United States Patent [19]

Patono

[11] **3,850,138**

[45] **Nov. 26, 1974**

[54] **SUBSTRATE CARRYING APPARATUS FOR USE IN COATING EQUIPMENT**

[75] Inventor: **Carlo Luigi Patono**, Turin, Italy

[73] Assignee: **Varian S.p.A. Leini**, Turin, Italy

[22] Filed: **June 22, 1972**

[21] Appl. No.: **265,403**

[52] **U.S. Cl.** **118/49**, 269/57

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

[58] **Field of Search** 118/48–49.5, 118/500, 503, 53; 269/55–57

[56] **References Cited**

UNITED STATES PATENTS

3,523,517	8/1970	Corbani	118/500
3,608,519	9/1971	Richardson	118/48
3,643,625	2/1972	Mahl	118/48
3,675,624	7/1972	Hunts et al.	118/503

OTHER PUBLICATIONS

Deposition Fixturing, Ion Equipment Corp., 1805 Walsh Ave., Santa Clara, Calif. 95050, Copy received 1971.

Primary Examiner—Morris Kaplan

Attorney, Agent, or Firm—Stanley Z. Cole; Leon F. Herbert

[57] **ABSTRACT**

Substrate supporting discs are arranged to travel around a circular path and to rotate about their own axes during such travel. The discs are held spaced from each other by separating arms which are connected to each other. A separable ball and socket contact is formed between each separating arm and its associated substrate supporting disc. The separating arms and their interconnecting structure are supported by said discs and do not contact any other portion of the apparatus during operation. A freewheel drive mechanism permits easy rotation of the apparatus by hand when the drive motor is off.

