

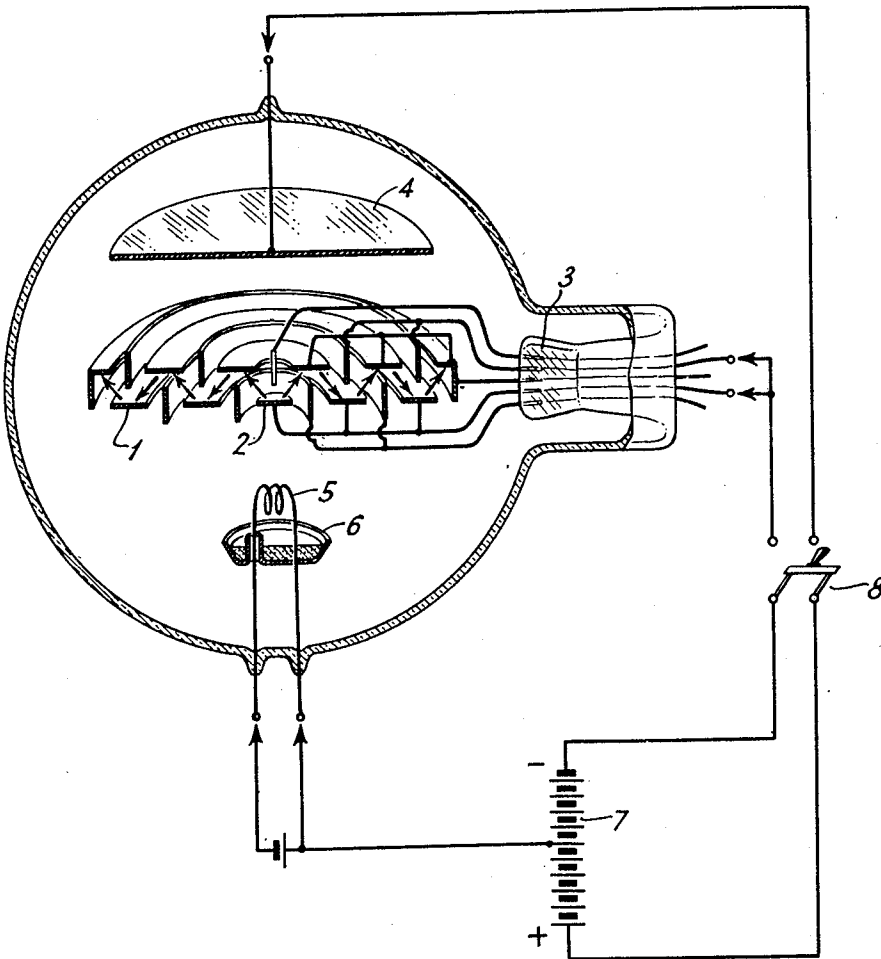
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METHOD OF COATING ELECTRODES

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METHOD OF COATING ELECTRODES

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In some types of electron discharge devices, such as photo-tubes, television tubes, electron multipliers and similar devices which utilize photo-electric emission or secondary electron emission one or more of the electrodes are coated with a thin layer or film of an alkali or alkaline earth metal. Usually this film or coating is obtained by vaporizing the active metal in the presence of the electrode to be coated, and permitting the active metal vapor to condense on the electrode. To make electrodes of uniform sensitivity and emissivity in this way is attended with certain practical difficulties, especially in discharge vessels with complicated electrode assemblies and mountings, such as electron multipliers in which electrical currents are amplified by utilizing the principle of electron multiplication by secondary electrons.

The present invention provides a method by which a very regular and uniform coat or layer of metal may be produced on a conductive body such as an electrode and particularly a layer of active metal on those electrodes or parts of an electrode system or assembly which are not easily accessible to the metal vapor.

According to the invention, the part or body to be coated, such as an electrode to be activated is disposed in the vicinity of an electric discharge which flows through the ionized vapor of one or of several active metals, while the electrode system or assembly, or the parts to be coated with the active or coating metal, are maintained negative with reference to the cathode of the discharge. Under these conditions, as is known from the theory of probe electrodes, a positive space-charge or space-charge layer appears about the electrodes or parts and also in the interior of the electrode system. The drop of potential in this positive space-charge layer causes particles of the vaporized metal with a positive charge to be conveyed to the electrode at negative potential where they deposit to form on the body or electrode a very regular and uniform film of the active or coating metal. The ionized particles will also be conveyed to parts or spots which would not be struck if the coating depended solely upon vaporization of the active metal, because the particles of vaporized metal tend to move in substantially straight paths from the source of the vapor.

