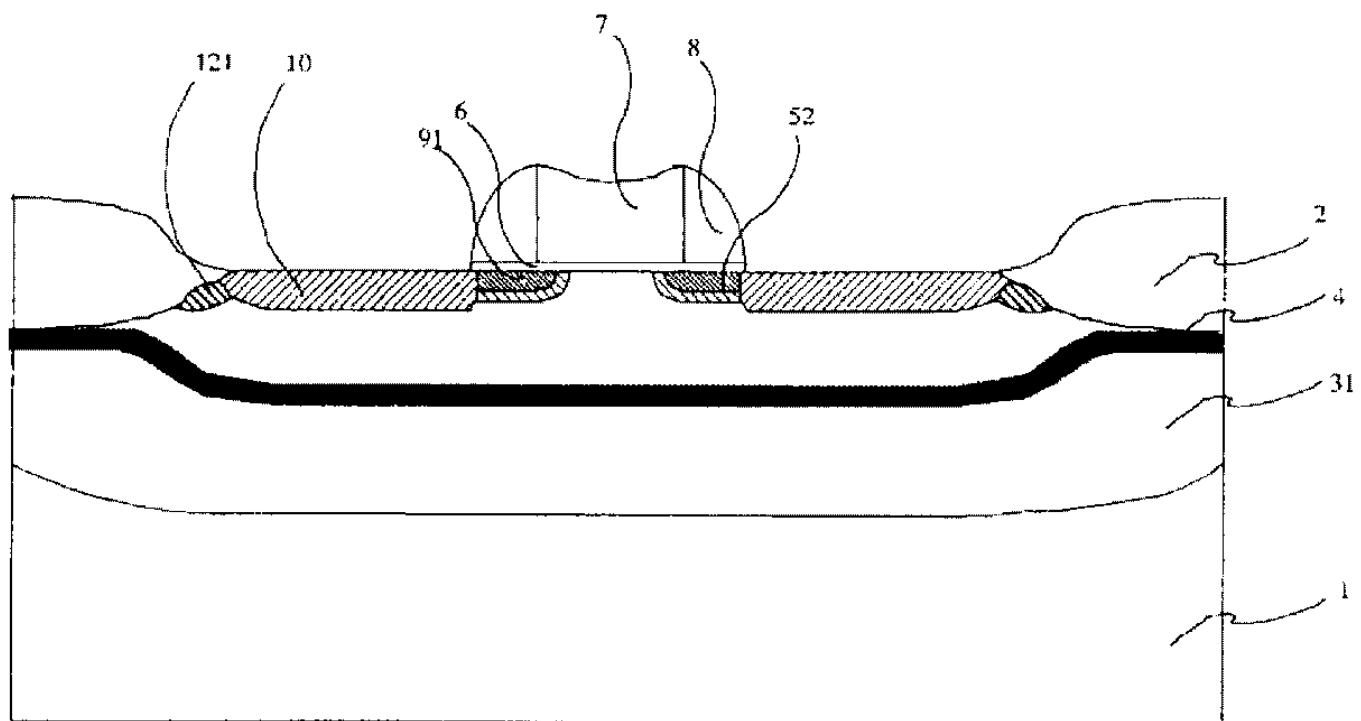
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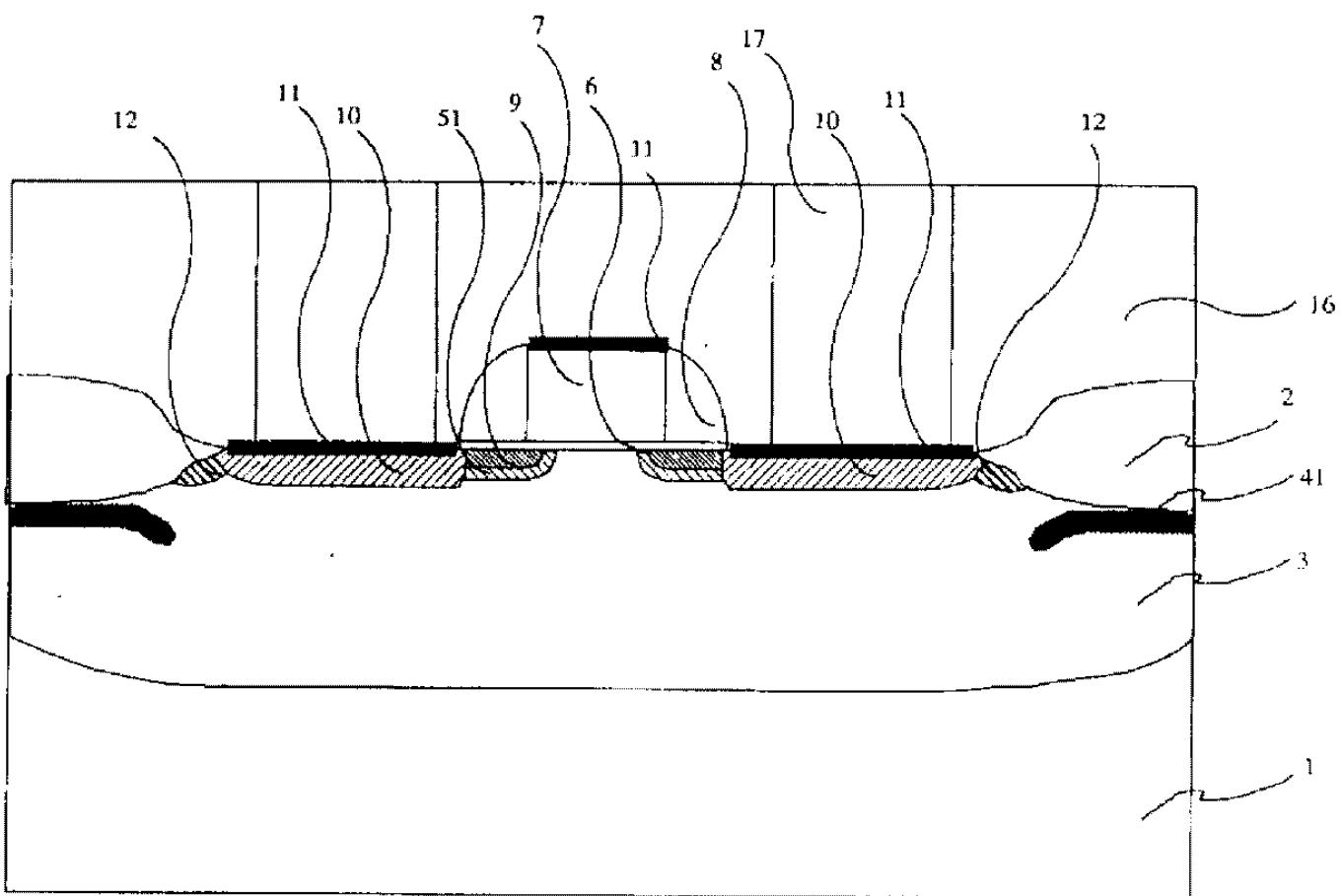
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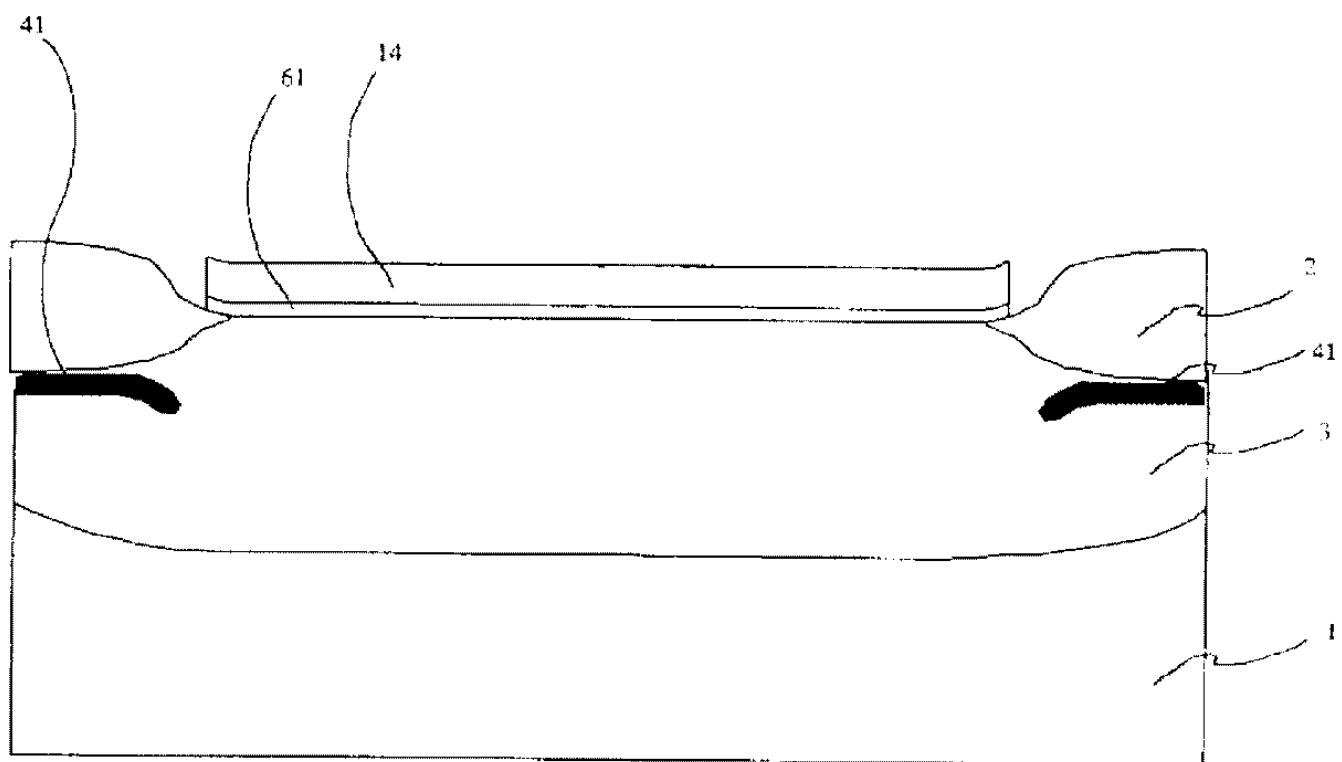