7 Claims, 4 Drawing Figures

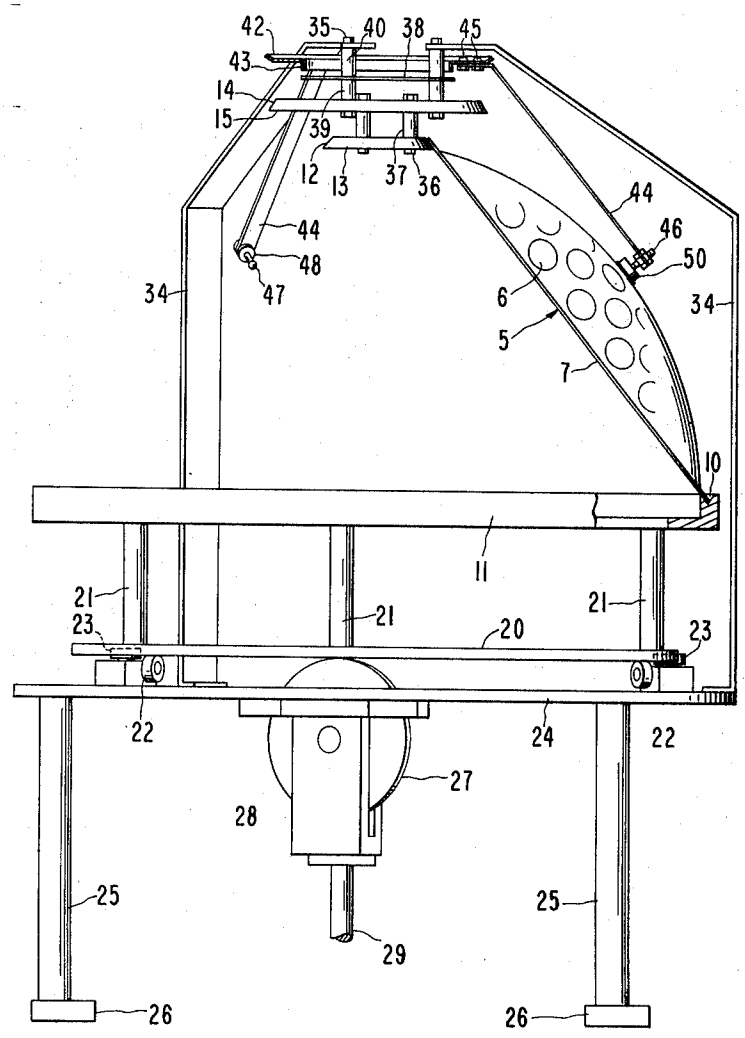
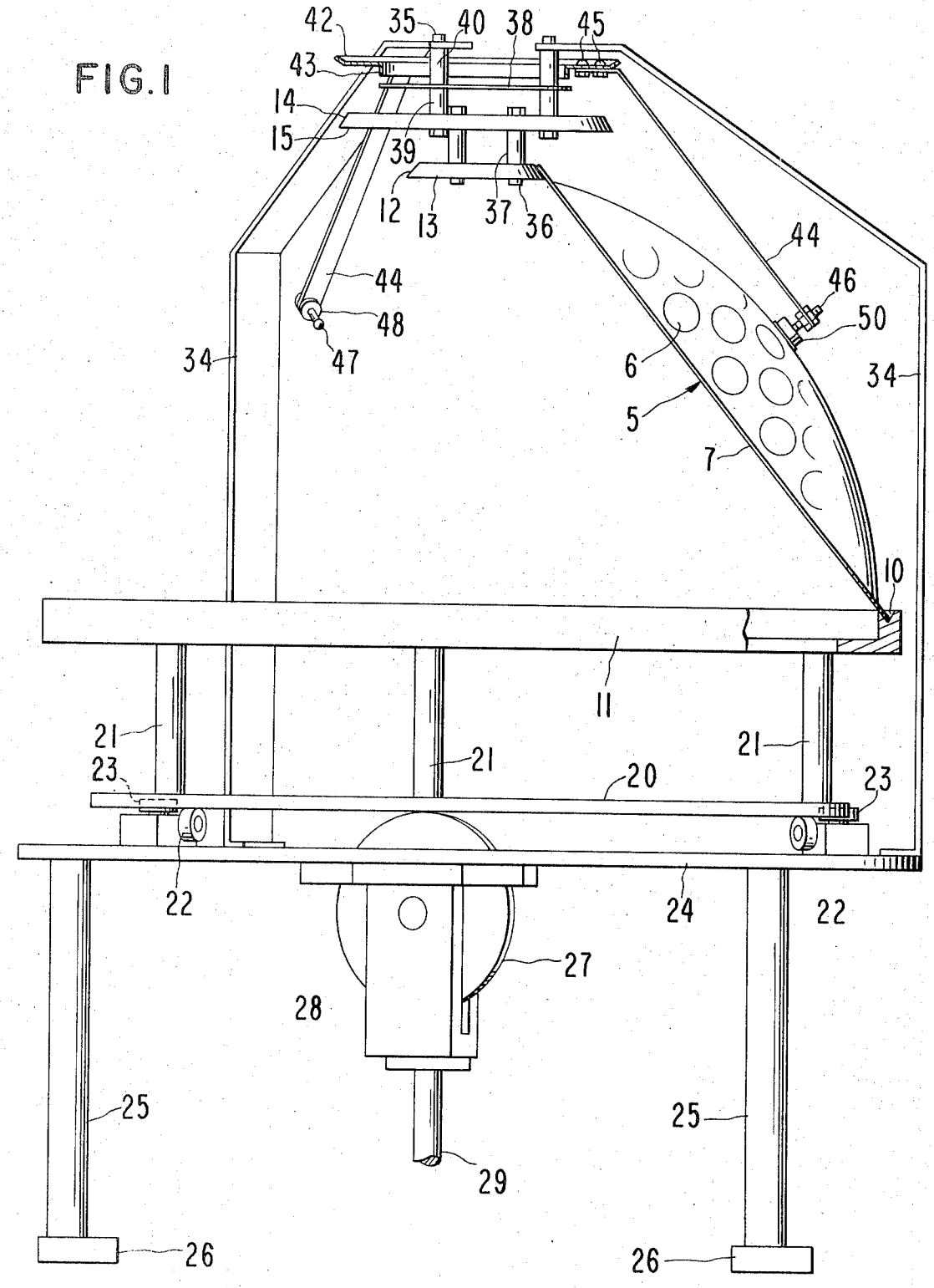


