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APPARATUS FOR FORMING EVAPORATED FILMS

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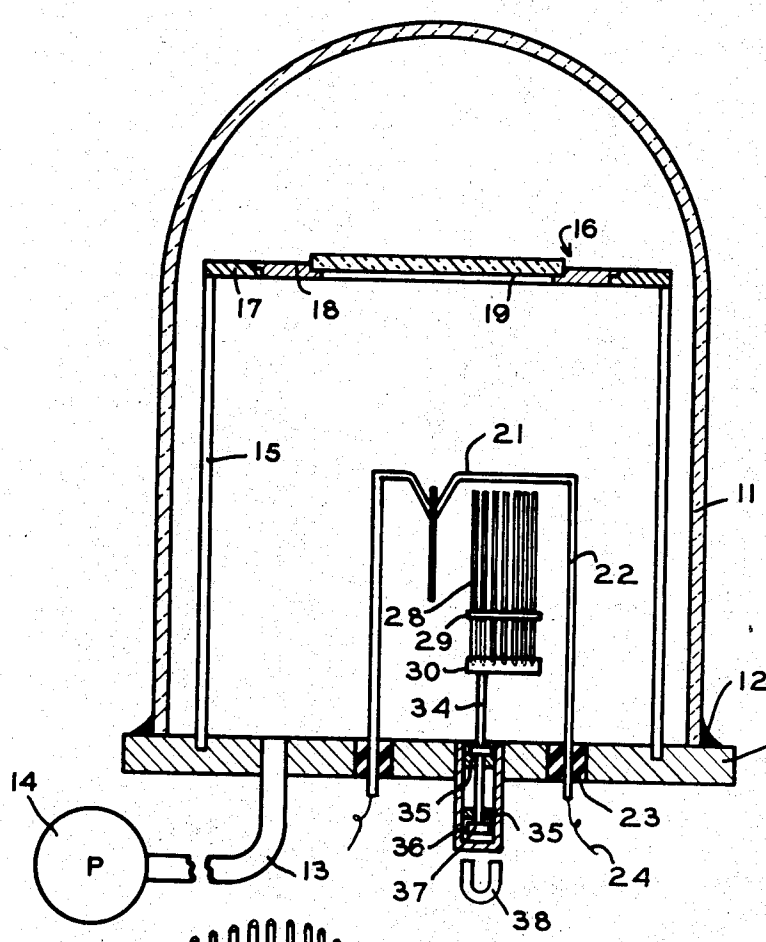


FIG. 1

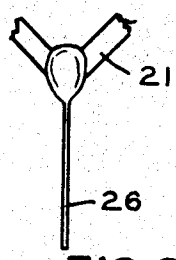


FIG. 3

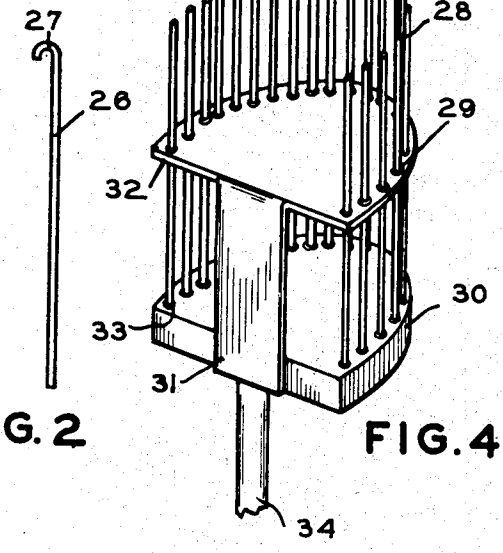


FIG. 2

FIG. 4

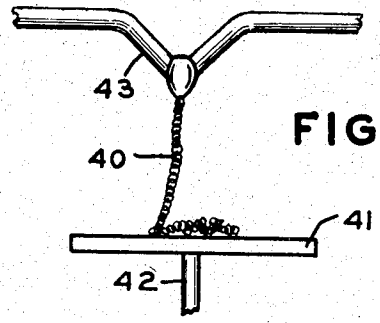


FIG. 5

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APPARATUS FOR FORMING EVAPORATED FILMS

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5 Claims. (Cl. 91—12.2)

1

This invention relates to apparatus for forming films of distilled materials.

