United States Patent [19]

Dobson

[11] **3,892,198**

[45] **July 1, 1975**

[54] **ENCLOSURES FOR VACUUM COATING**

[76] Inventor: **Christopher David Dobson,** 157 Linden Ct., Newbridge, Monmouthshire, England

[22] Filed: **June 27, 1974**

[21] Appl. No.: **483,501**

[52] **U.S. Cl.** **118/49**

[51] **Int. Cl.** **C23c 13/08**

[58] **Field of Search** ..... 118/48–50.1; 117/119, 106–107.2, 93–93.44; 34/92; 312/15, 37, 39; 62/268–270; 15/347; 128/214; 159/28 R, 28 C; 68/20; 21/91, 96

[56] **References Cited**

UNITED STATES PATENTS

1,299,618	4/1919	Robinson	62/268
1,304,379	5/1919	Row et al	159/28 C X
2,343,886	3/1944	Cornell, Jr.	159/13 B UX
2,852,416	9/1958	McNary et al.	118/49 X
3,473,954	10/1969	Mattson	118/48 X
3,526,206	9/1970	Jones	118/49.1
3,590,776	7/1971	Tudor	118/50.1 X

OTHER PUBLICATIONS

Bakish, *Introduction to Electron Beam Technology*, Wiley & Sons, N.Y., (1962), TK7835-B3-C2,Gp160, pp. 115, 120, 121.

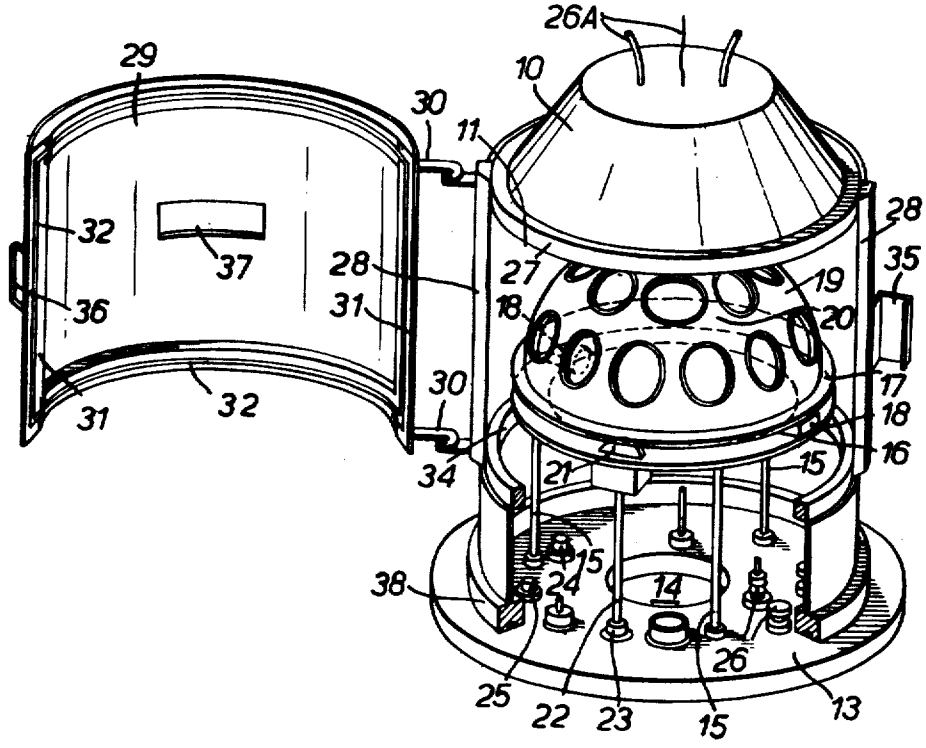
Primary Examiner—Morris Kaplan

Attorney, Agent, or Firm—Pollock, Philpitt & Vande Sande

[57] **ABSTRACT**

A vacuum enclosure for use in vacuum deposition, having an internal workholder to support the article being treated, and a hinged semi-cylindrical side door which can be swung open to give access to the interior and will seal against the main wall of the enclosure, and against the top and base plates. The main enclosure is also semi-cylindrical thus defining a cylindrical space around the circular workholder. Where the edges of the side door and main enclosure meet, flanges are provided at an angle of preferably 30° from the tangent to the cylindrical enclosure and a sealing ring extends all the way around a door where it closes onto the enclosure and especially down the angled side edges.

