Dec. 20, 1960 J. A. AMELOTTE ET AL 2,965,067

VACUUM COATING APPARATUS

Filed Oct. 24, 1957

2 Sheets-Sheet 1

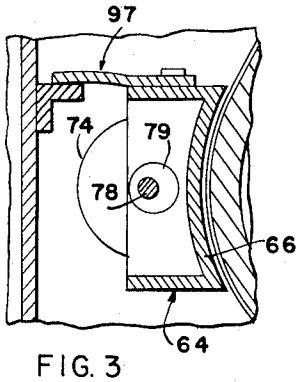


FIG. 3

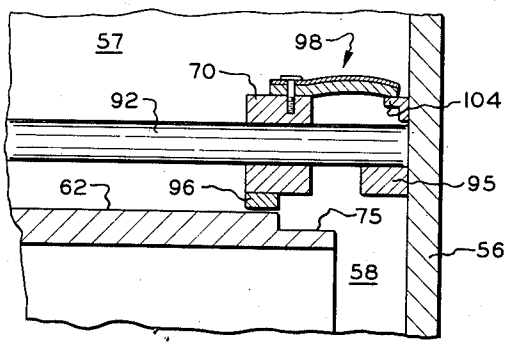


FIG. 2

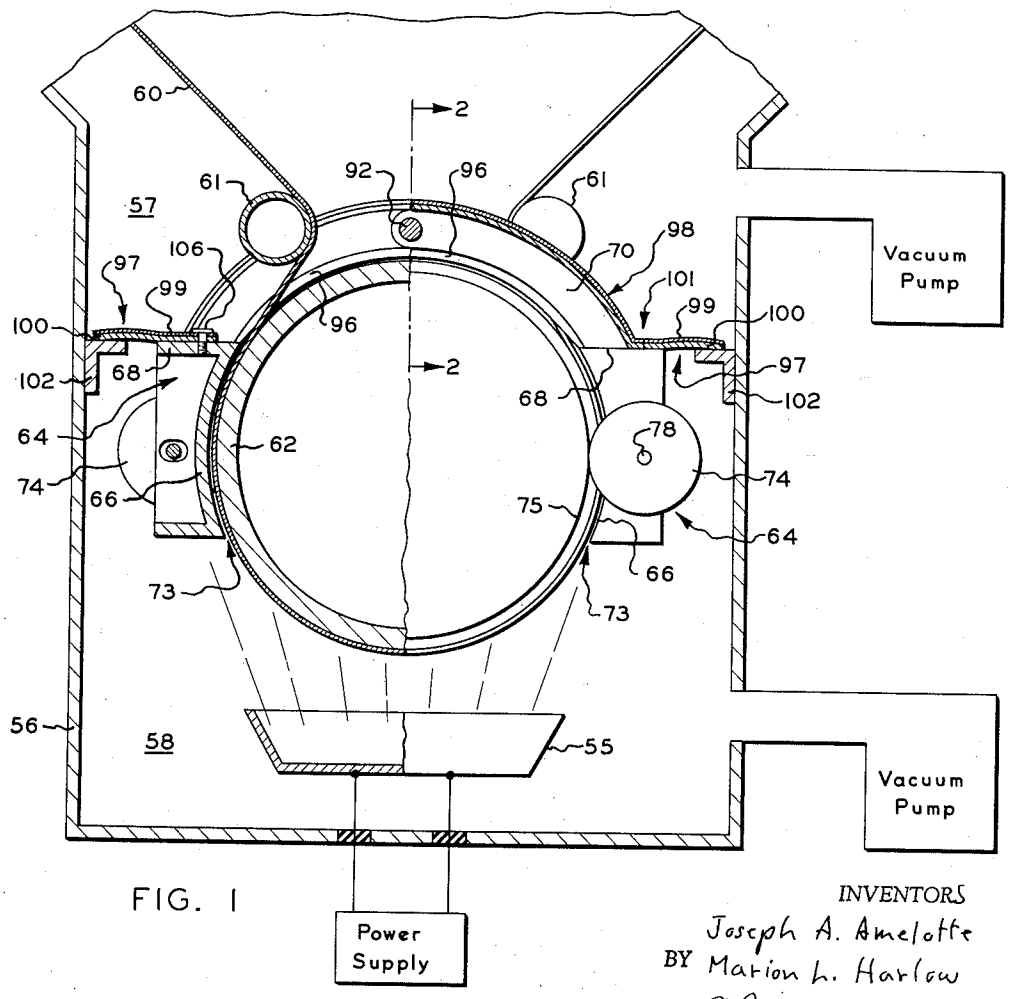


FIG. 1

INVENTORS
Joseph A. Amelotte
BY Marion L. Harlow
Oliver W. Hayes
ATTORNEY

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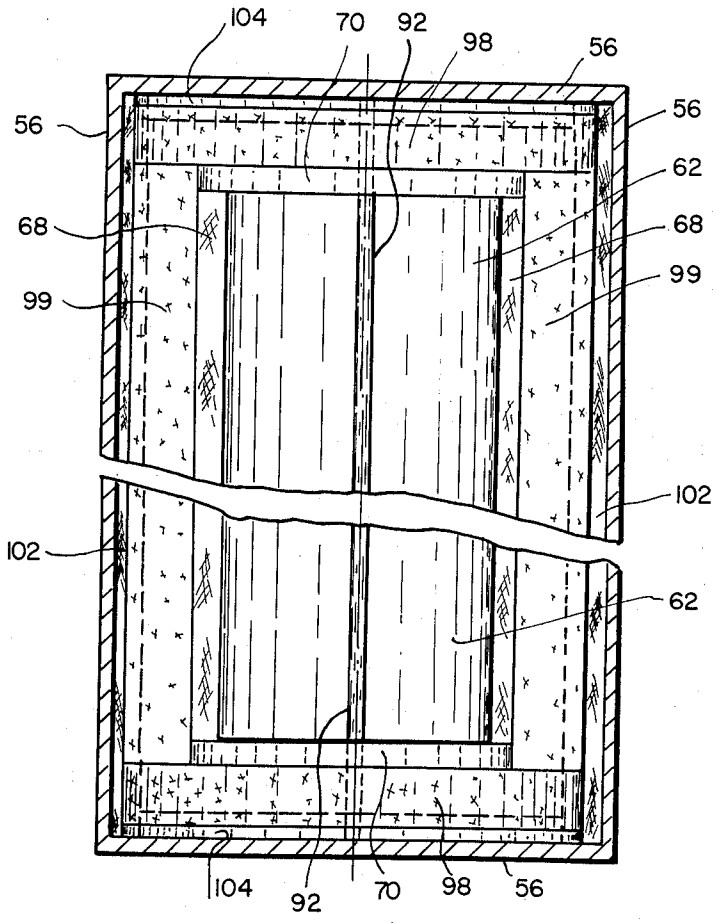


FIGURE 4.

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VACUUM COATING APPARATUS

Joseph A. Amelotte, Danvers, and Marion L. Harlow, South Sudbury, Mass., assignors to National Research Corporation, Cambridge, Mass., a corporation of Massachusetts

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5 Claims. (Cl. 118—49)

This invention relates to vacuum coating equipment.

Where material in the form of webs or "substrates" is to be coated in a high vacuum and then removed, a minimum of communication between the high vacuum system and the higher pressure volume to which the substrate is to be removed is necessary to minimize the amount of air pumping needed to maintain the high vacuum. In specific chambers, the amount of leak often determines the minimum pressure that can be maintained. Often in coating processes pressure obtainable in a chamber filled with metal coating vapors determines the character of the coating which can be effected upon substrates passing through the chamber. In aluminum vapor deposition it has been found impossible to obtain a metal coating with 70% reflectance unless the pressure is sufficiently low to prevent reaction of the aluminum vapors with residual gas.

