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SURFACE COATING APPARATUS

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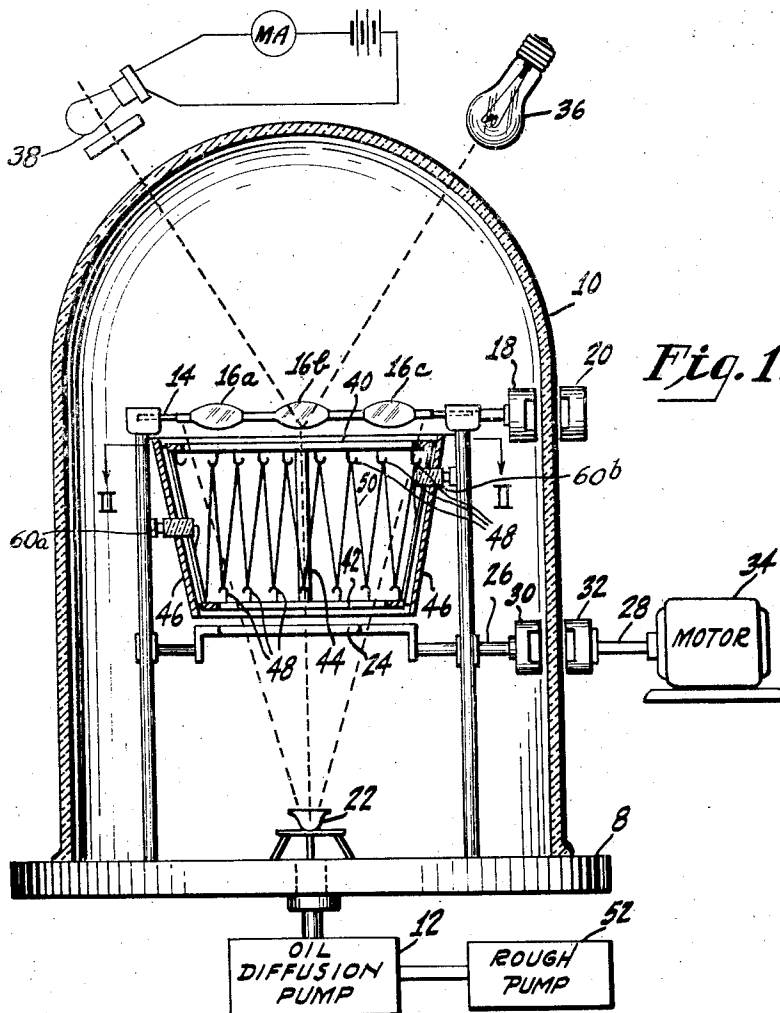


*Fig. 1.*

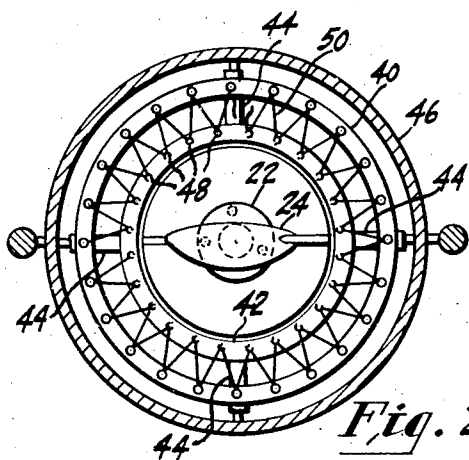


*Fig. 2.*

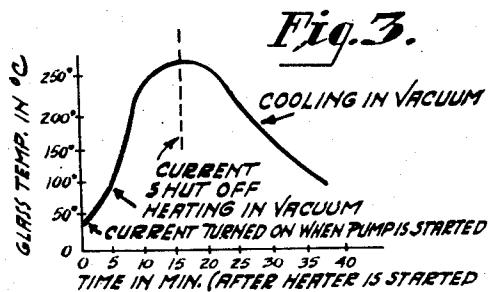


*Fig. 3.*

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## UNITED STATES PATENT OFFICE

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## SURFACE COATING APPARATUS

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6 Claims. (Cl. 91—12.2)

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This invention relates to surface coating, and particularly to the coating of light-reflecting surfaces to diminish or control the reflection of light from such surfaces.

