United States Patent [19]

Bobbio

[11] **Patent Number: 5,045,166**

[45] **Date of Patent: Sep. 3, 1991**

[54] **MAGNETRON METHOD AND APPARATUS FOR PRODUCING HIGH DENSITY IONIC GAS DISCHARGE**

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[21] Appl. No.: **526,572**

[22] Filed: **May 21, 1990**

[51] **Int. Cl.**[5] **B01J 19/12**; H01H 1/46; C23F 4/04; C23C 14/35

[52] **U.S. Cl.** **204/192.32**; 204/192.12; 204/298.06; 204/298.16; 204/298.37; 204/298.38; 118/723; 156/345; 156/643

[58] **Field of Search** 204/192.12, 192.32, 204/298.06, 298.16, 298.37, 298.38; 156/345, 643; 118/723

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,627,663	12/1971	Davidse et al.	204/192.15
3,654,123	4/1972	Hajzak	204/298.06
3,860,507	1/1975	Vossen, Jr.	204/192.12
4,155,825	5/1979	Fournier	204/192.13
4,175,029	11/1979	Kovalsky et al.	204/298.06
4,198,283	4/1980	Class et al.	204/298.12
4,252,626	2/1981	Wright et al.	204/192.15
4,277,304	7/1981	Horiike et al.	156/643
4,349,409	9/1982	Shibayama et al.	156/643
4,351,714	9/1982	Kuriyama	204/298.26
4,352,725	10/1982	Tsukada	156/643
4,361,472	11/1982	Morrison, Jr.	204/192.12
4,361,749	11/1982	Lord	219/121.4
4,362,611	12/1982	Logan et al.	204/298.06
4,369,205	1/1983	Winterling et al.	427/39
4,392,932	7/1983	Harra	204/192.32
4,399,016	8/1983	Tsukada et al.	156/643
4,404,077	9/1983	Fournier	204/192
4,417,968	11/1983	McKelvey	204/192.12
4,422,896	12/1983	Class et al.	156/643
4,426,267	1/1984	Münz et al.	204/192.12

(List continued on next page.)

FOREIGN PATENT DOCUMENTS

0027553	10/1979	European Pat. Off.	204/192.25
0162643	5/1984	European Pat. Off.	204/298.19
0163445	5/1984	European Pat. Off.	204/298.18
3434698	4/1986	Fed. Rep. of Germany	204/298.19
CH657381	8/1986	Switzerland	204/298.19
2093866	9/1982	United Kingdom	204/298.19

OTHER PUBLICATIONS

Thin Film Processes, Cylindrical Magnetron Sputtering, J. A. Thornton and A. S. Penfold, Academic Press, Inc., 1978, pp. 76–113.

Silicon Processing for the VLSI Era, Dry Etching for VLSI Fabrication, S. Wolf and R. N. Tauber, 1986, pp. 538–585.

"MCNC Technical Bulletin", Plasma Etching, S. M. Bobbio and Y. S. Ho, Jul.-Aug., 1986, pp. 2 and 8.

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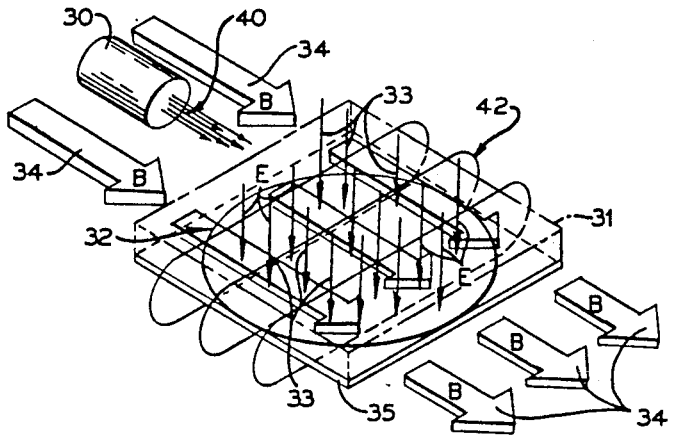
[57] **ABSTRACT**

A method and apparatus for magnetron gas discharge processing of substrates using a remote plasma source provides a uniform magnetic field (B) created across the surface of a substrate in an evacuable chamber. An electric field (E) is created perpendicular to the substrate by an electrically powered cathode located beneath the substrate. The magnetic and electric fields interact with the plasma to create an E×B electron drift region adjacent to the surface of a substrate. A remote plasma source is provided and oriented so that the plasma stream from the remote source is coupled to the E×B region adjacent to the substrate surface parallel to the magnetic field with minimal movement of the plasma stream perpendicular to the magnetic field to thereby provide a high density plasma stream into the E×B drift region.