In manufacturing machinery which handles substrates for coating under such conditions as those described above, it is necessary to provide adjustments so that various thicknesses of substrates can be handled by the same machine in order to ensure economic utilization of the machine.

In such apparatus used for coating substrates, it is desirable that the passage of the substrate be free, i.e., it is desired that there be no chafing or scraping contact between the moving substrate and any element of the seal apparatus.

A principal object of the invention is to provide vacuum coating equipment having an adjustable seal, permitting the free passage of substrates with various thicknesses while at all times maintaining at a minimum the leak of air to the high vacuum side of the wall from the side exposed to a higher pressure.

Another object is to provide a seal apparatus of simple construction which is easily assembled and maintained and which can be adjusted to allow free passage of splices of the substrate.

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

The objects of this invention are achieved by constructing an apparatus which creates a high impedance path to the flow of gas molecules adjacent to one side of a moving substrate, the other side of the subtrate being in contact with an impermeable surface that moves with the substrate between volumes of different pressures.

The invention accordingly comprises the apparatus possessing the construction, combination of elements, and arrangement of parts which are exemplified in the following detailed disclosure and the scope of the application which will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings wherein:

Fig. 1 is a diagrammatic, schematic, sectional end view showing the utilization of one preferred embodiment of the apparatus of the invention in a vacuum metallizing machine;

Fig. 2 is a fragmentary cross-section view taken along line 2—2 of Fig. 1;

Fig. 3 is a detailed view of a portion of Fig. 2; and

Fig. 4 is a plan view of the seal of the present invention with the substrate removed for clarity of illustration.

The invention will be described as relating to the vacuum metallizing of substrates.

Basic to the seal apparatus of this invention is a circular configuration of the substrate. The configuration is provided by holding the moving substrate in contact with a freely rotatable seal cylinder at the point where the sealing is to occur. The cylinder is located between walls which define a low pressure chamber from a volume of higher pressure. The seal itself comprises a shroud mechanism having a concave curved metal shroud member, shaped to approximate the curve of the cylinder, which is held in a substantially concentric relation to the cylinder a few thousandths of an inch away, forming an extremely high impedance path adjacent the substrate which rides on the cylinder. The shroud mechanism in effect extends to the walls, there being a unique spring backed gas-impervious connection placed between the shroud and the walls. The weight of the shroud mechanism is transferred to a single pivot shaft through pivot arms attached to the curved shroud member. The pivot shaft is located in such a position that gravity creates a turning moment on the shroud mechanism, causing the curved shroud member, together with the entire mechanism, to tend to swing towards the cylinder. For use where the curved shroud member is to be placed on the bottom of the cylinder, the weight of the shroud may be substantially supported by a spring held in compression against a bottom wall of the chamber, thus also providing the turning moment which tends to make the shroud swing towards the cylinder.

The shroud mechanism also preferably includes at least one rider wheel which contacts the cylinder and holds the shroud away from the cylinder. The journal of the rider wheel is fixed in relation to the shroud when the apparatus is adjusted to pass any given thickness of substrate. The rider wheel is rotatably supported on the journal and being in contact with the cylinder spins as the cylinder revolves. Provisions for adjustment of the journal and rider wheel in relation to the other portions of the shroud mechanism may be made by positioning the journal of the rider wheel in an eccentric position on the end of a shaft. The shaft is in turn rotatably supported by the shroud. Means may be provided to turn the shaft at a remote station by such an element as a flexible cable in cooperation with a worm and worm gear. The shroud mechanism is also provided with a stop which serves to fix the shaft at any desired position, which through cooperation with the eccentric rider wheel and the curved member of the shroud provides a clearance between the cylinder and the curved member which will not vary when the cylinder is rotated. With both the surface of the cylinder and the curved shroud member accurately machined, it is possible to adjust the clearance to .003 inch without danger of variation during a coating operation.

