

(12) **United States Patent**
Gopalraja et al.

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(54) **INTEGRATED PROCESS FOR COPPER VIA FILLING USING A MAGNETRON AND TARGET PRODUCING HIGHLY ENERGETIC IONS**

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(75) **Inventors:** **Praburam Gopalraja**, Sunnyvale;
Jianming Fu, San Jose; **Fusen Chen**,
 Saratoga; **Girish Dixit**, San Jose;
Zheng Xu, Foster City; **Sankaram**
Athreya, Sunnyvale; **Wei D. Wang**,
 Santa Clara; **Ashok K. Sinha**, Palo
 Alto, all of CA (US)

(73) **Assignee:** **Applied Materials Inc.**, Santa Clara,
 CA (US)

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 C23C 14/34

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 204/192.15

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 298.12, 192.12, 192.15, 192.17

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Primary Examiner—Mark F. Huff

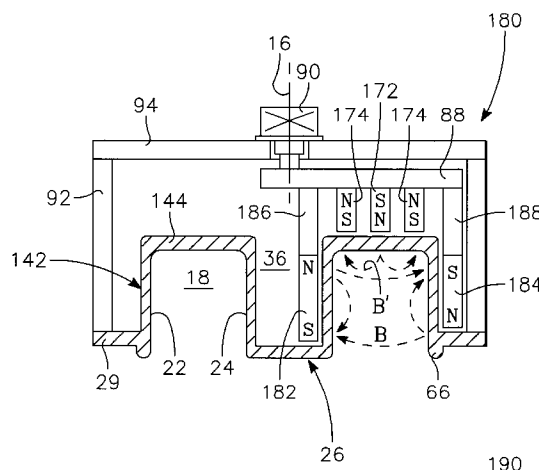
Assistant Examiner—Daborah Chacko-Davis

(74) *Attorney, Agent, or Firm*—Charles S. Guenzer

(57) **ABSTRACT**

A target and magnetron for a plasma sputter reactor. The target has an annular trough facing the wafer to be sputter coated. Various types of magnetic means positioned around the trough create a magnetic field supporting a plasma extending over a large volume of the trough. For example, the magnetic means may include magnets disposed on one side within a radially inner wall of the trough and on another side outside of a radially outer wall of the trough to create a magnetic field extending across the trough, to thereby support a high-density plasma extending from the top to the bottom of the trough. The large plasma volume increases the probability that the sputtered metal atoms will become ionized. The magnetic means may include a magnetic coil, may include additional magnets in back of the trough top wall to increase sputtering there, and may include confinement magnets near the bottom of the trough sidewalls. The magnets in back of the top wall may have an outer magnet surrounding an inner magnet of the opposite polarity. The high aspect ratio of the trough also reduces asymmetry in coating the sidewalls of a deep hole at the edge of the wafer. An integrated copper via filling process includes a first step of highly ionized sputter deposition of copper, a second step of more neutral, lower-energy sputter deposition of copper to complete the seed layer, and electroplating copper into the hole to complete the metallization.