It is known that coatings of the character described may be made more hard and durable by heating the surface to be coated to a temperature of approximately 225° C., while applying the coatings by evaporation in a vacuum. If the object whose surface to be coated is, for example, a glass lens, it is contained in an evacuated chamber, which may be a bell jar, with the surface to be coated facing downwards, and an appropriate substance (for example, magnesium fluoride) is evaporated onto the surface from below. Heat to raise the lens to the required degree is obtained from heater coils contained within a dome-shaped aluminum reflector which is located within the bell jar above the lens.

Such an arrangement heats the specific surface being coated only indirectly, and a considerable proportion of the heat generated is dissipated in unwanted directions. The major disadvantage of the arrangement, however, is that it restricts the visibility of the operator, who must see the lens being treated to determine the thickness of the coating. If the thickness of the coating is determined by photoelectric means responsive to light reflected from the surface being coated (as in my Patent 2,338,234), the dome-shaped heat reflector of the prior art obstructs light passing to said photoelectric means. Various attempts to solve this problem, some of them involving apparatus of considerable complication, have for some years past been made by workers in the art, but so far without practical success.

It is an object of the invention to provide an improved means for heating a surface to which a coating is being applied by evaporation in a vacuum, which shall be free from the before-mentioned defects of the prior art.

Another object of the invention is to provide an improved apparatus for surface coating, including means for heating the surface being coated without obstructing the passage of light to and from said surface.

A further object is to provide improved apparatus for surface coating by evaporation, including means for heating the surface being coated without impeding the path of material being evaporated onto said surface.

A further object is to provide improved means for heating a surface being coated, wherein the heat shall be applied directly to the surface under treatment and with a minimum of heat loss.

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A further object is to provide compact heating apparatus of the character described which does not interfere with any other process to which the surface under treatment is to be subject.

Another object of the invention is to provide an improved means for heating a surface, in which the danger of overheating the surface is obviated.

These objects are achieved in accordance with the invention by making a heat reflector in the form of a hollow, truncated cone open at both ends, and winding appropriate heater coils near the inner surface of the hollow cone thus formed. The unit is placed below the object whose surface is to be coated, and by this means heat is reflected directly to the surface without impeding the path of the material evaporated from below, nor of light directed onto the surface from above.

The invention may be better understood from a consideration of the following more detailed description of an embodiment thereof, when read in conjunction with the accompanying drawing, in which:

Figure 1 is a vertical view, partly in section, of coating apparatus in which an embodiment of the invention is employed,

Figure 2 is a view in horizontal section taken along the line II—II of Figure 1 and looking downwards, and

Figure 3 is a graph in which the temperature of a glass lens, treated in accordance with the invention, is plotted against the time of treatment.

Figs. 1 and 2 show lens coating apparatus which may be of the type described in the copending application of Lawrence T. Sachtleben for "Lens coating apparatus," Serial 508,267, filed October 29, 1943, and in my copending application, also for "Lens coating apparatus," Serial No. 511,231, filed November 22, 1943, both of said applications being assigned to the same assignee as the instant application.

The apparatus includes a base plate 8, which supports a bell jar 10 or other suitable chamber adapted to be evacuated by appropriate means. The base plate may be of any suitably rigid material, and while the bell jar will ordinarily be of glass, it may be made of steel or any other suitable material; but it should, in that event, be provided with ports for the passage of light into and out of the jar.

The evacuating means may include a rough pump 52 for a preliminary and rapid evacuation of the bell chamber, and an oil diffusion pump 12 for securing a high degree of vacuum.

Inside the bell jar is a work-holder 14, which

serves as a mount for the object whose surface is to be coated. The drawing shows, by way of example, three lenses 16a, 16b and 16c, whose lower surfaces are to be thus treated. The work-holder terminates in a U-shaped bar 18 of magnetic material, which is in magnetic relation with a magnet 20 outside the bell jar. By rotating this magnet, the work-holder may be reversed and the upper surfaces of the lenses treated.

The coating material (for example, magnesium fluoride) is contained in an evaporating boat or crucible 22, but a filament may be substituted for the boat where the material used evaporates properly from a filament.

The apparatus also includes a compensator 24 for securing a uniform distribution of the coating on the lens surfaces. This may be a blade of the type described in my copending application before referred to, and adapted to be rotated by the shafts 26 and 28, magnets 30 and 32, and motor 34.