The invention will be better understood by reference to the accompanying drawing of a discharge vessel with an electrode system which may be activated by the method of the invention. The drawing shows diagrammatically an electron

multiplier having an evacuated envelope enclosing an electrode system comprising annular accelerating and emitter electrodes 1 concentric with a central input electrode 2. In principle, this multiplier is like the electron multiplier shown in U. S. patent to Jarvis, 1,903,569, April 11, 1933. The electrode system is of circular symmetry about the input electrode, and is mounted on a press 3 by the usual supports, details of which are omitted in the drawing for the sake of greater clarity of illustration. For the purpose of deposition of the coating metal, an anode 4 and a heated cathode 5 are provided inside the envelope. In order that all parts of the electrode system may be shrouded by or immersed in the cloud of ionized metal vapor forming the plasma of the discharge flowing between cathode 5 and anode 4 through the vapor of the active metal, the anode should be coextensive with and of much the same dimensions as the multiplier electrode system or assembly. The envelope, in ways known in the art, is filled with vapor of the metal to be deposited, such as an activating metal which may be an alkali or an alkaline earth metal, such as caesium or barium. To this end a metal container 6 for the active or coating metal may be attached to the cathode, and heat radiated from the cathode will produce a supply of the vapor of the active material. Both the anode 4 as well as the cathode 5 and the holder for the active metal may in practical embodiments of the scheme be secured to the press 3. During activation a battery 7 may be connected to the various electrodes through a switch 8 to maintain the discharge between the cathode 5 and the anode 4, and at the same time maintain negative with reference to the cathode 5 those electrodes or emitters which are to be coated with the active metal.

The heated cathode may be replaced by a cold electrode if, for example, an atmosphere or filling of a rare gas is provided in conjunction with the metal vapor and a gaseous discharge is initiated at comparatively low potentials inside the vessel. The discharge will then occur more or less within a mixture comprising one or several rare gases and vapors of active metal such as caesium or barium. Under these conditions, the partial pressure of the vapor of the active metal to be deposited will remain about the same as the rare gas pressure.

If the discharge vessel, for the purpose of producing a discharge required for activation, is filled with a rare gas, the latter should later be removed to the extent required for the proper

operation of the tube, but, if desired, a trace of the gas may remain inside the vessel for space charge compensation.

5 In order to obviate difficulties of insulation, especially in cases where readily condensable metal vapors are employed for the activation of the electrodes, the electrode assembly supports consisting of insulation should be kept free from precipitation or deposits of the active metal. To
10 this end, use may be made of ways and means known in the art of preventing metal deposits on the press in hot cathode tubes; for instance, the electrode supports may be maintained at such a high temperature that the vapor of the metal
15 used for activation will be prevented from depositing upon these parts. By suitable masks or shields the supports may be so shielded and protected that no undesirable deposits will settle on them. Also the supports of insulation may be
20 provided locally or in certain sections with suitable protective coatings, such as barium carbonate or barium oxide.

Electrodes to be activated by a treatment as here disclosed may be prepared prior to such
25 treatment and activation in ways and means known in the prior art. For instance, they may be coated with a deposit of silver which is superficially oxidized, or silver oxide may be deposited directly upon the electrodes by volatilizing silver
30 inside an oxygenous atmosphere in which an electron discharge is maintained. Occasionally it may be sufficient to cover electrodes, for example, tungsten electrodes, with an extremely thin film of oxide, upon which is deposited the activating
35 metal by the method here disclosed.

I claim:

1. The method of activating an electrode with an active metal which comprises establishing between a thermionic cathode and an anode an
40 electron discharge through an atmosphere con-

taining the vapor of the active metal submerging said electrode in the ionized metal vapor in said discharge, and maintaining the electrode negative with reference to the cathode of the discharge during said discharge.

2. The method of activating selected electrodes of an electrode system which comprises establishing an electric discharge between two electrodes outside the electrode system, developing an atmosphere which contains vapor of the activating metal and through which the discharge between the two electrodes flows, immersing the electrode system in the discharge, and maintaining the selected electrodes negative with reference to the electrode constituting the
15 cathode of the discharge.

3. The method of depositing a film of metal upon a conductive body which comprises introducing the conductive body into an evacuated chamber containing a pair of electrodes, generating in the chamber vapor of the metal to be deposited, producing between the pair of electrodes an electric discharge which ionizes the metal vapor, and maintaining the conductive body negative with respect to the pair of electrodes while the discharge ionizes the metal vapor.

4. The method of depositing a film of metal upon a conductive body which comprises introducing the conductive body into an evacuated
30 chamber containing an electrode and a source of vapor of the metal to be deposited, generating metal vapor from said source, producing an electric discharge between said electrode and said source at a potential higher than the ionizing
35 potential of the metal vapor, and making the conductive body negative with reference to said source during the electric discharge.

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