

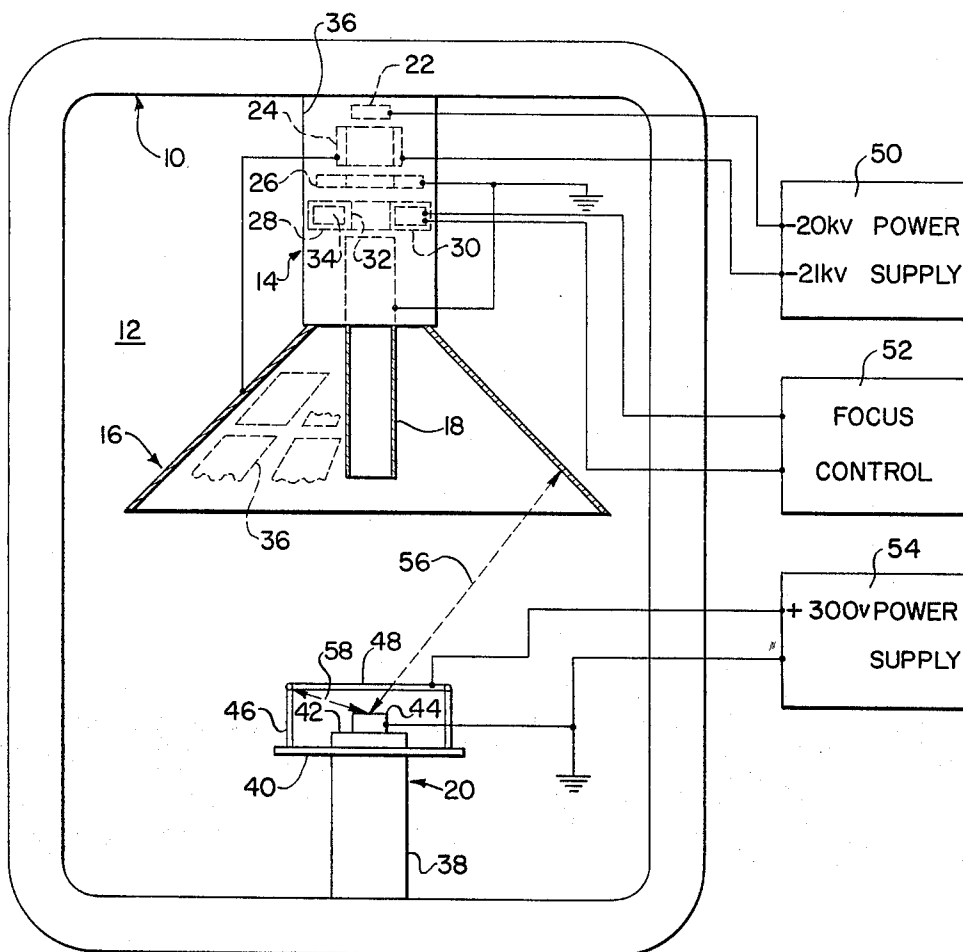
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SYSTEMS AND PROCESSES FOR COATING BY EVAPORATION

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SYSTEMS AND PROCESSES FOR COATING BY EVAPORATION

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The present invention relates to the coating of substrates with a material evaporated from a heated source and, more particularly, to the vaporization of a source material by electron bombardment heating and the impingement of the resulting vapor on a substrate. In the past, coatings formed in the foregoing way have suffered from poor adhesion and low reflectivity in consequence of anodization that is thought to be caused by electron flow through the deposited film, brought about by reflected electrons originating from the electron beam, secondary electrons emitted from the source material and vapor thereabove in consequence of energy imparted thereto by the electron beam and positive ions emitted from the source material in consequence of energy imparted thereto by the electron beam.