FIG. 1


42
35
40
38
45
43
14
15
39
12
13
37
36
44
48
47
34
44
46
50
6
5
7
34
10
11
21
23
21
21
20
23
22
24
22
27
28
25
29
25
26
26

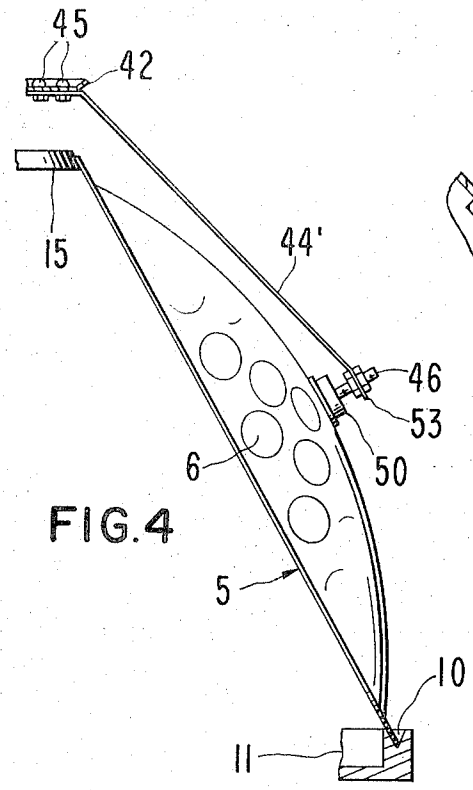


FIG. 4

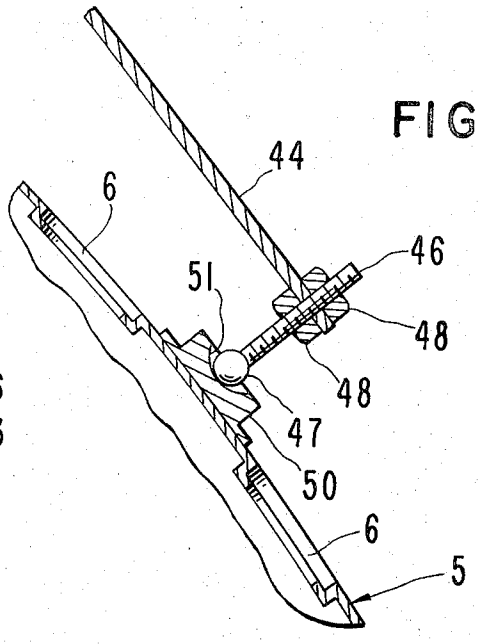


FIG. 3

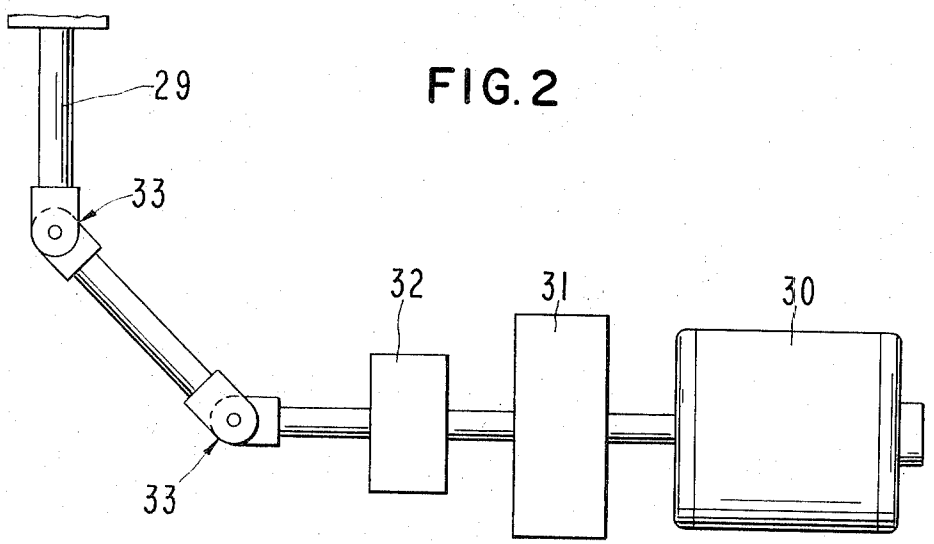


FIG. 2

SUBSTRATE CARRYING APPARATUS FOR USE IN COATING EQUIPMENT

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention is an improvement in the field of supporting and moving substrates in coating equipment.

2. Description of the Prior Art

Apparatus has been provided in which substrate supporting discs are arranged to travel around a circular path and to rotate about their own axes during such travel. However, the prior art devices have not solved the problem of providing movement of the discs in a simple and reliable manner. One reason the problem is difficult to solve is that the apparatus normally operates at high temperature and low pressure and in an atmosphere where coating material tends to coat all surfaces it can reach. All of these conditions make it difficult to create controlled movement of the discs and avoid intolerably high friction forces. Also the prior art devices which included properly geared down drive mechanisms are difficult to move by hand when the operator desires to reach a remote disc when the drive motor is off.

SUMMARY OF THE INVENTION

The object of the invention is to provide a substrate carrying apparatus which overcomes the deficiencies of the prior art. More specifically an object of the invention is to provide controlled movement of the substrate support discs in a reliable and efficient manner which minimizes friction problems. Another object of the invention is to provide a drive mechanism which permits easy movement of the apparatus by hand in the motor-off condition.

