

Oct. 15, 1968

E. E. CONRAD

3,406,041

METHOD AND APPARATUS FOR DEPOSITING PARTICLES ONTO AN OBJECT

Filed March 8, 1965

2 Sheets-Sheet 1

FIG. 1

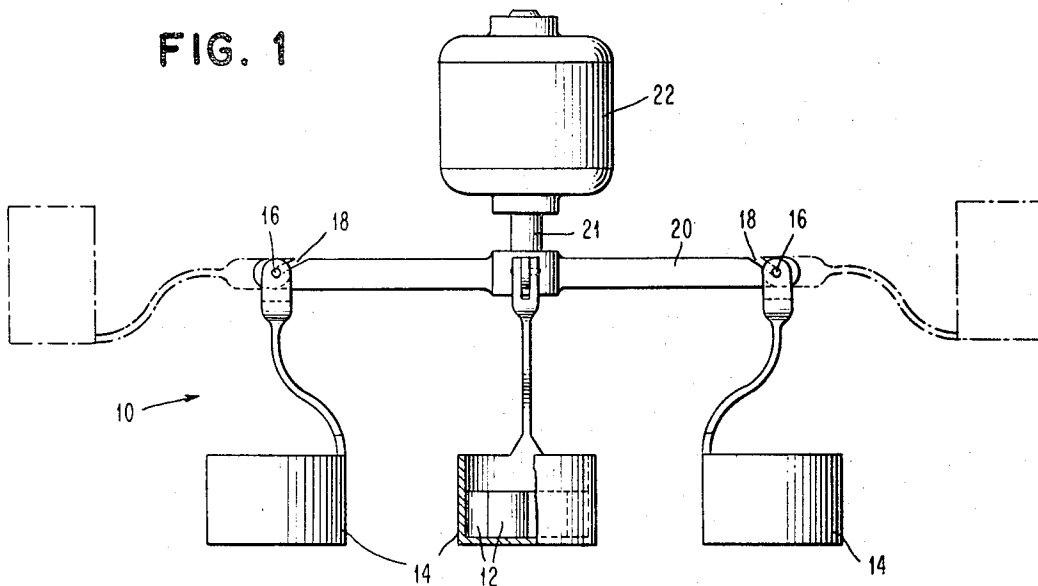


FIG. 2

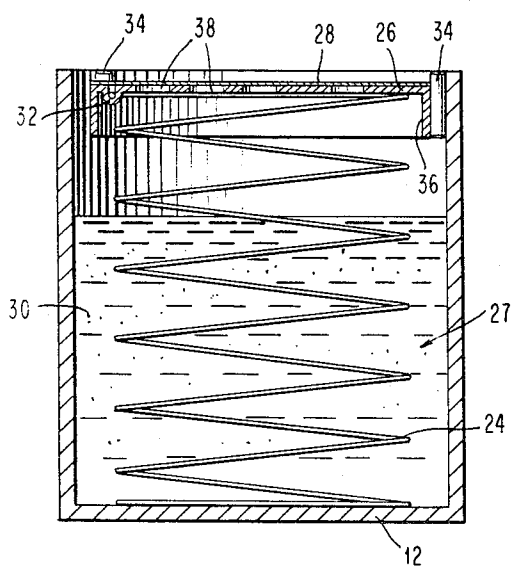
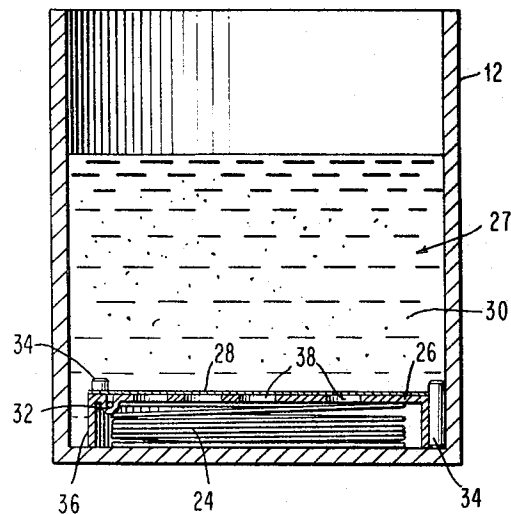


