

Nov. 27, 1956

L. A. HOLLAND

2,772,318

APPARATUS FOR VAPORIZATION OF METALS AND METALLOIDS

Filed Dec. 31, 1953

Fig. 1.

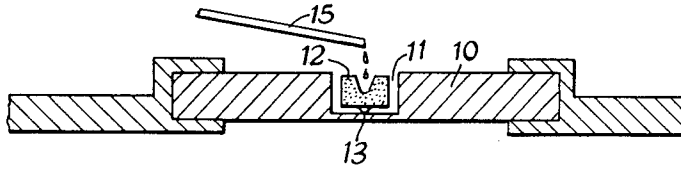


Fig. 2.

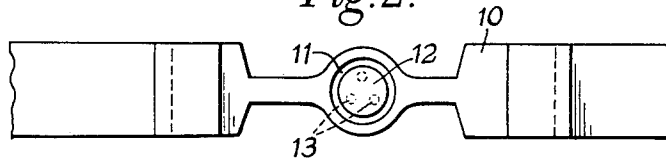


Fig. 3.

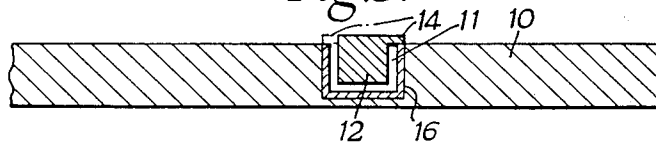
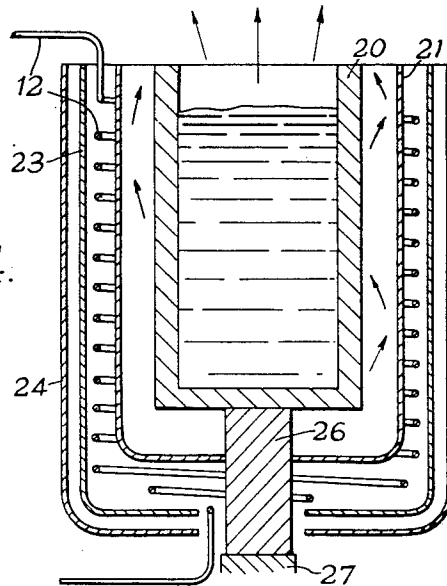


Fig. 4.



INVENTOR

LESLIE A. HOLLAND

BY *Young, Emery
& Thompson*
ATTORNEYS

1

2,772,318

APPARATUS FOR VAPORIZATION OF METALS AND METALLOIDS

Leslie Arthur Holland, South Norwood, London, England

Application December 31, 1953, Serial No. 401,667

Claims priority, application Great Britain
December 31, 1952

6 Claims. (Cl. 13—25)

This invention relates to vaporisation apparatus particularly of the kind in which materials, for example metals or metalloids, are vaporised on a continuous basis for the purpose of, for example, depositing thin films upon objects such as plastic films or sheets of material. The films or sheets of material to be coated are usually carried on a stock reel or drum from which they are driven on to a take up reel or drum. The invention is however also applicable to the deposition of thin or thick films on stationary articles.

Such vaporisation is usually carried out in a vacuum chamber containing objects to which, for example, metal films or coatings are to be applied and the vacuum chamber contains a small container or crucible in which the metal to be vaporised is placed and heated to the vaporisation temperature by a resistance element or by electromagnetic induction heating.

Owing to the fact that certain metals, particularly aluminium, react with known refractory materials which have been used in the position of crucibles heretofore, unsuccessful attempts have been made to utilise other materials. One object of the present invention is to provide a construction of evaporator which will have an increased life compared with forms of evaporator at present in use.

Another object of the invention is to provide a greater thermal efficiency that is to say a greater amount of vaporisation for a given amount of power used for heating.