Where it is desired to have the adjustment movement of the curved shroud member in a path substantially radial from the center of the cylinder instead of rigidly swinging from the pivot shaft, the curved shroud member may itself be pivotly mounted to the pivot arm. For proper positioning of the curved element in substantially concentric relation to the cylinder where the shroud is pivoted to the pivot arm, two arcuately displaced adjustable rider wheels are utilized at each end of the curved element. As the rider wheels are adjusted together by means of eccentric mounting as described above, being additionally held in place by the pivot arm, the curved shroud member will move away in such a manner that no portion of the curved

shroud member will appreciably increase in distance from the cylinder more than will any other portion of the curved shroud member.

Another preferred method of adjusting the rider wheel and its journal in relation to the shroud is to position the journal in a block which can be laterally adjusted in a grove provided at the ends of the curved members, extend-radially in relation to the curved members. The block can be locked in any position within the groove so as to provide a means for varying the distance between the journal and the curved member.

Referring now to Fig. 1, Fig. 2 and Fig. 3 where indicated, there is illustrated a pair of the shroud assemblies 64 of this invention which cooperate with a housing defined by walls 56 to form part of a high vacuum coating chamber 58, one of the assemblies permitting the introduction of a substrate 60 into the chamber from a chamber of much higher pressure 57 and the other the removal of the substrate 60 from the coating chamber into the higher pressure chamber. One of the shrouds is shown in cross section, taken across the cylinder where the substrate contacts it. A source of coating vapors 55 is located in the high vacuum chamber 58.

Within the housing there is supported a rotatable seal cylinder 62. The seal cylinder is supported by bearings in the housing walls at both ends of the cylinder (not shown).

On opposite sides of the cylinder 62 there are located the shroud assemblies 64. These assemblies comprise concave curved shroud member 66, each strengthened by a gas impervious shroud top 68 and other elements. Welded to both ends of the shrouds are pivot arms 70 which are pivoted on a single pivot shaft 92 which is supported in a fixed relation to ends of the housing by a suitable supporting means indicated at 95 in Fig. 2. The pivot arms tend to swing toward the cylinder 62, carrying the curved shroud member 66 into the cylinder. The pivot arms 70 and the attached curved shroud member 66 are held away from the cylinder 62 by positioning means such as rider wheel 74 which rides on an extension 75 of the cylinder 62. The extension 75 serves as a rider surface. The journal 78 of the rider wheel 74 is an eccentric longitudinal extension of a shaft 79 (see Fig. 3) which can be rotatably adjusted, thus adjusting the special relationship between the curved shroud element 66 and the rider wheel 74. There is thus formed an adjustable arcuate passage 73 between the curved shroud member 66 and the cylinder 62.

Substrate storage reels may be provided in the high pressure chamber 57 upon which there is stored substrate 60. Alternatively, the substrate may be fed from fabrication machinery exposed to the atmosphere as shown in Stoll Patent 2,384,500. The substrate is passed over guide idlers 61 onto and off of the cylinder 62, and the substrate is held in intimate contact with the cylinder by virtue of lengthwise tension applied to the substrate. While in contact with the cylinder 62, the substrate passes through the arcuate passages 73 between the curved shroud members 66 and the cylinder 62. The cylinder is rotated at a surface speed the same as that of the moving substrate. When moved, the substrate is transferred from the high pressure chamber 57 into the low pressure chamber 58 and back again without rubbing or scraping the cylinder, and chafing against the curved shroud members is precluded by the clearance provided there-between.

Though it is possible to move the substrate at any of the points where it contacts a movable element, e.g., one of the storage reels, a preferred embodiment has the seal cylinder 62 provided with a drive sprocket so that the cylinder 62 serves to move the substrate 60.

With the exception of the arcuate passage 73, the high pressure chamber 57 is completely isolated from the low pressure chamber 58. This sealing is effected by providing gas-impervious connections between the shroud assemblies 64 and the wall 56. In the preferred embodiment of Fig. 1 these gas-impervious connections are made in the following manner.

