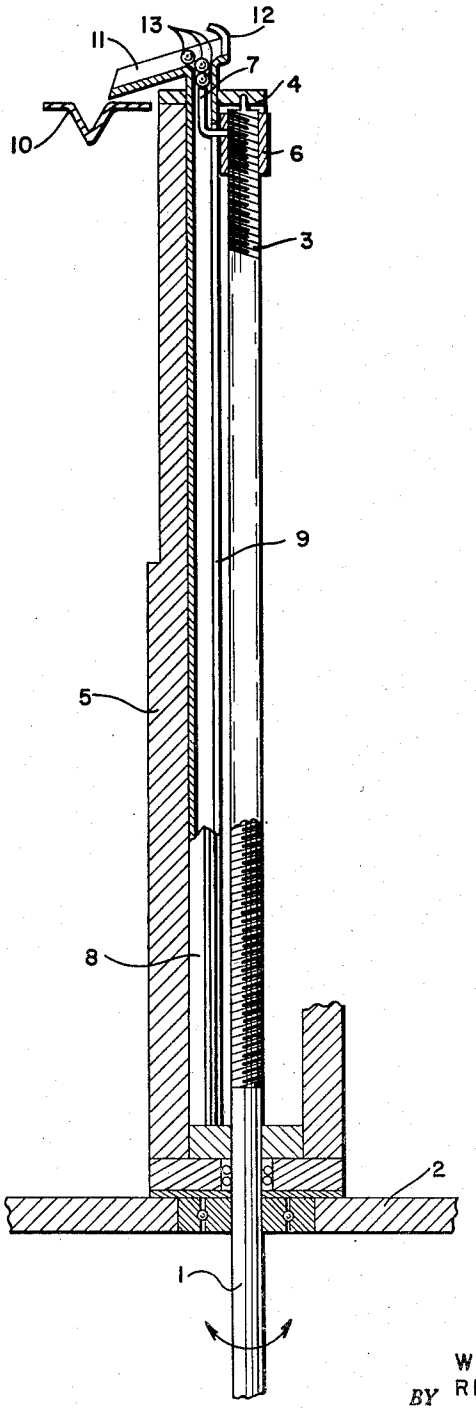
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AUTOMATIC FEED FOR EVAPORATION MATERIAL

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AUTOMATIC FEED FOR EVAPORATION MATERIAL

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This invention relates to apparatus for evaporating material in a vacuum chamber and more particularly to apparatus for continuously feeding material to be evaporated into a heated filament.

When material is to be evaporated and deposited onto a substrate to form a thin film on the substrate, the work is performed in a vacuum chamber. This vapor deposition is particularly adaptable to the manufacturing of thin film microcircuitry. It is common practice to use a filament in the shape of a trough, or the like, wherein the filament becomes extremely hot. A material to be evaporated is usually placed in the filament prior to the vacuum chamber being sealed. The substrate upon which the material is to be deposited is usually positioned above the filament. Once the vacuum chamber has been evacuated, the filament is heated and then the material vaporizes and deposits on the substrates. The problem is that if more than one substrate is to be coated with the thin film, there is the problem of replenishing the supply of material to be evaporated.

It is very time consuming to open the vacuum chamber, put in new material and evacuate the chamber again. The evacuation of the chamber may take up to two hours while the vapor deposition of the material only a few seconds. Sometimes it is possible to put an over-supply of material to be evaporated in the filament, but in this case it is extremely difficult to control the amount that will be evaporated on each substrate.

Another known method in supplying material to be evaporated to the filament is to have the material in a long strip wherein it is fed through an electrode in the shape of a circle, and the material itself becomes the anode and is evaporated by electron bombardment. The problem with the electron bombardment method if evaporation is, again, one where it is hard to accurately control the amount of material deposited on a given substrate. To control the exact amount of material deposited on a given substrate, the easiest method is to place a known amount of material in the filament and to evaporate all of the material. With the substrate at a given distance from the filament, this process may be repeated with a certain degree of accuracy. But, again, the problem is that the vacuum chamber has to be opened after each operation to put a fresh supply of material in the filament.

It is, therefore, an object of this invention to provide a means for automatically feeding material to a filament in a vacuum chamber.

Another object of this invention is to provide a means for automatically feeding and accurately controlling the amount of material to a filament.

Still another object of this invention is to provide successive feeds of material to be evaporated wherein the material may be several types of material.

Other objects and advantages of the present invention will become apparent in the following description when taken in conjunction with the drawing, in which the sole FIGURE is a cross-sectional view of the present invention.

Referring to the drawing, a shaft 1 is rotatably supported at one end by a support 2. It is to be noted that

the support 2 may be the base of the vacuum chamber in which case the seal around the shaft 1 can be a vacuum seal of the type well-known in the art which allows rotary motion of the shaft 1. The shaft 1 has a threaded portion 3. The other end of shaft 1 is rotatably supported by the end plate 4. A housing 5 connects the end plate 4 with the support 2. A threaded nut 6 engages the threads 3 on shaft 1. Extending from the nut 6 is an arm 7. A slotted tube 8 is also supported by the housing 6. The slot 9 of tube 8 runs longitudinally along the axis of the tube 8. The slot 9 is wide enough to permit the arm 7 to extend into the tube 8.