FIG. 3



INVENTOR
ERNEST E. CONRAD

BY *Harry M. Weiss*
ATTORNEY

Oct. 15, 1968

E. E. CONRAD

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2 Sheets-Sheet 2

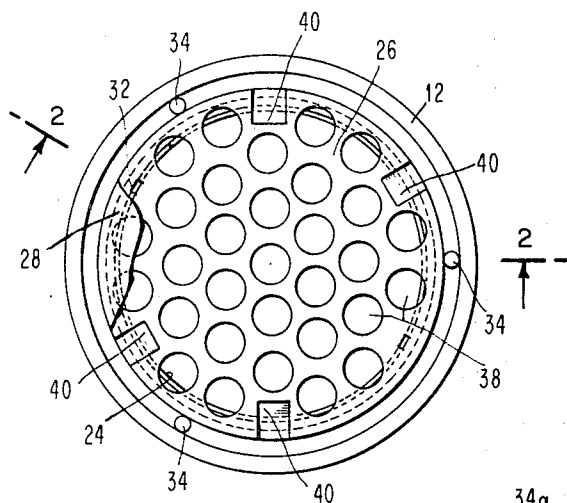


FIG. 4

FIG. 5

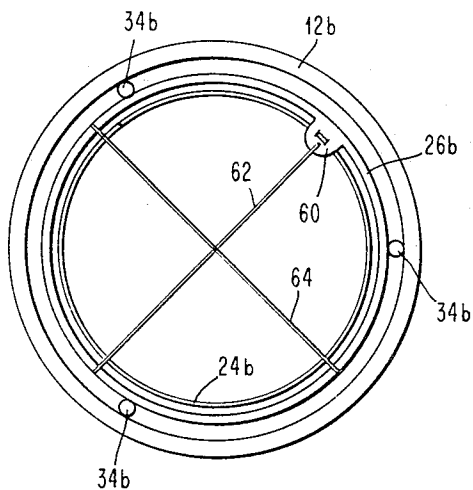
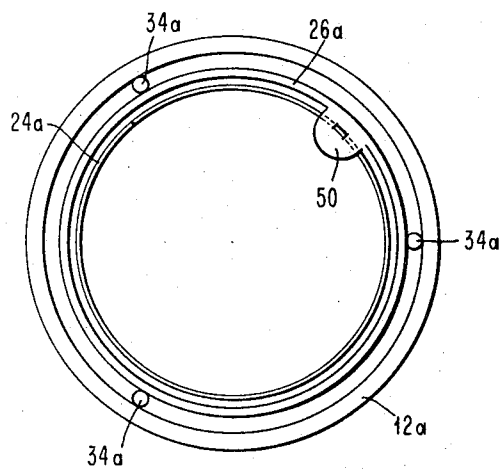


FIG. 6

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METHOD AND APPARATUS FOR DEPOSITING PARTICLES ONTO AN OBJECT

Ernest E. Conrad, Clinton Corners, N.Y., assignor to International Business Machines Corporation, Armonk, N.Y., a corporation of New York
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14 Claims. (Cl. 117—101)

ABSTRACT OF THE DISCLOSURE

A method and apparatus for depositing particles onto an object which involves centrifuging the object and an enveloping fluid containing the particles to be deposited on the object for a period of time and with a force sufficient to deposit particles in the fluid onto the object. The object is supported so as to be movable relative to the fluid depending upon the centrifugal force on the object. The centrifugal force on both the object and the fluid is reduced after the deposition process is completed which causes the object, with the particles uniformly deposited thereon, to move out of the fluid before termination of the centrifuging force.

This invention is directed generally to a method and apparatus for depositing particles onto an object and, more particularly, to a method and apparatus for depositing glass particles onto an object and subsequently forming a thin, hole-free, glass film thereon.

It is often desirable to deposit particles of a particular substance onto an object to create a new or improved product which has enhanced qualities. In manufacturing cathode ray tubes, for example, it is often desirable to form the screen by depositing fluorescing powdered material sensitive to electron beam bombardment on the face of a cathode ray tube. The deposited powdered material is generally deposited with a binder substance to adhere the powdered material to the face of the cathode ray tube, however, the binder material can be applied to the powdered material after its deposition on the face of the cathode ray tube.