52 Claims, 6 Drawing Sheets



U.S. PATENT DOCUMENTS

4,427,524	1/1984	Crombeen et al.	204/298.06
4,428,816	1/1984	Class et al.	204/298.18
4,434,038	2/1984	Morrison, Jr.	204/192.15
4,464,223	8/1984	Gorin	156/643
4,465,575	8/1984	Love et al.	204/192.26
4,472,259	9/1984	Class et al.	204/298.18
4,492,620	1/1985	Matsuo et al.	204/192.12
4,525,262	6/1985	Class et al.	204/192.12
4,526,643	7/1985	Okano et al.	156/345
4,572,759	2/1986	Benzing	156/345
4,581,118	4/1986	Class et al.	204/298.16
4,588,490	5/1986	Cuomo et al.	204/298.06
4,609,428	9/1986	Fujimura	156/643
4,610,770	9/1986	Saito et al.	204/192.1
4,624,767	11/1986	Obinata	204/298.37
4,657,619	4/1987	O'Donnell	156/345
4,668,338	5/1987	Maydan et al.	156/643
4,738,761	4/1988	Bobbio et al.	204/192.12
4,778,561	10/1988	Ghanbari	156/643
4,842,683	6/1989	Cheng et al.	156/345
4,885,068	12/1989	Uramoto et al.	204/192.11

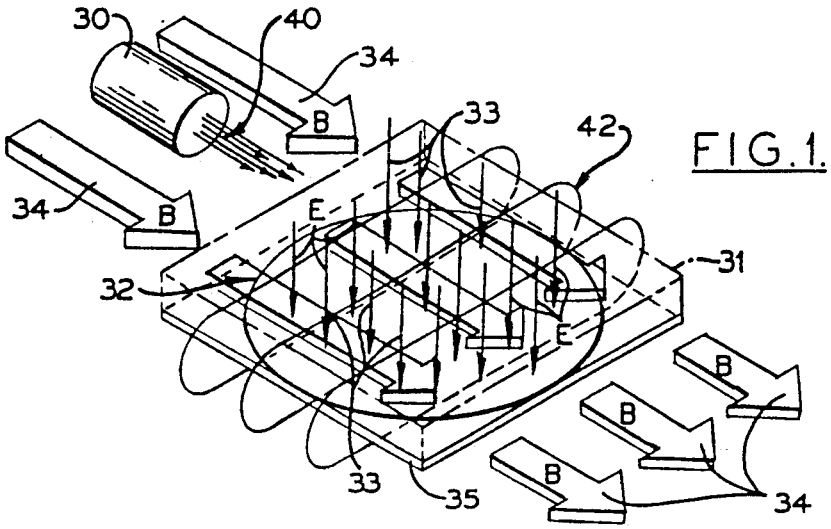
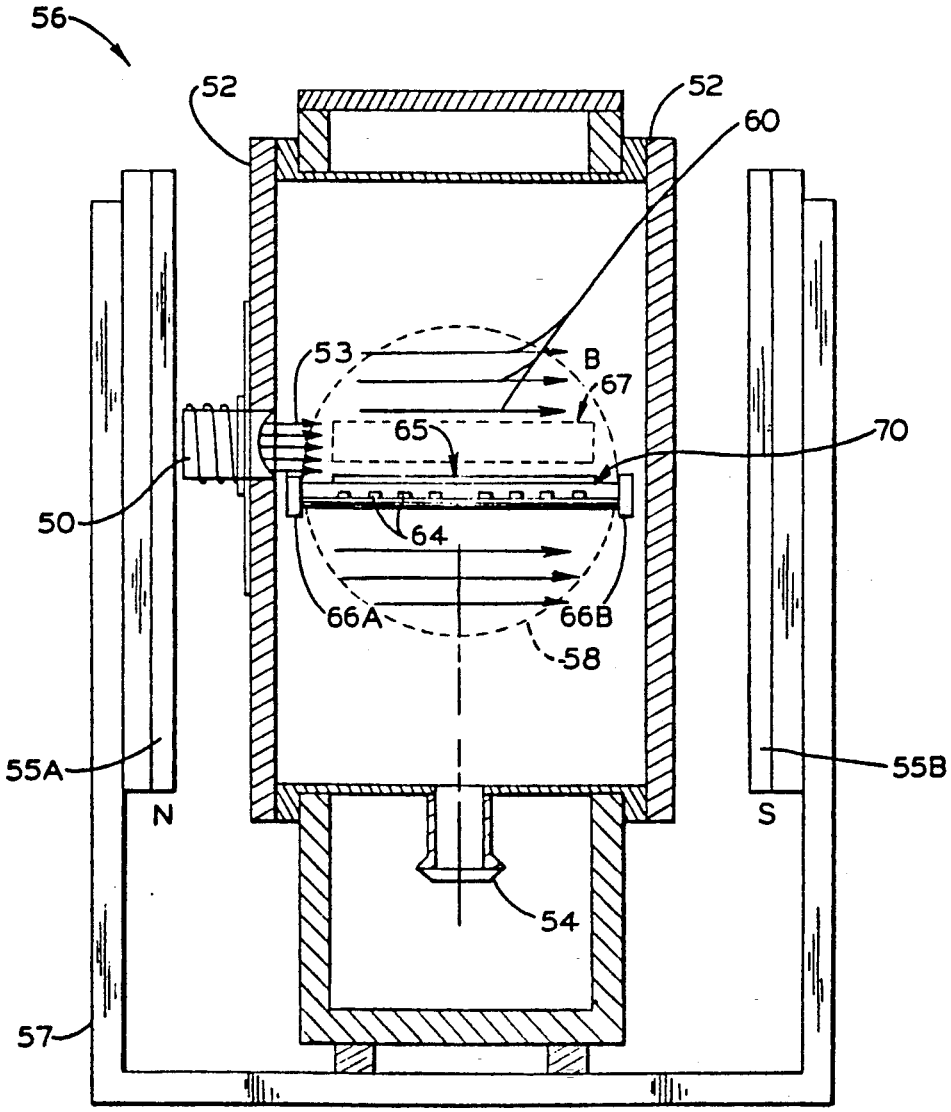