Along the length of the shroud assemblies 64 a slightly flexible seal combination 97 comprising flat seal material 100 and spring backing 99 extends from the shroud to the wall. The seal material 100 is preferably sheets of neoprene or other rubber-like, gas-impervious pliable substance. In the preferred embodiment of Fig. 1 a flat strip seal spring backing is in intimate contact with the seal material 100. This seal spring backing may be of copper-beryllium, steel, bronze, plastic, or other spring material. The seal material 100 and seal spring backing 99 are fastened in a gas-tight connection to the gas-impervious shroud top 68 by means of screws 106. The seal combination 97 extends to the wall 56 where it rests on a gas-impervious ledge 102 attached to the wall 56. The seal spring backing 99 is so curved that a compression is exerted upon the seal material 100 by the cooperation of the ledge 102 and the seal spring backing 99.

At the ends of the cylinder a number of elements cooperate to form a seal, which are indicated in Fig. 2 as well as in Fig. 1. The pivot arms 70 constitute gas-impervious end pieces. From the upper surface of the pivot arms there extends to the end walls seal combinations 98 of the same nature as that formed by seal material 100 and seal spring backing 99. In the preferred embodiment of Fig. 1 where there are two shroud assemblies and for that reason two pivot arms oppositely mounted at each end, seal 98 extends from the gas-impervious shroud top 68 of one seal, up on the upper surface of the attached pivot arm 70, over the supporting shaft 92, and down on the upper surface of the opposing pivot arm to its shroud top 68. The end wall ledges 104 for these seals have the same curvature as the upper surface of the pivot arms 70. Near the point where the upper surface of the pivot arms join the gas-impervious shroud tops 68 there are gas-tight joints 101 between seals 98 and extending portions of seals 99 which rest on ledges at the end walls (not shown). End leak between the upper surface of the cylinder 62 and the lower surface of the pivot arms is precluded by end seals 96 which extend from the bottom of pivot arms 70 to the cylinder 62, along the upper part of the cylinder 62 from one shroud top 68 to the other.

The amount of sealing obtained between chambers 57 and 58 depends upon the length of the arcuate passages 73 and the clearance between the substrate 60 on the cylinder 62 and the curved shroud member 66. In extremely high vacuum operations it is preferred to operate chamber 58 at a vacuum of about 1 micron Hg abs., while the chamber 57 may be at pressures as high as atmospheric. Under such conditions it is obvious that any gas leaking from chamber 57 into chamber 58 will greatly expand and hence create a large volume of gas that must be removed in order to mantain the preferred high vacuum. For such conditions it is preferred to very accurately machine the outer surface of cylinder 62 and the matching surfaces of the curved shroud members 66.

In the coating mechanism utilizing shrouds of the construction indicated, it is seen that the only housing positions which must be accurately aligned are the cylinder bearings and the pivot arm shaft supporting means 95.

Shaft supporting means 95 is such that vertical removal of the shaft 92 is possible. It should be obvious that the shaft 92, pivot arms 70, shroud assemblies 64 with attached adjustable rollers 74, and the seals 97 and 98 which extend from the shroud mechanism to the walls can be removed or inserted as a unit.

It is thus possible, with the apparatus of this invention, to produce web treating mechanisms for transferring substrates from one chamber to another without leaks which are unusually easy to assemble and maintain.