27 Claims, 11 Drawing Sheets



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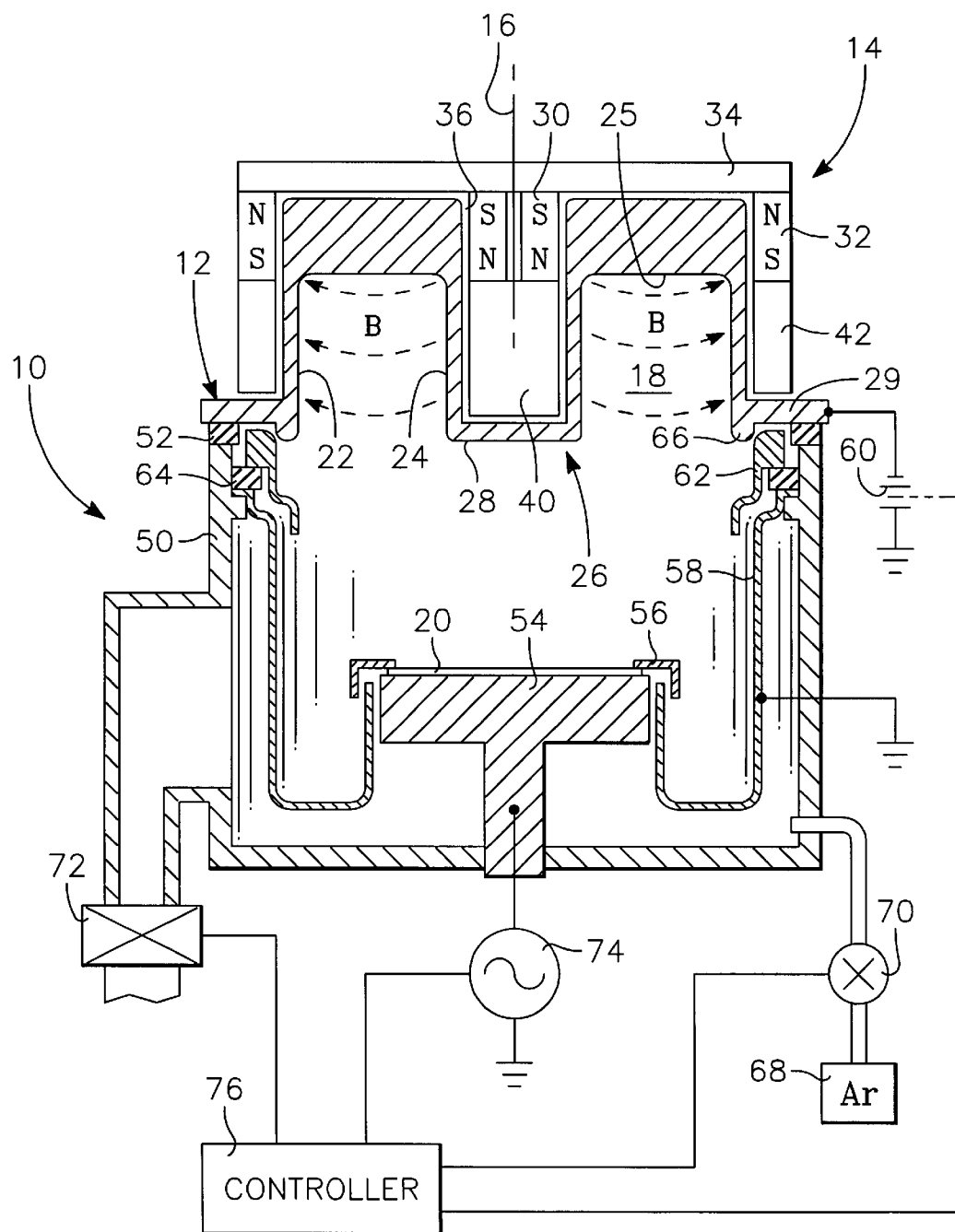
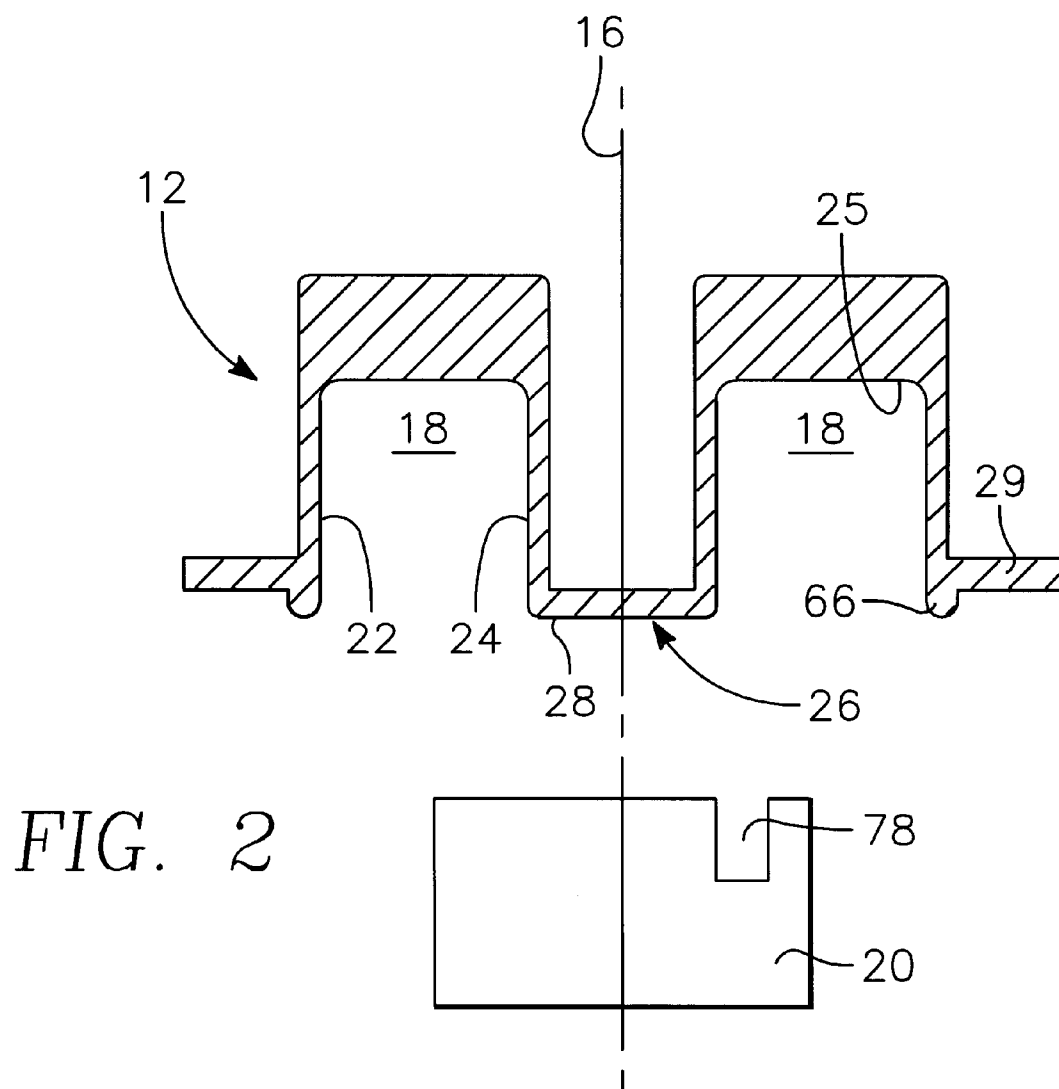