According to the present invention an evaporator in or for vaporisation apparatus of the kind referred to comprises an evaporator base composed of refractory material which is supported in spaced relation with respect to a heated vapour reflector. The reflector may constitute a heater element or a separate heater may be provided.

If the material to be vaporised is to be fed continuously, the base may be in the form of a plug mounted inside a cavity in the heater. If the material is not fed continuously the base may be in the form of a crucible surrounded at its sides and bottom by a reflector which in turn is surrounded by radiation shields.

Even if the heater for the evaporator or vapour source could be made of a material which is completely resistant to molten aluminium, electrical fluctuations in the heater circuit may occur where direct resistance heating is employed, due to variation in the resistivity of the heater when molten metal contacts its surface. For purely electrical reasons therefore, it is found to be of advantage when using a wire feed source to separate the evaporation surface from the source heater.

In practice, it is found that those refractory materials which are capable of resisting the attack of molten aluminium are invariably porous in nature and aluminium is able to diffuse through the body of the refractory. If such a refractory is raised to the evaporation temperature with a heater made of carbon which readily forms

2

an aluminium carbide when molten aluminium contacts its surface, then, I find it desirable to prevent the flow of molten metal through the porous body and on to the heater. According to one desirable method of applying the present invention, a cylindrical refractory plug is mounted inside a cavity, the walls of which are at a high temperature and radiate heat on to the plug.

Constructional forms of the invention will now be described by way of example with reference to the accompanying diagrammatic drawings wherein:

Figure 1 is a vertical sectional view of an evaporator device made in accordance with the invention;

Figure 2 is a plan view thereof;

Figure 3 is a view similar to Figure 1 but showing a modification; and

Figure 4 is a vertical sectional view of an alternative form of the device.

In Figures 1 and 2 the heater itself consists of a piece of carbon 10 shaped in plan, rather like a dumb bell, the bar of which at the middle is of enlarged circular shape and deeply recessed to form a cavity 11. The evaporator base is constituted by a cylindrical plug 12 of refractory material which is placed within the cavity 11, the plug being of less diameter than the cavity and also of less depth than the cavity. There is thus an annular space between the plug and the wall of the cavity in the heater and also a space between the bottom of the cavity and the inserted end of the plug. The plug is, however, provided integrally therewith with short supporting legs 13 of small cross section which rest on the bottom of the cavity, or (Figure 3) with short radial projections 14 at its outer periphery to assist positioning of the plug within the cavity. The face of the plug is preferably slightly dished.

The carbon heater may be heated in any convenient manner, and preferably by resistance heating due to the flow of current through it. The metal, for example, aluminium, is fed in the form of a wire 15 on to the dished face of the plug and is thereupon vaporised. Some molten metal may flow over the surface of the plug into the space between the plug and the wall of the cavity in the heater but such molten metal will be vaporised due to the high temperature of the walls of the cavity and will be reflected from the walls of the cavity. Any vapour which may find its way into the space referred to will also be reflected back into the main vapour space.

The provision of short legs on the plugs instead of the radial projections previously referred to ensures that the point of contact between the refractory plug and the carbon heater is disposed more remotely from the point of maximum concentration of molten aluminium than in the case of radial spokes.

Although carbon has been referred to as a suitable material for the heater, it is of advantage to use materials which are electrically conducting and resistant to chemical decomposition or reaction when in contact with aluminium at a high temperature, for example a refractory carbide. A plug separate from the heater would however still be used in accordance with the invention for the reasons already explained. Again in practice however, it is at present difficult and expensive to construct carbide heaters in the manner described and, for this reason, it is proposed to use carbon for the heater. In the case of the particular construction of heater described there is the risk that a molten droplet of aluminium from the wire feed source may fall on to the carbon heater surface where it would rapidly form an aluminium carbide and the heater would quickly deteriorate. This may be prevented by fitting a crucible liner 16 (Figure 3) inside the cavity of the heater, the liner being made of a material similar to the plug. Although the lining may

be porous as in the case of the plug, there is never a constant and high concentration of aluminium at the outer surface of the liner and the possible occasional droplet of aluminium which may fall on its surface is quickly removed at the high temperature before appreciable diffusion takes place.

