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# United States Patent [19]

Campbell et al.

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- [54] **HIGH DENSITY PLASMA DEPOSITION AND ETCHING APPARATUS**
- [75] Inventors: **Gregor A. Campbell**, Glendale; **Robert W. Conn**, Los Angeles; **Dan Katz**, Beverly Hills; **N. William Parker**, Fairfield; **Alexis de Chambrier**, Glendale, all of Calif.
- [73] Assignee: **Plasma & Materials Technologies, Inc.**, Chatsworth, Calif.
- [21] Appl. No.: 979,574
- [22] Filed: Nov. 20, 1992

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*Primary Examiner*—R. Bruce Breneman  
*Assistant Examiner*—Jonathan D. Baskin  
*Attorney, Agent, or Firm*—Skjerven, Morrill, MacPherson, Franklin & Friel; Alan H. MacPherson; David T. Millers

### Related U.S. Application Data

- [63] Continuation-in-part of Ser. No. 964,149, Oct. 19, 1992, which is a continuation-in-part of Ser. No. 887,278, May 21, 1992, abandoned, which is a continuation of Ser. No. 650,788, Feb. 4, 1991, Pat. No. 5,122,251, which is a continuation-in-part of Ser. No. 365,533, Jun. 13, 1989, Pat. No. 4,990,229.
- [51] Int. Cl.<sup>6</sup> ..... C23C 16/50; H01L 21/00
- [52] U.S. Cl. .... 118/723 R; 118/719; 118/723 MP; 118/723 AN; 156/345; 204/298.37; 204/298.38
- [58] Field of Search ..... 118/723 MP, 723 MW, 118/723 ME, 723 MR, 723 MA, 723 AN, 723 E, 723 ER, 723 IR, 723 R; 156/345; 204/298.37, 298.38

### [57] ABSTRACT

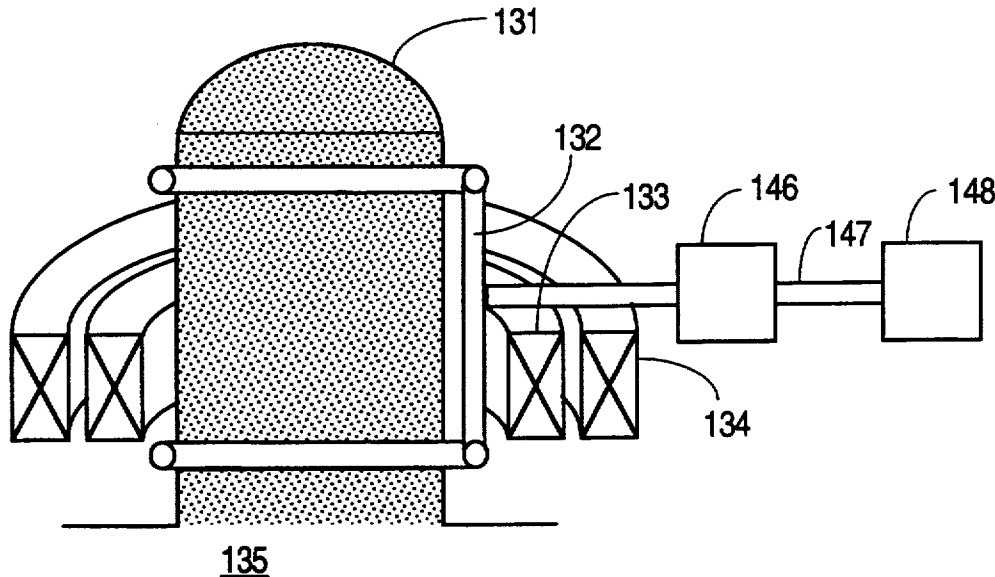
Plasma deposition or etching apparatus is provided which comprises a plasma source located above and in axial relationship to a substrate process chamber. The plasma source may include a sapphire or alumina source tube for use with plasmas containing fluorine. Surrounding the plasma source are an inner magnetic coil and an outer magnetic coil arranged in the same plane perpendicular to the axis of the plasma source and the substrate process chamber. Preferably a first current is provided through the inner coil and a second current in a direction opposite to the direction of the first current is provided through the outer coil. The inner and outer coils are wrapped with a thin sheet of conducting material to shield the coils from RF signal generated by the plasma source. The result is to advantageously shape the magnetic field in the process chamber to achieve extremely uniform processing, particularly when a unique diamond shaped pattern of gas feed lines is used wherein the diamond is arranged to be approximately tangent at four places to the outer circumference of the workpiece being processed in the apparatus.