In many situations it is desirable to deposit particles onto an object and fuse or join the deposited particles to form a coating on or about the object. In the manufacture of various electrical components such as resistors, capacitors and semiconductor devices, it is often necessary to provide a tightly adherent protective jacket which serves as a hermetic seal and prevents the contamination of the components by foreign or noxious materials which may impair the electrical characteristics of the device or may physically damage them so as to render them unsatisfactory or worthless. A wide variety of coating materials such as plastic and glass have been employed with some success and some of these coating materials have been formed by fusing or joining particles deposited on the components.

The present trend in the electronic computer fields is toward the miniaturization of semiconductor or solid state components, i.e., integrated or monolithic circuits. Accordingly, only thin protective coatings are practical since thick protective coatings undesirably increase the bulk of such components and often such thick jackets are subject to cracking during use over a range of operating temperatures.

Two U.S. patent applications entitled "Method of Forming a Glass Film on an Object and the Product Produced Thereby" and "Method of Forming a Glass Film on an Object," whose respective serial numbers and filing dates are S.N. 141,668, now Patent No. 3,212,921, and S.N. 181,743, now Patent No. 3,212,929, filed Sept. 29,

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1961, and Mar. 22, 1962, and assigned to the same assignee of this invention, relate to techniques for forming thin glass films on an object for the purpose of providing a hermetic seal or coating therefor. Both of these above-identified applications use centrifuging techniques for depositing glass particles onto the object and a glass film is then formed on the object by fusing or joining the deposited glass particles.

The essential step in forming a uniform, hole-free, thin glass film on an object is to deposit a smooth layer of particles onto the object and maintain the smooth deposited layer during the entire centrifugation process. In prior art centrifuging operations for depositing particles onto an object, it was the common practice to decant the liquid from the centrifuged container which caused the liquid to flow over the surface of the object located at the bottom of the container and thereby caused some of the deposited particles to flow with the liquid. This action is termed "running" and produces an uneven coating of glass particles. Hence, it was a problem to retain a smooth deposited layer on the object after the centrifuging process because of the "running" effect caused by decanting the liquid.

In addition, during the slowing down of the centrifuging apparatus after the particles had been smoothly deposited on the object, the container, housing the object upon which the particles had been deposited, attains a centrifuging position which is, for a period of time, at an angle with respect to both the horizontal and vertical planes. Consequently, with the container in this position, the level of the fluid in the container is not perpendicular to the side wall of the container but is at an angle with respect to the side wall of the container so that a vortex motion of the fluid, due to the position of the container between horizontal and vertical planes and the angle of the fluid level, disturbs the smooth coating of deposited particles on the object. Therefore, the smooth deposited particle layer that was initially created in the beginning of the centrifuging process was not consistently achieved by the end of the process because of the vortex effect naturally caused by the centrifuging arrangement and also because of the "running" effect from decanting the fluid.

Furthermore, in past centrifuging operations for depositing particles onto an object, the object was generally dropped into the centrifuging container so that on occasion, the object turned over before resting on the bottom of the container which necessitated removal of the object from the container since particle deposition would not occur on the desired surface of the object. After the object was properly located at the bottom of the centrifuging container and after decanting the fluid from the container, when the centrifuging process was terminated, it was generally necessary to heat the bottom of the container so as to evaporate a film of fluid which formed between the object and the bottom of the container. This heating step was time consuming, but was essential for removing the object from the container since the surface tension of the film of fluid caused the object to adhere to the bottom of the container.

Accordingly, it is an object of this invention, therefore, to produce a new and improved method for depositing particles onto an object.

It is another object of this invention to provide an improved centrifuging apparatus for depositing particles onto an object.

It is a further object of this invention to provide an improved method and apparatus for depositing glass particles onto an object for the purpose of producing a hermetically sealed glass coating that would prevent contamination of the object.

It is an additional object of this invention to provide an arrangement for keeping an object that particles are

to be deposited thereon out of the fluid containing the particles both before the beginning and ending of a centrifuging particle depositing process and thereby avoid the effect of vortex fluid motion and eliminate decanting of the fluid to reach the object.

It is a still further object of this invention to provide an arrangement which permits rapid removal of an object, on which particles have been deposited, from a container after a centrifuging process.