A distilled film can be formed by vaporizing a film forming material in an evacuated space adjacent the body to receive the vapor. The film forming material has generally been either formed into small U-shaped strips and suspended over a heating filament or the film forming material has been held in a suitable crucible in heat receiving relationship with the filament.

The practice of suspending the strip of the film forming material over the filament is practical where a relatively small quantity of the material is to be vaporized. It cannot be used where either a relatively heavy film is to be deposited or a relatively large surface is to be coated, unless the source be replenished from time to time. This is not practical, for it necessitates the dismantling of the evacuated container to gain access to the source and then pumping down the container after it has been again assembled and resuming the evaporation cycle.

Although a relatively large amount of film forming material can be evaporated from a crucible in heat receiving relationship with a filament, considerably more input is required to heat the material, and the heat may cause objectionable out-gassing of adjacent metal parts of the apparatus. Furthermore, in some applications it is necessary to maintain a point source of material during the evaporation process.

The primary object of the present invention is to provide means for vaporizing a relatively large quantity of film forming material without the heat of the prior crucible method and yet maintain a point source during the evaporation cycle. The means for accomplishing this feature of the present invention comprises means for holding an elongate member of the film forming material in contact with the heating filament until the portion of the member in contact with the heating filament becomes molten and forms a bead. We have found that, after the bead of molten material is formed, the member will not separate from the bead and that as the material of the bead is vaporized, the member is drawn up into heat-receiving relationship with the filament so that the molten mass is constantly replenished as it is vaporized.

If it is desired to evaporate a larger quantity of the material, a plurality of members can be mounted in a suitable carrier and seriately moved into contact with the filament to carry out the process. As a number of the members can be seriately vaporized, it is possible to deposit

2

laminated films of different materials by forming the members of the desired materials.

In a modified form of the present invention, the film forming material can be formed into a chain having a length longer than that length of member which can be vaporized in the preferred embodiment of the invention. In this form of the invention, the one end of the chain is held in contact with the filament until a bead is formed, the body of the chain being supported adjacent the filament, and the chain vaporized as in the earlier described form of the invention.

Other features and advantages of the present invention will be apparent from the following description taken in connection with the drawing in which:

Fig. 1 is an elevational view, partly in section, of the apparatus of the present invention.

Fig. 2 is an elevational view of one form of the film-forming material.

Fig. 3 is an enlarged fragmentary view showing a portion of the heating filament and the molten mass of the film-forming material.

Fig. 4 is a perspective view of the carrier of the apparatus for holding a plurality of the elongated pieces of film-forming material.

Fig. 5 is a view of a modified form of the apparatus of the present invention.

The apparatus of the present invention, referring now to the drawing, comprises a suitable base plate 10, which supports an evacuable container shown here as a bell jar 11 of glass or other material. A vacuum-tight seal is formed between the lower edge of the bell jar 11 and the base plate 10 by any suitable sealing means 12. The bell jar 11 is connected by some conventional means, such as the pipe 13, to a high vacuum pump shown here diagrammatically at 14. A plurality of stanchions 15 extend vertically upward from the base plate 10 and carry at the upper end thereof a support 16 which, in the form of the apparatus now preferred, comprises a plurality of concentrically arranged annular members. The outer member 17 of the support, fixed to the upper end of the stanchion 15 in any manner desired, is formed with a seat on which is removably mounted an annular flange of the inner member 18. The inner member 18 is likewise formed with a seat such as the seat of the outer member, and which can be used to concentrically mount a plate 19, the underneath surface of which is to receive the film of distilled material.

In the illustrated form of the invention, the

material to be evaporated is heated by a heating filament 21 carried by current-conducting posts 22 supported in the bushings 23 of insulating material fitted into apertures formed in the base plate 10. The heating element 21 is connected to a suitable source of current, not illustrated in the drawing, through lead-in conductors 24.