Although reference has been made to a plug of refractory material, it will be understood that the plug may consist of a refractory carbide or other refractory such as a tungsten refractory.

In the construction shown in Figure 4 the base comprises a crucible 20 surrounded at its sides and bottom by a vapour reflecting shield 21 (e. g. of tantalum) spaced from the crucible, the shield being in turn surrounded by an electrical resistance heating coil 22 which may be made of tungsten. The coil is surrounded by radiation shields 23, 24. Aluminium vapour leaves the open end of the crucible and some aluminium also diffuses through the walls of the crucible and escapes through the space between the vapour reflector and the crucible. The shields 23, 24 may be made of refractory material. The crucible stands on a small block 26 which may be composed of the same kind of material as the crucible and which in turn stands on a suitable foundation 27. If desired the coil 22 may be omitted and the electric current passed directly through the reflector 21.

In the construction of vacuum coating apparatus embodying the invention, it is necessary electrically to isolate the wire feeding mechanism from the heater of the evaporator or vapour source. Unless such electrical isolation is effected, contact between the solid aluminium feed wire and the evaporator may result in the formation of an arc producing spitting of the molten aluminium. Conveniently therefore, the evaporator or source heater, namely the carbon heater or its equivalent is connected at one end to earth potential and the wire feed mechanism is insulated from earth.

Although heating of the source heater by resistance heating has been mentioned, it will be understood that forms of evaporators or sources embodying the invention, other than that specifically described, may lend themselves to heating by other methods including radiation, or electron bombardment of the metal to be vaporised.

Those refractory materials which have a high degree of resistance to decomposition by reaction with liquid aluminium at high temperatures are generally permeable bodies, through which liquid aluminium readily diffuses. Further, liquid aluminium freely wets and flows over and up the walls of refractory containers made from either dense or porous materials.

The present invention provides a method and apparatus whereby certain refractory materials which are resistant to disintegration and chemical decomposition but not to wetting and penetration can be used as bases in the construction of aluminium vapor sources without the foregoing attendant difficulties impairing the efficient operation of the source.

I claim:

1. An apparatus for vaporisation of materials consisting of metals and metalloids comprising an evaporator base composed of refractory material, a heat radiator having an opening therein surrounding said base whereby the said material during evaporation flows over into said opening, and means for heating the radiator in order that the heat for the evaporation is applied by radiation from the radiator to the base.

2. An apparatus for vaporisation of metals and metalloids comprising a heater radiator element having a cavity therein, means for heating the heater element, and an evaporator base in the form of a plug located in said cavity with a space between the walls of the cavity and the side and bottom surfaces of the plug.

3. An apparatus as claimed in claim 2 wherein the plug is mounted by means of short supporting legs formed thereon.

4. An apparatus as claimed in claim 2 wherein the plug is mounted by means of short radial projections thereon.

5. An apparatus as claimed in claim 2 wherein the heater is a carbon element of reduced plan thickness between its ends and its central portion where it is formed with the cavity.

6. An apparatus as claimed in claim 2 wherein the plug is composed mainly of at least one refractory carbide and the radiator includes a liner in the cavity also composed of at least one refractory carbide and from which the plug is spaced.

References Cited in the file of this patent

UNITED STATES PATENTS

2,100,045	Alexander	Nov. 23, 1937
2,206,020	Berghaus et al.	July 2, 1946
2,440,135	Alexander	Apr. 20, 1948
2,554,902	Godley	May 21, 1951
2,665,223	Clough et al.	Jan. 5, 1954
2,665,229	Schuler et al.	Jan. 5, 1954
2,665,320	Chadsey et al.	Jan. 5, 1954
2,693,521	Alexander	Nov. 2, 1954