In accordance with a particular form of the invention, the method of depositing particles onto an object comprises centrifuging the object and an enveloping fluid containing the particles to be deposited on the object for a period of time and with a force sufficient to deposit particles in the fluid onto the object. The object is uniquely supported so as to be movable relative to the fluid depending upon the centrifugal force on the object. The centrifugal force on both the object and the fluid is reduced after the deposition process is completed which causes the object, with the particles uniformly deposited thereon, to move out of the fluid before termination of the centrifuging force.

Also in accordance with the invention there is provided an apparatus for depositing particles onto an object which includes a container having a fluid containing the particles suspended therein. Support means are located in the container for supporting the object from the bottom of the container. The support means are resilient and adapted to move within the container relative to the fluid depending upon the centrifugal force on the resilient support means. Means are provided for centrifuging the container to deposit particles from the fluid onto the object supported by the support means. The centrifuging means cause the resilient support means to be compressed and thereby move the object into a position in the container for receiving particles from the fluid. The object is suspended above the fluid by the resilient support means before the beginning and the ending of the centrifuging of the container.

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of preferred embodiments of the invention, as illustrated in the accompanying drawings.

In the drawings:

FIG. 1 is a diagrammatic representation of a centrifuging apparatus employed in depositing glass particles on objects with parts of one container broken away to show the arrangement of smaller containers therein;

FIG. 2 is a cross sectional view of one of the smaller containers of FIG. 1 showing the object located on a spring supported platform;

FIG. 3 is a view similar to FIG. 2 showing the object and spring supported platform during particle deposition from centrifuging;

FIG. 4 is a top view of the platform and container of FIG. 2 with most of the object broken away to show the platform configuration; and

FIGS. 5 and 6 are top views similar to FIG. 4 with objects removed to show other platform configurations.

In practicing the present invention, a suitable glass is comminuted as by ball milling to form a powdered glass. Many different types of glasses are suitable for use in accordance with the method of the present invention. The type of glass selected may depend upon the particular application at hand. For example, the object to receive a thin, hole-free, glass film of uniform thickness may require a chemical resistive glass such as borosilicate type glass for protective purposes and for withstanding high operating temperature. Also the object may be a device such as a transistor which may dictate that, for protective purposes, the coefficient of thermal expansion of the semiconductor material of the device and that of the glass film be substantially equal so as to minimize stresses which might otherwise crack the glass during temperature cycling. For example, silicon has a coefficient of expansion per degree centigrade of 32×10^{-7} , which is closely matched by that of a borosilicate glass available to the trade as Corning 7740 or Pyrex and having a coefficient

of expansion of 32.6×10^{-7} . The ball milling operation produces small particles of glass of varying size. The powdered glass from the ball milling procedure is then introduced and dispersed in a suitable fluid suspending medium. An organic fluid such as methyl alcohol is one of many which are satisfactory for this purpose. Other appropriate fluids are ethyl alcohol, isopropyl alcohol, acetone and water. Ultrasonic agitation is particularly useful in dispersing particles in this suspending medium.

Next it is now desirable to remove the larger glass particles from the suspension since they are ordinarily too large for use in subsequent filming operations. This may be accomplished with a centrifuging apparatus 10 such as that represented diagrammatically in FIG. 1. To that end, the suspension of glass particles is placed in twenty-eight containers 12, seven of which are mounted in each of four carriers 14 that are supported by trunnions 16 in slots 18 in a transverse member 20 that is mounted in a horizontal plane at the end of a drive shaft 21 of a variable speed motor 22. Rotation of the motor for a few minutes at a relatively low speed develops a centrifugal force of from about 15 to 100 times the force of gravity g which swings the carriers 14 and their containers 12 to the broken-line positions represented in FIG. 1 and separates out the larger glass particles in the suspension by depositing them on the bottoms of the containers. When the machine comes to rest, the containers 12 may be removed and the suspension decanted leaving behind the undesirable larger particles. The suspension is then placed in other containers and again centrifuged at a higher speed to develop say 500 g . to separate out the desired finely divided glass particles. It will be appreciated that these speeds of rotation may be varied from that indicated depending upon the particle size separations which are desired. The last-mentioned suspending fluid is decanted leaving the desired finely divided glass particles. The suspension which had been decanted in this last step contains extra fine glass particles which are not always desirable in subsequent operations and may contain unwanted impurities that were picked up in the ball-milling operation.