FIG. 1



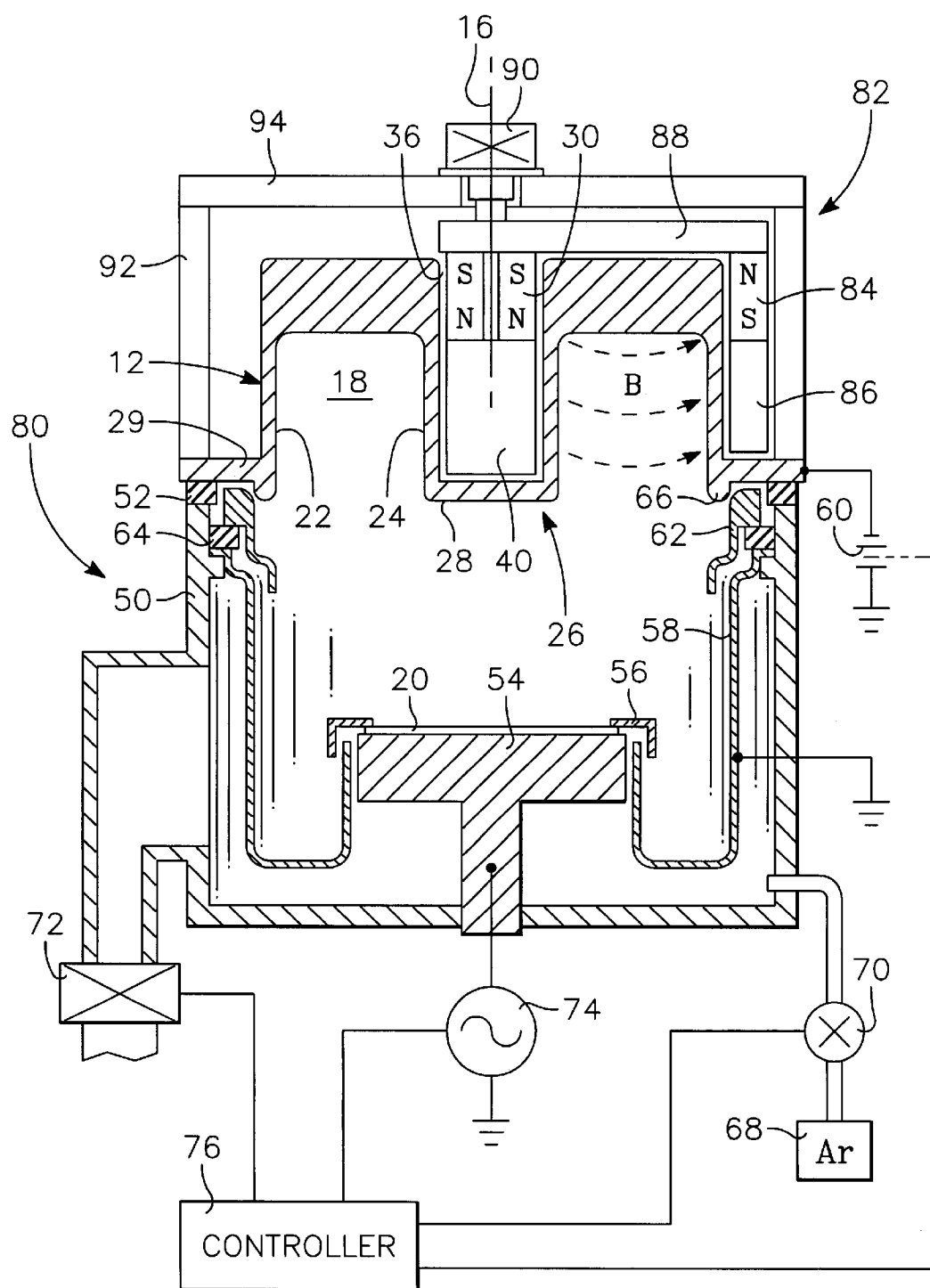


FIG. 3

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