PROCESS FOR THE VAPOR DEPOSITION OF MATERIAL WITHOUT THERMAL RADIATION OF THE SUBSTRATE
Filed Jan. 14, 1963

Fig. 1

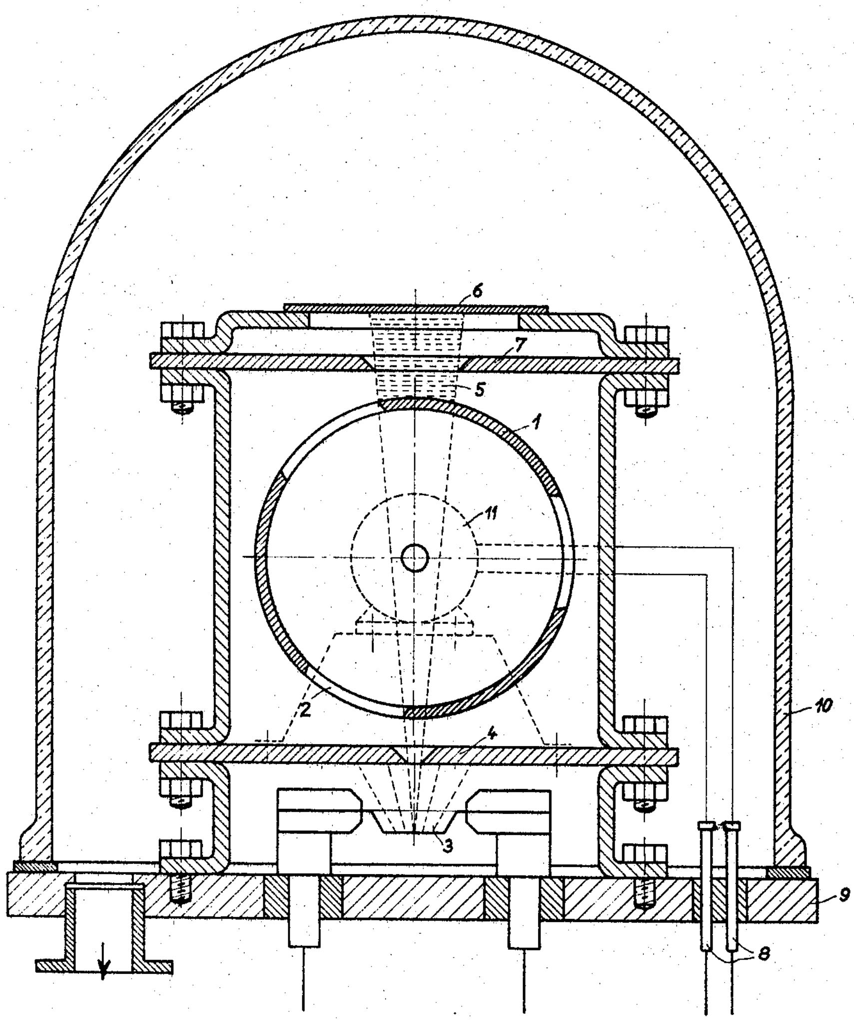
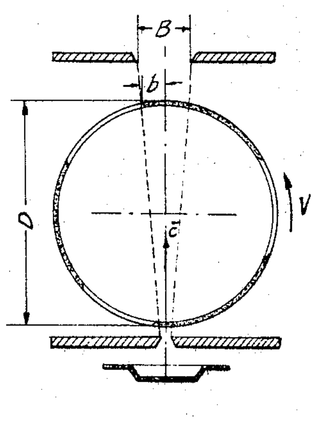


Fig. 2



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United States Patent Office

3,333,982

Patented Aug. 1, 1967

3,333,982

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Filed Jan. 14, 1963, Ser. No. 251,325
Claims priority, application Austria, Jan. 16, 1962, A 303/62
1 Claim. (Cl. 117—106)

This invention relates to a process, and more particularly to a process for depositing thin layers by thermal vaporization without thermal radiation loading of the receiver. In depositing thin layers by thermal vaporization of the material to be deposited from the vapor state (metals, semiconductors, and the like), the receptor is heated by the heat waves which accompany the vapor waves. In all the processes known heretofore, not only the vapor waves but also the heat waves get to the receiver; the increase in the receiver temperature so produced is generally undesired. For example, in the preparation of replica for electron microscopy, such radiant heat may change the sample to be examined.

The process of the invention avoids impact of the heat waves on the receiver by making use of the circumstance that heat and vapor waves possess very different velocities. The process of this invention is useful, for example, in making replica for electron microscopy.

In the devices embodying the principles of the invention, the heat and vapor waves coming from the vapor source are broken down into impulses of definite length which, after a fixed transit time, are separated on the basis of their differing rates of propagation.

