

a) 1 (2) 가 1 (4)
1 , b) (58) 1 가
1 , c) 1 1

17

(electrochemical deposition)

(microfabrication processes; 가) (micron)
(submicron) (feature)
(macroscopic scale) 가 (bulk) 가 ;
가 ; (synchrotron-processed)
2.5-D LIGA
1-4
(geometries,
)
(rapid prototyping) (solid freeform fabrication)
50-150μm (macroscopic parts)
50-100μm (features)

a) 1 가 1 가
1 ; b) 1 가 1
1 ; c) 1
; d) 2 2
2 가 , 2 , a) 2 2 가
2 가 2 ; b) 2 2 가
2 가 ; c) 2 가
3 ; a)~c)
1 , 1 가

21 4
 22
 23 2
 24 23
 25 3
 26 25
 27 3 (2)
 28 3
 29
 30 3
 31
 32 3

가 ((,) ())
 ((, , (microscopic)) (mesoscopic)
 가 (articles)
 가 가

(electroplating article)

1 (4) (8; support) 가 (6; confo (p
 rrmable mask) 가
 orous medium;),

2 (4)
 (13)

가 (flash; ,) ,

(() , /
 가 , ())

가 가 (()
 (, 가) 가 (()
 (,) 가 (negat
 ive and positive features) (rigid) 가 (peak) ()
 valley)

(, 10⁻¹⁴ Ohm-cm) , (hy
 drophilic) 가 (hydrophobic) 가 (hy

, 15X15 μm) (positive feature) (,)

(, 10 25 μm) 가 ,
 (,) (wall angle; ,
) (synchrotron-processe
 d polymethyl methacrylate) 가 SU-8 가
 가 (positive photoresist) AZ4620
 RMS-033 가 (Sylgard; 가 182 184)
 (porous medium) 가 (pores) 가
 μm 1% (retention rating) , 0.3 3 μm 20
 가 가 가 (permeable)
 (shedding) (,) ,
 (rigid, hydrophilic, slip cast ceramic disk porous medium;
 가) , (GH 가),
 (polyvinylidene fluoride; " GH 가)
 (polytetrafluoroethylene; LCR 가)
 (hydrophilized) (edge)
 (porous membranes)
 n) (backing) (masking applicatio
 (,)
 (,)
 가 가 가
 가 (dummy) 가
 , 가 , , (,)
) , (,)
 / 가 (microrvolume)
 (bulk) (granular) , (tiny spheres),
 가 (, /)

(). / . /
 (anode)
 e), 가 (soluble) 가 (insolubl
 가 () 가
 가 " (redressed)"
 가 (through-mask) 가
 (cured; , , (hardened), ,
)
 hemical microetching), (lapping), (sandblasting) (sintering) (c
 (promotor; 가 (Sylgard Prime Coat))가
 (mechanical interlocking)
 가 가 ()
 가 () (, 가 (microns
) (, 가)
 " " (, 가)
 가 ;
 (barrier) 가
 ;
 (investment casting cores) 가 (acetone-soluble) (waxes) (lacquers),
 가 509, 가
 [(electrorheological fluids)]
 3 (131;) (132) () (130) 1
 (136) (spun-on) (132) (3a) , (132)
 (3b) , (132) (132)
 (130) 1 (130) 2 (138) (132) (1
 34) (,) (134) (134)
 () (132)
 (132) (130) (132)가 (134) (134)
 (soak in) 가
 가 가 가 (transfer

) (,) .
 가
 (barrier layer)
 (application)
 가 (ion milling), 가
 (dry film)
 ;
 ; (CVD)
 ;
 ;
 ; ()
 ; ()
 ; (filling)
 ;

4
 (144; SU-85 가) (142) ()
 (micromold; 140) () 가 (photopatternabl
 e) (micron) ()
 (not-stick) (excimer ablation)
 (master mold)
)-1- (passivated) () -1,1,2,2-
 가)
 (146) (148)가 (140) 가
 () (148)
 (150) (146) (142) (150)
 (152)
 (oven)
 (148) (154)
 (156) (140) (156) (140)
 (156) (140) (148) (140)
 (140)
 (stripper), CCR(가)
 (156) (158) (, O₂ CF₂ 가
)
 " (dummy)"
 가
 가

5
 (148;) (142)
 (142) (148)

(148) (146)

가 (vacuum degassing) (148) (146) 가

(, PTFE) (160) (148) (142) (146) 가

(146) (146) (160) (142) (160) (O₂ CF₂ 가

) (142) 가

6 가 [photoinitiator; (, 2,2- -2 가 ((146),

가)) RMS-033(가] (148) ((Mylar)]

) (146) [((162)]

146 가 ((xylene)) ((

) 가 (156) (negative working) 가

가 (developer)

(textured)

7 (148) (

146;) ; (156)

; ; (164) (164) ; () (156)

; (164) [(lift off)] (156)

(156) [(ion mill)] (164;)

; (164;) ;

8) (148) ; (156) (146;

; ; (ablating))

; (156) ; (148)가 (156)

; () (170)

(relief printing)

AZ4620 SU-8 (aspect ratio)

/ 가 ;

(inverse pattern) (, SU-8)

/ ; ; (

가) (,) ; (

9 (148) (156) (148) (

174) (174) " "

가 (,)

; 2 , 2
 (blanket) 가
 ()
 1 (230) 2 (232) 10 (234) , 1
 2 (232) 1 (230) 가 11 (6) (8) 1 (4)
 (2) , 1 [(10)] 1 (12;
) , (16) (18) 2 (14) (2)
 [, (22)] 2 (20; (4a, 4b, 14a, 14b)
 , (12) (26)가 (24)
 2 1
 가 1
 12 () (2)
 , 1 (12; , 2 (20; 12b)
) (12b)
 (가) () , -
 , 1-6
 , (segregation) 가
 가
 (slurry) (wear resistant stops) 가
 (precision flat metal plate) 가
 " (conditioni X/
 ng ring)" (motion stage) 360° (delivery)
 Y 가 $r=r_0 + A\sin B$
 ()
 13 (pad) 가
 (bus) 13 (40),
 (36) (34) ; (38)
 (42), (41) (44; passivation layer) ; (38)
 (36) ; (40, 41) (46) (38)
 (35) ; (40) (41) (38)