FIG. 1.



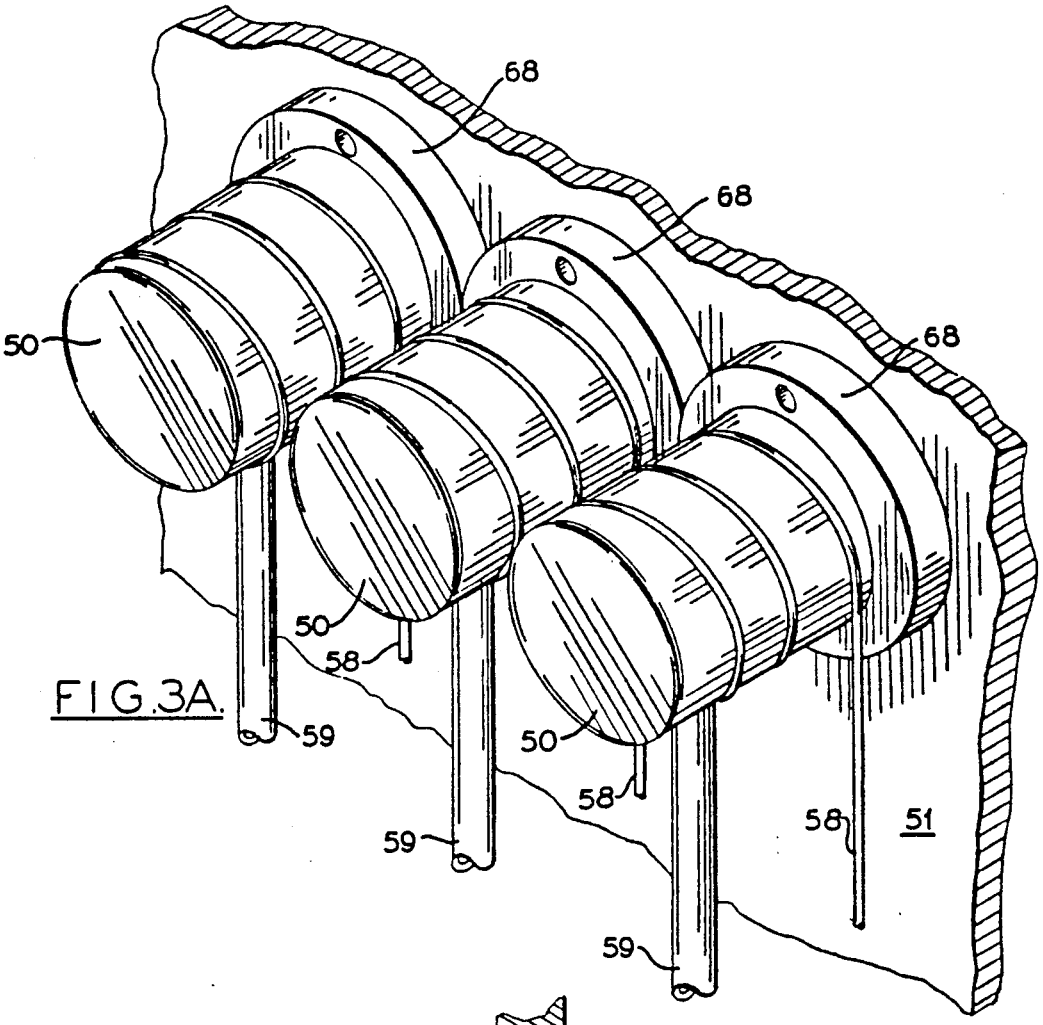