5 Claims, 6 Drawing Figures



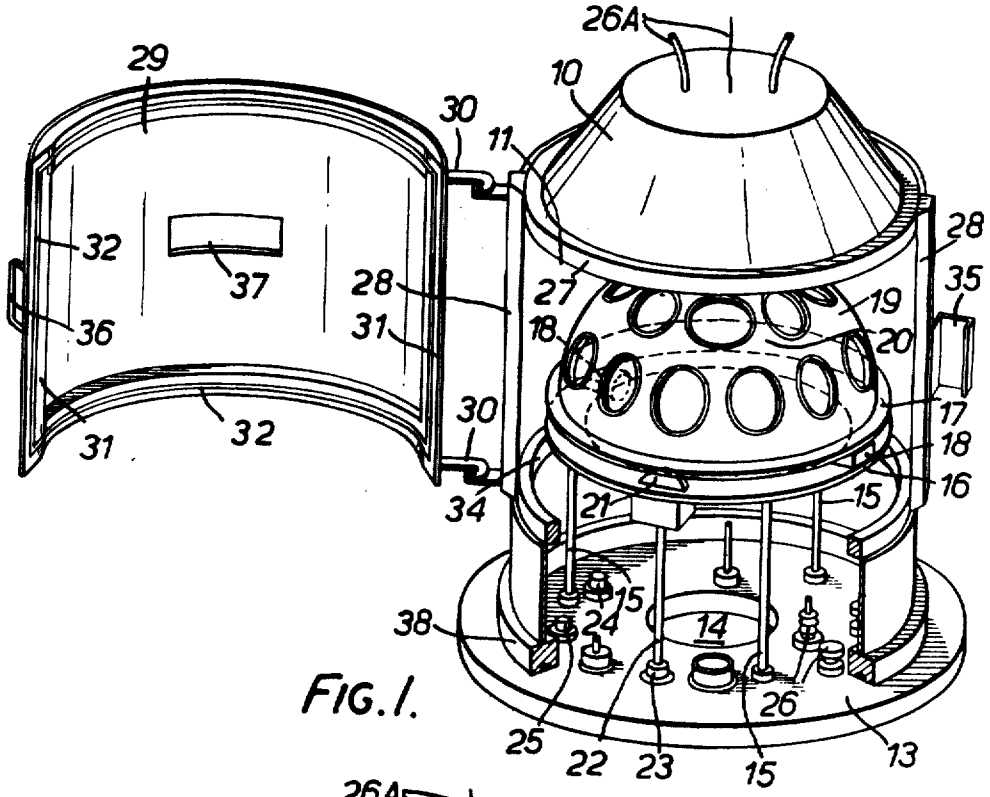

26A
29
10
30
11
28
35
32
37
28
27
19
36
31
18
20
30
17
31
32
18
34
16
21
15
15
38
24
14
26
25
22
23
15
13

FIG. 1.