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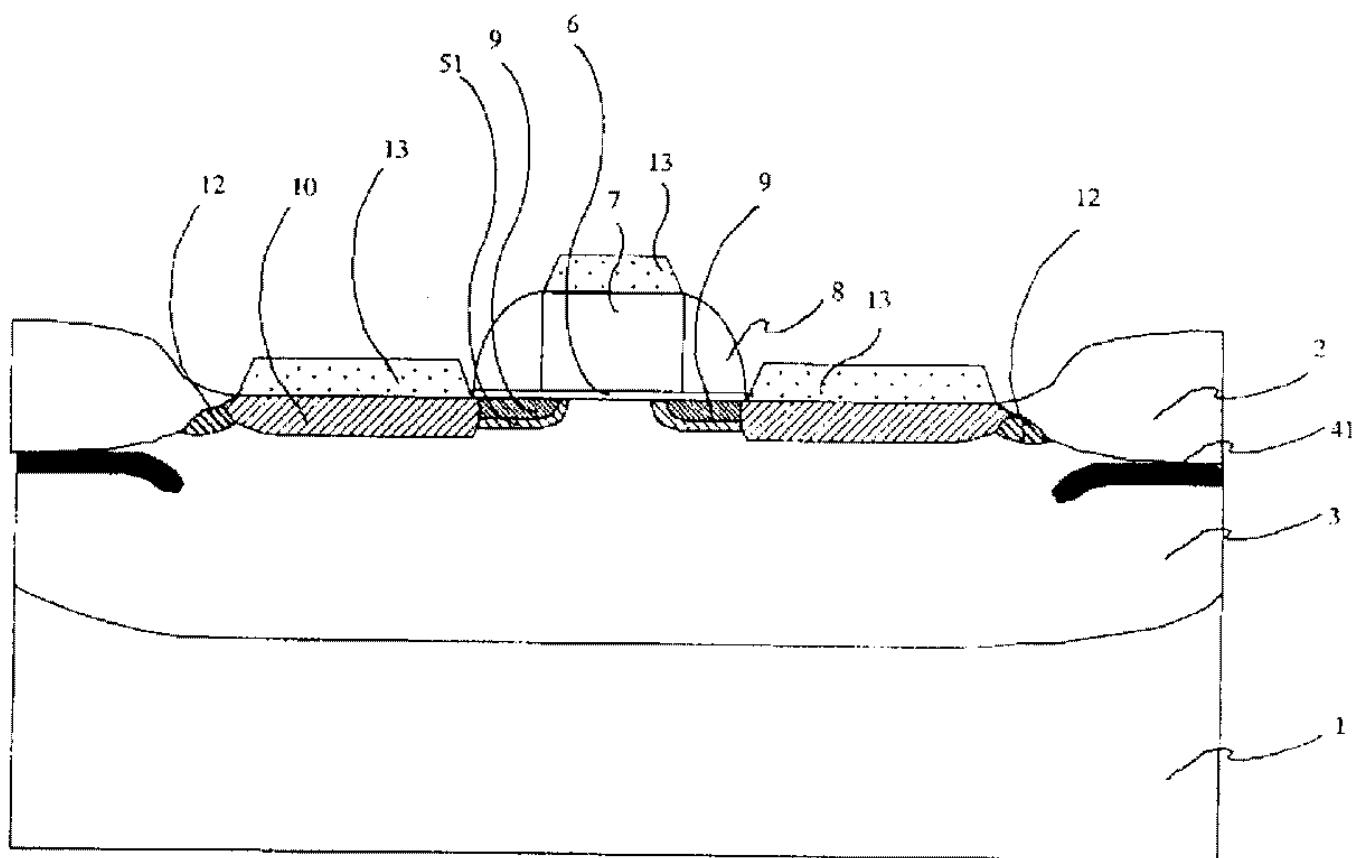
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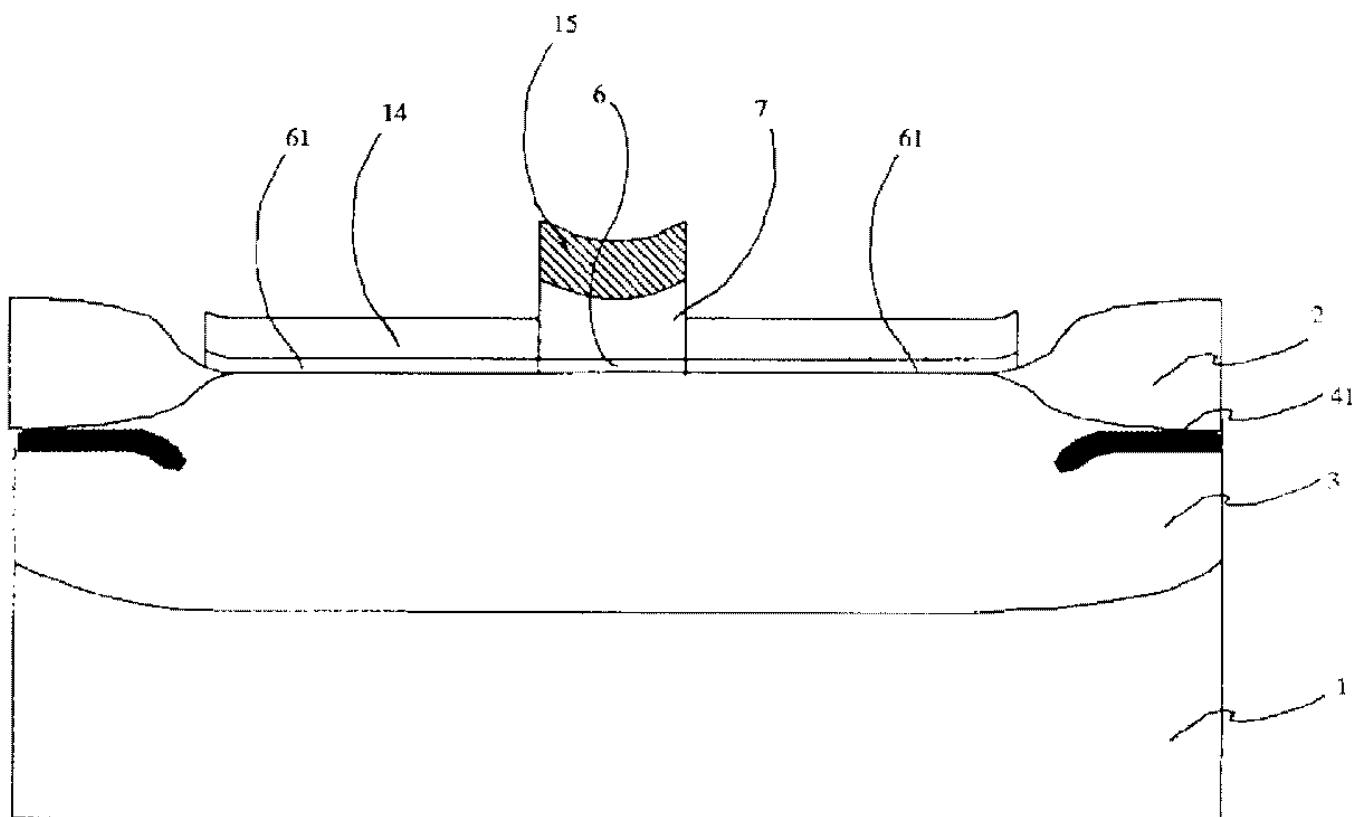
