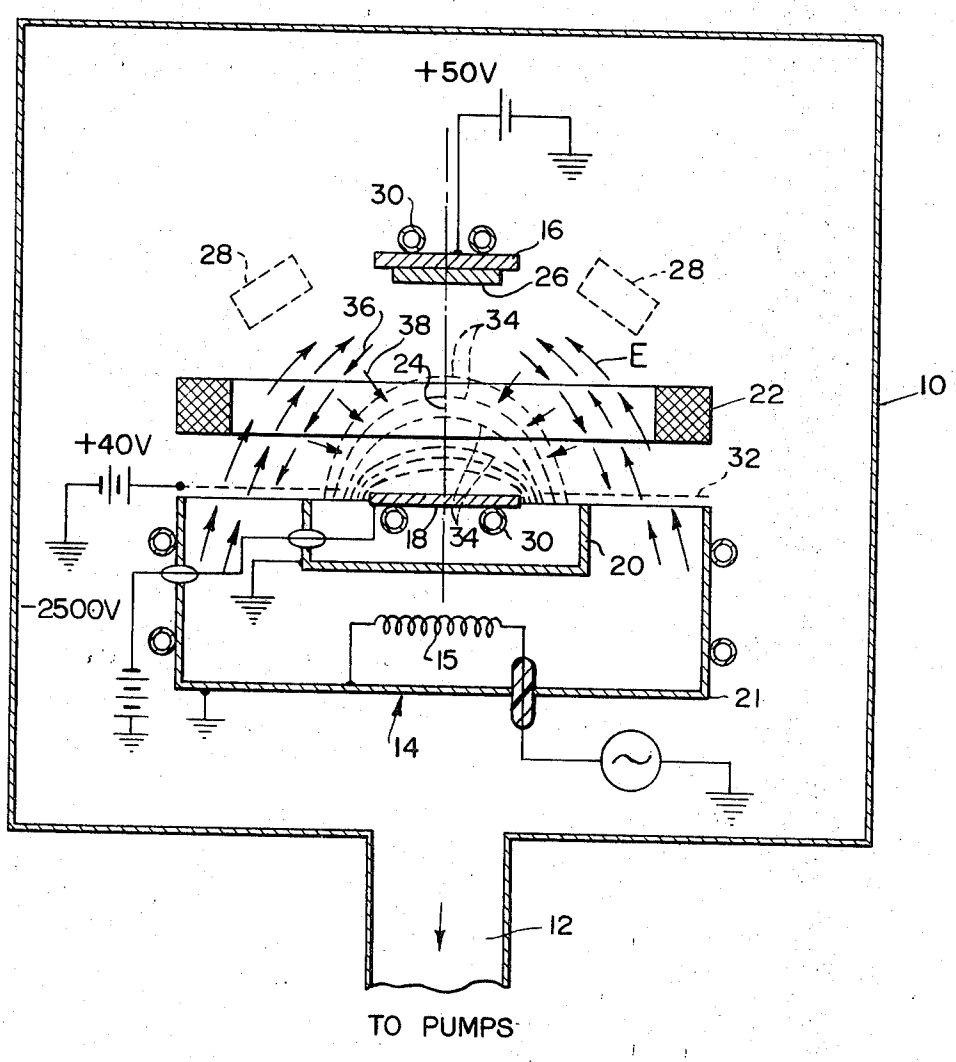
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SPUTTERING

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SPUTTERING

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ABSTRACT OF THE DISCLOSURE

A sputtering apparatus with an opposing anode and sputter cathode target with an electron source behind the target producing an electron beam encircling the target and conveying towards the anode.

The present invention relates to sputtering apparatus. It is the object of the invention to provide a highly efficient sputtering apparatus.

Referring now to the drawing there is shown a vacuum chamber **10** with a pumping port **12** for connection to vacuum pumping means (not shown). Within the vacuum chamber is a thermionic cathode **14**, and anode **16**, a sputter target **18**, a target electrostatic shield **20** located within the Crooke's dark space region of the target, and a magnet **22** producing a magnetic field about the apparatus axis **24**. The anode, cathode and target are also aligned along essentially the same axis.