The objects of the invention are achieved in a structure which comprises a circular driving track that supports the lower portion of each substrate supporting disc and causes the discs to rotate when the track is rotated. The upper portion of each disc rests on the rim of a support plate positioned concentrically above the track and of smaller diameter. The discs are held in place separated from engagement with each other by separating arms. The upper ends of the separating arms are interconnected with each other, and the lower end of each arm has a ball and socket contact coaxial with its respective disc. During operation the arms and their interconnecting means do not engage any portion of the apparatus except the discs. A freewheel drive mechanism permits easy rotation of the driving track when the motor is off.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an elevational view, partly in section, showing the apparatus according to the invention;

FIG. **2** is a schematic view of the drive mechanism;

FIG. **3** is an enlarged cross section through the ball and socket connection between the separating arms and their respective substrate support discs; and

FIG. **4** shows a portion of FIG. **1** in which a modified separating arm is employed.

DETAILED DESCRIPTION OF THE INVENTION

Referring in more detail to the drawings as shown in FIGS. **1–3**, the apparatus comprises a plurality of substrate support discs **5** each containing a plurality of apertures **6** in which the substrates (not shown) are mounted in conventional manner. The embodiment shown in the drawings is designed for a total of three discs but more or fewer can be used within the scope of the invention. In the drawings only one of the three discs **5** is shown mounted in the apparatus. Each of the discs has a circular peripheral edge **7** which rests in a V-groove **10** which forms a driving track in the rim of a driving ring **11.** The upper portion of each disc rests on the circular support surface **12** of a support plate **13** or the circular support surface **14** of a support plate **15.**