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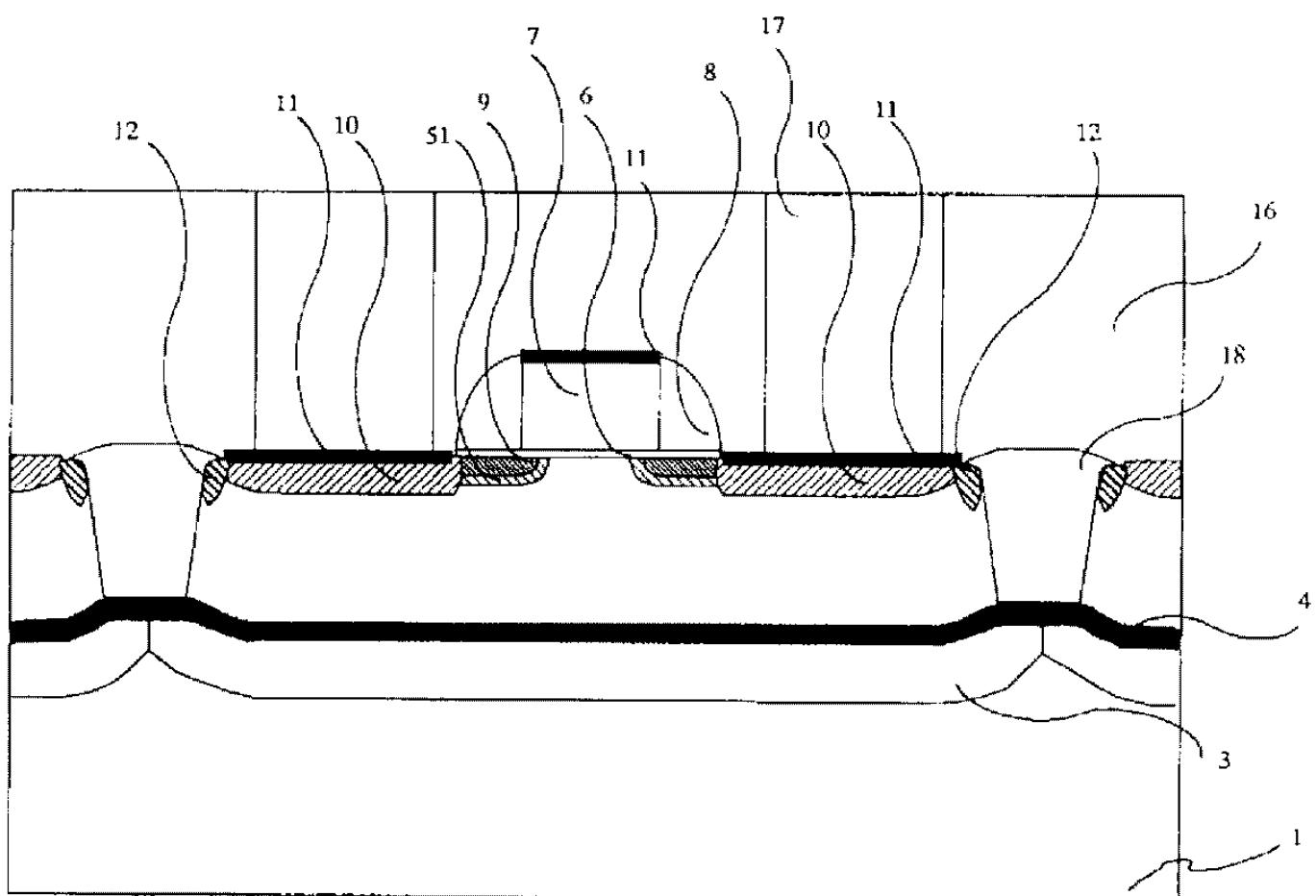
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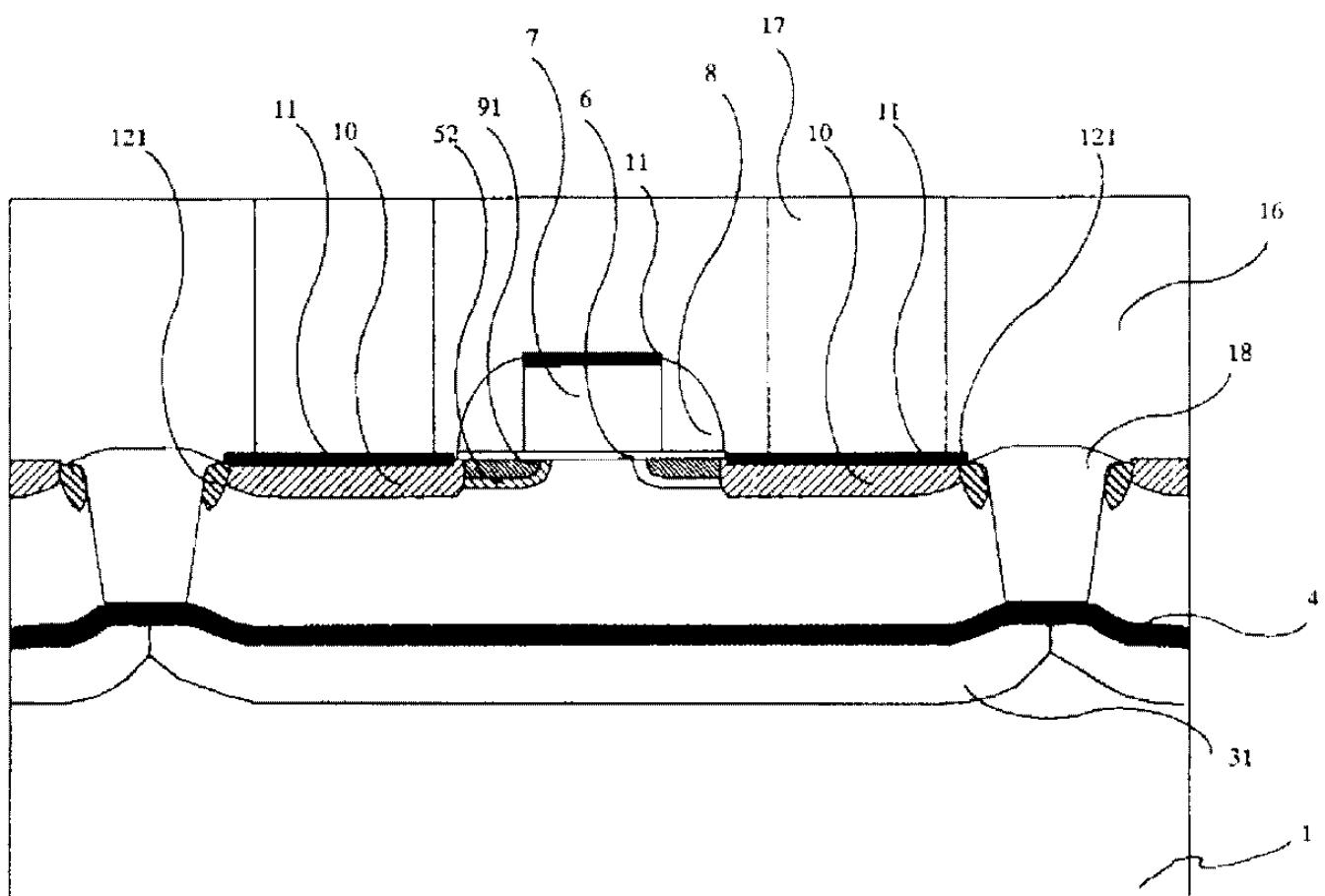