(48) ; (degreasing) ; (41) ; (48) ; (41) ; (48) ; (48) ; (35) ; (52) ; (50) ; (50) ; (36) ; (34) ; (48) ; (51) 52) (36) (54)(13i) (cyclic plating) ; (38; ,) ; 가 가 , 가 (microrvolume) 가 (break-down) 가 (taper) (draft;) ; 가 가 가 (bulk) ; 가 (hydrophobic microporous) ; (antipitting) (SNAP) (pi) ; CMOS ; OMI 가 가 C38 가 (projections) (surfactant) (flash) ; 1 5μm ; (200; retaining clips) (192) 14 (192; gear) (194) (190) (188) (198) (chuck, 196;) (196) (194)가 (192) (190) (192) (190) 가 14c (188) (184) 14d-e (200) (196) (184) 가 가 (238) (238) (236) (238) (240) 15 ; (stacking axis) (mold insert) (thermoforming), (ejection axis) (parting surface) (undercut) 2 s) , 16b (draft)가 16a ; 16c 16d (801-805)] 16c , (800) (801) [(electroplating apparatus)

가 17 (56) 2 (baths; 58, 60,)
 (62; inspection station) (58, 60) (58, 60)
 (58, 60) (59, 67) (4, 14) (56)
 (2)
 (4, 14) (6, 16)

0) (66) DC (2) (58, 6
 (64x, 64y, 64z) (68) (precision encoder)가
 (6) (6) (2) 1 (58)
 (2) (58) 2 (60) , 2 2 (16
) (, 1) , 1 (5
 8) PC (frame grabber)
 (62) (56) 가 (degas)

ink) [ball joint;] 가 (counters
 가

가 (,) , X/Y
 (,) 가 (244) (2)
 (250) 17 18 (67)가 (14)

eaning) 가 , (agitation) (HEPA) - (self-cl
 가

oop thickness control) ; 1 2
 가 ; 1 1 (, 0.1μm)
 1 ; 1 2
 () 2

(vernier) 1 2

19 , 1 (68), 2
 (70), (72a-f) 74a-f (66)
 (72a) (2; 2a-e) (68) (76) (66) (70)
 (74a) , (72a) (74a) 1 2 , ()

(72b) (68) 가 . (2a) 1 3 4 1
) (2a) 2 (2b) (2a) (2c)

(78) 8 (2) 24 (78) (concentric) , 2
 (80, 82) (85) (80) 1
 (84) (82) 2 (82) 2 (86)
 (lapping) (85;) (78) (2) (

8 가 , 1 1
 , 1 (2) (78)

X 200 (500 micron square by 200 microns tall) 250 8 500
 가 (, 가 (Watt bath) J.

Material Sci., 22 494 (1987) " 2 ,
 , 2 , 2 , 3 () 21
 (94) (2a-e) (88)가 (90), 1 (92), 2
 a) (2) (90) 1 (96) (88) (92a) (94a) (92)
 2 1 3 , 4 (92b) 가 , (2a)
 a) 1 3 , 4 (2c) (2a) 2 1 2 (2b) (2
 가 (; laser enhanced plating) , (pulsing) ,
 atic) 가 (galvanost
) 20-50mA/cm² (1-2mm
) 가 (poten

tionstatically) 가 22 (98) (100) ,
 (104) (98) (volume) 가 (102) , (106;
 (98) (98)

positive potential) (biased) , 가 (more
 가 23 (260) (262, 264; (bias) ,
 (266) (268; lapping station) (262, 264)
 (262, 264) (270, 272) (264) 1
 (274) (262) 2 (blanket)
 (262) (2) (276)
 (276) 24 , (262) (278)
 (276) (2)

25 (280) , 가 .
 (2) (108) (110) ,
 (112) 가 , (112)
 (114) (114) (2) , (116)
 (110) (118) (114) (,)

26 (112) (120) 가 .
 (112) (112)
 (110) (112) (112) (112) (112)
 (122) (112) O- (124) (128)
 " "(126; barrel)
 (112) (110) (126)
 (2) (2) ,
 (intermediate compliant material;
 (112) (110))
 (open pore foam)

27 (602) (valve) (602)
 (A-D) B C A D
 B C 가 (가) 가 .
 가 , 가 , 가 .

1 CMOS 가 .

28 3 (610) (612), [614; (RAM) , (6
 28 ((612) ROM 가 (ROM)], (616) (6
 18) (CPU) (612) PC, (614) (612)
 가 (614)
 (616)
 RT ((618) , , ,) , C
 (linotronic)

29 3 (parameter
) 620 가 (612)
 622 (612) (616) 623 3 3
 (612) 624 ()
 M 1 , M 3 (612) 625 , (copies) ,
 , M (scaling), (612) 616
 M 628 630 M
 (614) 628 632 M
 (614) 630 (612)
 634 (614) 632 3 가 .
 (612) M 가 , 636 M
 (612) M 638 640 , M
 N 0(zero) (612) 642 646 , M
 가 M-N