The desired glass particles are removed from their containers and may be dried on a hot plate to which mild heat is applied or they may be dried in a desiccator at room temperature. Then a suspension is made by ultrasonically mixing the dried glass particles in a fluid suspending medium. 0.02 to 0.1 gram of the glass particles in 100 cc. of the suspending medium has proved to be a useful concentration although other concentrations may be employed. The glass particles are probably irregular in shape and may have a selected mean particle size in the range of 0.1 to 2 microns. Better results may be obtained by using the smaller particle sizes. A selected mean particle size in the range of 0.1 to 0.7 micron has been employed with particular success in forming glass films having uniform thicknesses in the range of 0.8 to 10 microns on substrates of semiconductor and insulating material.

The suspending medium is an organic fluid having a dielectric constant in the range of 3.4 to 20.7. Various suspending media which have proved satisfactory are methyl alcohol, ethyl acetate, isoamyl acetate, tertiary butyl alcohol mixed with a slight amount of secondary butyl alcohol to maintain the former fluid at room temperature, isopropyl alcohol, acetone and methyl ethyl ketone. Various mixtures of the recited fluids and also mixtures of those fluids with one or more of the fluids benzene, hexane, petroleum ether and methyl alcohol may be employed. Also mixtures of methyl alcohol and either benzene, hexane and/or petroleum ether have also proved satisfactory. A few examples of appropriate such mixtures are 73 cc. of normal hexane and 27 cc. of acetone producing a dielectric constant of about 7. 69 cc. of normal hexane and 31 cc. of isopropyl alcohol producing a dielectric constant of 7 have also given good results. A mixture of 9 cc. of isopropyl alcohol and 91 cc. of isoamyl acetate producing a dielectric constant of 6 has been satisfactory. 5-15 parts of isopropyl alcohol and 95-85 parts of ethyl

acetate have provided excellent results. A four-component mixture of 10 cc. of isopropyl alcohol, 3 cc. of secondary butyl alcohol, 64 cc. of tertiary butyl alcohol, and 23 cc. of benzene have afforded a dielectric constant of 10 and good results. Best results in the terms of the most uniform glass films have been obtained using suspending media having dielectric constants in the range of 6 to 12. However, when other values of dielectric constants are employed, multiple coats of the glass film have proved effective to avoid pin-hole difficulties. Excellent results have also been obtained when the suspending medium for the glass particles, having a mean particle size of about 0.1 to 0.7 micron, consists of 10 parts of isopropyl alcohol to 90 parts of ethyl acetate. The dielectric constant of that fluid mixture is about 7.2 and its viscosity is about 0.6 centipoises. Materials such as isopropyl alcohol and acetone have higher dielectric constants than fluids such as the organic esters, ethyl acetate and amyl acetate or a pure hydrocarbon such as n-hexane. The use of a high dielectric constant fluid which is miscible in a low dielectric constant fluid as the suspending medium for the glass particles is advantageous. The dry glass particles are first ultrasonically mixed with the higher dielectric constant fluid. Any agglomerates which are already present in the dry particles will have a greater tendency to break up and go into suspension. It is believed that the colloidal particles of glass acquire a high electric charge in the higher dielectric constant medium, repel each other more, and thus tend to form a better colloidal suspension. When the lower dielectric constant fluid is added to the suspension just described, the particles still remain in suspension. When the glass particles are first suspended in isopropyl alcohol as explained above, excellent films are obtained. The alcohol also removes water which may be physically absorbed on the glass particles. Another fluid mixture which has afforded good results is one containing 95% tertiary butyl alcohol and 5% secondary butyl alcohol. The important component in this mixture is the tertiary butyl alcohol, the secondary butyl alcohol being used to keep the former in a liquid state since its freezing point is 26° C.

If desired, suspensions prepared according to the teachings of U.S. patent application S.N. 181,743, filed March 22, 1962, entitled "Method of Forming a Glass Film on an Object" may also be used with an increase in the dielectric constant of the fluid.

In the next step, a spring 24 supporting a platform 26 is placed in a clean container 12 together with a quantity of the colloidal suspension 27 of the desired glass particles sufficient to cover approximately two-thirds of the height of the spring 24. Mounted on each platform 26 is an object 28 on which glass particles 30, suspended in the fluid or suspension 27, are to be deposited. The platform 26 and object 28 are suspended above the fluid 27 by means of the spring 24. The containers 12 are placed in the centrifuge and a centrifuging operation is conducted for a period of time and with a force sufficient to compress the spring 24 and move the platform 26 and the object 28 to the bottom of the container 12.