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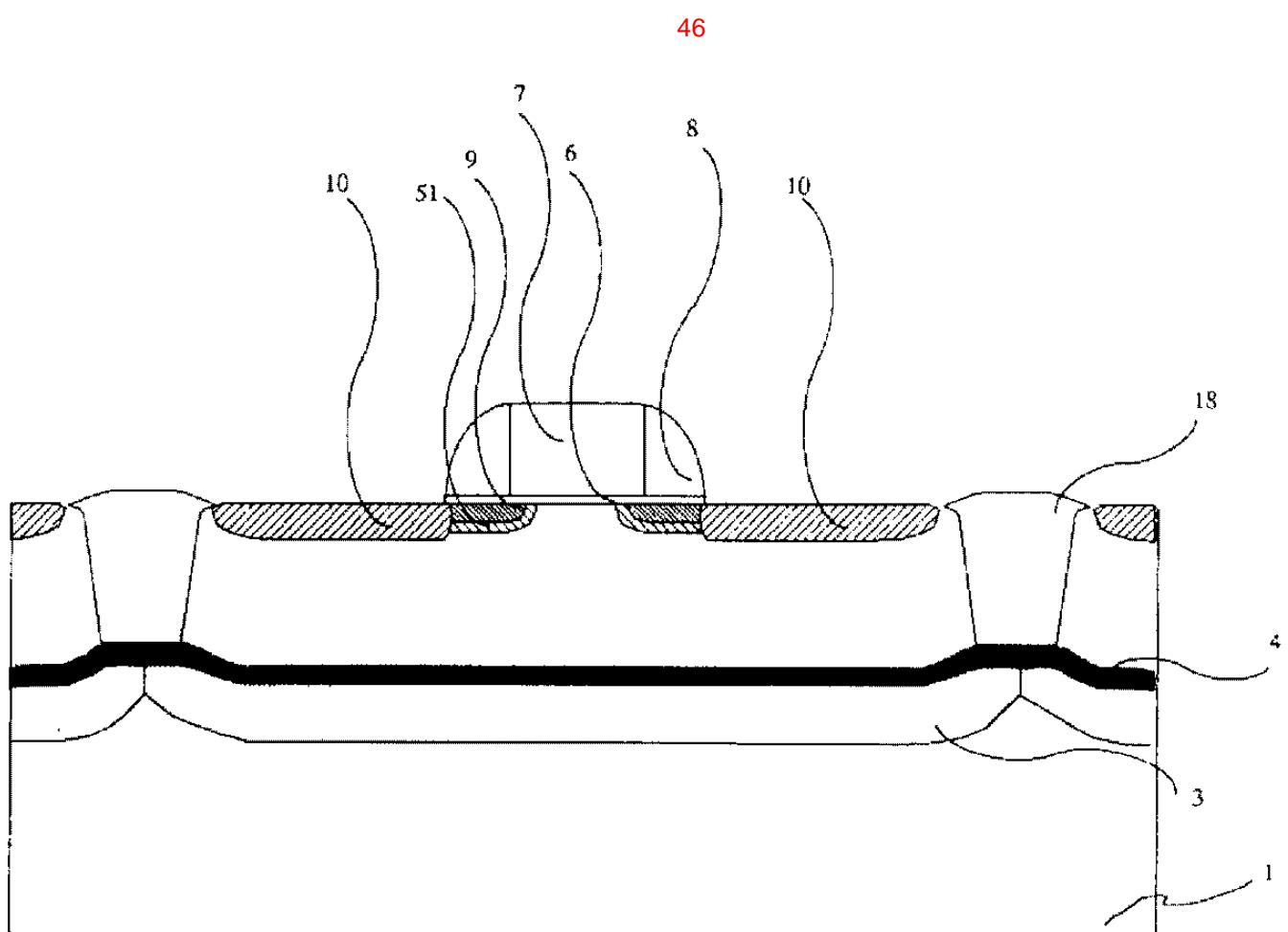


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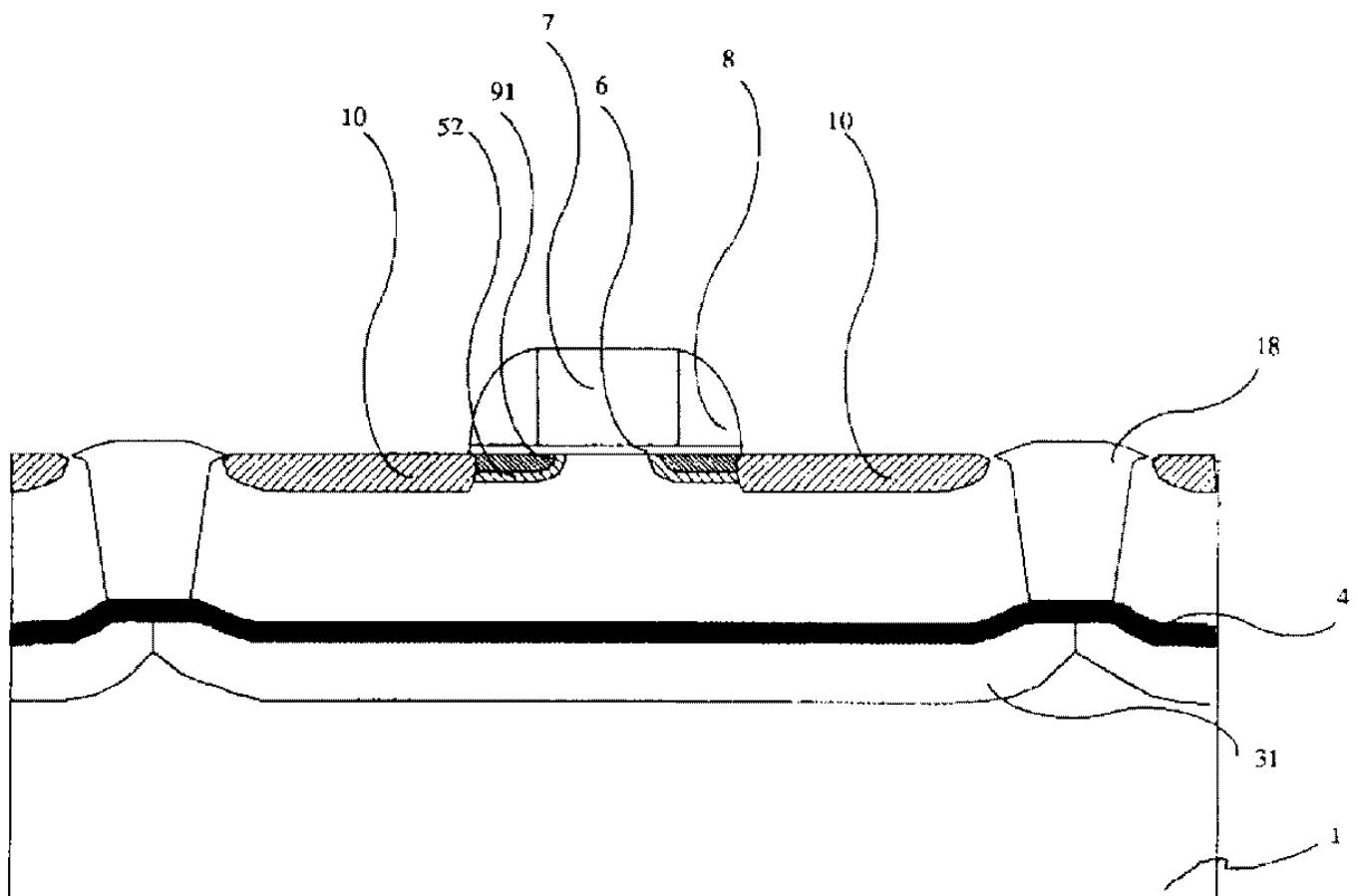


