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Nulty et al.

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(54) **STRUCTURE HAVING REDUCED LATERAL SPACER EROSION**

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(*) Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(22) Filed: **Mar. 31, 2000**

(65) **Prior Publication Data**

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Related U.S. Application Data

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(51) **Int. Cl.**[7] **H01L 23/48**; H01L 23/52; H01L 29/40

(52) **U.S. Cl.** **257/774**; 257/774; 257/775; 257/776; 438/634; 438/637; 438/639; 438/257

(58) **Field of Search** 257/774, 775, 257/776, 756–760, 762, 763, 765; 438/634, 637, 639, 257

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,660,276 A 4/1987 Hsu 438/595
4,806,201 A 2/1989 Mitchell et al. 438/595
4,956,312 A 9/1990 Van Laarhoven 437/180
5,037,777 A 8/1991 Mele et al. 43/639

(List continued on next page.)

FOREIGN PATENT DOCUMENTS

JP 11111691 A * 4/1999

OTHER PUBLICATIONS

J. Givens et al., "Selective dry etching in a high density plasma for 0.5 μm complimentary metal–oxide–semiconductor technology," J. Vac. Sci. Technol. B 12(1), Jan./Feb. 1994, pp. 427–432.

K.K. Shih et al., "Hafnium dioxide etch–stop layer for phase–shifting masks," J. Vac. Sci. Technol. B 11(6), Nov./Dec. 1993, pp. 2130–2131.

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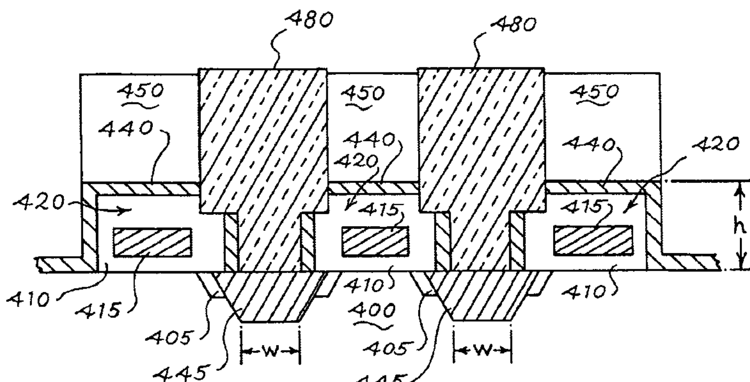
(57) **ABSTRACT**

A process for minimizing lateral spacer erosion of an insulating layer adjacent to a contact region and an apparatus whereby there is provided a contact opening with a small alignment tolerance relative to a gate electrode or other structure are disclosed. The process includes the steps of forming a conductive layer on a semiconductor body, then depositing an insulating layer adjacent to the conductive layer. Next, substantially rectangular insulating spacers are formed adjacent to the gate electrode. An etch stop layer is deposited adjacent the insulating layer, followed by an etch to remove the etch stop layer material from the contact region. This etch is conducted under conditions wherein the etch removes the etch stop layer, but retains the substantially rectangular lateral spacer profile of the first insulating layer. The apparatus is capable of maintaining high quality contacts between the conductive material in the contact region and an underlying device region such as a source or drain, or some other layer or structure, and is an effective structure for small feature size structures, particularly self-aligned contact structures.

12 Claims, 7 Drawing Sheets



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U.S. PATENT DOCUMENTS

5,100,838 A 3/1992 Dennison 437/195
5,166,096 A 11/1992 Cote et al. 438/595
5,234,856 A * 8/1993 Gonzalez 438/244
5,264,341 A 11/1993 Maciak et al. 435/7.21
5,275,972 A 1/1994 Ogawa et al. 43/639
5,306,657 A * 4/1994 Yang 438/278
5,306,952 A 4/1994 Matsuura et al. 257/165
5,338,700 A * 8/1994 Dennison et al. 438/253
5,364,817 A 11/1994 Lur et al. 437/190
5,366,929 A 11/1994 Cleeves et al. 437/195
5,378,646 A 1/1995 Huang et al. 438/595
5,382,483 A 1/1995 Young 430/5
5,384,281 A 1/1995 Kenney et al. 437/189
5,466,636 A 11/1995 Cronin et al. 43/639
RE35,111 E 12/1995 Liou et al. 438/595
5,482,894 A 1/1996 Havemann 437/195
5,488,011 A * 1/1996 Figura et al. 438/253
5,521,121 A 5/1996 Tsai et al. 437/190
5,562,801 A 10/1996 Nulty 156/643.1
5,569,628 A 10/1996 Yano et al. 437/190
5,587,331 A 12/1996 Jun 437/190
5,756,396 A 5/1998 Lee et al. 438/622
5,759,867 A 6/1998 Armacost et al. 438/634
6,046,505 A * 4/2000 Howard 257/776