It can be seen, now, that as shaft 1 is rotated, the nut 6, which would normally rotate with the shaft 1, is caused to move up and down the shaft 1 on the threads 3 because the arm 7 holds the nut 6 stationary with respect to rotation.

A filament 10, shown as a V-shaped trough, is electrically connected to a power supply (not shown). The top of the tube 8 has a spout portion 11 mounted to form an angle of less than 90° with the tube 8 and extending from the tube 8 to a position over the V-shaped trough 10 but not touching the V-shaped trough 10. Note, that the spout portion 11 has a small lip means 12 blocking its upper end to prevent the pellets from being emitted from the upper end. The material to be evaporated is in the shape of balls 13 and positioned above the arm 7.

In operation, the shaft 1 is rotated to lower the nut 6 and arm 7. The vacuum chamber is opened and the balls 13 are fed into the tube 8 either from the top of tube 8 or from the bottom of tube 8. The balls are selected to be the proper volume to give the desired thickness of evaporated thin film. The vacuum chamber is then closed and evacuated and the filament 10 is heated. The shaft 1 is then rotated so that the desired number of balls 13 fall into the filament 10 where they are vaporized. It is to be noted that the balls 13 may be fed into the filament 10 before the filament 10 is heated, but that heating the filament first provides for almost instantaneous vaporization of the material, rather than prolonged vaporization, as in the case where the filament 10 is brought up to the temperature with the material in the filament. The tube 8 holds several balls of material, and therefore, the evaporation may be done in any number of substrates without opening the vacuum chamber to put in new material in the filament 10. In order to accomplish a new evaporation, shaft 1 has merely to be tuned to allow more balls 13 to fall into the filament 10.

It is to be noted that if different materials are to be evaporated, the first few balls are of one material and the next few balls of another material, and so on. This allows one filament to evaporate several different kinds of material without opening up the vacuum chamber.

This system has two major advantages: one, in storing a supply of material inside of a vacuum chamber thereby eliminating the need to open the vacuum chamber to re-supply the material to be evaporated; and secondly, the size of the balls can be controlled with extreme accuracy so that each ball gives a desired film thickness of evaporated material on the substrates.

Example I

A ⅛ inch diameter copper ball used with the present invention with the substrate twelve inches from the filament in a vacuum of approximately 10^{-5} millimeters of mercury provided a film thickness from 2–3 thousand angstroms. The balls were placed in the tube and the filament was heated and then the balls were ejected one at a time from the tube. One ball was used for each substrate providing approximately 2–3 thousand angstroms of film thickness.

Example II

Alternate balls, first ⅛ inch diameter copper balls and, second, ⅛ inch diameter nichrome balls used in the same apparatus and with the same vacuum as in Example I provides a film thickness of copper of approximately 2–3 thousand angstroms and a film thickness of nichrome of approximately 2–3 thousand angstroms. The balls are ejected from the tube successively so that the first film is deposited on the substrate and then the second film is deposited on the substrate, either over the first film or on a second substrate.

Example III

By using a 1/16 inch diameter ball of nickel in a tube to accommodate the same, the results in Example I, change to a film thickness of approximately 1.2–1.4 angstroms, and by the same token changing the ball size to ¼ inch diameter and the tube accordingly, the results in Example I are changed to a film thickness of approximately 10–20 thousand angstroms.

Although this invention has been particularly described above, it is not intended that it should be limited by the above description, but only in accordance with the spirit and scope of the appended claims.

What we claim:

1. An apparatus for feeding material to be evaporated to an evaporating means in a vacuum chamber, comprising

(*a*) a tube having an open end and a slot running longitudinally thereof capable of storing pelletized material to be evaporated,

(*a'*) a dispensing spout means, fixedly mounted on said tube at said open end, said spout means having a first end and a second end and having an opening in the bottom portion thereof with said opening registering with the opening in said open end of said tube,

(*b*) a threaded shaft means rotatably mounted externally of said tube and parallel thereto,

(*c*) nut means threadedly engaging said threaded shaft,

(*d*) an arm member fixedly mounted on said nut means, said arm member extending through said slot and into said tube, whereby rotary actuation of said shaft means brings about longitudinal displacement of arm member within said tube and thereby provides a means for expelling pelletized metal from said tube upon movement of said arm member towards said open end of said tube.

2. The apparatus of claim 1 wherein said threaded shaft means extends through a wall of said vacuum chamber and is adapted to be actuated from without said chamber.

3. The apparatus of claim 1 wherein said spout means is mounted so that the part of said spout means containing said first end forms an angle of less than 90° with said tube.

4. The apparatus of claim 3 wherein said spout means has a lip means mounted at said second end to prevent pelletized matter from being emitted from said second end.

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