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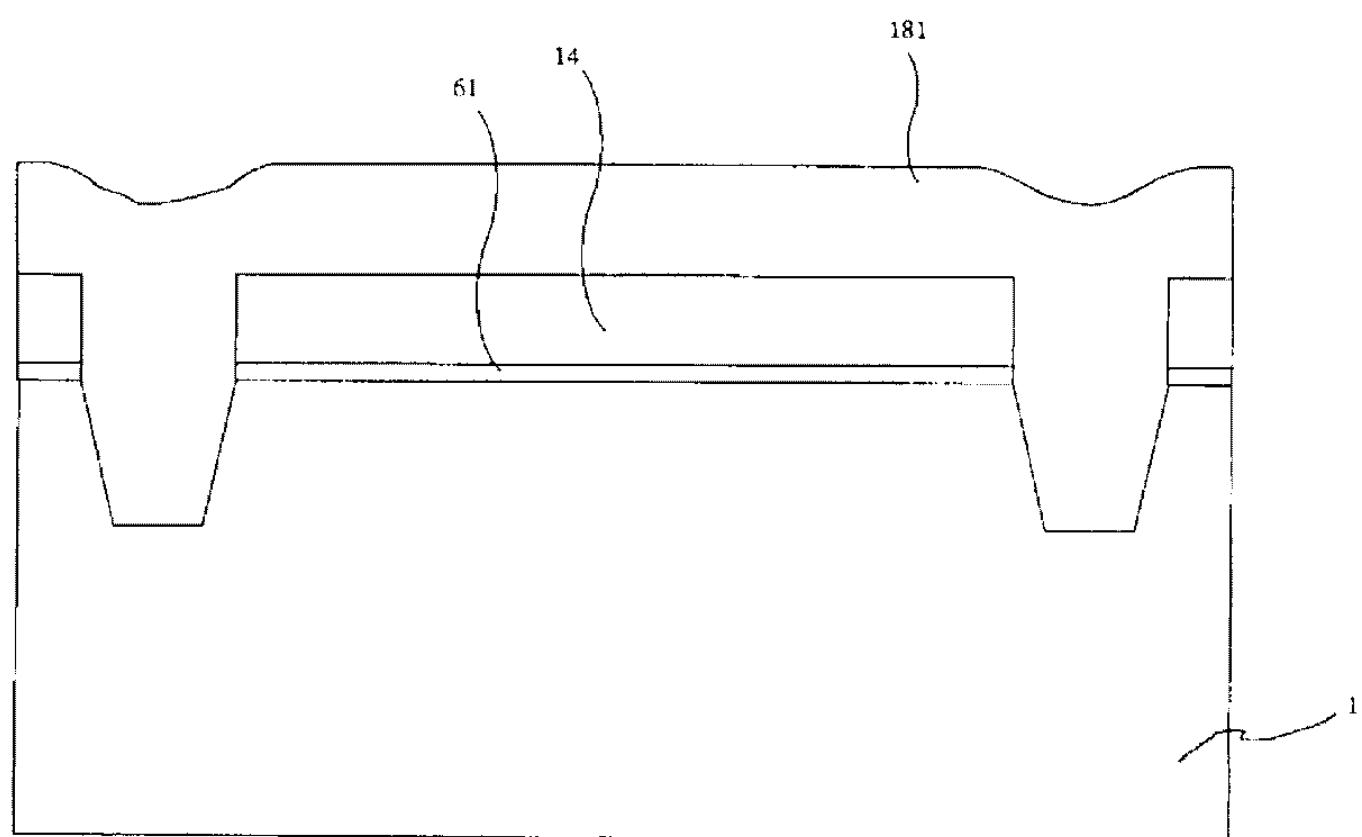




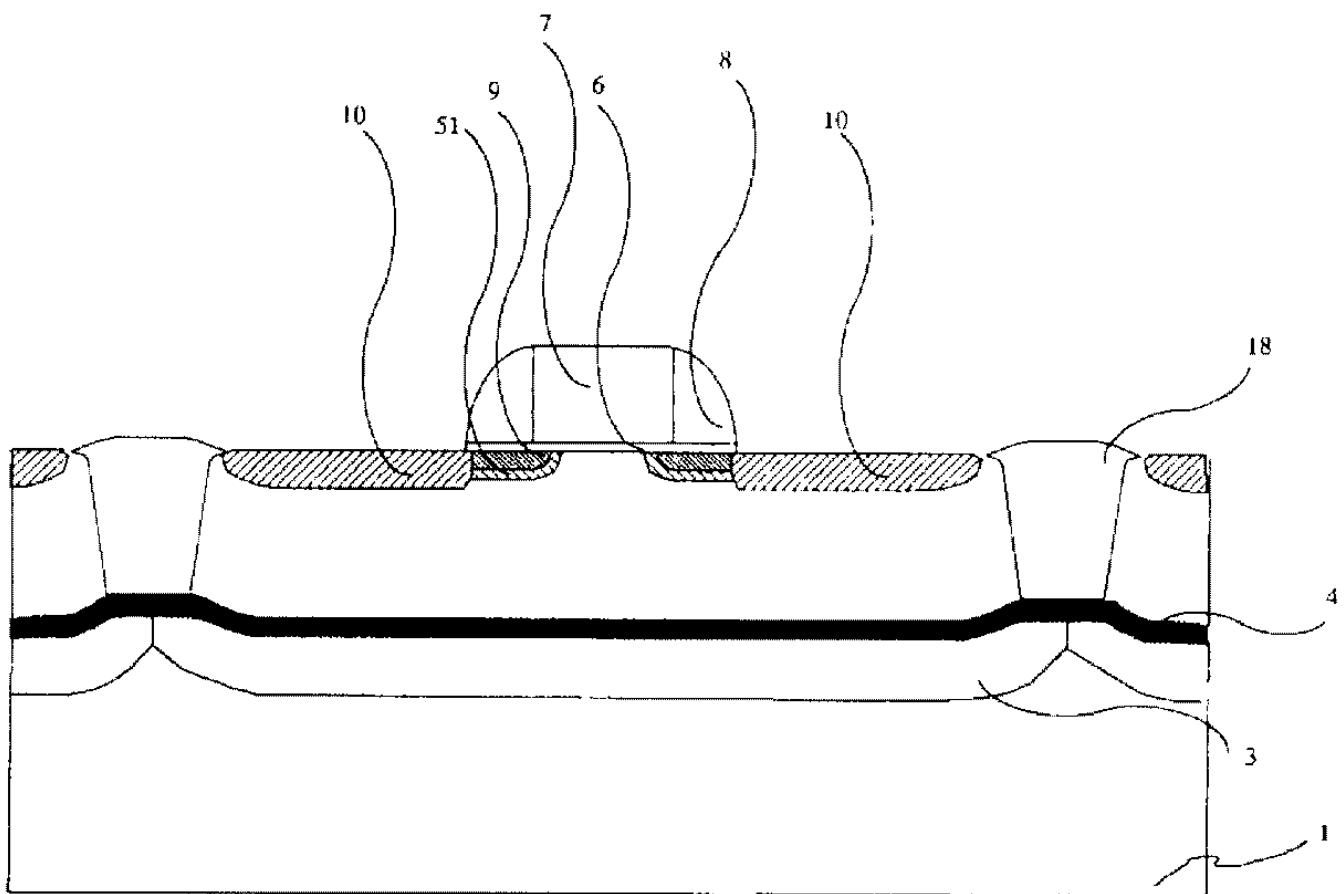
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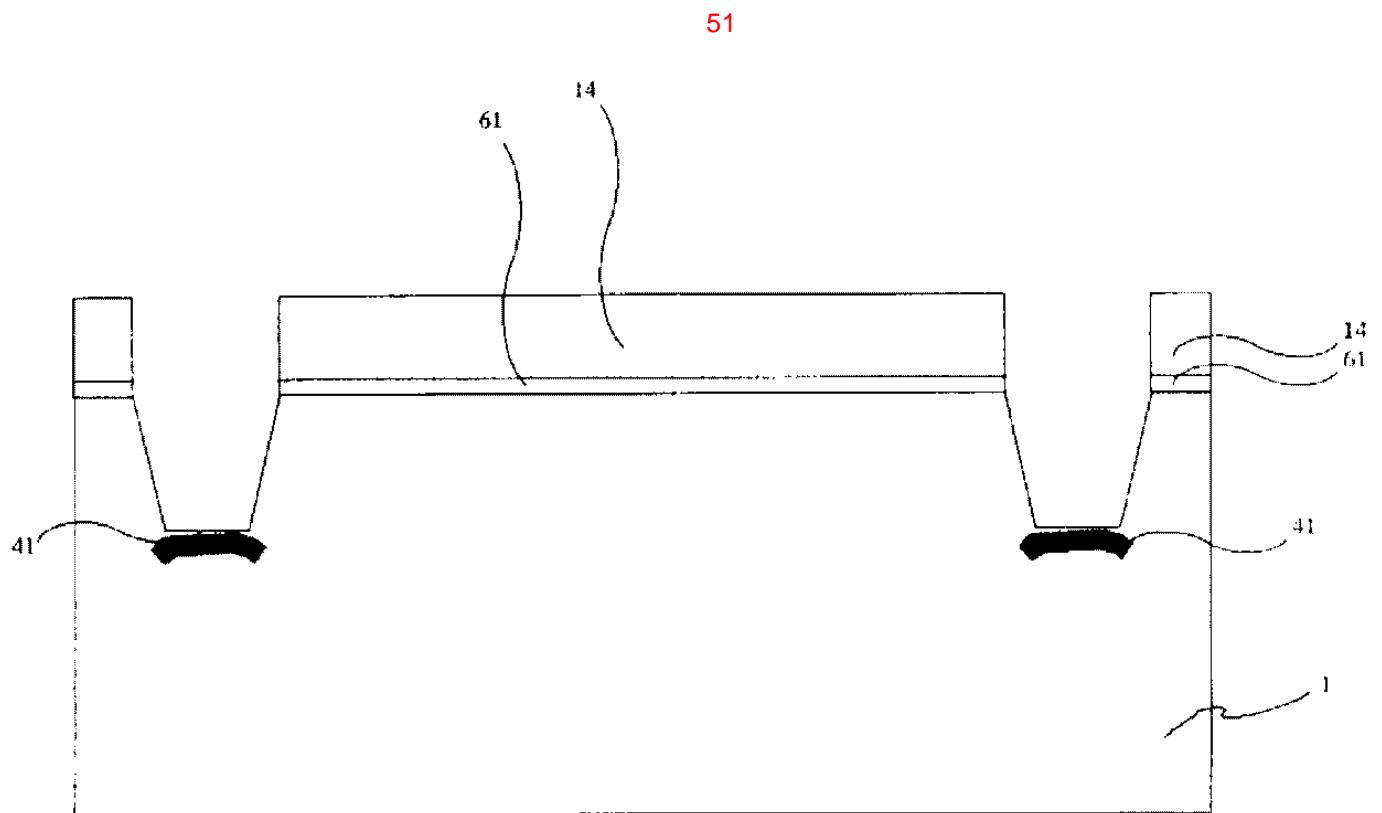