The spring 24 and the platform 26 are selected by strength and weight, respectively, to permit complete compression of the spring at the proper centrifugal force. In one example, the platform 26, object 28, and spring 24 had a combined weight of 5.32 grams and the spring 24 exhibited complete collapse at a centrifugal force of about 12 g. Accordingly, since a centrifugal force of about 6 g. is needed to lift the carrier 14 into a horizontal position, the spring 24 is not compressed until after the carrier 14 is in a horizontal position. The spring 24 compresses when the centrifugal force approaches 12 g. and the platform 26 with the object 28 located thereon move slowly to the bottom of the container 12. The fluid 27 with the glass particles 30 flows around the platform 26 since the platform 26 is spaced from the side wall of the container 12.

At a centrifugal force of approximately 64 g., glass

particles 30 from the fluid 27 start to deposit onto the surface of the object 28 which is now located at the optimum position for receiving particles, namely, near the bottom of the container 12. Therefore, since the spring 24 collapses at a force of approximately 12 g., the glass particles 30 from the fluid 27 are deposited on the object 28 after the collapse of the spring 24.

The centrifuging operation necessary to deposit the glass particles 30 onto the object 28 is ordinarily conducted for 1 to 2 minutes at a speed sufficient to develop a centrifugal force of 1000 to 2500 g. The centrifuging time and speed are not critical. Slow speeds ordinarily require a longer time to deposit the glass particles on the object or substrate. Speeds sufficient to develop centrifugal forces of about 1870 and 2500 g. have proved to be particularly desirable in depositing particles of glass having the average sizes under consideration.

The spring 24 is preferably attached to the platform 26 by having an upper turn of the spring 24 inserted through a recessed loop 32 formed in the platform 26 by punching out a portion of the platform. Guide means 34 in the form of preferably three equally spaced pins brazed to a flange portion 36 which is connected to the platform 26 serve to both retain the object 28 on the platform 26 and also maintain the central spacing of the platform 26 with respect to the side walls of the container 12.

Referring to FIG. 3, after the centrifuging force of approximately 12 g. is reached, the spring 24 compresses to the position shown. The flange portion 36 touches the bottom of the container 12 and thereby acts as a stop for the platform 26. The flange portion 36 performs two functions, namely, serving as a stop for platform 26 and thereby preventing the absolute collapse of the spring 24 which would, after a number of cycles, cause the failure or destruction of the spring 24 and for stabilizing the platform 26 near the bottom of the container 12 so that particles 30 from the fluid 27 can be evenly deposited onto the object 28.

After the glass particles 30 from the fluid 27 have been deposited onto the object 28 because of the centrifuging of the container 12, the centrifuging apparatus 10 is slowed down by either braking mechanisms (not shown) or naturally, due to friction effects. Consequently, the spring 24 urges the object 28 with the glass particles 30 deposited thereon out of the fluid 27 when the centrifugal force falls below 12 g. Since a centrifugal force of below 6 g. causes the container 12 to move from its horizontal position to a position between the horizontal and vertical positions, it is evident that the spring 24 will lift the object 28 with the glass particles 30 deposited thereon out of the fluid 27 in the container 12 before the container 12 moves from its horizontal position. Therefore, the vortex motion of the fluid 27 when the container 12 is between the horizontal and vertical positions will not affect the particles 30 on the object 28 since the object 28 is already out of the fluid before the vortex motion of the fluid starts.

During the movement of the object 28 from the bottom of the container 12 to the top of the container after the completion of the particle deposition process, the glass particles 30 are held in place on the object 28 by the centrifugal force thereon. It is evident that the holding force can be increased or decreased, as desired, by proper selection of the platform weight and the spring force.

After the object 28 is removed from the platform 26 upon completion of the centrifugation particle deposition process, a thin, hole-free, glass film is formed by fusing or joining the glass particles 30 on the object 28 by heating to a temperature above the melting point of the particles for a period of time sufficient to join the particles to form a thin film on the object.