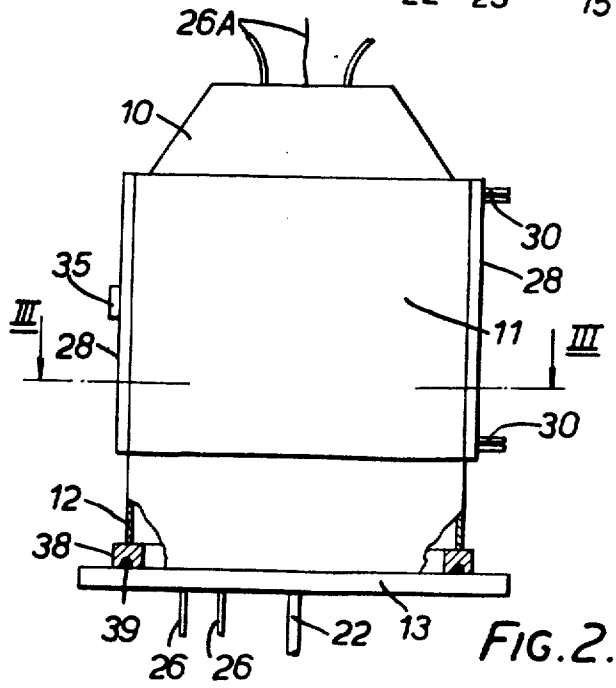

26A
10
30
35
28
III
28
11
III
30
12
38
39
26
26
22
13

FIG. 2.

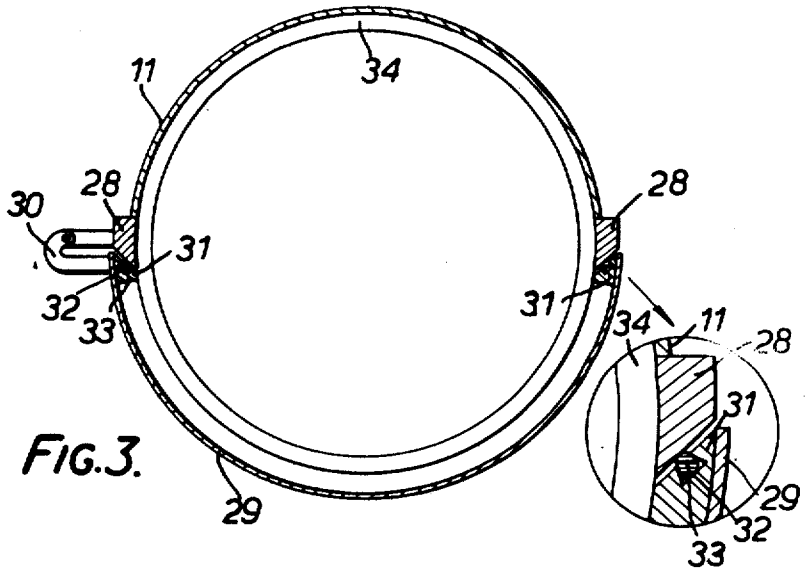


FIG. 3.

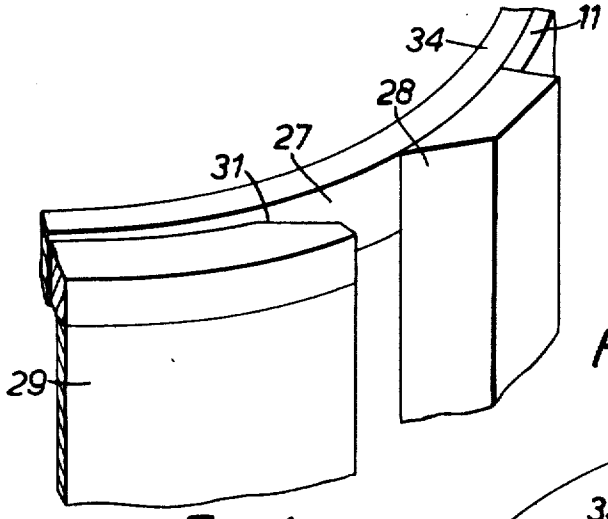


FIG. 4.

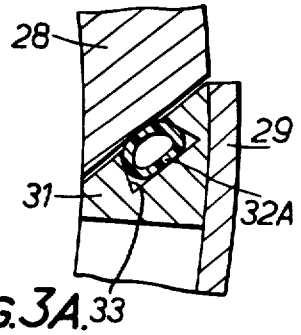


FIG. 3A.