(612) , 648 , M (650 M-N
 (612) M) 652
) , 654 , (612) M-N 1
 , (612) N 가 642 M
 M-N (612)가 M
 가 656 , M (658) , (612) M
 (660) , M (650 6
 52) . 3 (634
 (612) 가)
 , (612) M 가 .
 30 3 (slice)
 , 722 , 720 , 가
 ro)) , 1 P(, M (612) M 가(724 0(ze
) , 1 P(, M (612) M 가(724 0(ze
 (730 (biased) . (612)) , (728 M P
)) (732) (612)
 , 734 (612) , (612) 736 , ()
 (612)) (turned off) . (612) (612) , 738 , , ()
 M (bias) D (740) () . (612) , , ,
 4 (740 740) () M (612) (74
) , 746 , P가 M
 1) , (612) P 1 가(748) , M P(, Pi+
) (612)
 , (612) M , P가 M (750) .
 , (612) 752 () .
 , (612) 724 M 1 가 , (612)
 , , (firmware),
 가 (pr
 ogrammable processor) - 가
 , (program of instructions) 가
 , 가
 가
 (compiled) (interpreted) , , (real only
 memory) / (random access memory) . (non-volatile mem
 ory) , EPROM, EEPROM ; ;
 가 ; ; CD-ROM ;
 ASICs(; application-specific integrated circuit) ..
 LCD , 가

(trackball)

r) (non-plana

가, 가 (powdered medium) 2

가

가

(182)
(178)

(186)

(184;

31
(rotor core)
(180; amateur winding)

(184)

(, Ne-Fe-B)

(sintered),
(sputtered)

(topography)

(porosity;

()
()

(sense))

(flushing),

(deplating)

(reconditioned)

32

가

(200)

(coextensive)

(204)

32a

1

; 1

(206)

1

(200)

(202)

(208)

1 (200)
(32c),

(210)

(32b); (204)

2 (208)

(32d).

(210)

가

가

가

(engrave)

(57)

1.

a) 1

1

1 가

1

- b) 1 가 ; 1 1 1
- c) 1 ;
- d) 2 2 .
- 2.**
- 3.**
- 1 ,
- a) 2 2 가 2 2
- b) 2 ; 2 가 2 2
- c) ; 2 .
- 4.**
- 3 , a)~d) 1 , 1 가 .
- 5.**
- a) 가 ;
- b) 가 ; 1
- c) ;
- d) ; a)~c) 3 .
- 6.**
- a)) 1 ,) 1 가 1 1 1
- 1 2 ,) 2 ,) 1 ,)
- b) 1 2 ; 1 2 .
- 7.**
- 6 ,
- a) 2 2 가 2 2
- b) 2 ; 2 가 2 2
- c) 2 ; .
- 8.**
- a) 1 ;
- b) 1 가 - 가
- 가 1 - ; 1 2
- , 1 2 .
- 9.**
- a) 1 ;
- b) ;
- c) ;
- d) 가 1 - 1 i) 1 ,) 1
- 가 , 가
- e) 1 - ; 1 ;

f) 1
3

10.
a) 1 1 - 1 i) 1 1 1 1)
1 , 2) ,) 1 가 1) 1 ,

b) 가 2 2 - 2 i) 2 2 - ; 2 ,)
2 - ; 가 ;

c) 1 2
d) , 1 , 2 ,
e) 1 2

11.

a) 가 1 ;
b) 2 ;
c) 1 가 2 가 ;
d) 가 가 가 1 2
e) 가 가 1 - 가 2 가
가

12.

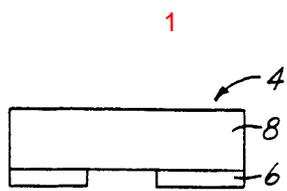
a) 1 ;
b) ;
c) 1 ;
d) 가 가 ;
e) 가

13.

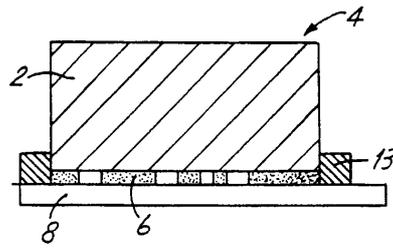
3 , 2

14.