In one example, the container 12, spring 24 and platform 26 were made of stainless steel parts for better corrosion control and the object was a circular silicon wafer whose diameter was 1.25 inches. The inner diameter of the container was 1.375 inches thereby leaving a space be-

tween the platform and the container for the fluid to flow during movement of the platform into and out of the fluid 27.

Referring to FIGS. 2 and 3, apertures 38 in the platform 26 serve to prevent fluid from forming behind the entire surface of the object 28 thereby facilitating the removal of the object 28 from the platform 26 after the centrifuging process is terminated. The apertures 38 are of sufficient size and number to expose approximately 67% of the rear surface of the object 28 to minimize the surface tension effects caused by a film of fluid formed between the object 28 and the platform 26.

Referring to FIG. 4, the platform 26 with its apertures 38 is shown spaced from the side wall of the container 12 by means of the three guide pins 34. The platform 26, in addition, contains recess portions 40 which serve as a means for facilitating the removal of the object 28 from the platform 26 by the use of a suitable gripping mechanism such as a pair of tweezers.

Referring to FIG. 5, another platform embodiment is shown wherein like parts are denoted by the use of the same numbers with the addition of the letter *a*. The embodiment of FIG. 5 shows the platform 26a as being simply a rim which has an extended portion 50 in which is formed a loop for permitting the spring 24a to be attached to the platform 26a. This arrangement permits the rear surface of an object placed on the rim or platform 26a to be almost completely open and hence, virtually no film of fluid is formed between the object and the rim thereby facilitating removal of the object from the rim or platform 26a after centrifuging is completed.

Referring to FIG. 6, a still further embodiment of a platform arrangement is shown wherein like parts are denoted by the same numbers used in FIG. 2 with the addition of the letter *b*. An extended portion 60 is formed on the rim or platform 26b which is used to support a loop formed therein to hold the upper ring of the spring 24b. In addition, a pair of crossed wires 62 and 64 connected to the rim 24b such as by brazing serve to provide additional support for an object placed on the rim or platform 26b.

While the invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those skilled in the art that the foregoing and other changes in form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. A method of depositing particles onto an object comprising the steps of:

centrifuging said object and a fluid containing the particles to be deposited on said object for a period of time and with a force sufficient to move said object into said fluid, said object being movable relative to said fluid depending upon the centrifugal force on said object;

continuing centrifuging said object and said fluid for a period of time and with a force sufficient to deposit particles in the fluid onto said object; and

reducing the centrifugal force on said object and said fluid to move said object with the particles uniformly deposited thereon out of said fluid.

2. A method of depositing particles onto an object comprising the steps of:

suspending said object above a fluid containing the particles to be deposited on said object, said object being movable relative to said fluid depending upon the centrifugal force on said object;

centrifuging said object and said fluid for a period of time and with a force sufficient to move the object into one end region of said fluid;

continuing centrifuging said object and said fluid for a period of time and with a force sufficient to deposit the particles in the fluid onto said object; and

reducing the centrifugal force on said object and said

fluid to move said object with the particles uniformly deposited thereon out of said fluid.

3. A method of depositing particles onto an object comprising the steps of:

suspending said object on a movable platform above a fluid containing the particles to be deposited on said object, said object and said platform being movable relative to said fluid depending upon the centrifugal force on said object and said platform;

centrifuging said object, platform, and fluid for a period of time and with a force sufficient to move said object and platform into the fluid;

continuing centrifuging for a period of time and with a force sufficient to deposit particles in said fluid onto said object; and

reducing the centrifugal force on said object, platform, and fluid to move said platform and said object with the particles uniformly deposited thereon out of said fluid.

4. A method of uniformly depositing glass particles onto an object comprising the steps of:

inserting a fluid containing glass particles suspended therein into a container;

placing said object on a spring supported platform positioned in said container, said object and said platform being suspended above said fluid by said spring;

centrifuging said container for a period of time and with a force sufficient to move said object and said platform into said fluid and to the bottom of said container;

continuing centrifuging said container for a period of time and with a force sufficient to deposit glass particles from said fluid onto said object; and

reducing the centrifugal force on said container to move said spring supported platform and said object with the glass particles uniformly deposited thereon out of said fluid.