In one widely used prior practice, the film-forming material was formed into small U-shaped strips which were suspended over the heating filament. The U-shaped strip carried by the filament melted when the filament was energized and formed a small bead of material which clung to the filament until the material was completely evaporated. This technique could be used only where a small amount of material was to be evaporated, and if a larger quantity was desired, it was necessary to place the material in a suitable crucible placed in heat-receiving relationship with the filament. Although this technique permitted a larger amount or quantity of the material to be evaporated, it had its limitations and could not be used where it was necessary in the process to have the vapor emanating from a point source.

The present invention provides means for evaporating a large quantity of the film-forming material and yet maintain substantially a point source during the entire evaporation cycle of the process. In carrying out the process of the present invention, the film-forming material can be formed into an elongate member or rod 26 and, preferably, the one end of the rod is formed with a small hook 27 to permit the rod to be suspended from the filament 21.

We have found that the portion of the rod in contact with the filament will melt and form a bead as in the prior practice and that the rod, if the mass weight thereof is kept below some easily predetermined value, will not separate from the molten bead but will depend therefrom as best shown in Fig. 3. It will be understood that the film-forming material must "wet" the filament, for otherwise the bead will not cling to the filament.

The end of the rod not only is held to the bead but will be pulled up into heat-receiving relationship with the filament as the mass of the material forming the bead vaporizes.

The size of the rod which can be used will, of course, depend upon the material of which the rod is formed and the specific gravity of the same. We have found that rods approximately four inches in length and 0.020 of an inch in diameter of aluminum, and even materials having a specific gravity as high as that of the alloy "Inconel," comprising 79.5% nickel, 13% chromium, and 6.5% iron, can be successfully evaporated by the method herein disclosed.

As the end of the rod adjacent the filament melts, the bead is replenished and the evaporation cycle can be carried on until the rod is completely evaporated. Thus, a relatively large quantity of material can be evaporated without sacrificing the advantages of a point source.

If a larger quantity of material is desired to be evaporated, a plurality of rods can be formed and the rods successively vaporized. This can be accomplished without dismantling the bell jar by supporting the rods in such a manner that each rod can be moved into contact with the heating filament as the vaporization of the preceding rod is completed.

In the embodiment of the present invention illustrated in Fig. 4, the rods 28 of the film-forming material are supported by a suitable carrier comprising upper and lower semi-circular plates 29 and 30, respectively. The plates are spaced apart by a strip 31 which can be formed integral with the upper plate 29 and bent down and secured to the one edge of the lower plate 30 by any means desired. The upper plate 29 is formed with a plurality of apertures 32 equally spaced from the center of curvature of the plate 29. The apertures have a diameter greater than the diameter of the rods 28 and are in alignment with sockets 33 formed in the upper face of the lower plate 30. It will be seen, referring to Fig. 4, that the rods 28 can be supported in the carrier by passing each rod through an aperture 32 until the lower end thereof is received in the socket 33.

The carrier is rotatably mounted on the base plate 10 through a shaft 34 rotatably supported by a plurality of dry bearings 35 mounted within a well 36 formed of some non-magnetic material. It will thus be seen that the carrier is rotatably mounted for movement about the longitudinal axis of the shaft 34 which passes through the center of curvature of both of the plates. The shaft carries an armature 37 at the lower end thereof and as the well 36 is formed of some non-magnetic material, the carrier can be moved into any desired adjusted position by moving the magnet 38 held adjacent the lower wall of the well.

In carrying out the process where a plurality of rods 28 are to be evaporated, after the carrier has been placed within the container and the same evacuated, the filament 21 is energized and the carrier moved to bring one of the rods 28 into contact with the filament 21.