* cited by examiner

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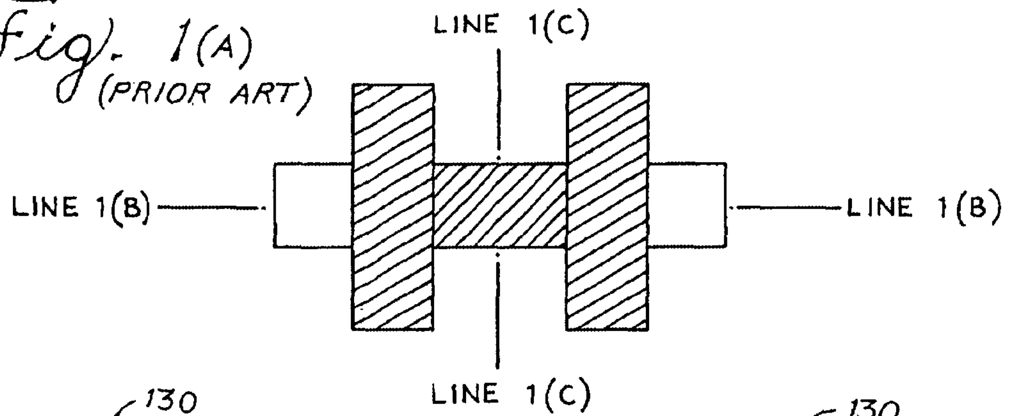
Fig. 1(A)
(PRIOR ART)



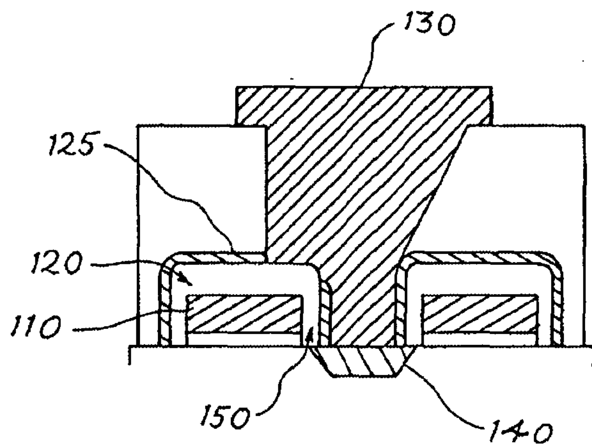


Fig. 1(B)
(PRIOR ART)

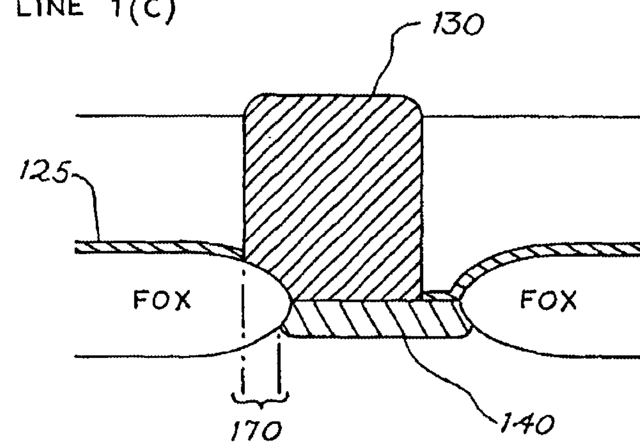


Fig. 1(C)
(PRIOR ART)

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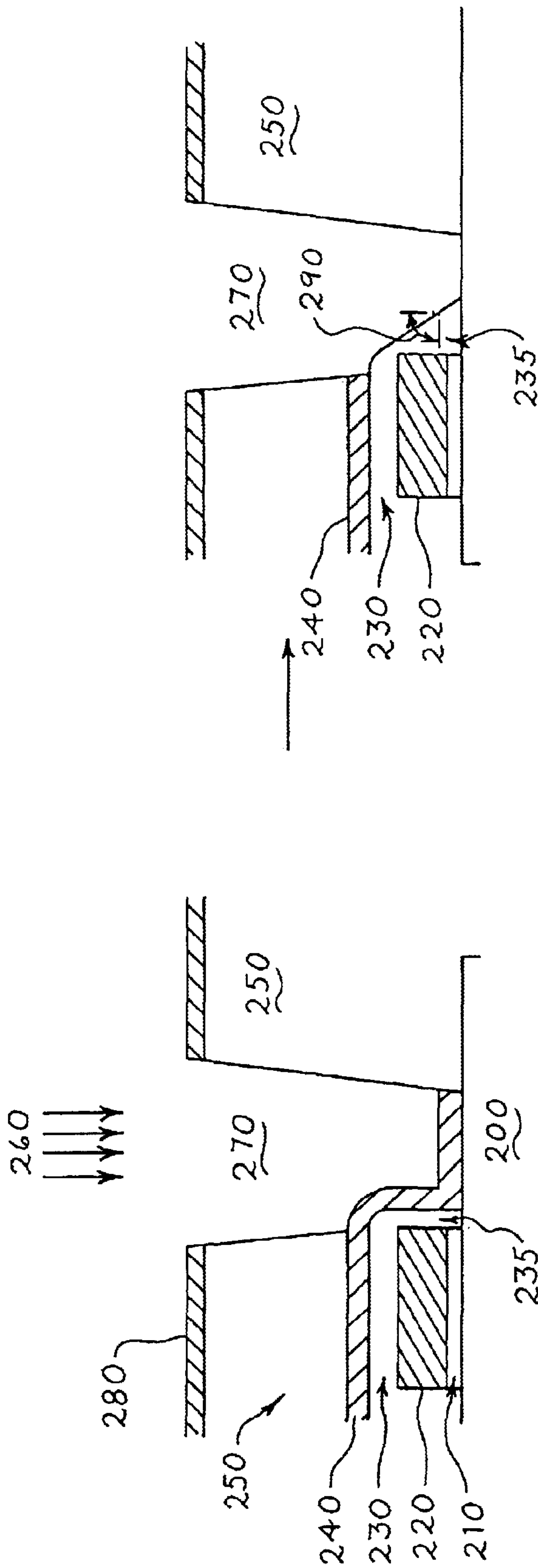

