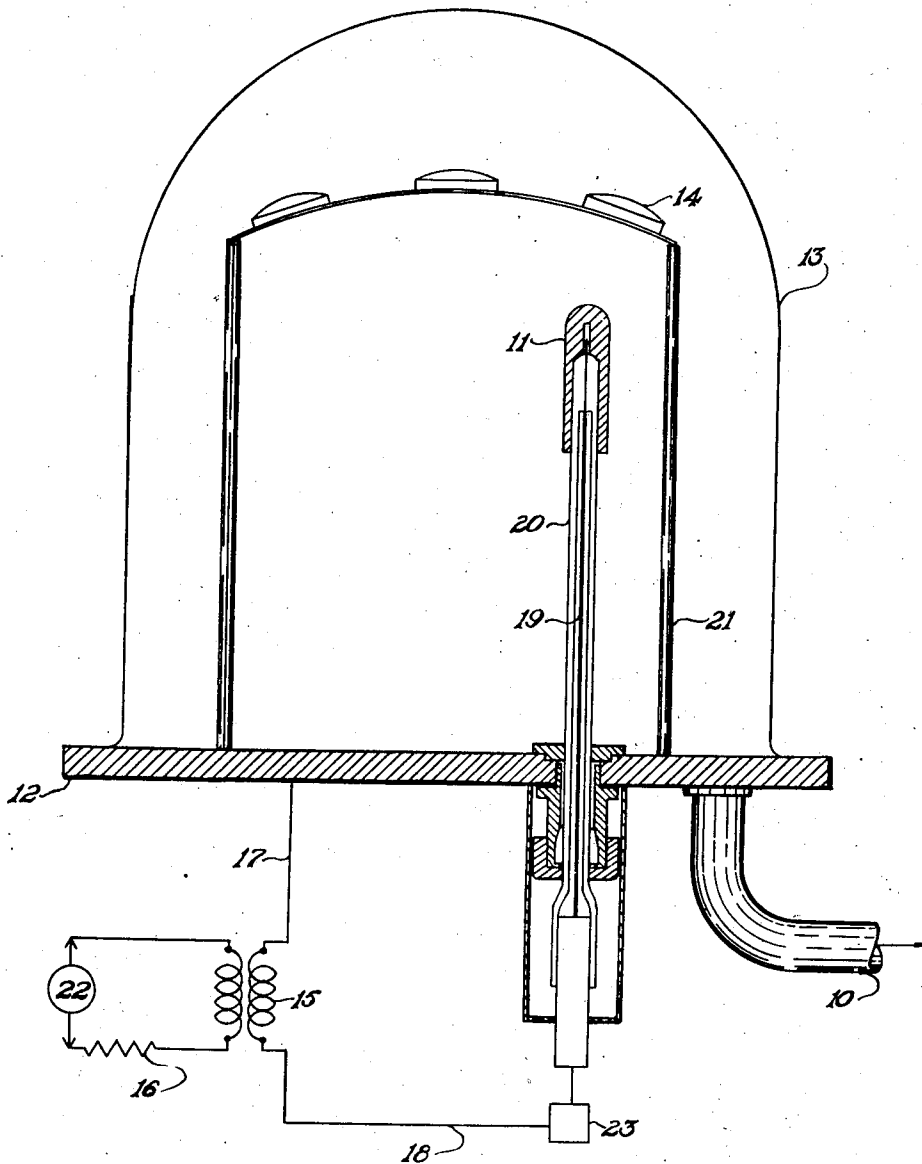


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USE OF GLOW DISCHARGE IN VACUUM
COATING PROCESSES
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USE OF GLOW DISCHARGE IN VACUUM
COATING PROCESSES

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This invention relates to improved cleaning and degassing of work pieces by the glow discharge method and particularly to a method whereby the same cleaning effect may be obtained with the expenditure of less electrical energy.

In the high-vacuum coating of materials with thin films, an adherent deposit can be obtained only if the work piece is clean and free of adsorbed gases. This cleaning and degassing operation may be carried out by subjecting the work piece to a glow discharge under high-vacuum. The practice has been to use voltages ranging from 5,000 to 40,000 volts and currents ranging from 10 to 200 milliamperes.

This invention has for its object to provide an improved method for cleaning and degassing. Another object is to make more efficient use of electrical energy and add increased convenience in cleaning and degassing operations. A further object is to improve the state of the art. Other objects will appear hereinafter.

These and other objects are accomplished by our invention which includes apparatus for obtaining high vacuum together with apparatus for producing moderately high voltage and comparatively high current.

In the following description we have set forth several of the preferred embodiments of our invention, but it is to be understood that these are given by way of illustration and not in limitation thereof.