The primary object of the present invention is to provide systems and processes in which coatings of superior brightness and greater adherence are deposited from vapor resulting from heat generated by electron bombardment. This electron bombardment is effected by an electron beam emitted by a cathode at relatively low potential, accelerated by an anode at relatively high potential and focused by a coil that restricts impingement of the beam to a predetermined region of the source material. In accordance with the present invention, all charged particles are prevented from reaching the substrate being coated by the generation of suitable electric potentials as barriers between the position from which they emanate and the position of the substrate being coated. It has been found that these barriers may be generated effectively by maintaining the substrate material at the same low potential as the grid bias of the electron gun and interposing between the source material and the substrate a screen grid, adjacent to the source, that is positively charged. In consequence, only uncharged or neutral evaporant reaches the substrate, the resulting coating being free from the anodization normally produced by impinging charged particles.

Other objects of the present invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the system and process incorporating the various components, steps and relationships thereamong, which are exemplified in the following disclosure, the scope of which will be indicated in the appended claims. For a fuller understanding of the nature and objects of the present invention, reference is to be had to the following detailed description, taken in connection with the accompanying drawing, wherein a system embodying the present invention is illustrated, partly in mechanical schematic and partly in electrical block.

Generally, the illustrated system includes a housing 10 providing a vacuum chamber 12 which is adapted for continuous exhaustion to reduced pressure, preferably less than one micron of mercury, by a suitable exhaust pump (not shown). Carried in and supported by housing 10 are an electron gun 14, a substrate mount 16, a metallic drift tube 18 and a source material mount 20. Drift tube 18 serves to prevent any interference with the electron beam by the electrostatic control fields established by the components now to be described.

As shown, electron gun 14 includes a cathode 22, a bias electrode 24, an anode 26 and a focusing coil 28.

Cathode 22 is at a low negative potential of from -10 to -30 kilovolts, preferably approximately -20 kilovolts. The grid bias is maintained slightly more negative than the cathode, preferably approximately -21 kilovolts. Anode 26 and drift tube 18 both are at a relatively high potential, preferably ground potential. Focusing coil 28 is in the form of a hollow magnetic metal annulus 30, the inner periphery of which is provided with a slot 32 and the hollow interior of which is provided with a coil 34. Electron gun 14 is mounted within an insulating casing 36. Drift tube 18 is supported, at ground potential, from focus coil 28.

Depending and diverging from casing 36 is substrate holder 16, which is in the form of a hollow conical metallic shape, at the inner surface of which, substrates 37 are adapted to be affixed. Electron gun 14, drift tube 18 and substrate mount 16 all are coaxial. It will be noted that drift tube 18 projects almost to the lower edge of substrate holder 16, specifically to approximately within two inches of the lower periphery.

Source material holder 20 includes a post 38 that is coaxial with electron gun 14, a cross-plate 40 for use as a support, an upper face 42 upon which source material 44 may be placed, a plurality of insulating posts 46 resting upon cross-plate 40 and a metallic annulus 48 which is supported at the upper extremities of the posts. Preferably, annulus 48 ranges in potential from +100 to +500 volts, preferably approximately +300 volts.

In operation, at reduced pressure with substrates 37 affixed to the inner surface of mount 16 and a source material on mount 20. Cathode 22 is provided with a potential of -20 kilovolts and bias 24 and mount 16 are provided with a potential of -21 kilovolts by a suitable supply 50; anode 26 and drift tube 18 are grounded; focus 30 is adjusted by focus control 52; grid 48 is provided with a potential of +300 volts by a supply 54; and source material 44 is at ground potential. The arrangement is such as to heat the source material, for example, aluminum to a temperature above its vaporization point. The present invention is particularly adapted to the vacuum deposition of aluminum when a coat of high optical reflectivity is desired. It has been found that the reflectivity of such an aluminum coat, on a typical metallic or ceramic substrate such as steel or glass, is remarkably high when the interrelationships among the components are such that the distance 56 from source material 44 to substrate 37 is from ten to thirty times the distance 58 from source material 44 to grid 48. On the other hand, in the absence of the foregoing relationships, the reflectivity as well as the adherence of the resulting aluminum coating is considerably lower.