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13 Claims, 21 Drawing Sheets



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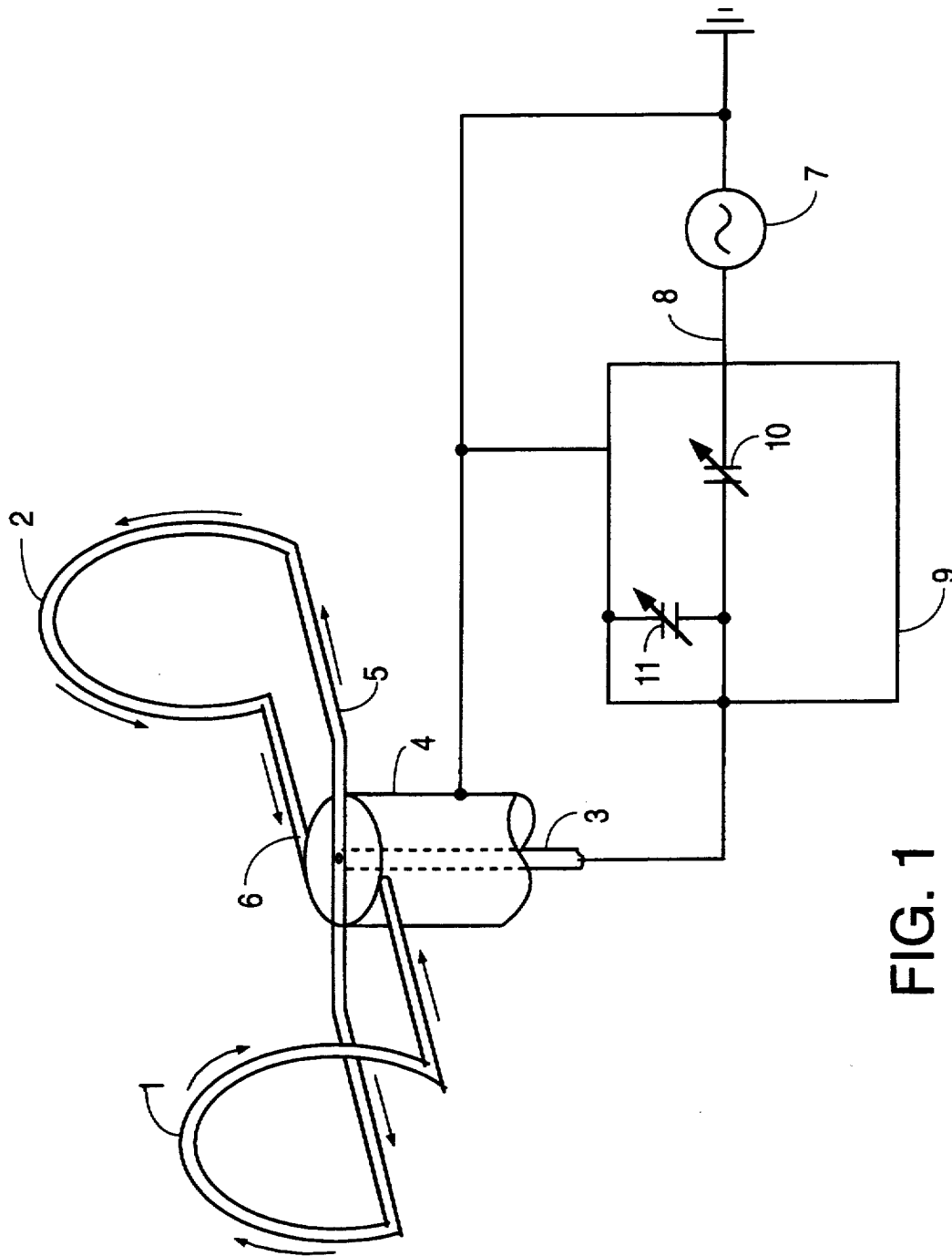