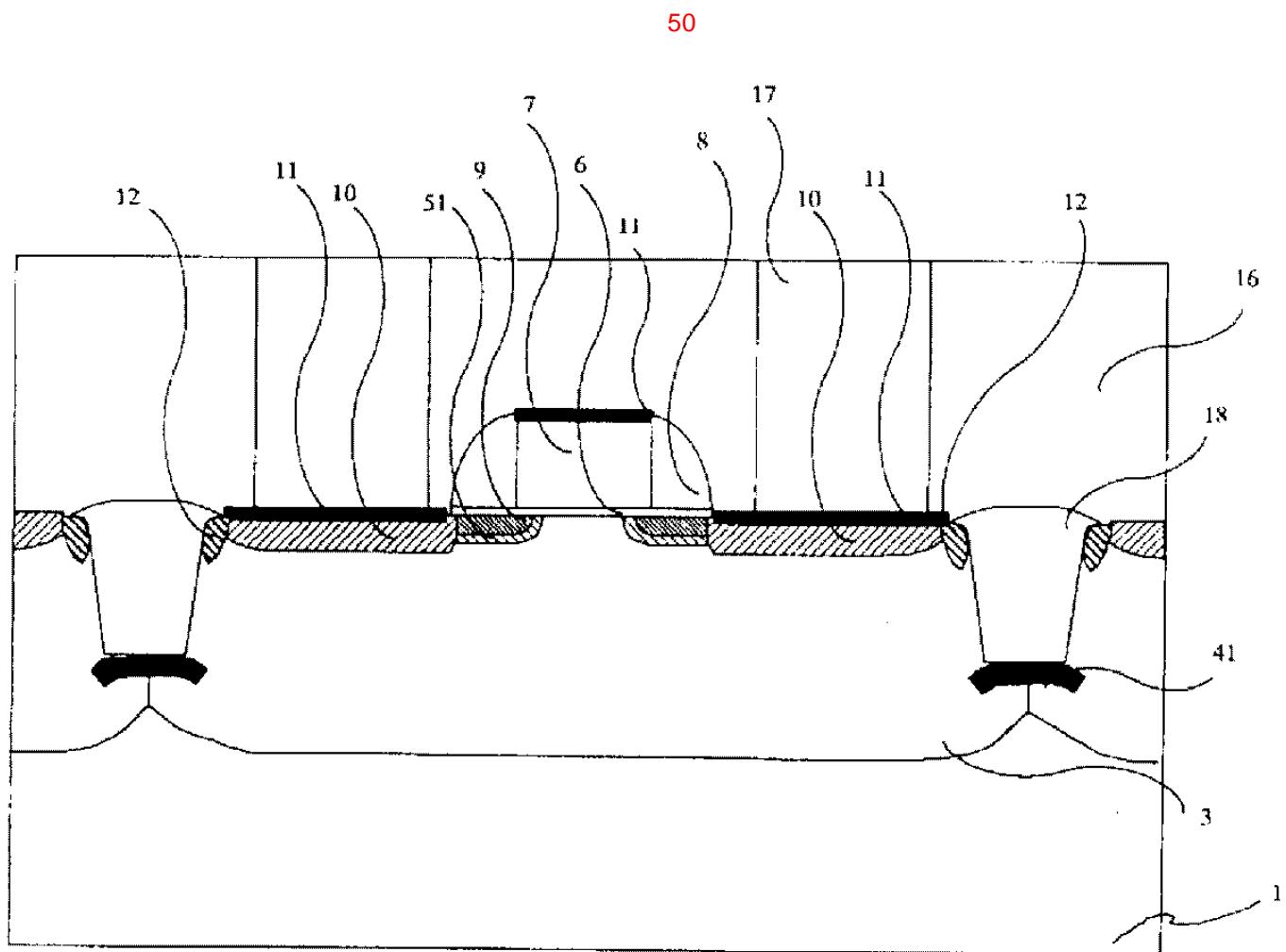


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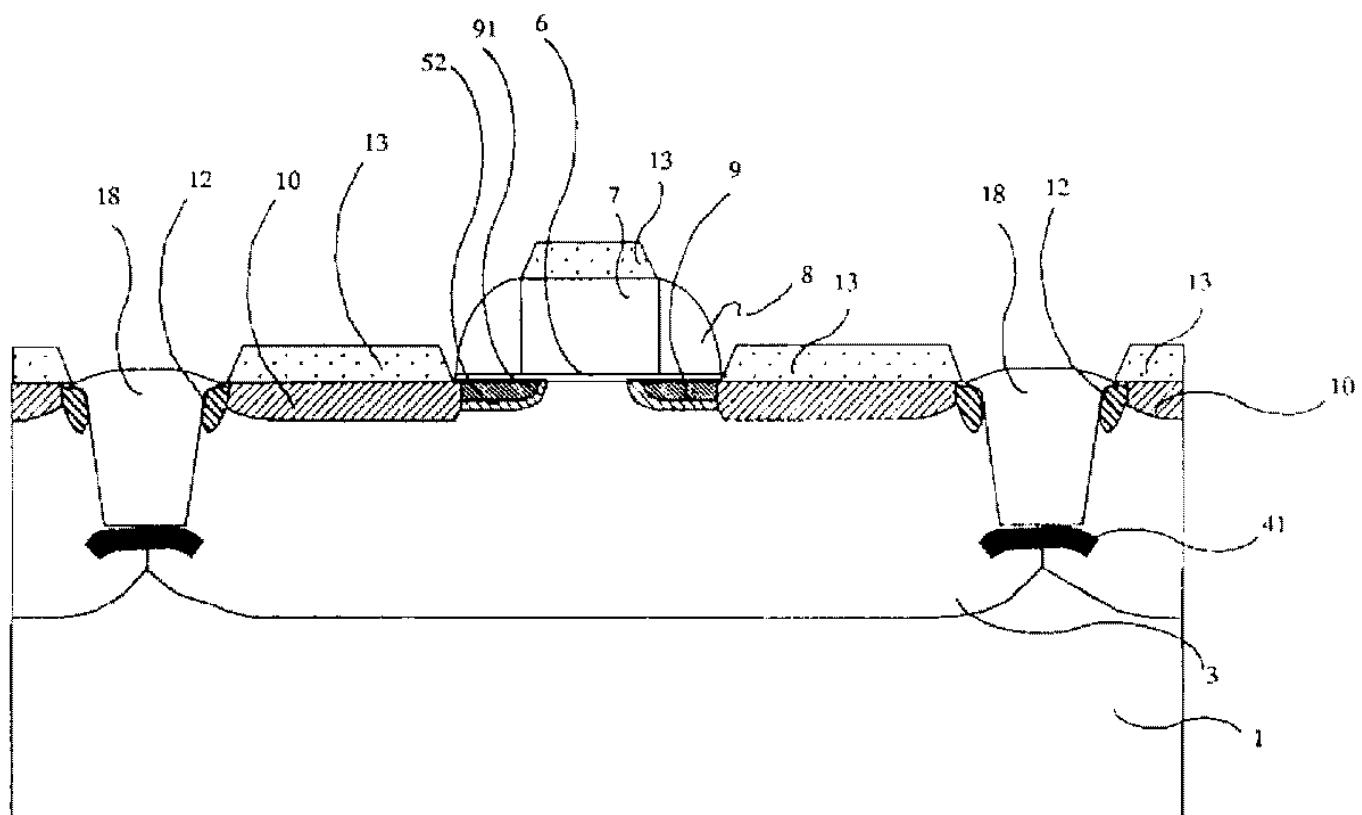


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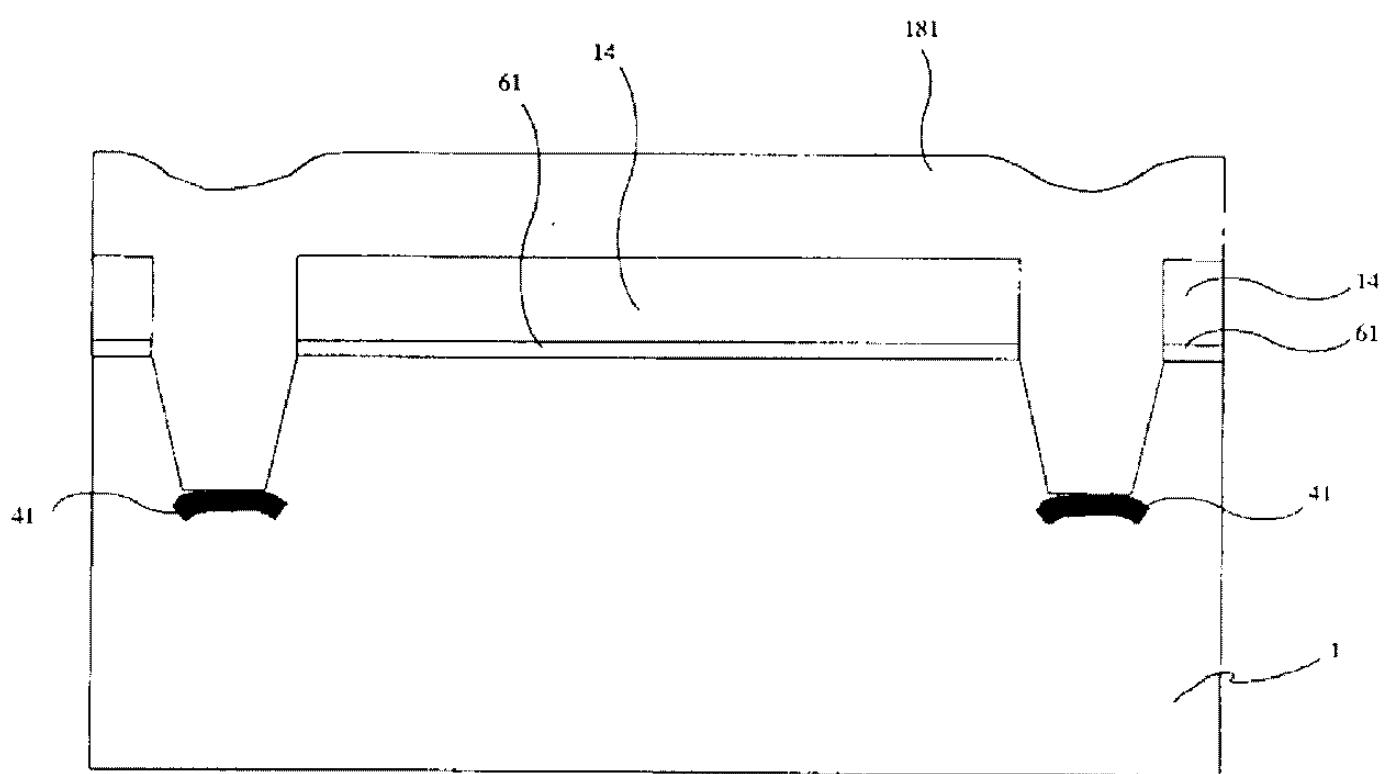