FIG.3A.

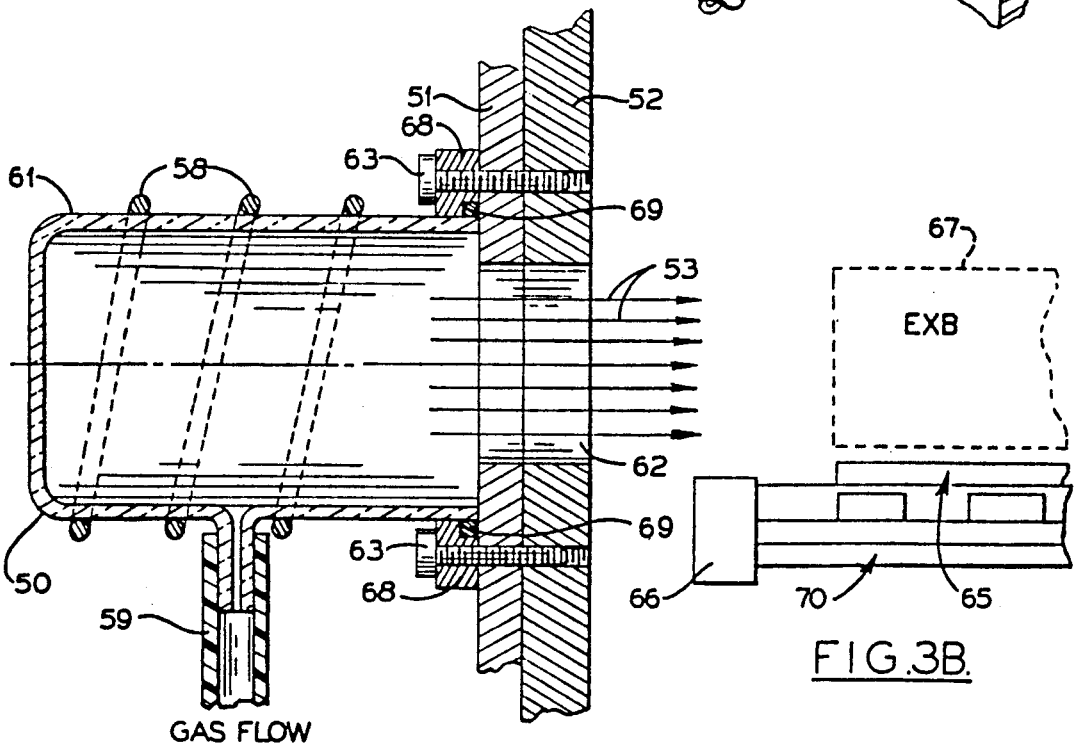


FIG.3B.