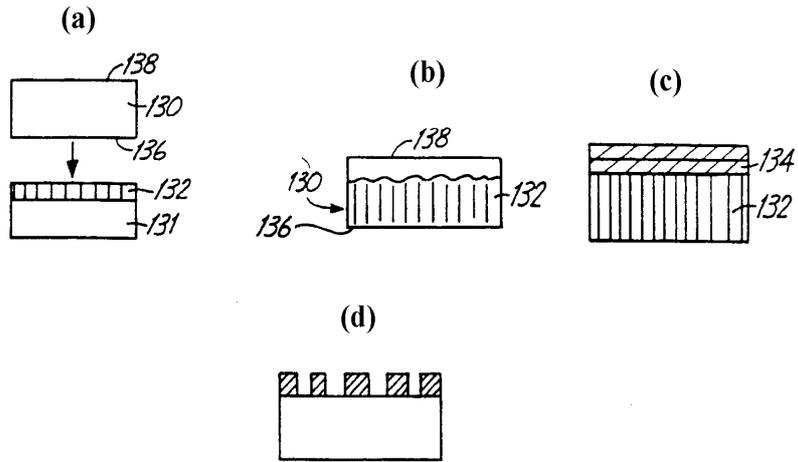
3 , 2



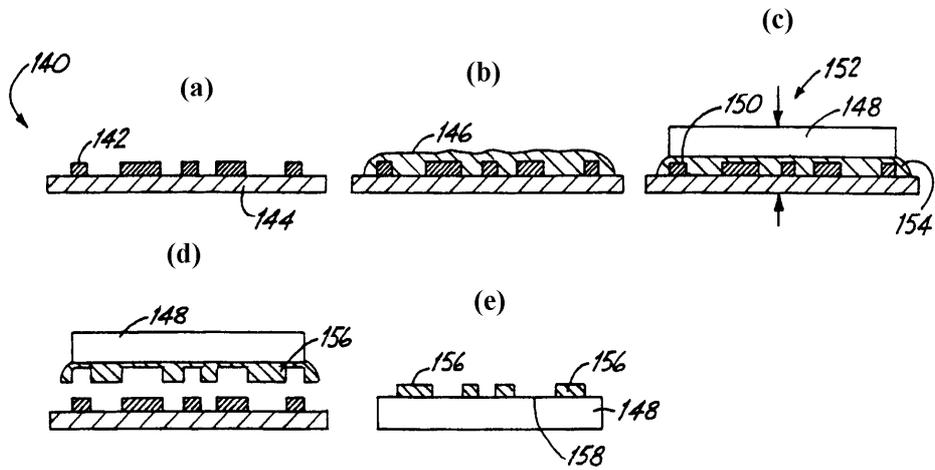
2



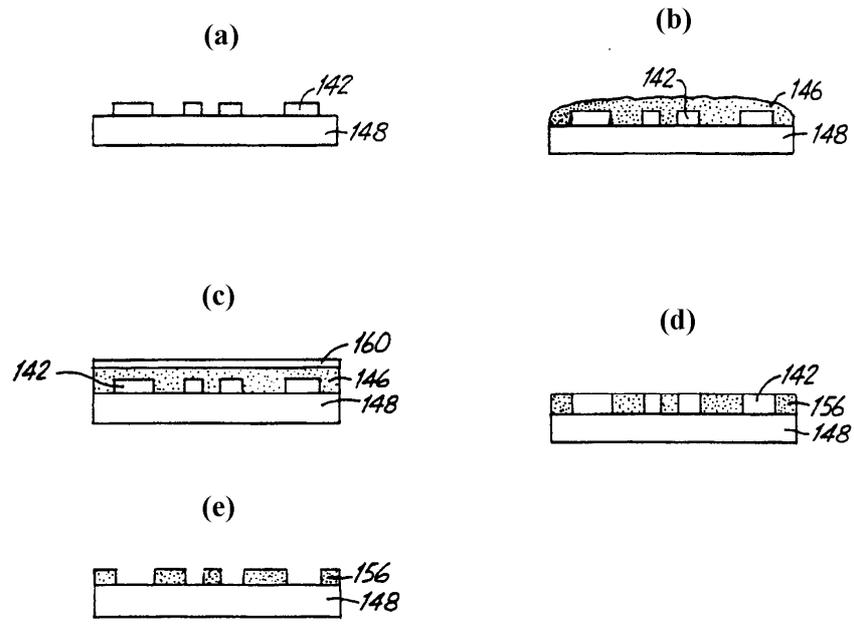
3



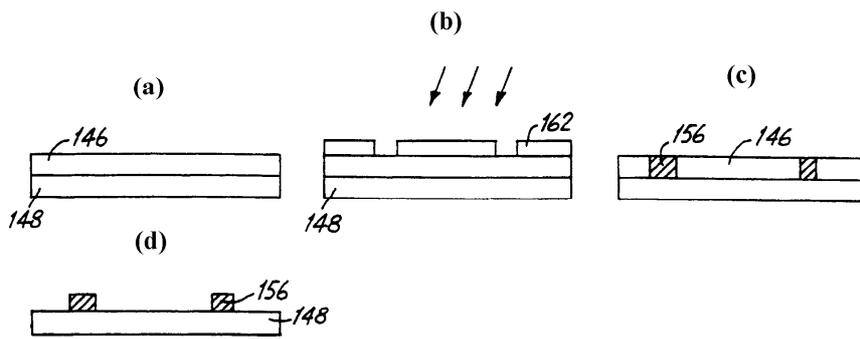
4



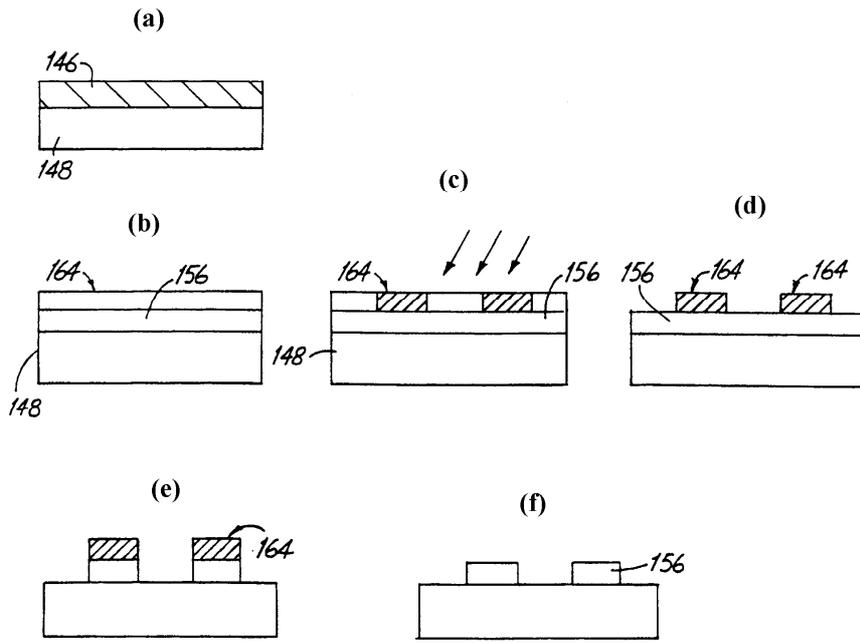
5



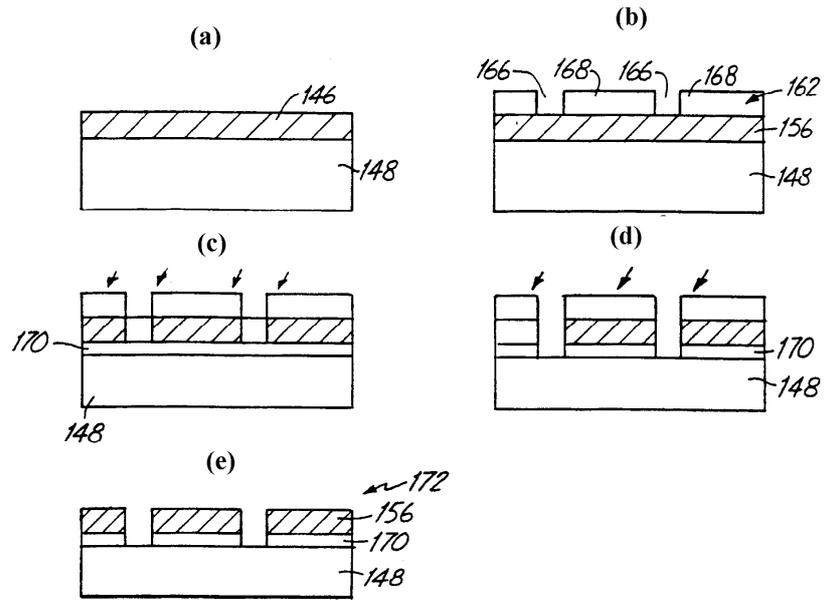
6



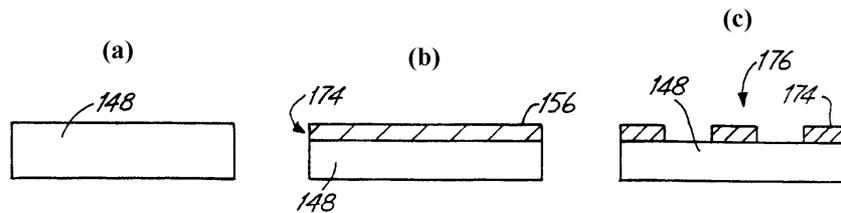