The driving ring **11** is mounted to rotate with a driven ring **20** by means of at least three posts **21** secured to he two rings. Driven ring **20** is supported on at least three roller bearings **22** equally spaced around the ring **20.** Throughout the description where reference is made to at least three items, such as bearings **22,** less than three may appear in the drawing because of sectioning or because one item is behind another or for clarity of disclosure. Ring **20** is constrained to rotate about an axis concentric with its own axis by means of at least three equally spaced roller bearings **23** which engage the outer periphery of ring **20.** The roller bearins are mounted on a base support ring **24** which is in turn supported on at least three posts **25,** each having a leg **26** adapted for mounting on the underlying portions of a conventional coating system, not shown. As is well known by those skilled in the art, such conventional coating equipment includes a source of coating material such as a vapor source usually located on the axis of rotation of driving ring **11.** Rings **11, 20** and **24,** and plates **13** and **15** are all concentric with each other.

Ring **20** is driven by friction engagement with a drive wheel **27** which rotates on a horizontal axis. A conventional gear and bearing box **28** supports the drive wheel **27** and is mounted on the underside of base ring **24.** Gear box **28** houses conventional gearing to convert rotation of a drive shaft **29** from the vertical axis of shaft **29** to the horizontal axis of drive wheel **27.** As shown in FIG. **2,** shaft **29** is driven by a motor **30** through a conventional speed reduction gear box **31** and thence through a conventional freewheel drive **32** and conventional universal joints **33.** The freewheel drive **32** is an important aspect of the apparatus because it permits the operator to turn driving ring **11** by hand when the motor is off, so that the operator can reach a disc **5** which is on the opposite side of the vertical center of rotation of ring **11.** Gear box **31** contains extremely high reduction gearing so that if it were necessary to turn the motor by hand via drive ring **11** and the reduction gearing, it would be extremely difficult. Thus it is important to have the freewheel drive **32** or similar mechanism which disconnects the gear box **31** from the driving ring **11** when the motor is off, and thus permits easy rotation of driving ring **11** by hand in the motor-off condition. It will be understood that the reduction gearing is directed such that shaft **29** turns much more slowly than the motor shaft.

Returning to the means for supporting the discs **5,** the support plates **13** and **15** are carried by at least three support arms **34** mounted on the base support ring **24.** For clarity of disclosure the nearest arm **34** is not shown. A bolt **35** extends downwardly from the top of each support arm **34** and carries the support plate **15.**

Support plate **13** is mounted from support plate **15** by means of at least three bolts **36** surrounded by spacing collars **37.** A circular heat shield plate **38** is also mounted on bolts **35** by means of spacing collars **39** and **40.**

The operation of the apparatus thus far described is as follows. Motor **30** turns the driving ring **11** in the manner previously described. The frictional engagement between the bottom of each disc **5** and the drive ring **11** causes the discs to move around the axis of the driving ring and also rotate about their own axes. In order to assure free and uniform rotation of the disc **5,** it is necessary to hold the discs spaced slightly from each other so that frictional engagement between the discs does not hinder their desired movement. It is also desirable to bias the discs **5** slightly inwardly to prevent any tendency to move outwardly as they rotate around the axis of drive ring **11.** According to the invention these objectives are achieved in a very simple and efficient manner as will now be described.

An apertured ring **42** is loosely positioned around bolts **35** above the support plate **15.** In order to provide rigidity to the ring **42** it has a downwardly projecting rim **43** around the periphery of its central aperture. Spring metal separating arms **44** equal in number to the desired number of substrate support discs **5** are attached at their upper ends to the ring **42** and extend downwardly and radially outward therefrom in equally spaced arrangement. Each arm **44** is attached to the ring **42** by two short bolts **45.** As shown in detail in FIG. **3,** the free end of each arm **44** carries a threaded shaft **46** having a spherical ball **47** at its lower end. Shafts **46** are connected to their respective support strips by nuts **48.** A socket member **50** is secured to each of the support discs **5** by welding or other suitable means and is provided with a spherical recess **51** preferably having a radius of curvature larger than the radius of curvature of ball **47.** The socket members are adapted to receive the balls **47** to form in effect a ball and socket bearing. The socket members **50** are positioned so that the center of the recess **51** is coaxial with the center of its disc **5.** When it is desired to remove a disc the operator simply flexes the strap shaped arm **44** outwardly and upwardly. The reverse operation permits the operator to insert a disc. When all of the discs **5** are removed, apertured ring **42** moves downwardly to rest on the heat shield **38.**