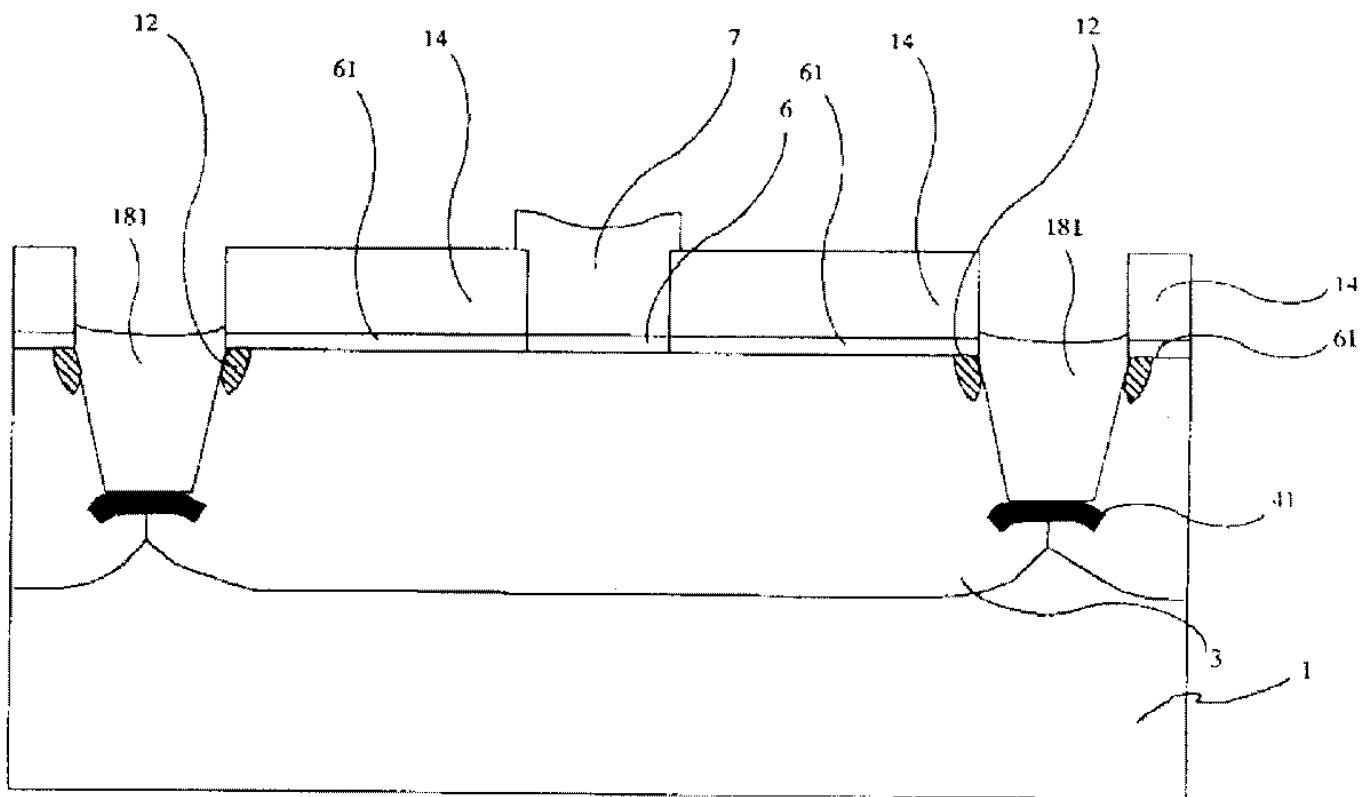
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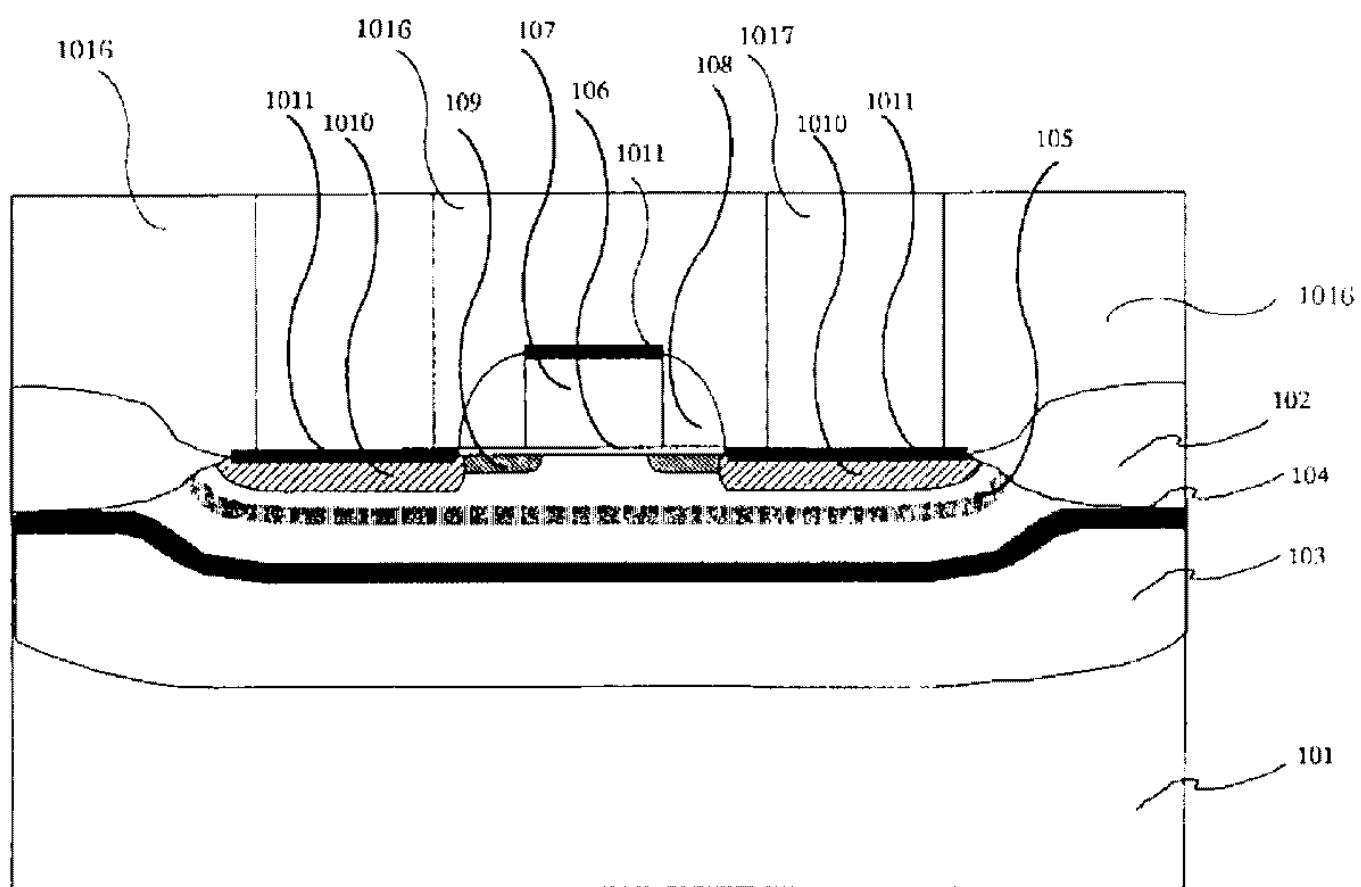
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