In the embodiment of the invention illustrated by the drawing, use is made of a hollow cylinder **1** which is rotated at high speed by a motor **11**. This motor is energized over power supplies **8**. The hollow cylinder **1** is provided with slots **2** so that the heat and particle radiations emerging from the furnace **3** through the shield **4** are separated into impulses by means of the openings **2** and need different times for travelling through the diameter of the hollow cylinder because of their different propagation velocity. Thus, the particle rays the velocity of which is low (and a function of the furnace temperature and of the atomic weight of the material to be deposited) pass freely through the slots **2** and through the shield **7** and reach the receiver **6** if the rotation velocity of the hollow cylinder **1** is properly chosen. The heat rays, on the other hand, which migrate with light velocity cannot pass through the slots **2** in the cylinder because of the geometrical arrangement thereof (the hatched area **5** remains free from heat rays). The apparatus described is mounted on a base plate **9** and is arranged within an evacuated vessel **10**.

Other arrangements which likewise allow separation of the vapor waves from the heat rays are feasible in accord with the same inventive principle. Thus, instead of one hollow cylinder, two can be used which rotate in the same direction or counter to one another and are arranged one above the other or one inside the other.

The same goal is achieved with two disks rigidly connected by a common shaft when the disks are provided with openings adjustable with respect to one another about an appropriate angle. These disks are displaced

such a number of revolutions that the vapor waves—but not the heat waves—are able to go through the openings to the receiver.

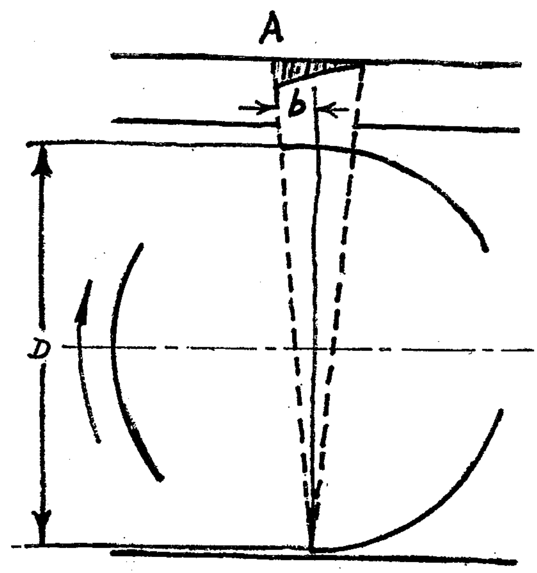
Another embodiment consists of shields with appropriately positioned openings. The shields, positioned in fixed standoff from one another, are set in phase-displaced motion by conventional means (mechanical or electromechanical) so that penetration through the openings only by the vapor waves—but not by the heat waves—is made possible.

Example

On a photosensitive support a gold layer is to be coated by vapor deposition. The evaporation temperature is 1770° K. (incandescent filament to white heat).

The mean velocity of the gold atoms which emerge from the vapor source is $\bar{C}=513$ m.sec.$^{-1}$.

This value can be calculated from the Maxwell equation.



$$\bar{c}=a\sqrt{\frac{T}{M}}$$

T=absolute temperature

M=atomic (molecular) weight of the substance

a=constant=1.712×10^{-4}

$$U=\frac{60}{\pi}\frac{\bar{c}b}{D^2}$$

for gold:

At a cylinder diameter of 80 mm. and at a value of b=5.6 mm. the necessary rotation velocity follows to U=8600 r.p.m. At this rotation number the Au atoms of the velocity mentioned arrive at the support at the point A; faster atoms cannot penetrate through the cylinder, slower atoms impinge on the support at another point. Thus, an Au layer is formed on the substract without light rays (and/or heat rays) impinging thereon.

With reference to the diagram as shown on FIG. 2, this is for the purpose to indicate and satisfy the conditions that light never can pass the upper diaphragm and that the vapour-rays here possess a diameter B. Then the rotating cylinder (diameter D) even when it overlaps the lower diaphragm just overlaps the upper diaphragm by the distance *b*. A vapour-impulse which enters the cylinder through the lower diaphragm passes through the cylinder while it rotates by the distance *b*. In this way the vapour-impulse is able to leave the cylinder. Therefore the distance *b* represents an apparatus constant depending only on v (velocity on the periphery of the rotating cylinder) and on $\bar{c}$ (velocity of the vapour-rays).

We claim:

Process for depositing thin layers by thermal vaporization without thermal radiation loading of the receiver comprising separating the vapor waves coming from the vapor source from the accompanying heat waves by decomposing both types of waves simultaneously into impulses of definite length, and catching the more rapid

and therefore preceding heat wave impulses by a moving screen system while the relatively slower vapor wave impulses are allowed to pass through unhindered.

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