7



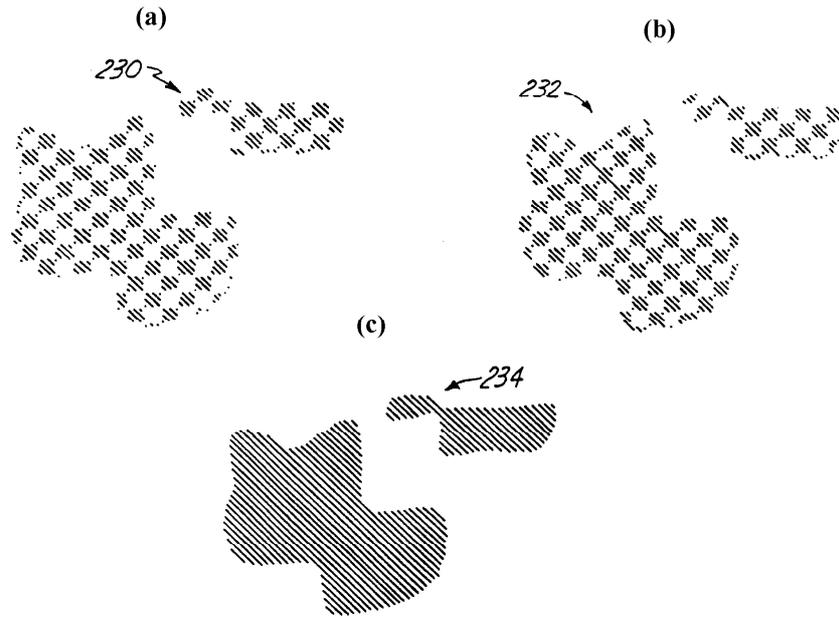
8



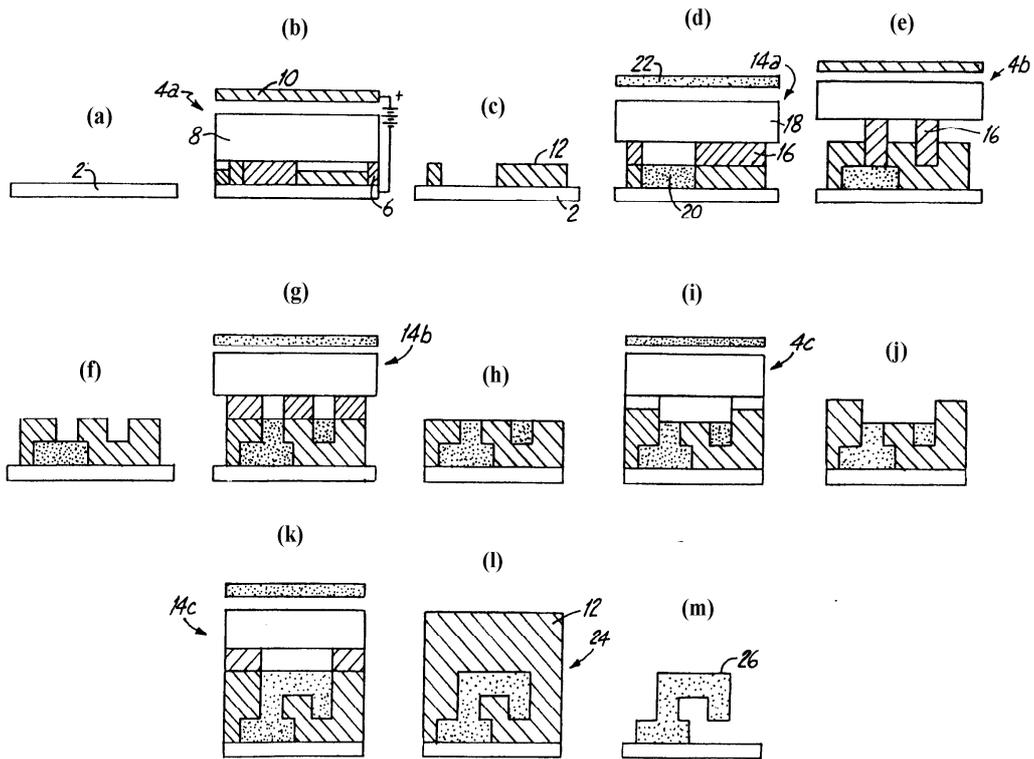
9



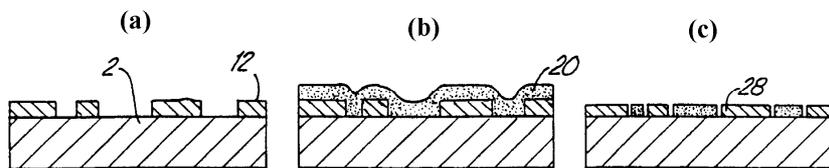
10



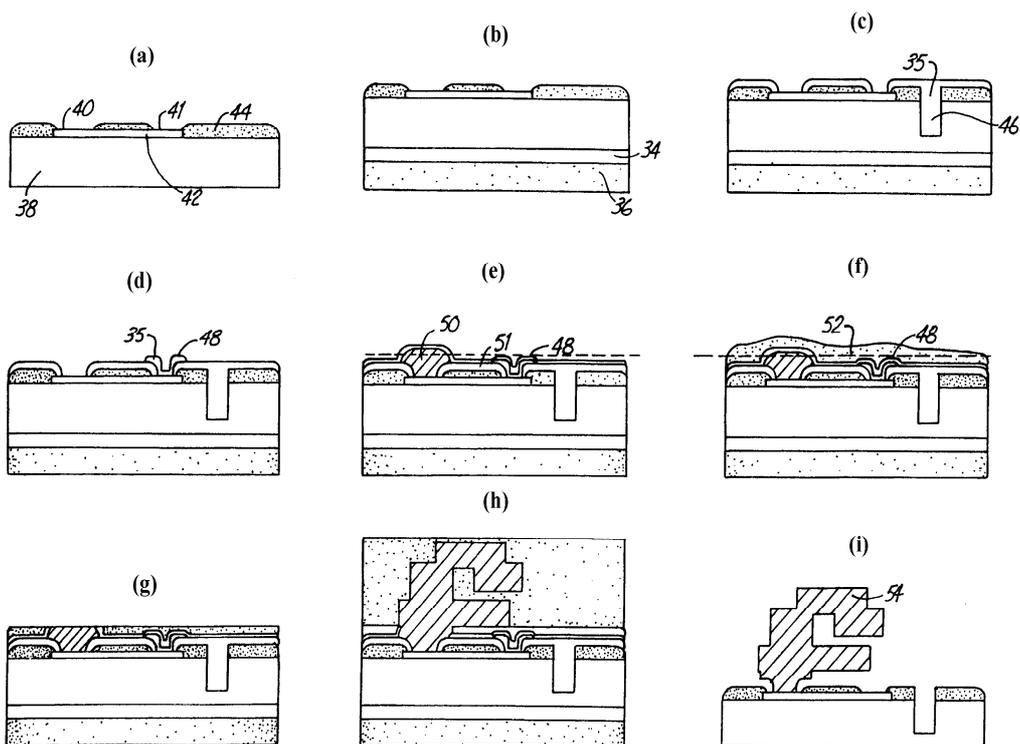
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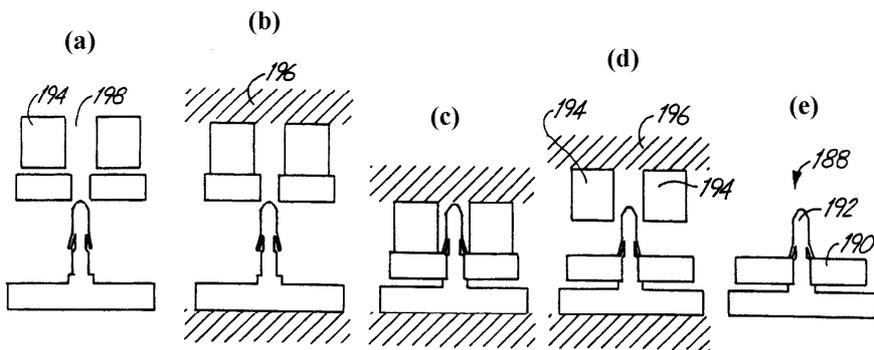