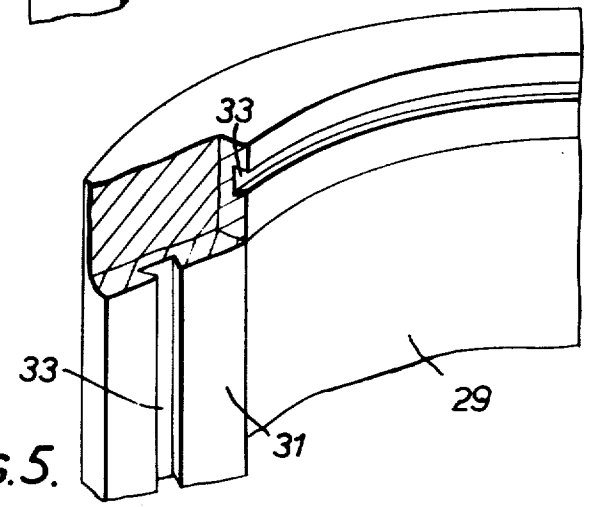


FIG. 5.

ENCLOSURES FOR VACUUM COATING

This invention relates to vacuum enclosures for use in high vacuum coating techniques, as used for example in the production of semi-conductors, and also certain optical products, and also for example in the application of thin metal layers on to glass or synthetic plastic products.

Conventional vacuum enclosures for such processes comprise a glass bell jar arranged to fit on and be sealed to a base plate by a rubber sealing ring. The base plate may have a number of apertures or fittings to accommodate the various services required within the enclosure, such as low and high voltage supplies, mechanical drives, and couplings for gas supply ducts. It is also known to use bell jars fabricated from other materials which can be water cooled and thus able to operate at higher temperatures. Bell jar type enclosures have two main disadvantages owing to the fact that the jar normally has to be raised vertically off the work pieces and all the ancillary equipment mounted on the base plate; firstly it is necessary to provide a hoist to raise the jar, and also accurate guides to avoid damaging the work pieces, and secondly the use of a hoist requires considerable overhead clearance which can be very inconvenient.

Accordingly it is an object of the invention to provide an improved vacuum enclosure which will avoid at least some of the disadvantages of conventional bell jar type enclosures which have to be lifted off the internal structure or mechanism of the vacuum treatment equipment, but which will enable adequate access to the internal structure, whilst ensuring that good vacuum seals are formed during the evacuation step of the process.

In accordance with this object, the invention provides a cylindrical vacuum enclosure for vacuum coating processes comprising a main body portion of part-cylindrical form including part of the side wall of the cylindrical enclosure which is shaped to define a lateral opening extending around substantially **180°** of the periphery of the cylindrical enclosure, said enclosure including top and bottom circular plates, said bottom plate defining apertures to accommodate electrical, mechanical or other inputs to the enclosure, said top and bottom plates connected to said main body portion with an air-tight seal, a workholder within said enclosure arranged to support devices for coating, and means for supporting and rotating said workholder, a movable access closure member of approximately semi-cylindrical shape arranged to form a seal with the body portion around said lateral opening, mutually co-operating vertical flanges being provided between said body portion at the two sides of the lateral opening and at the two sides of the closure member, the mutually cooperating flanges being provided at an angle of from **15°** to **60°** from the tangent to the side wall of the cylindrical enclosure and to the closure member respectively, a hinge for the closure member provided between one pair of said mutually cooperating flanges on one said side, and a locking flange on the other pair of flanges for retaining the closure member in sealing relationship to the peripheral walls of the opening in the body portion, and a sealing ring between the cooperating surfaces of the closure member and the peripheral walls of the opening in the main body.

It will be understood that the term "vacuum enclosure" as used herein does not necessarily imply that the enclosure is complete: it may be designed to combine with another element to form the actual vacuum vessel, as for example a bell jar combines with a base plate to form the complete sealed chamber.

By forming the whole enclosure as a cylindrical shape this minimises the wasted internal volume, and maximum accessibility, effective sealing, and minimum wasted volume are achieved by forming the closure member in the semi-cylindrical shape.

