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2,482,329

APPARATUS FOR SELECTIVE VAPOR COATING

Filed May 27, 1946

2 Sheets-Sheet 1

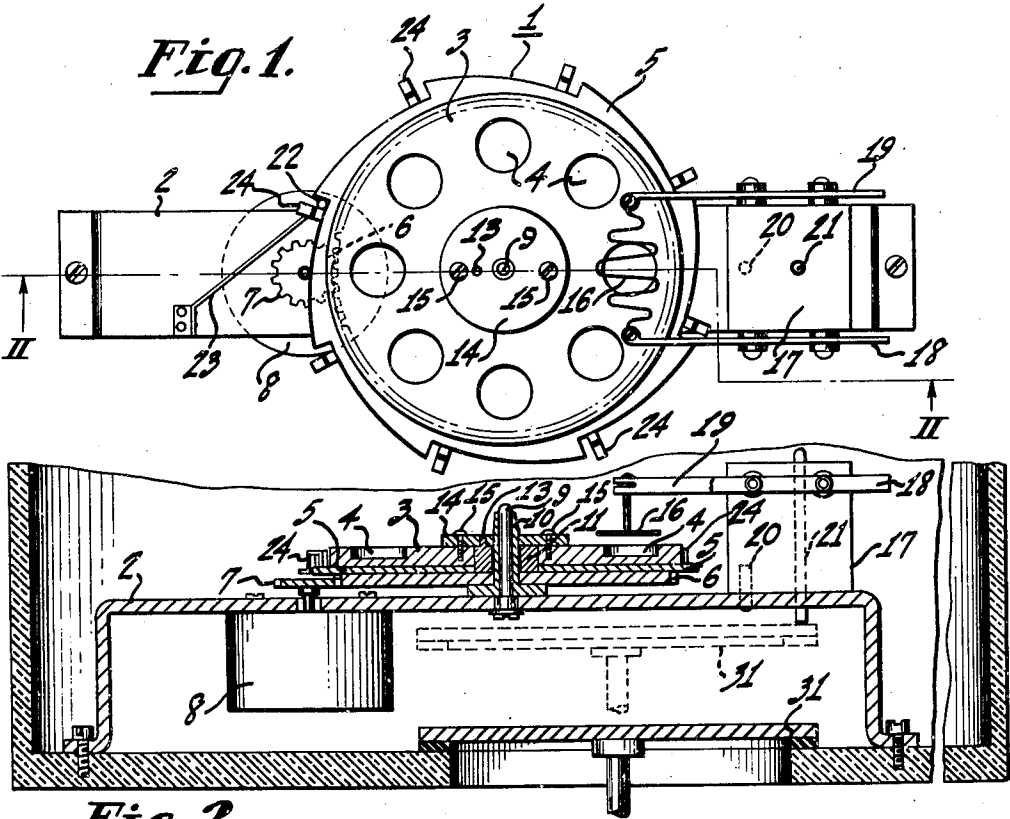
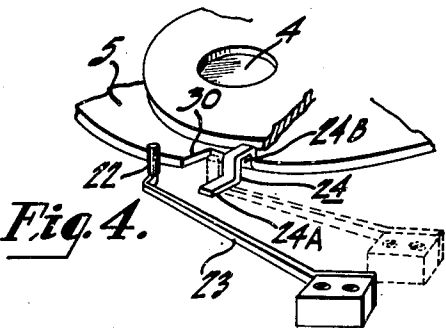
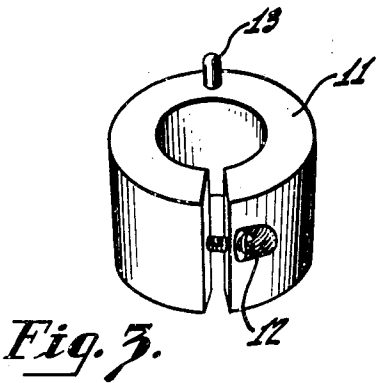


Fig. 2.