A substrate to be coated is mounted on the anode at **26**. However, the substrate can also be at the alternate locations indicated at **28** or even eliminated since the apparatus is useful even without its coating function for sputter etching of selected target materials, getter pumping and other purposes.

The various electrodes and shields are water-cooled by coolant flowing in piping **30** to reduce outgassing and promote electrical stability of the apparatus.

A grid electrode **32** may be provided to assure good starting of the electron discharge from the electron source **14** at low pressures.

The various electrodes are provided with power supplies for biassing to appropriate voltage. Typical values are indicated in the drawing. The supplies are indicated schematically. In practice they would be outside the chambers and connections would be made in electrical feedthroughs.

Electrons are emitted from the thermionic filament **15** and emerge from the electron source **14** as an annular beam directed as indicated by the arrows E. The electrical field of the target **18** indicated by the lines **34** tends to make the electron beam E go out. But this tendency is counteracted by the magnet **22** to produce the desired resultant path. Collision of the electrons with residual gas molecules along the electron path produces positive ions of the gas among the collision products. These ions tend to travel along the path indicated by the arrows **36**. However, they are stripped from this path by the highly negative target **18** and are attracted to the target at high velocity to sputter it. The sputtered target material will leave the target and a portion of it will be collected on the substrate at **26**.

The invention provides a highly efficient production and concentration of ions, thus allowing faster rates of sputtering and is consistent with operation at lower pressures such as 1×10^{-4} torr where a lower density of gas molecules is available for ionization and sputtering, but where traditional sputtering problems of contamination and diffusion are attenuated.

In fundamental terms, the present invention provides a sputter target and means for producing electrons moving obliquely in front of and axially away from the target as indicated by arrows E. There is a prior art unit in which electrons move obliquely in front of and axially towards the target. In the prior art unit, the basic tendency is for ions to drift away from the cathode dark space of the target whereas in the present invention, the tendency is for ions to move into the dark space, thus providing an efficiency of 2–3 times that of the prior art apparatus.

In distinctly advantageous specific embodiment of the invention the electron beam starts in an annular form around the edge of the target—meaning the conical beam shown in the drawing adjacent circular target **18** or one or more sheet beams adjacent along edge(s) of an elongated target or other equivalents.

Advantageously, the electron emitter is located behind the target as in the drawing and the electrons are electrostatically guided by the nested cup-like shields **20**, **21** with the inner shield **20** also serving as an arc preventing shield for target **18**.

It is desirable to provide a current regulating circuit (not shown) for the power supply of anode **16** the limit current drawn thereby to as high as about 10 amperes.

Variations of the above described apparatus will now be apparent to those skilled in the art. It is therefore intended that the above description shall be read as illustrative and not in a limiting sense.

What is claimed is:

1. In a sputtering device the combination of a sputter target, having a front surface and a back and an annular edge and an axial frontal direction extending perpendicular to the front surface, means for biassing the target to a high negative potential, means including an electron emissive source separate from said target and located in a region behind said target for forming and directing a beam of electrons as an annular beam moving adjacent the target edge and moving obliquely with respect to said axial frontal direction and away from the frontal surface to converge in front of the target.

2. The apparatus of claim **1** with an anode electrode arranged in opposing relation to the target.

3. The apparatus of claim **2** with means for supporting a substrate, to be coated by sputtered target material, located at the anode.

4. The apparatus of claim **1** wherein the said electron forming means are defined by a pair of nested cup-like shields with an electron emitter therebetween.

5. In a sputtering device the combination of a sputter target, having a front surface and a back and an edge and an axial frontal direction extending perpendicular to the front surface, means for biassing the target to a high negative potential, means including an electron emissive source separate from said target and located in a region behind said target for forming and directing a beam of electrons moving adjacent the target edge and moving obliquely with respect to said axial frontal direction and away from the frontal surface to converge in front of the target.

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