Ideally the edges of the door and the enclosure, where they meet, are provided at an angle from the tangent at the meeting point of no greater than **45°** and the specifically preferred angle is **30°**. If such an angled arrangement was not provided, but the door was allowed to meet the enclosure by overlapping, any seal present between the overlapping portions would be subjected to a sliding motion which would probably result in dislodging of the seal from the groove in which it sits. Conversely if the meeting surfaces where the seal is provided are formed in a radial direction of the enclosure it is possible that the seal may not be made in a positive manner. I have discovered that by forming the surfaces at an angle, as in the claimed invention, the seal is subjected to a slight sliding action which is initially effective to press the seal into a lozenge shape so that good sealing contact between the two surfaces is achieved. Because of the angle, however, the sliding movement during closing is only for a short distance and thus the seal is not sufficiently deformed to cause the seal to be torn out of the groove in which it sits. By this arrangement a very positive seal is achieved upon closure of the door and this is even further enhanced if the sealing ring is of hollow cross-section.

Both the body portion and the closure member may be formed of metal, for example stainless steel, which minimises contamination within the vacuum chamber.

The invention may be performed in various ways and one particular embodiment will now be described, by way of example, with reference to the accompanying drawings, in which:

FIG. 1 is a partly cut-away general perspective view of a vacuum enclosure according to the invention with the access door open,

FIG. 2 is a rear view of the enclosure with the door closed,

FIG. 3 is a horizontal cross-section on line III — III of FIG. 2 showing the door sealing arrangement,

FIG. 3A is a detail of FIG. 3 illustrating a modified sealing ring,

FIG. 4 is a perspective view of interengaging parts of the door sealing arrangement, and

FIG. 5 is a partly cut-away view of part of one of the sealing members showing the sealing ring retaining groove.

In this example the enclosure comprises a main body having a circular domed top plate **10** and a fixed semi-cylindrical side wall **11** extending into a lower cylindrical part **12**, which rests on a bottom plate **13**. This bottom plate **13** is provided with a main opening **14** for connection to a high vacuum diffusion pump system (not shown), in the normal manner. The bottom plate is also provided with sealed couplings or connections for electrical, mechanical, gaseous and other inputs and/or outputs, and supports for appropriate "furniture", i.e. equipment for supporting workpieces within

the vacuum chamber and the equipment for evaporating the substance used for coating. In this particular example the base plate is provided with three support posts **15** carrying a horizontal support ring **16** at their upper ends and on this ring is mounted a further rotary ring **17** located by bearings **18** and having a dome **19** with apertures **20** in which small circular discs or other workpieces can be located. The ring **17** and the dome can be rotated about a vertical axis by a friction wheel **21** driven through a small bevel gearbox from a vertical drive shaft **22** whose lower end passes through a sealed rotary coupling **23** in the base plate. The coupling **23** has a connection below the base plate for attachment to an external rotary drive whereby the dome **19** can be slowly turned during the coating process and while the chamber is subject to vacuum. The metal to be evaporated is contained in a small heated bowl or "boat" (not shown) supported centrally below the dome **19** and connected to an external electrical heater supply through a pair of electrical insulated terminals such as **24, 25** mounted in the base plate **13.** The base plate is also formed with other electrical, mechanical, and/or gas couplings or inputs as indicated diagrammatically for example at **26,** which may be used for different arrangements of furniture for various different vacuum coating processes. The top plate **10** is likewise provided with sealed input/output couplings indicated at **26A.**

The top plate **10** is welded and sealed in a gas-tight manner to a ring **27** which carries, by a gas-tight joint, the half-cylindrical side wall **11,** and this wall is provided with vertical flanges **28** at opposite sides lying on a common diametral plane. The enclosure is completed by a half-cylindrical hinged door **29** hinged to the body on a pair of hinges **30** adjacent one of the vertical flanges **28.** This door also has vertical flanges **31** along both opposite sides to co-operate with the flanges **28** on the body, and a rubber ring **32** of circular cross-section is located in a groove **33** in the internal edge surfaces of the hinged door to seal against the corresponding surfaces of the top ring **27** and a bottom ring **34** and the vertical flanges **28** of the body part when the door is closed.