The means for supporting discs **44** is adapted for use whether the discs **5** are positioned against the small diameter plate **13,** as shown in FIG. **1** or are positioned against the larger diameter plate **15.** One way of accomplishing the change and still assure that the axis of shaft **46** will be exactly coaxial with the axis of its associated disc **5,** is to replace arms **44** with arms **44'** by removing and replacing small bolts **45.** As shown in FIG. **4,** arms **44'** are slightly longer than arms **44** and have an inwardly bent portion **53** at their lower ends.

It should be understood that when the apparatus is in operation the apertured ring **42** is not in contact with any other portion of the apparatus and is thus free to rotate without any frictional resistance. The ring **42** and arms **44** or **44'** are supported entirely by the balls **47.** This is important because, as is well known to those skilled in the art, conventional coating apparatus normally includes a heater located above support arms **34** to heat the substrates to a very high temperature for cleaning or stress relieving prior to deposition of the coating. The very high temperatures associated with this heating step and the extremely low pressure atmosphere in which the deposition is carried out are extremely detrimental to the functioning of normal bearings, particularly those which are located up near the heater as would be the case if apertured ring **43** were mounted on a bearing at its center. It should also be understood that the ball and socket contacts **47, 51** carry very little load and are not the conventional closed, tight tolerance type of structure which is normally employed as a bearing. Therefore the ball and socket contacts are less subject to the binding effects of high temperature and low pressure atmosphere.

What is claimed is:

1. Apparatus for carrying substrates comprising means forming a circular driving track, a plurality of substrate supporting discs each having a circular rim supportable on said track, support means above said track having a circular support surface positioned so that when the lower portion of each said disc rests on said track the upper portion of each said disc rests against said support surface, means for rotating said track, positioning means for holding said discs in fixed spacial relation to each other as they travel around the axis of said track, said positioning means comprising a positioning arm for each of said discs, means interconnecting the upper ends of said arms, a first bearing contact surface on the lower portion of each of said arms, a second bearing contact surface on each of said discs and engageable by one of said first bearing contact surfaces, said first bearing contact surfaces being disengageable from said second bearing contact surfaces by outward movement of said first bearing contact surfaces relative to said second bearing contact surfaces, said arms being flexible in an outward direction to accomplish said disengagement of said first and second bearing contact surfaces, an abutment surface positioned below said interconnecting means to support said interconnecting means when said discs are removed, and said interconnecting means being spaced above said abutment surface when the bearing surfaces on said arms engage the bearing surfaces on said discs.

2. Apparatus as claimed in claim **1** in which one of said first and second bearing surfaces is concave and the other is convex.

3. Apparatus as claimed in claim **1** in which said bearing surfaces are held in contact with each other by the weight of said arms and said interconnecting means.

4. Apparatus as claimed in claim **1** in which each said second bearing surface is concentric with the center of its respective substrate supporting disc.

5. Apparatus as claimed in claim **1** in which one of said first and second bearing surfaces is concave and the other is convex, said second bearing surface is concentric with the center of its respective substrate supporting disc, and the unit formed by said arms and said interconnecting means is supported by said discs and when so supported is out of contact with any portion of said apparatus other than said discs.

6. The apparatus as claimed in claim **1** in which said driving means comprises a motor, gear reduction means, and freewheel drive means between said gear reduction means and said driving track.

7. Apparatus as claimed in claim **5** in which said first bearing surface has a radius of curvature which is smaller than the radius of curvature of said second bearing surface.

* * * * *