The present invention thus provides a simple technique for deriving coatings of superior reflectivity and adherence. Since certain changes may be made in the foregoing disclosure without departing from the scope of the invention herein involved, it is herein intended that all matter contained in the foregoing description and shown in the illustrated drawing be interpreted in an illustrative and not in a limiting sense.

What is claimed is:

1. An electron beam evaporating system comprising an electron gun including a cathode for emitting electrons and an anode for accelerating electrons in order to generate an electron beam, a source material holder in the path of said electron beam at which sufficient heat may be generated by said electron beam to vaporize said source material, and a substrate holder for mounting a substrate to receive evaporated material from said source means for applying a relatively low potential to said cathode and said substrate holder, a grid between said source material holder and said substrate holder, means for ap-

plying relatively high potential to said grid and said source material holder, means for applying an intermediate potential, between said relatively low potential and said relatively high potential, to said anode, the distance from said source material holder to said substrate holder ranging from 10 to 30 times the distance from said source material holder to said grid, said relatively low potential of said substrate holder establishing a field repelling reflected electrons and secondary electrons emanating from said source material holder and said grid establishing a field reflecting ions emanating from said source material holder, whereby a brilliant deposit is producible on a substrate on said substrate holder.

2. The electron beam evaporating system of claim 1 wherein a drift tube extends from said electron gun toward said source material holder in order to shield said electron beam from said field of said substrate holder and said field of said grid.

3. The electron beam evaporating system of claim 1 wherein said substrate holder is disposed about a conical surface axially aligned with said gun.

4. The electron beam evaporating system of claim 1 wherein said negative potential ranges from approximately -10 to -30 kilovolts.

5. The electron beam evaporating system of claim 1 wherein said positive potential ranges from 100 to 500 volts.

6. The electron beam evaporating system of claim 1 wherein said anode is approximately at ground potential.

7. The electron beam evaporating system of claim 1 wherein the distance from said source material holder to said substrate holder ranges from 10 to 30 times the distance between said source material holder and said grid.

8. An electron beam evaporating system comprising a hermetic enclosure, means for continuously evacuating said hermetic enclosure to a pressure below 1 micron of mercury, an electron gun defining an axis and having therealong cathode for emitting electrons and anode means for accelerating electrons in order to generate an electron beam, a source material holding means disposed along said axis in the path of said electron beam at which sufficient heat may be generated by said electron beam to vaporize said source material, and substrate holding means for mounting a substrate to receive evaporated material from said source material holder, power supply means, said power supply means applying a relatively low potential to said cathode and to said substrate holder, grid means between said source material holder and said sub-

strate holding means, said power supply means applying a positive potential to said grid means, and drift limiting means extending along said axis from said electron gun toward said source material holding means, said low potential of said substrate holding means establishing a field capable of shielding said substrate holding means from reflected electrons and secondary electrons emanating from said source material holding means, said positive potential of said grid means establishing a field capable of shielding said substrate holding means from ions emanating from said source material holding means.

9. The electron beam evaporating system of claim 8 wherein said low potential ranges approximately from -10 to -30 kilovolts, wherein said positive potential ranges approximately from 100 to 500 volts and said anode means and said drift limiting means are approximately at ground potential.

10. A process for producing a brilliantly reflecting metallic coat on a substrate, said process comprising the steps of directing an electron beam at a source material in order to heat said source material to a temperature above which it vaporizes, directing vaporized source material from said source material to a substrate, maintaining said substrate at a low negative potential in order to repel reflected electrons and secondary electrons emitted from said source material, and interposing between said substrate and said source material a positive field in order to repel positively charged ions emitted from said source material, the magnitudes of said fields being such that said electron beam is capable of penetrating said positively charged field, the distance between said source and said substrate ranging from 10 to 30 times the distance between said source and the point of said interposing whereby only neutral vaporized particles from said source material reach said substrate.

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