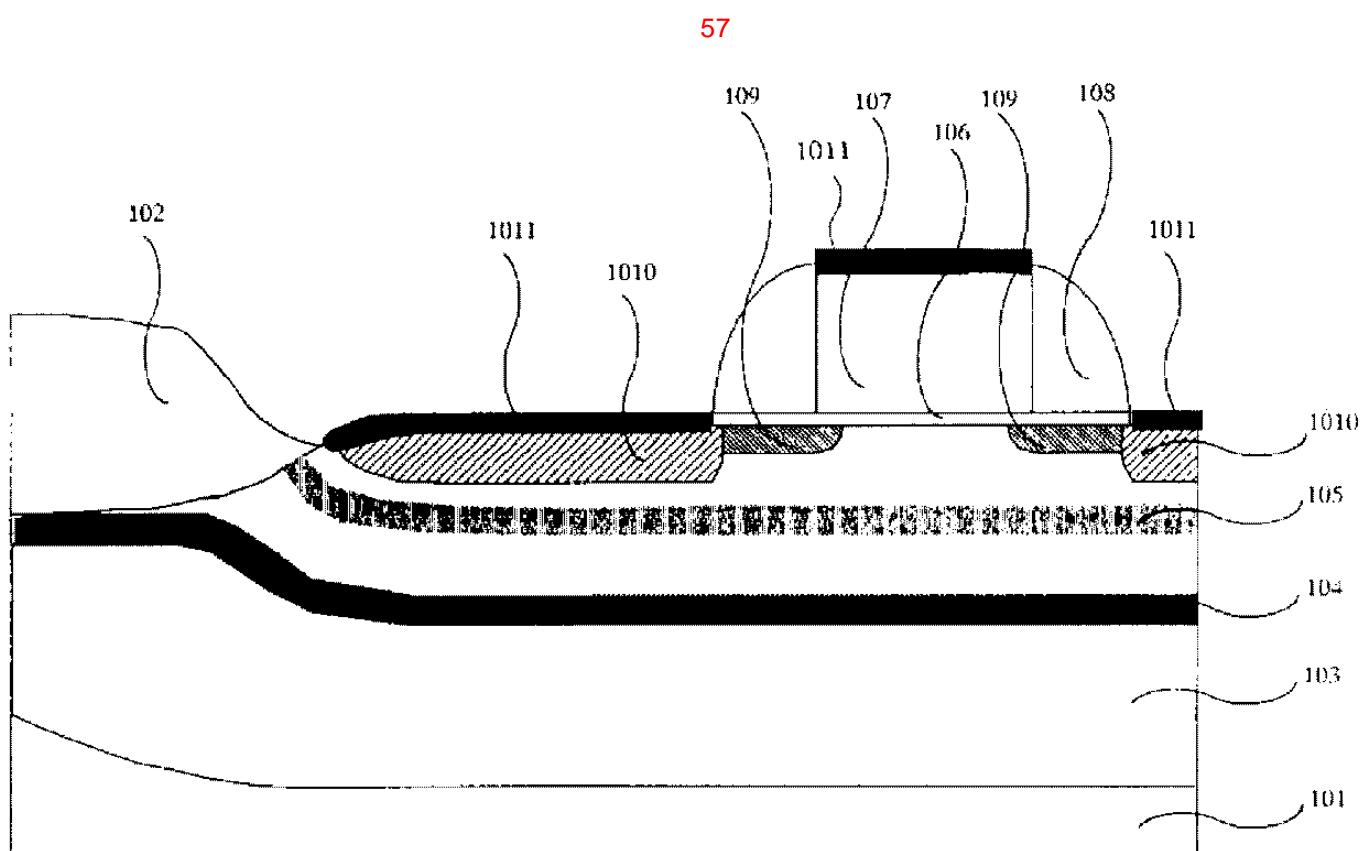
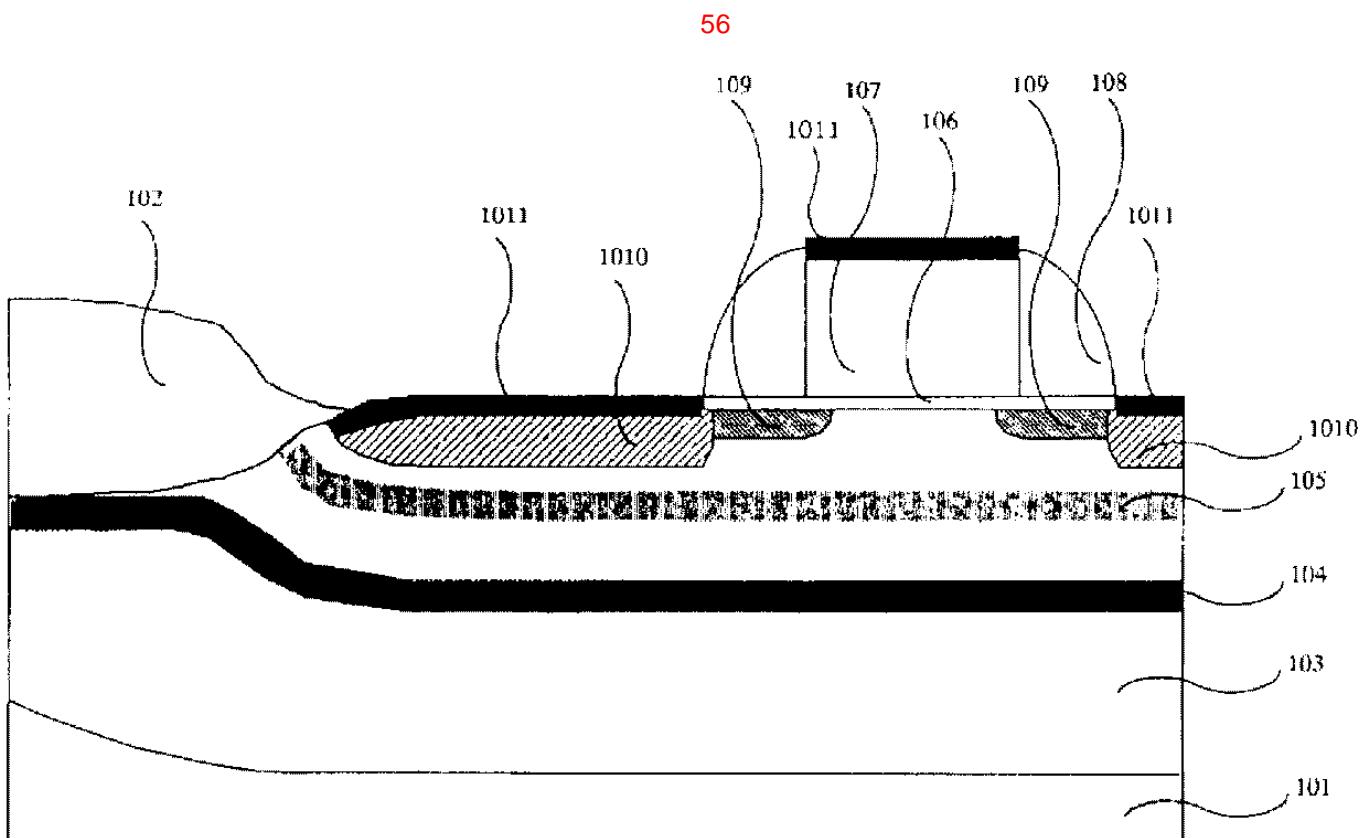


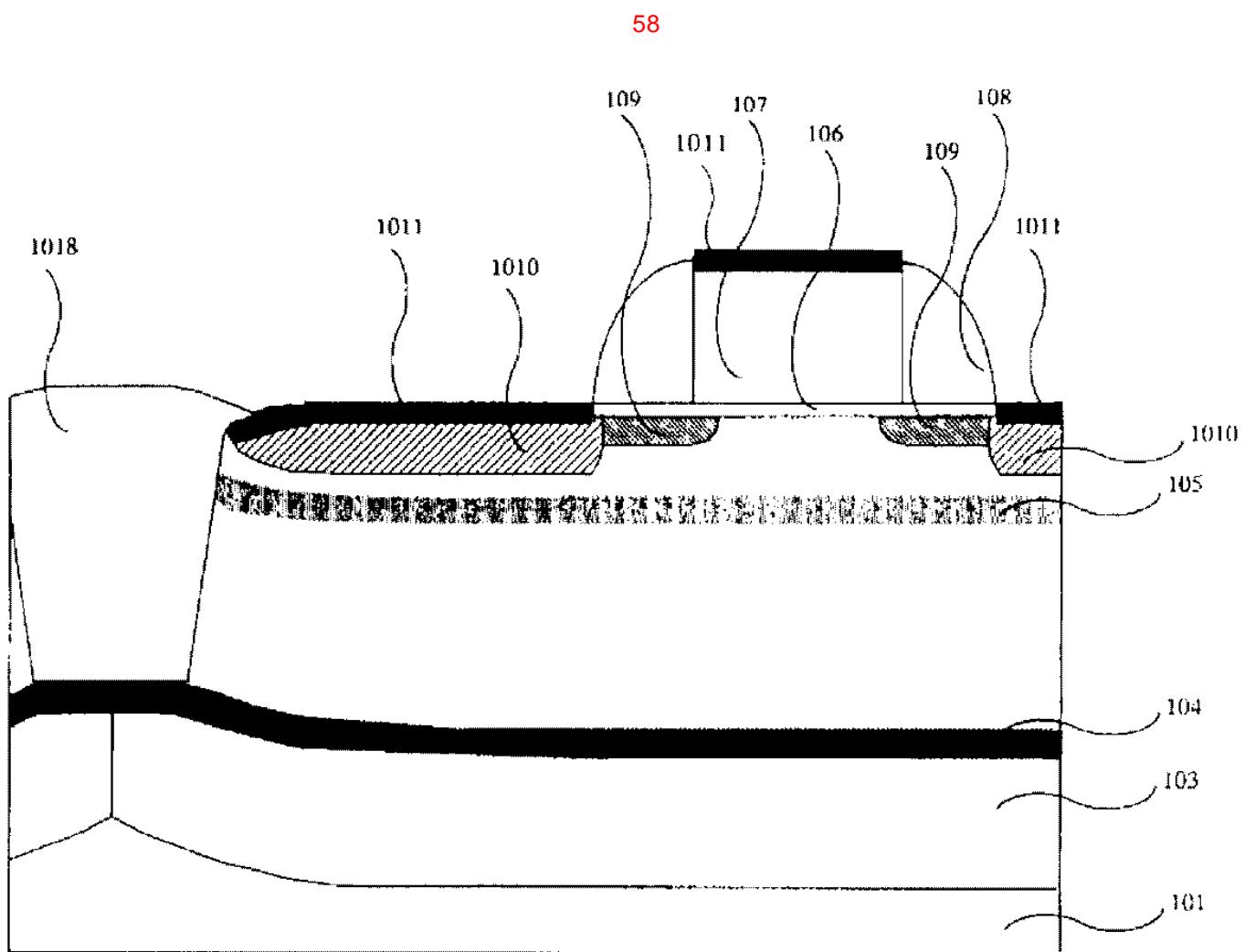
54



55







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