FIG. 1

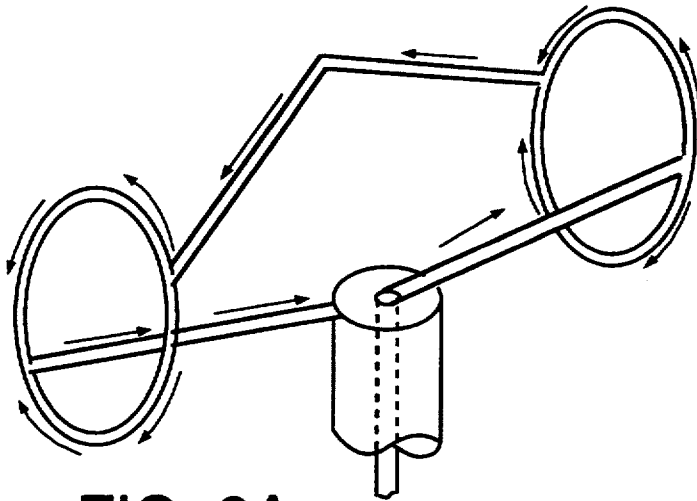


FIG. 2A

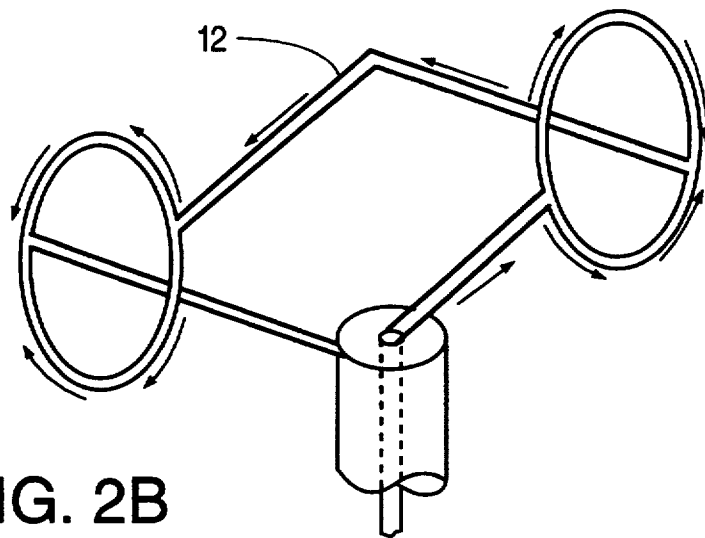