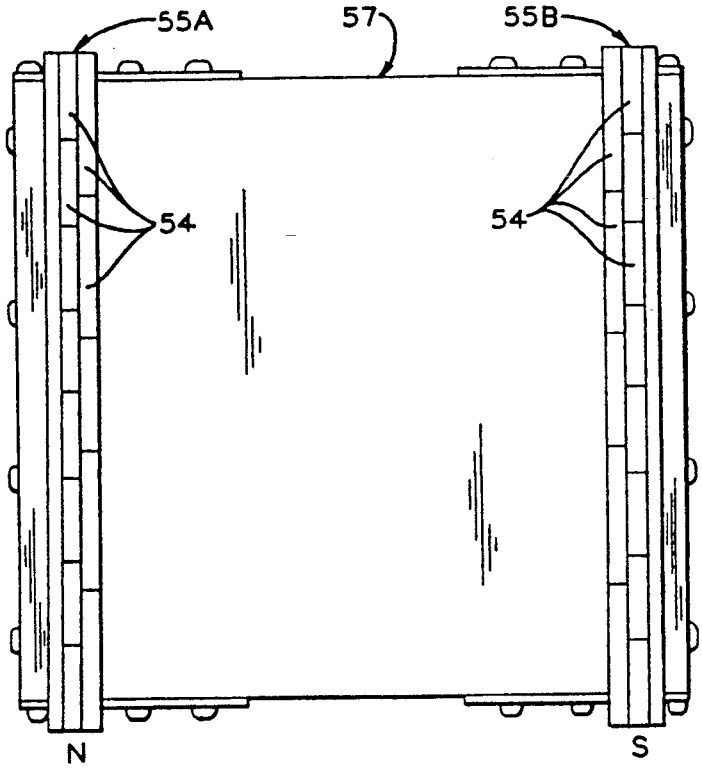


FIG.4.

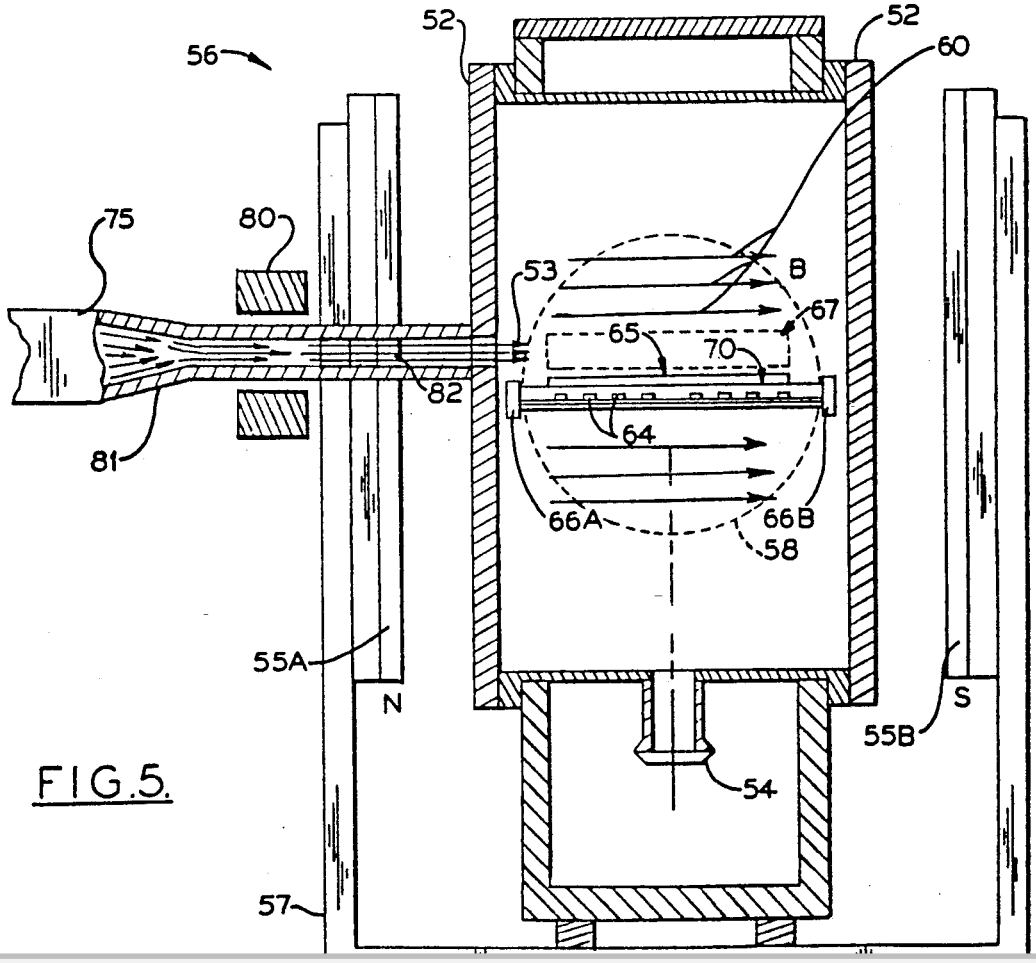


FIG.5.

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