Light from a source 36 is directed to the surface to be treated and the progress of the coating operation may be viewed by light reflected from that surface. The reference numeral 38 is a photocell which is used to determine the thickness of the coating as described in my before-mentioned patent. The path of light transmitted to the surface being coated and of light reflected therefrom is indicated by broken lines, as is also the path of evaporating material from the boat 22 to the surfaces under treatment.

Beneath the work-holder 14 are a pair of rings 40 and 42, preferably of brass, and held apart by posts 44. The rings are of different diameters, the upper ring 40 being the larger. A sheet of aluminum 46, or other heat-reflecting material, is secured to the outer face of the rings and posts, thus forming a hollow, truncated cone open at both ends. Insulating hooks 43 are screwed or otherwise inserted into holes in the two rings. In the preferred embodiment, these hooks were about one-half inch long and were made of molybdenum wire coated with Alundum cement. The coated hooks were treated by heating to yellow temperature in a vacuum.

A heater wire 50 of high electrical resistance material (e. g., "Nichrome" wire) is looped back and forth in a generally vertical direction over the hooks, and is provided with appropriate terminals 60a, 60b for connection to a 110-volt or 220-volt A. C. or D. C. supply source. The heater unit thus runs parallel with the conical heat reflector and is spaced from and about one-half inch inside its inner surface. Heat from the source 50 is reflected by the reflector 46 directly onto the surface being coated; and as will be seen from the drawing, a path is provided for the evaporating material from the boat 22 to the lenses 16a, 16b and 16c. The evaporating material passes through a generally conical region, and the reflector 46 and heater 50 are coaxial with this region and surround at least a part of it. Light from the lamp or other source 36 passes to the lenses 16 and thence to the photocell 38 without interruption.

In one embodiment of the invention, the rings 40 and 42 had diameters of 8" and 5½", respectively, and the reflector was 2½" high. The heater 50 was of No. 22 B+S gauge "Nichrome" wire and consumed 660 watts at 110 volts.

Fig. 3 is a graph of lens temperature plotted

against the time of treatment. The heater was switched on when the vacuum pump was started, and the temperature data was obtained by cementing a thermocouple to the lens under treatment. It will be seen that the lens temperature levels off as it approaches 250° C. This is probably due to the fact that at that temperature the radiation from the coil is equal to the energy supplied to it, and the practical effect is that the lenses cannot be overheated even if the power to the heater is not switched off in time.

There has thus been described an improved means for heating a surface being coated by evaporation, including a source of heat and means for reflecting that heat onto the surface under treatment. The source of heat and reflecting means are so shaped and so placed as not to interfere with the path of the evaporating material, nor of light to the surface under treatment, and heat is applied directly to that surface with a minimum of waste.

While the invention has been described primarily with reference to the application of reflection-reducing coatings to lenses, it is of general utility wherever a surface is to be heated while material is being evaporated thereon.

I claim as my invention:

1. The combination, with means for evaporating material onto a surface of an object, of a source of heat and means for reflecting heat from said source to said surface, said source of heat and said heat-reflecting means being on the same side of said object as said surface and outside the direct path of said evaporating material to said surface.

2. The combination, with means for evaporating material onto a surface of an object, of a source of heat and means for reflecting heat from said source to said surface, said source of heat and said heat-reflecting means being on the same side of said object as said surface and surrounding part of the substantially conical region constituting the path of said evaporating material from said evaporating means to said surface.

3. The combination according to claim 2, wherein said heat-reflecting means are constituted by a sheet of heat-reflecting material having the form of a hollow, truncated cone, open at both ends and coaxial with said conical region.

4. The combination according to claim 2, wherein said heat-reflecting means are constituted by a sheet of aluminum having the form of a hollow, truncated cone, open at both ends and coaxial with said conical region.

5. The combination according to claim 2, wherein said source of heat is constituted by material of high electrical resistance, including terminal connections to a source of electrical energy, and is spaced and electrically insulated from said heat-reflecting means.

6. In apparatus for evaporating material from a source thereof to form a coating of controlled thickness on a surface, means responsive to light reflected from said surface for determining said thickness, a source of heat and means for reflecting heat from said last-mentioned source directly to said surface, said source of heat and said heat-reflecting means being outside the path of said light and also outside the direct path of said material from said evaporating source to said surface.

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