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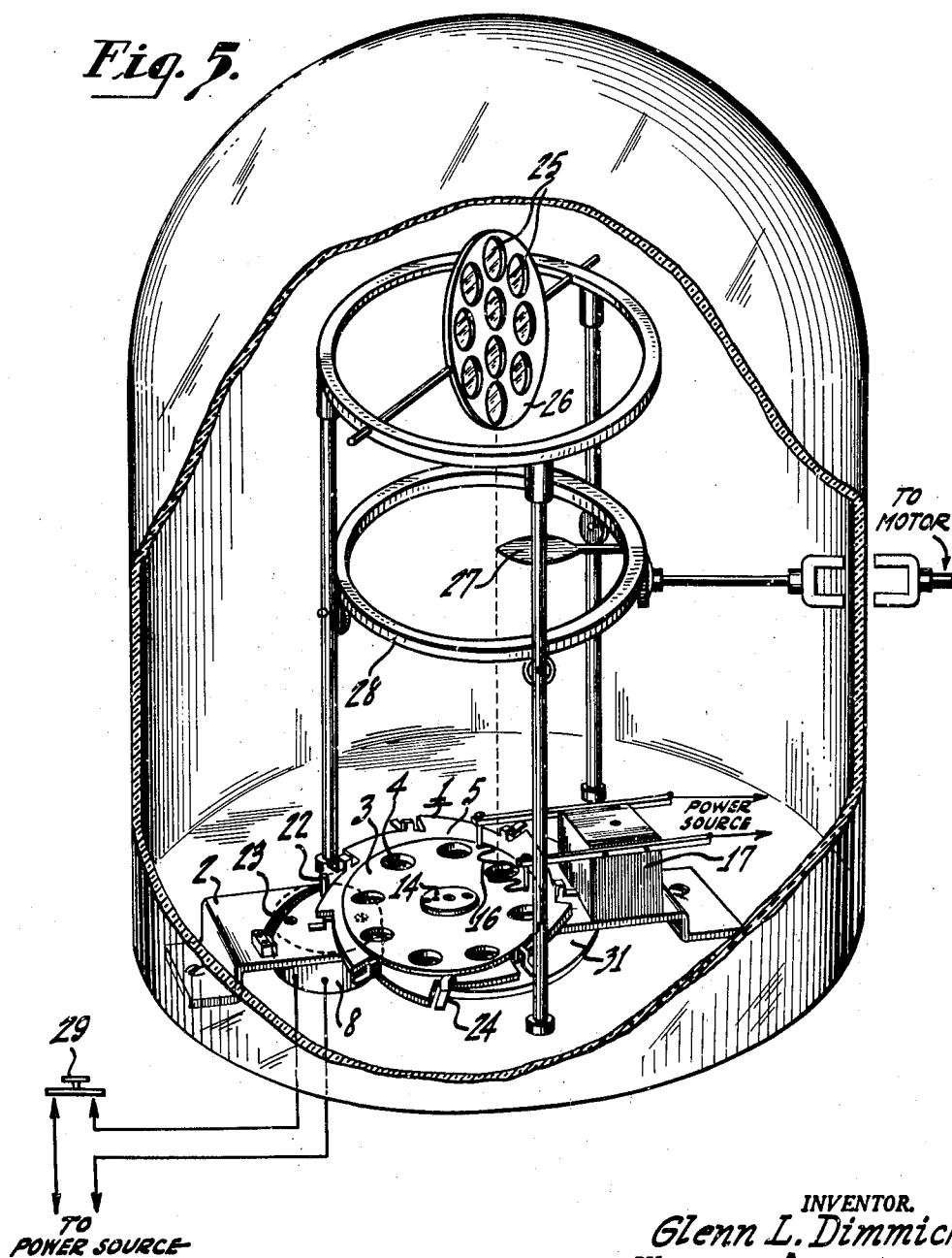
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Fig. 5.



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APPARATUS FOR SELECTIVE VAPOR COATING

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Application May 27, 1946, Serial No. 672,583

8 Claims. (Cl. 91—12.2)

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This invention relates to the art of vapor coating in vacuum and especially to improvements in apparatus for applying a plurality of layers of coating material to a surface without breaking the vacuum between coating operations.

Previous devices for applying a plurality of vapor coatings to the same surface are known. One such apparatus involves the use of an array of heating coils distributed in fixed positions within a vacuum chamber. Coating material is supplied to each coil, the coating chamber is evacuated, and then each coil is heated in the desired order so as to deposit its coating material on an opposing surface. Since each coil is necessarily in a different position with respect to the surface to be coated, the coatings cannot be made uniform. Therefore, the device is applied mainly in preparing mirror coatings on glass, since rather wide tolerances of thickness and distribution are allowable in this type of coating. But where very exact uniformity of distribution is desired, such as in coatings for reducing reflection from transparent surfaces and in making selective reflectors, this type of apparatus cannot be used.

An improved apparatus, the use of which enabled multiple vapor coatings of uniform thickness and distribution to be deposited, was designed and embodied in the application, Serial No. 511,231, of Glenn L. Dimmick, filed November 22, 1943, which application is now Patent No. 2,410,720.

The present invention is an improvement over the above mentioned device which embodies certain advantages not present in applicant's earlier invention. For example, the earlier device used either molybdenum crucibles, each wound with coils of resistance wire, or the material was evaporated from a tungsten filament. Some substances cannot be evaporated readily from tungsten filaments and crucibles must be used. But molybdenum crucibles are expensive and have the undesirable property of relatively high heat inertia. This resulted in coating material continuing to be evaporated for some time after the heating current was turned off and necessitated use of a shutter to halt evaporation. Moreover, high amperage currents had to be used to satisfactorily heat the bulky crucibles. A further disadvantage in using the earlier device was that it did not lend itself well to automatic operation, using simple motor-driven apparatus.

The apparatus embodied in the present invention obviates the above listed disadvantages and

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permits rapid and accurate coating of large numbers of articles.

One object of the present invention is to provide improved apparatus for applying a plurality of uniform vapor coatings to a surface without the necessity of using a cut-off shutter to stop the evaporation process.

Another object is to provide an improved apparatus for applying a plurality of successive coatings by the evaporation process using only a single heating element for all of the evaporators.