Fig. 2(B) (PRIOR ART)

Fig. 2(A) (PRIOR ART)

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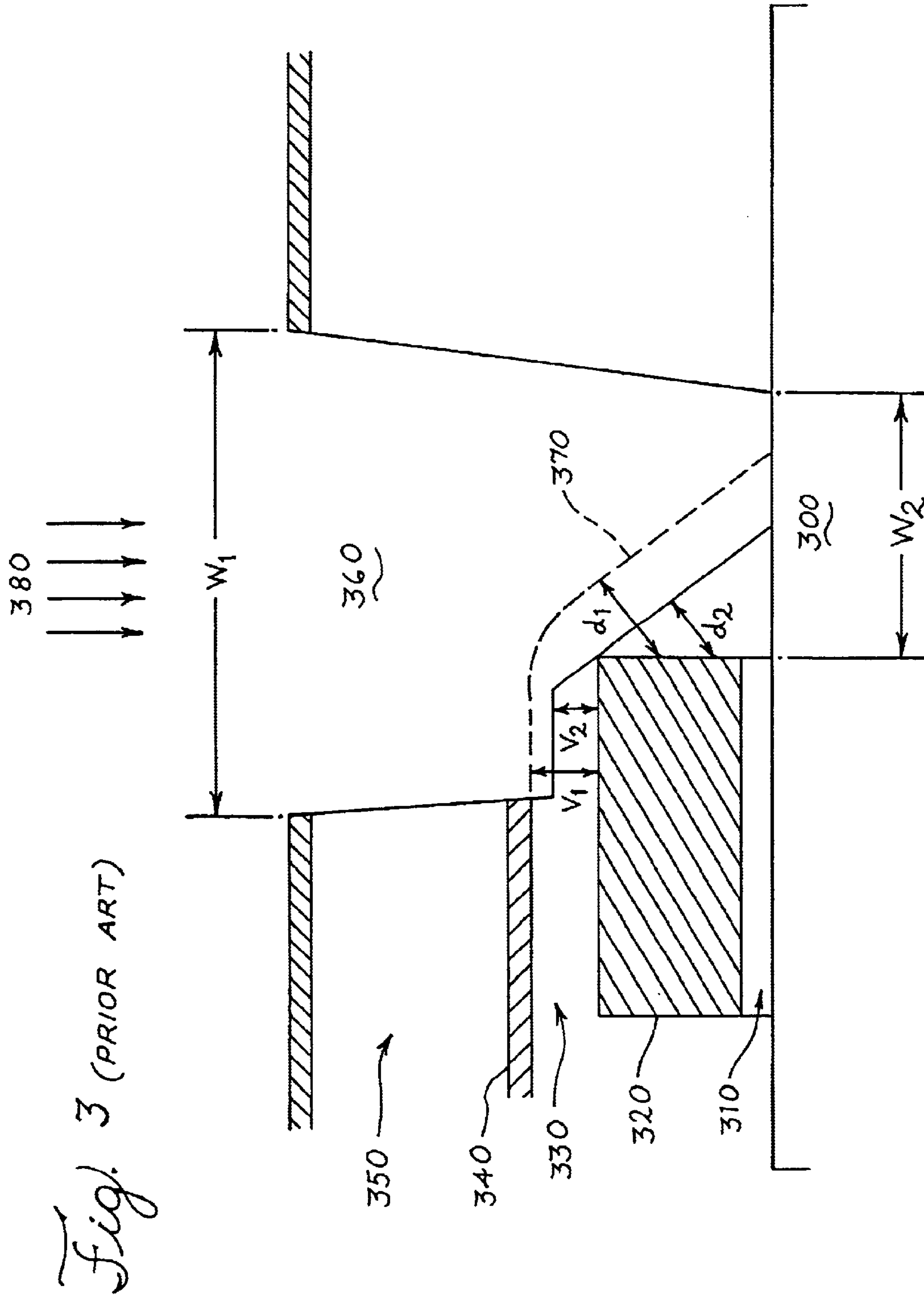

Fig. 3 (PRIOR ART)

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