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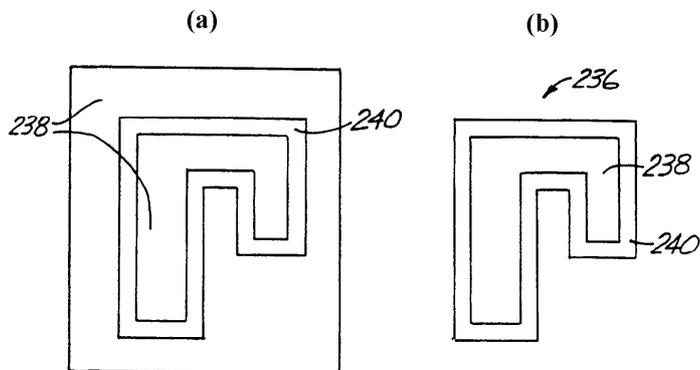
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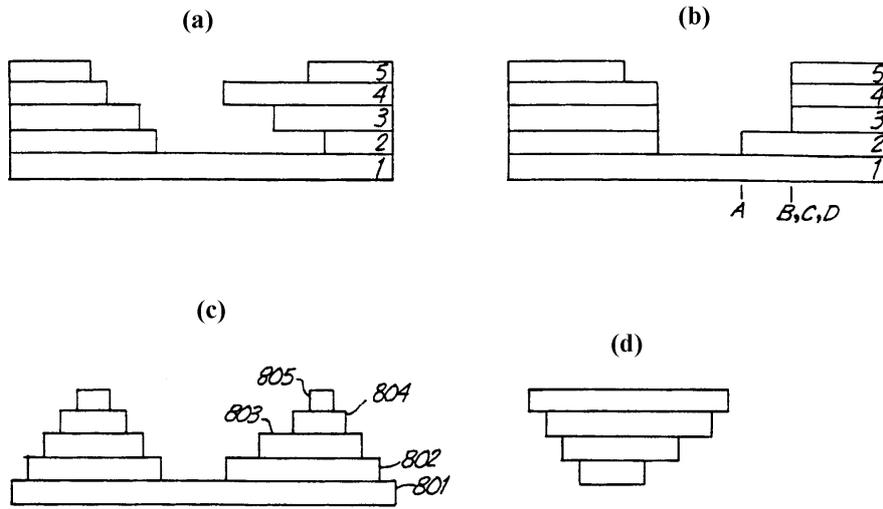
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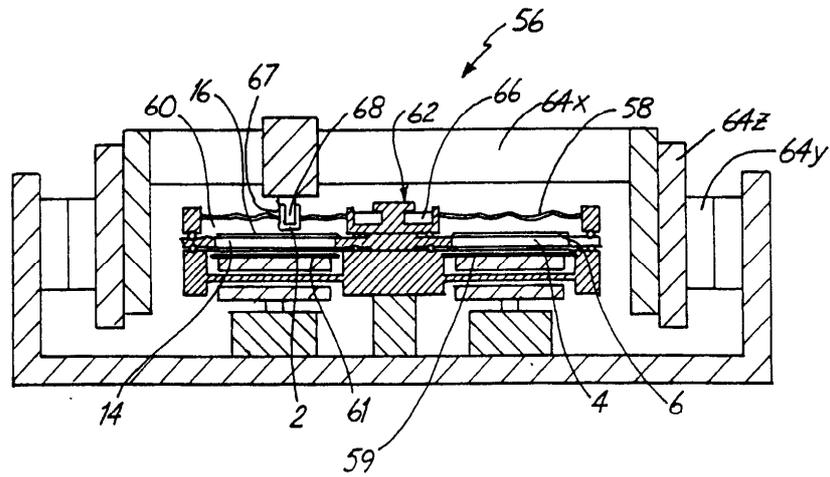
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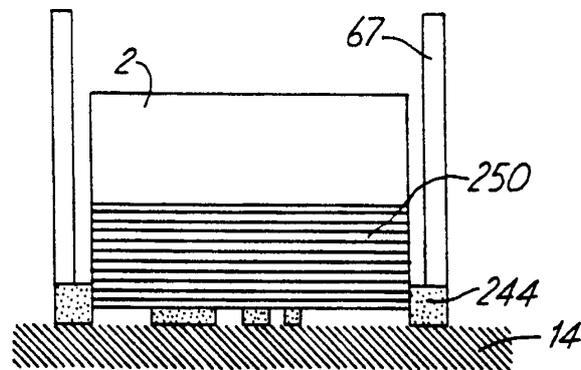