FIG. 2B

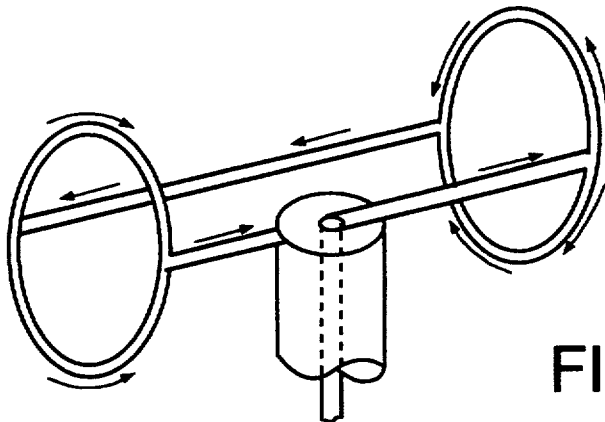


FIG. 2C

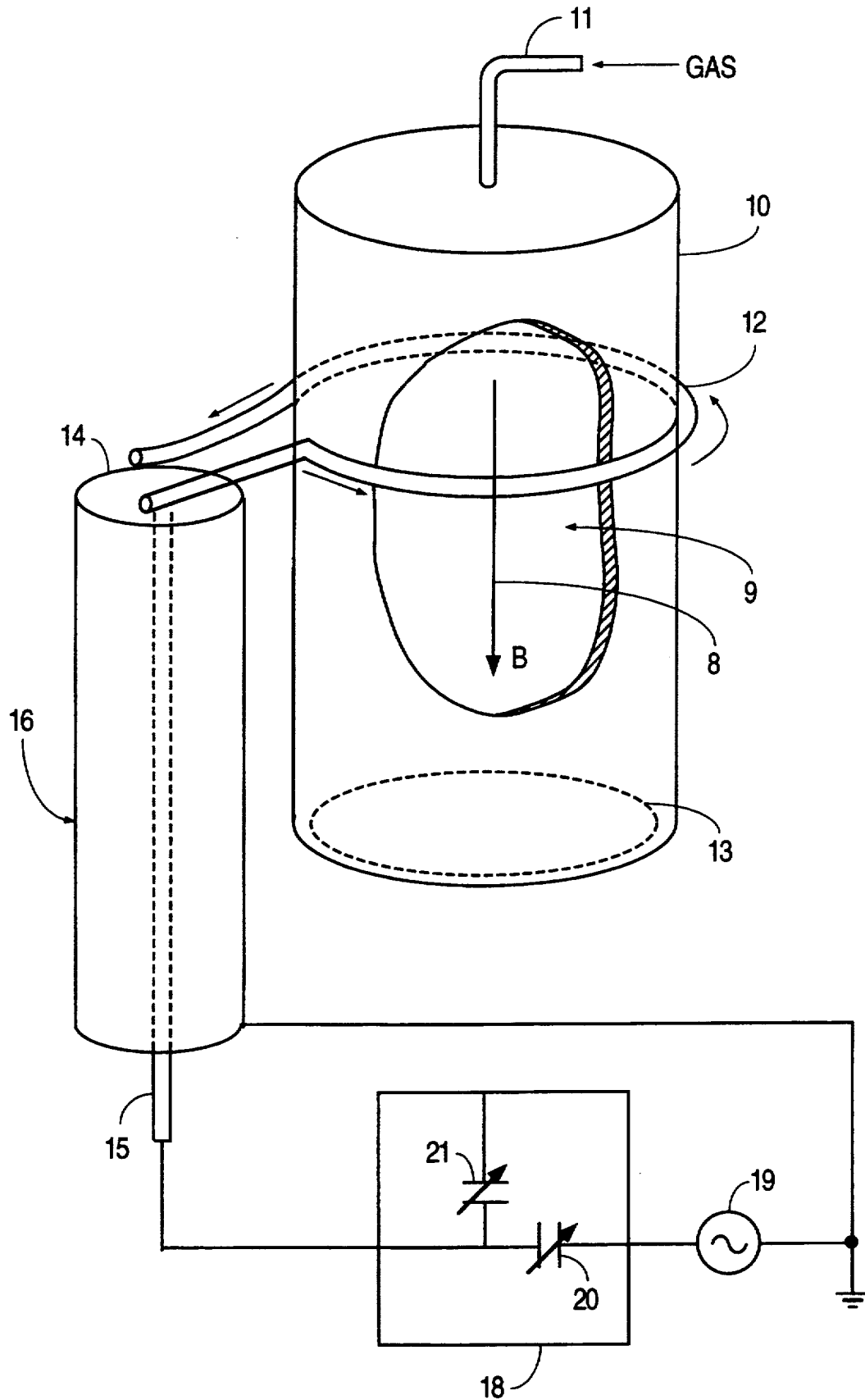


FIG. 3