The accompanying drawing represents an embodiment of our invention in which an alternating current is used as the power source. Numeral 12 designates a metal base plate, which acts as an electrode. Numeral 13 designates a glass bell jar which, together with base plate 12, comprises a vacuum chamber. Numeral 10 designates a conduit which connects the vacuum chamber to a vacuum pump (not shown). Numeral 20 designates a glass tube which projects through a vacuum-tight seal in the base plate into the vacuum chamber. Numeral 19 designates a conducting wire which extends from terminal 23 through tube 20 to make contact through a vacuum-tight glass-metal seal with electrode 11.

Numeral 22 designates a source of alternating current which may be, for example, 110-volt 60-cycle A. C. This current passes through fixed resistance 16, which governs the amperage, and step-up transformer 15, thence through leads 17 and 18 to base plate 12 and terminal 23 respectively.

Numeral 14 designates a work piece which rests on support 21.

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In operation the work piece is placed in the vacuum chamber, the chamber is sealed off and evacuated to a pressure of about 20 to 70 microns, and an electric current of 300–1000 volts and 0.5–3.0 amperes run between base plate 12 and electrode 11.

In an alternating current apparatus for cleaning and degassing by means of a glow discharge, 110-volt single-phase alternating current is run through a step-up transformer and thence to electrodes located within an evacuated chamber. The work piece is placed between the electrodes if it is a nonconductor. If the work piece is a conductor it may be used as an electrode.

In a direct current apparatus for cleaning and degassing by means of a glow discharge, if the work piece is a nonconductor it is supported in an evacuated chamber between electrodes in the field of an electrical discharge. If the work piece is a conductor it may be made the anode and subjected to glow discharge.

The voltage necessary to effect the glow discharge decreases with the pressure as a chamber is evacuated from atmospheric pressure. However, at low pressures of the order of 10 microns or less there are insufficient gas ions to maintain current flow and the voltage required to maintain the discharge increases very rapidly. In a graph of voltage vs. pressure, the curve is nearly asymptotic at a pressure of 1 micron. It is to maintain current flow under very low pressure conditions that high voltages are used. Under the usual conditions of the glow discharge there is a large voltage drop across the transformer secondary. If direct current is used this voltage drop would be due to a resistance placed in the circuit in order to match the applied voltage to the IR drop across the glow discharge, or the drop would be across the transformer secondary if rectified alternating current were used as the power source.

We have discovered that at pressures of 20 to 70 microns an adequate discharge may be maintained at voltages of 300 to 1000 volts and currents of 0.5 to 3 amperes. We prefer to operate within the narrower limits of 25 to 50 microns pressure, 500 to 800 volts and 1 to 2 amperes current.

Our discovery has the advantage that less power is wasted in the generation of the glow discharge. A typical high voltage arrangement will have 40,000 volts and 100 milliamps current, or a power consumption of 4000 watts. By applying 600 volts and 1.5 amperes current at pressures between 25 and 50 microns, our power consumption

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is 900 watts, or less than 25% of the usual load. Use of lower voltages reduces the incidence of breakdowns and this advantage accrues to the use of direct current as well as alternating current. Additionally, larger currents give greater electron bombardment, resulting in faster and more efficient cleaning.

What we claim is:

1. In a vacuum coating method in which coating material is deposited on a work piece under high vacuum conditions, the process which comprises the preparatory steps of cleaning and degassing said work piece by supporting said piece temporarily in a closed chamber, evacuating said chamber to a pressure substantially within the range 20 to 70 microns and, while maintaining said pressure, producing within said chamber and in the region of said work piece a glow discharge by supplying to a gap an electric current of from substantially 0.5 to 3 amperes at a voltage of substantially from 300 to 1,000 volts.

2. In a vacuum coating method in which coating material is deposited on a work piece under high vacuum conditions, the process which comprises the preparatory steps of cleaning and degassing said work piece by supporting said piece temporarily in a closed chamber, evacuating said chamber to a pressure substantially within the range 25 to 50 microns and, while maintaining said pressure, producing within said chamber and

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in the region of said work piece a glow discharge by supplying to a gap an electric current of from substantially 1 to 2 amperes at a voltage of substantially from 500 to 800 volts.

3. In a vacuum coating method in which coating material is deposited on a work piece under high vacuum conditions, the preparatory steps which comprise temporarily supporting the work piece in a closed chamber, evacuating said chamber to a pressure below 70 microns and, while maintaining said pressure, producing in said chamber and in the region of said work piece a glow discharge from an electrode gap with an electric current of at least 0.5 ampere and a voltage of at least 300 volts.

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