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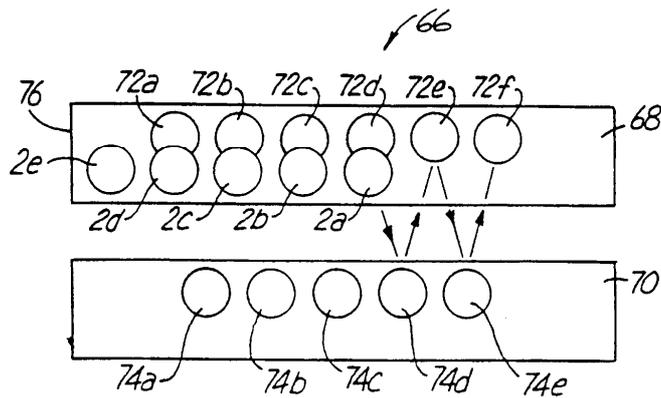
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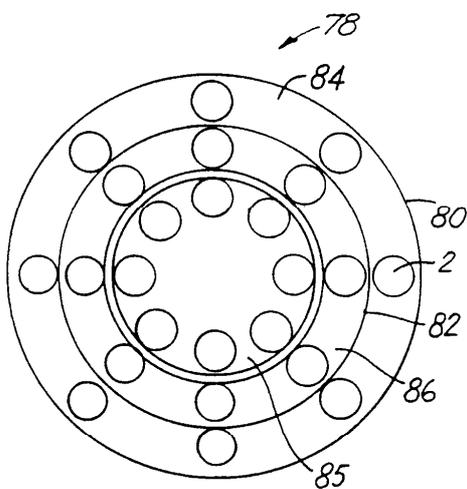
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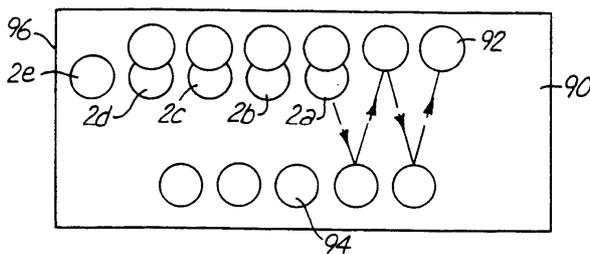
19