What is claimed is:

1. A vacuum coating apparatus comprising chamber walls creating a chamber which defines a low pressure coating zone from a zone of higher pressure, vacuum

pump means for maintaining a low pressure in said chamber, a source of coating vapors in said chamber, and means for minimizing air leak into the coating zone and precluding chafing of a substrate while passing the substrate between the low pressure coating zone and a zone of higher pressure, said means comprising a rotatable cylinder supported in an opening in one of the chamber walls, so positioned that substrate passing from one side of the wall to the other is held in arcuate contact with the rotatable cylinder, cylinder end sealing means substantially precluding the flow of air into the high vacuum coating chamber adjacent to the ends of the cylinder, cylinder side sealing means extending from one side of the cylinder to the adjacent edge of the opening in the chamber wall, preventing air leak adjacent to that side of the cylinder, and on the opposite side of the cylinder a shroud mechanism comprising a concave curved shroud member shaped to substantially match the curve of the cylinder and pivot arms, said concave curved member being pivotly suspended by the pivot arms from a shaft above the cylinder in such a manner that gravity acting upon the shroud mechanism tends to swing the curved member into concentric arcuate contact with the cylinder, a positioning element which prevents said arcuate contact, thus providing an arcuate path between the cylinder and the curved member through which a substrate may pass when in contact with the rotatable cylinder without contacting the curved member, and sealing means extending from the curved member to the adjacent wall, thus confining substantially all air leak to the arcuate path.

2. A vacuum coating apparatus comprising a high vacuum chamber containing coating vapors, a rotatable cylinder upon which substrate to be coated is held in intimate contact while said substrate moves between the high vacuum coating chamber and a space of higher pressure, and a shrouding mechanism which in combination with the rotatable cylinder forms a high impedance path for air molecules which tend to move from the space of high pressure to the high vacuum coating chamber adjacent to the moving substrate, the shroud mechanism comprising a concave gas impervious member substantially shaped to the curve of a longitudinal segment of the curve of the moving cylinder, pivoting center means for said concave member so positioned that the curve of the member is in a substantially concentric relation with the outer surface of the cylinder means provided causing the concave member to pivot towards the cylinder, a rotatable shaft longitudinally attached to the concave member, and at least one roller rotatably mounted upon a journal, said journal being eccentrically attached to said longitudinal shaft, said roller being in contact with the rotating cylinder to prevent contact of the concave member with said rotating cylinder, said

shaft being provided with a stopping means whereby the shaft may be fixed in any of a number of rotary positions, thus cooperating to locate the journal in a number of positions relative to the concave member, and sealing means extending from the curved member to a ledge of the chamber comprised of a spring backed sealing material which in cooperation with end sealing means, the curved member, and the cylinder creates the high impedance path.

3. For use in a vacuum coating apparatus a means for creating a high impedance path to air molecules tending to flow adjacent a moving substrate, said means comprising a rotatably supported cylinder with which the moving substrate is in arcuate contact for a portion of the arc of the cylinder, and a pivoted shroud mechanism including a concave curved member held in a concentric relationship to the arc of the substrate created by the contact with the cylinder, said shroud mechanism being so positioned that gravity tends to swing the concave curved member into arcuate contact with the substrate, and a rider wheel journaled to said shroud mechanism, said rider wheel being in circumferential contact with the cylinder so as to hold the curved shroud member away from the substrate, the journal of said rider wheel being spacially adjustable in relation to said curved shroud member so that the distance between the cylinder and the curved shroud member is adjustable.

4. An apparatus creating an arcuate passage adjacent to a substrate moving in intimate contact upon a cylinder into a high vacuum coating chamber from a zone of higher pressure comprising a pivotly mounted curved gas impervious shroud member, the curve of which substantially matches the curve of the substrate, a means causing the curved member to pivot so as to tend to arcuately contact the substrate along a portion of the substrate in contact with the cylinder, and a positioning element comprising a round rider wheel which rides upon the cylinder, a journal rotatably supporting said rider wheel and an adjustable journal positioning means capable of locating the journal a number of fixed positions in relation to the curved member, said positions varying in distance from the curved member.

5. The apparatus of claim 4 wherein the adjustable journal positioning means comprises a shaft rotatably mounted in a fixed special relationship to the curved shroud member upon which the journal is eccentrically mounted with the longitudinal axis of said journal in a parallel relation to said shaft.

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