The filament should be so disposed relative to the rods that as each rod is moved into engagement with the filament, the same will contact each rod at a point spaced downwardly from the upper end thereof. This has been accomplished in the present invention by crimping the filament to form the V shown. As a portion of the rod spaced downwardly from the upper end thereof is moved into engagement with the filament, this portion of the rod will be the first to melt, which causes the upper portion of the rod to fall over into contact with the filament and form as it softens a hook somewhat like the hook 27 formed on the rod 26. This portion of the rod melts to form the bead of molten metal which clings to the filament and holds the remainder of the rod as in the earlier described form of the invention.

The carrier can be moved back to the position shown in Fig.1 after the rod has been vaporized to the extent that the lower end thereof is clear of the plate 29. When the first rod is completely vaporized, the carrier can be again moved to bring the next rod into contact with the filament 21 and this process can be continued until the entire stock of rods held by the carrier has been completely vaporized.

It is possible, with the apparatus of the present invention, to conveniently form films of different materials without dismantling the bell jar. This is accomplished by the apparatus of the present invention by forming the rods 28 of different materials so that successive films of different materials will be formed as the rods are successively evaporated. It will also be apparent that different materials could be simultaneously evaporated by slight modification of the apparatus.

In a modified form of the present invention, the film-forming material is made up into the form of a chain 40 which is partially supported by a small platform 41 which, if desired, may be

held above the base plate 10 by a vertically extending rod 42 having the lower end thereof fixed in the base plate. As in the earlier described form of the present invention, the one end of the chain 40 is held in contact with the filament 21 until the material is melted and the bead 43 is formed. The molten bead holds the end of the chain in heat-receiving contact and as the material of the bead vaporizes, the material of the adjacent link of the chain melts and replenishes the bead.

As the chain is partially supported by the platform 41, a larger mass of material can be evaporated than in the method where the material is formed into rods. Laminated films can be deposited in this form of the invention by forming the links of the chain of different materials.

It should be understood that, while the present preferred embodiments of the invention have been illustrated and described herein, the invention need not be limited thereby but is susceptible of changes in form and detail within the scope of the appended claims.

We claim:

1. In an apparatus of the type described, an evacuable container; means for evacuating said container; means within said container for supporting a body to receive a film; a heating filament; means for movably supporting a plurality of rods of vaporizable material adjacent said filament; and means for moving said supporting means whereby the upper ends of said rods can be seriately moved into contact with said filament.

2. In an apparatus for forming a film on a body comprising an evacuated container; means for evacuating said container; means within said container for supporting the body to receive the film; a heating filament; means for connecting said filament to a source of current; a rotatably mounted carrier member; means on said carrier member for holding a plurality of rods of vaporizable material; and means for rotating said carrier member whereby the upper end portions of said rods can be seriately moved into contact with said filament as each rod is vaporized.

3. In an apparatus for forming a distilled film on the surface of a body, an evacuable container; means for evacuating said container; means within said container for supporting the body to receive the film; a heating filament; means for connecting said heating filament to a source of current; a rack; means for rotatably mounting said rack adjacent said filament; means on said rack for mounting a plurality of rods of film-forming material concentric with the axis of rotation of said rack; and means for rotating said rack whereby said rods can be seriately moved into contact with said filament.

4. In an apparatus for forming a film on the surface of a body, an evacuable container; means for holding the body in the container; means for evacuating said container; a carrier member; means for rotatably mounting said carrier member; means on said carrier member for vertically supporting a plurality of rods of film-forming material so that the same are equally spaced from the axis of rotation of said carrier member; a heated filament; and means for rotating said carrier member, said heated filament being so mounted relative to the axis of rotation of said carrier member that the same lies in the circular path of the upper ends of said rods as said carrier member is rotated whereby the upper ends of the said rods can be seriately moved into contact with said filament.

5. In an apparatus for forming a film on the surface of a body, an evacuable container; means for evacuating said container; means for supporting the body within said container; a heated filament; means for mounting a plurality of vertically disposed rods of film-forming material for arcuate movement about a common axis, the upper end portion of each rod being spaced from said axis a distance equal to the distance between said axis and the heated filament, whereby the upper end portions of the said rods can be seriately moved into contact with said filament by moving said supporting means about said axis; and means for moving said supporting means about said axis.

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