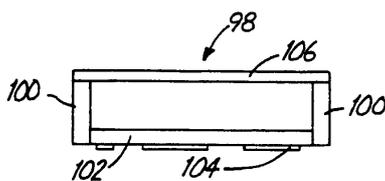
20



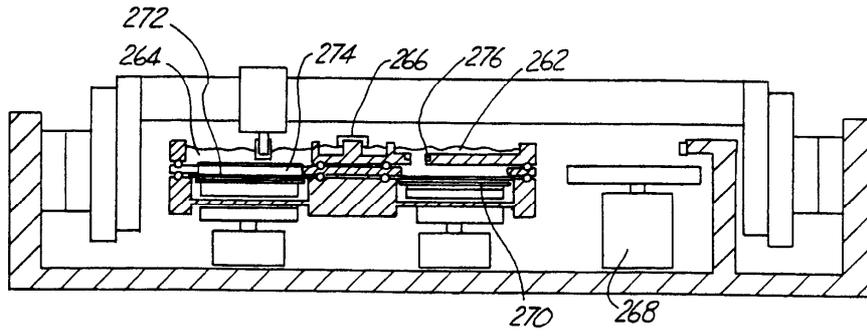
21



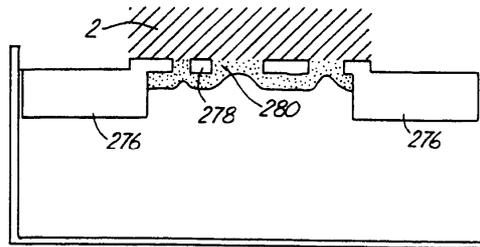
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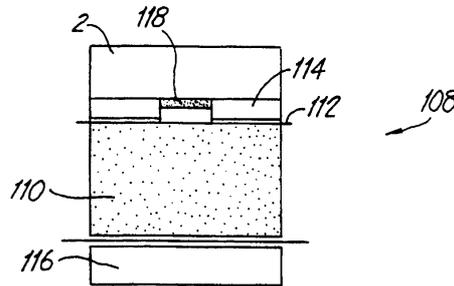
23



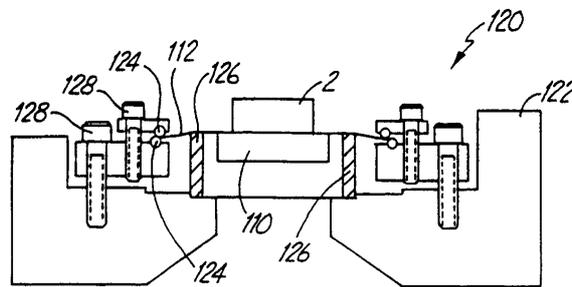
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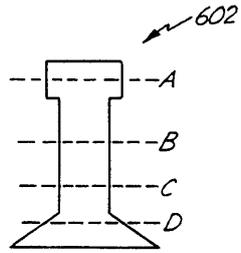
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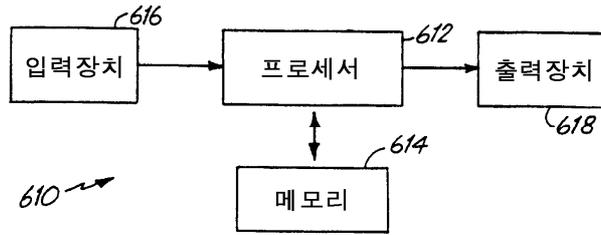
26



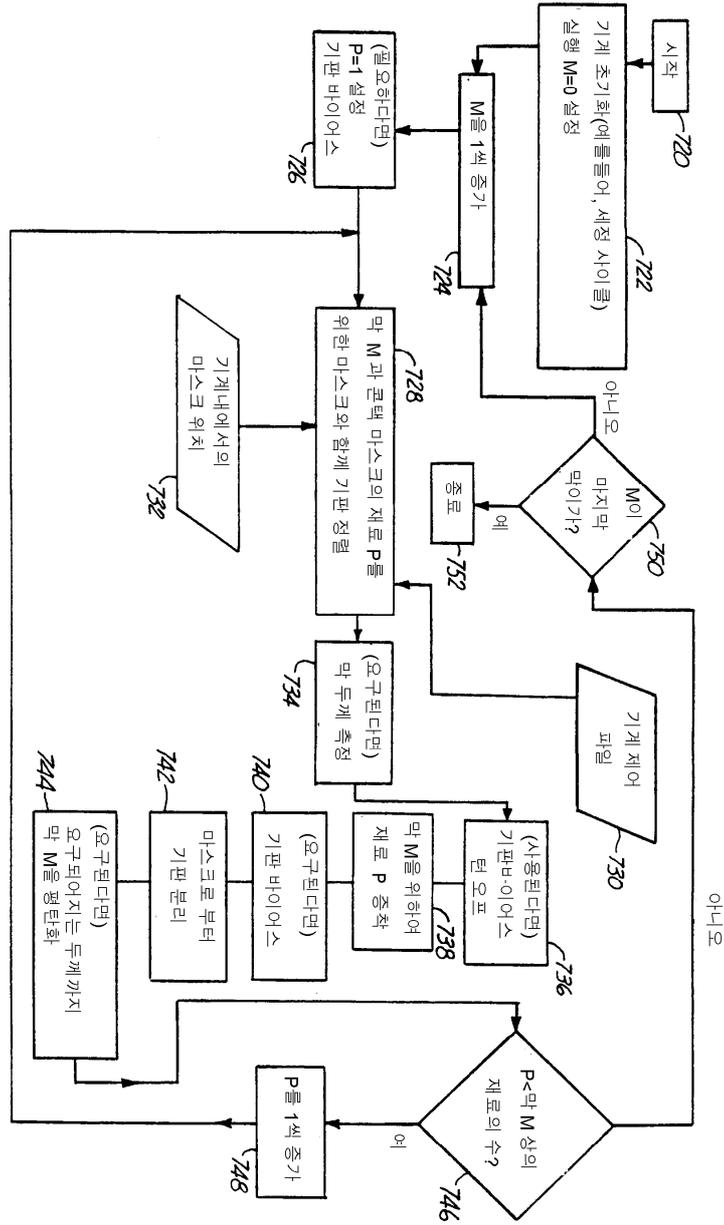
27



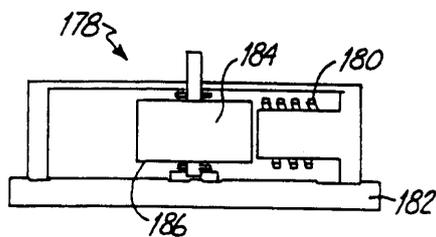
28



30



31



32