5. A method of forming a thin, hole-free glass film on an object comprising the steps of:

inserting a fluid containing glass particles suspended therein into a container;

placing said object on a spring supported platform positioned in said container, said object and said platform being suspended above said fluid by said spring;

centrifuging said container for a period of time and with a force sufficient to compress said spring and move said object and said platform into said fluid and near the bottom of said container;

continuing centrifuging said container for a period of time sufficient to deposit glass particles from said fluid onto said object;

reducing the centrifugal force on said container to permit said spring to expand and move said platform and said object with the glass particles uniformly deposited thereon out of said fluid; and

heating the glass particles on said object for a period of time and at a temperature sufficient to join the glass particles into a thin, hole-free, glass film.

6. A method of forming a thin, hole-free glass film on a wafer comprising the steps of:

suspending finely divided glass particles in a fluid having a dielectric constant of at least 3.4;

inserting said fluid with said glass particles suspended therein into a container;

placing said wafer on a spring supported platform positioned in said container, said wafer and said platform being suspended above said fluid by said spring;

centrifuging said container for a period of time and with a force sufficient to compress said spring and move said wafer and said platform into said fluid and to the bottom of said container, the centrifugal force for compressing said spring being greater than the centrifugal force necessary to raise said container into a horizontal position;

continuing centrifuging said container for a period of

time sufficient to deposit glass particles from said fluid onto said wafer;
 reducing the centrifugal force on said container to permit said spring to expand and move said platform and said wafer with the glass particles uniformly deposited thereon out of said fluid, said platform and said wafer with the glass particles uniformly deposited thereon being moved out of said fluid before said container moves from its horizontal position; and
 heating the glass particles on said wafer for a period of time and at a temperature sufficient to join the glass particles into a thin, hole-free, glass film.

7. An apparatus for depositing particles onto an object comprising, in combination, a container, said container having a fluid containing particles suspended therein; resilient support means located within said container and adapted to move relative to said fluid; an object supported by said resilient support means; and means for centrifuging said container to compress said resilient support means and move said object into a position in said container for receiving particles from said fluid.

8. An apparatus in accordance with claim 7, in which said support means comprises a platform provided with a plurality of apertures.

9. An apparatus in accordance with claim 7, in which said support means comprises a platform having a rim surrounding a large aperture, said rim supporting the object.

10. An apparatus in accordance with claim 7, in which said support means comprises a platform having a rim surrounding a large aperture, and a pair of crossed wires connected to said rim and supporting the object with said rim.

11. An apparatus for depositing particles onto an object comprising, in combination, a container, said container having a fluid containing particles suspended therein; resilient support means located within said container and adapted to move relative to said fluid; an object supported by said resilient support means; and means for centrifuging said container to compress said resilient support means and move said object into a position in said container for receiving particles from said fluid, said object being supported by said resilient support means above said fluid before the beginning and the ending of the centrifuging of said container.

12. An apparatus for depositing particles onto an object comprising, in combination, a container, said container having a fluid containing particles suspended therein; resilient support means located within said container and adapted to move relative to said fluid, said resilient support means comprising a platform and a spring supporting said platform;

an object supported by said platform; and means for centrifuging said container to compress said spring and move said object into a position in said container for receiving particles from said fluid.

13. An apparatus for depositing glass particles onto an object comprising, in combination, a container, said container having a fluid containing glass particles suspended therein; resilient support means located within said container and adapted to move relative to said fluid, said resilient support means comprising a platform and a spring supporting said platform; an object supported by said platform; and means for centrifuging said container to compress said spring and move said object near the bottom of said container for receiving glass particles from said fluid, said object being suspended above said fluid before the beginning and the ending of the centrifuging of said container.

14. A centrifuging apparatus for glass particle deposition comprising, in combination, a container, said container having a fluid containing glass particles suspended therein; resilient support means located within said container and adapted to move relative to said fluid, said resilient support means comprising a platform and a spring supporting said platform, said platform being spaced from the side walls of said container and having at least one aperture therein, guide means connected to said platform for maintaining uniform spacing of said platform from the side walls of said container during movement of said platform within said container, and a flange portion connected to one side of said platform; an object supported by the other side of said platform; and means for centrifuging said container to compress said spring and move said object near the bottom of said container for receiving glass particles from said fluid, said flange portion contacting the bottom of said container and adapted to hold the level of the platform parallel to the bottom of the container during the centrifuging of said container, said object being suspended above said fluid by said platform and said spring before the beginning and the ending of the centrifuging of said container.

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