As can be seen from FIGS. **3** to **5** in particular, the co-operating flanges **28** and **31,** on the wall **11** and the door **29** respectively, are set at an angle; in this case **30°** to the tangent to the cylindrical walls of the wall **11** and door **29.** Thus, when the door is shut, at the final stage of closing, the angled faces of the flanges **28** and **31** will be subjected to a slight sliding action which will be effective to press the sealing ring **32** into a lozenge shape, but the forces on the ring **32** will not be so great as to cause disruption of the ring from its groove **33.** It will be seen incidentally that the groove **33** is so formed that the walls thereof converge towards one another in the direction towards the groove opening so that the ring is held tightly in the groove. It will be appreciated also that a similar sliding-seal action is produced on the sealing ring **32** against the top and bottom rings **27** and **34** as the door **29** closes. Thus a very secure sealing effect is achieved in the region of the flanges **28** and **31** when the door is fully closed to ensure that an adequate sealing may be achieved as is necessary with vacuum chambers.

In use the articles to be treated are inserted in the chamber, and the door **29** is closed, sealed, and located by a catch **35** engaging a fitting **36** on the door. The aperture **14** in the bottom plate is connected in the normal manner to a vacuum pumping system (not shown) for evacuating the chamber and the process of vacuum deposition is then carried out.

It will be appreciated that this enclosure gives a minimum of internal wasted volume when used with circular swept-volume equipment, and a minimum of internal surface area on which contaminents could collect, and also avoids the disadvantages of a bell jar system, while providing excellent accessibility to the internal structure.

The door **29** and side wall **11** may be formed of stainless steel sheet, and provided with a viewing window **37.** In some examples of the invention the door is formed wholly or partly of a rigid transparent material such as glass which allows inspection of the interior but will not have any harmful effect on the vacuum conditions inside the enclosure. The enclosure is separable from the bottom plate **13,** so that it provides in effect a form of bell jar with a hinged side door. Thus the enclosure includes a bottom ring **38** to which the fixed cylindrical part **12** is attached and also a complete annular sealing ring **39** in a groove in the base of the ring **38** to rest on and provide an effective seal with the base plate **13.**

The angles produced by the flanges **28** and **31** are preferably **30°** but good results can be obtained if the angle is no less than **15°** and no greater than **45°** although an angle of up to **60°** is possible.

The hollow sealing ring **32A** shown in FIG. **3A** provides a particularly effective seal.

I claim:

1. A cylindrical vacuum enclosure for vacuum coating processes comprising a main body portion of part-cylindrical form including part of the side wall of the cylindrical enclosure which is shaped to define a lateral opening extending around substantially **180°** of the periphery of the cylindrical enclosure, said enclosure including top and bottom circular plates, said bottom plate defining apertures to accommodate electrical, mechanical or other inputs to the enclosure, said top and bottom plates connected to said main body portion with an air-tight seal, a workholder within said enclosure arranged to support devices for coating, and means for supporting and rotating said workholder, a movable access closure member of approximately semi-cylindrical shape arranged to form a seal with the body portion around said lateral opening, mutually co-operating vertical flanges being provided between said body portion at the two sides of the lateral opening and at the two sides of the closure member, the mutually cooperating flanges being provided at an angle of from **15°** to **60°** from the tangent to the side wall of the cylindrical enclosure and to the closure member respectively, a hinge for the closure member provided between one pair of said mutually cooperating flanges on one said side, and a locking flange on the other pair of flanges for retaining the closure member in sealing relationship to the peripheral walls of the opening in the body portion, and a sealing ring between the cooperating surfaces of the closure member and the peripheral walls of the opening in the main body.

2. A cylindrical vacuum enclosure according to claim **1,** wherein the angle of the co-operating flanges is no greater than **45°.**

3. A cylindrical vacuum enclosure according to claim **1,** wherein the angle of the co-operating flanges is **30°.**

4. A cylindrical vacuum enclosure according to claim 1, wherein the sealing ring defines a hollow cross-sectional shape.

5. A cylindrical vacuum enclosure according to claim 1, wherein the closure member defines a groove for receipt of the sealing ring, the walls of the groove converging towards each other to the outside of the groove.

* * * * *