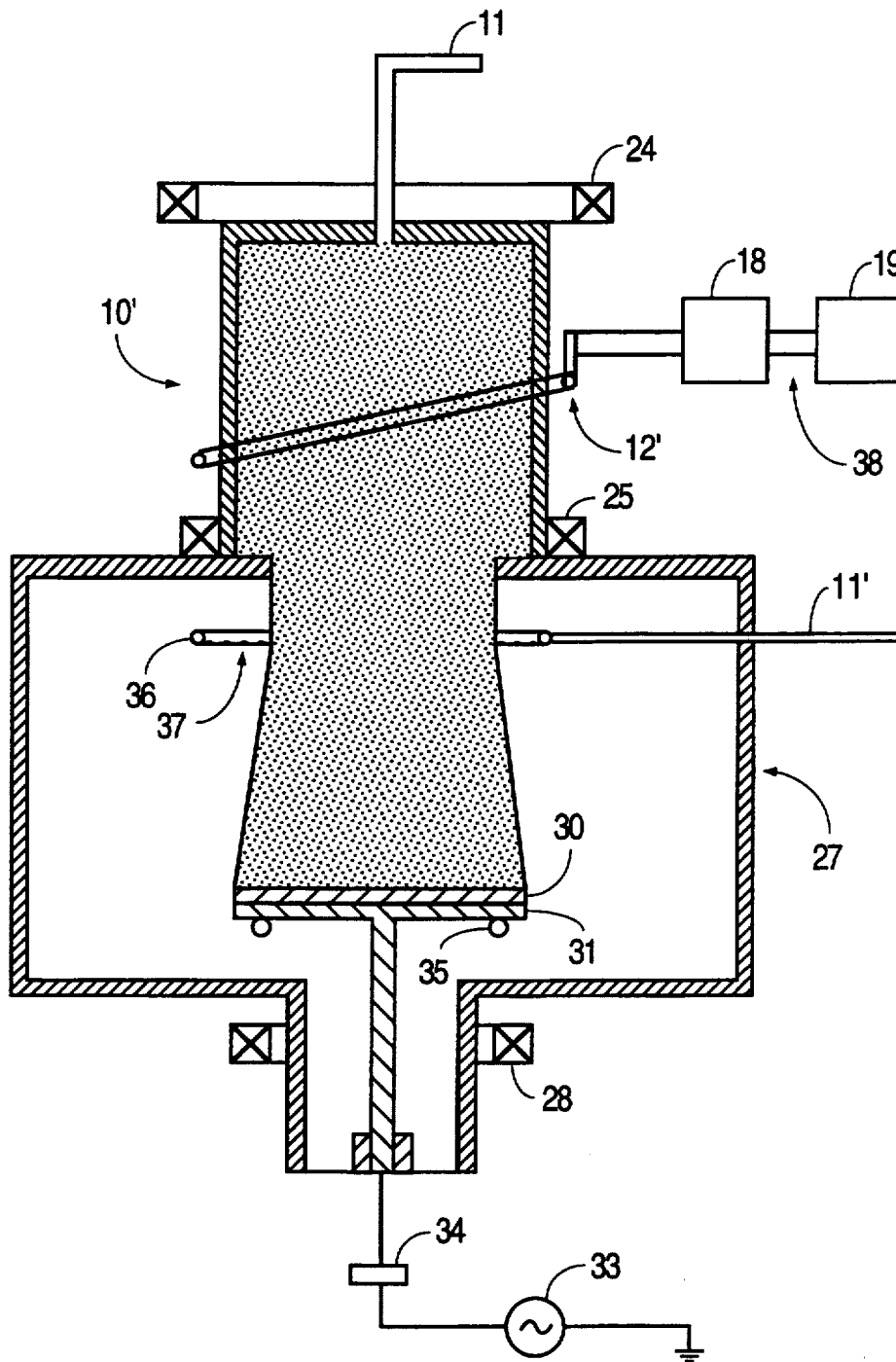


FIG. 4A

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