Another object is to provide an improved vapor coating apparatus employing evaporators having but little thermal inertia.

Another object is to provide an improved vapor coating apparatus from which a plurality of coating materials may be successively applied to a surface without breaking the vacuum between coats.

Still another object is to provide an improved vapor coating apparatus whereby a number of successive coats may be applied to a surface in a uniform and extremely accurate manner.

The invention will be better understood from the description of the invention which follows, together with the accompanying drawings of which,

Fig. 1 is a plan view of an improved evaporating device embodying the invention;

Fig. 2 is a cross section view taken partially along the line II—II of Fig. 1;

Fig. 3 is a detail view in perspective of a preferred type of friction clutch ring used in connection with the instant invention;

Fig. 4 is a detail view of an improved indexing mechanism forming a part of applicant's invention;

Fig. 5 is a perspective view showing how the improved evaporator is used in one type of vacuum coating apparatus.

The apparatus of the present invention involves, in its preferred form, an improved evaporating unit requiring the use of only one heating means which is so placed as to be operative on each of a plurality of coating material holders when they have been brought successively into a desired position with respect to a work holder. More than one heating means may be used if, for example, it is desired to increase the amount of heat applied to the holders or for other reasons. A single heating means, however, should be sufficient for most purposes.

The apparatus of the present invention also includes an improved, but simple, indexing mechanism for stopping each of the coating material

holders when it has reached the desired position at which it is to be heated and for allowing it to be removed from this position so as to allow another holder to be stopped at the same point.

Referring now to Fig. 1, a rotatable turret 1 is positioned on a holding bracket 2. The turret comprises a plate 3 which may be of light metal having a desired number of impressed shallow recesses 4 for containing individual charges of coating material. The recessed plate 3 in turn rests on and is fastened to a flat metal plate 5 having on its periphery a number of spiral notches corresponding to the number of recesses 4 in plate 3.

As shown in Fig. 2, the notched plate 5 rests on a large gear 6 which is driven by a small pinion 7 attached to the shaft of motor 8. A shaft 9 which serves as the axis of rotation for plates 3 and 5 and gear 6 is fastened to the bracket 2. The large gear 6 is provided with a hollow spindle 10 which fits over this shaft. Fitting around the spindle is a clutch 11 shown in more detail in Fig. 3. The clutch comprises a split sleeve having an adjustment screw 12 and a pin 13 which projects from its upper face.

When the unit is assembled, the hollow spindle 10 of gear 6 is slid down over the shaft 9. Then the clutch is pressed down over the spindle and the plates 3 and 5, which are joined together, are set down on gear 6. A top holding plate 14 is then placed in position. This plate has, in addition to its center hole which enables it to fit over spindle 10, another hole which engages pin 13 projecting upward from the clutch. The holding plate 14 is fastened to recessed plate 3 by means of screws 15.

As a means of heating the coating material placed in recesses 4, there is provided a flat grill of resistance wire 16 held a slight distance above plate 3. This grill is suspended from holding block 17 by two conducting electrodes 18 and 19 which are suitably insulated from the block. The block is fastened to bracket 2 by two holding pins 20 and 21.

The invention includes particular means for indexing each one of the recesses 4 successively beneath the heater wire. This indexing means is shown in more detail in Fig. 4. A pin 22 held on the end of leaf spring 23 rides on the periphery of the spiral notches in plate 5. A number of formed leaf detents 24 are positioned as shown, one being placed immediately following each notch. Each detent has a projecting tongue portion 24A and an arched portion 24B.

Although not intended to be restricted to such use, the apparatus of the present invention has particular utility when used in conjunction with part of the coating apparatus disclosed in an earlier application of Glenn L. Dimmick, Serial No. 511,231, filed November 22, 1943, and now Patent No. 2,410,720. Fig. 5 shows how the present apparatus is incorporated with the apparatus of the earlier invention as an improved evaporator unit. In this application of the invention, a number of units such as lenses 25 are fastened to a work holder 26 which may be swung out of position as illustrated to facilitate re-loading. Coating material is placed in the receptacles 4 and each in turn is brought beneath the heater grill 16 and subjected to a temperature sufficient to evaporate a desired amount of the material. Most of the evaporated material deposits on the lower surfaces of the lenses 25. In order to obtain uniform or other desired distribution of the coating material over the surface of the work

holder, a rotating attenuator blade 27 is set in operation by causing ring 28 to rotate. This blade is designed as described in the previously mentioned earlier application and assures the desired distribution of the evaporated coating material. The center of the coating material-holding recess being used is preferably axially aligned with the center of the work holder and the tip of the attenuator blade 27 is preferably positioned at this axis and at the center of the ring 28.

The operation of the apparatus of the present invention will now be described as it applies to depositing a number of coatings of material on a work surface. One of the specific applications is in the making of selective reflectors. These reflectors are glass plates coated on one or both sides with very thin alternate layers of material having widely different indexes of refraction such as thorium oxyfluoride and zinc sulfide.

Carefully cleaned glass blanks are set in the work holder 26 which is then rotated to the position in which a flat surface of the plates faces vertically downward. The recess which is to be under the heater at the start of the operation is left empty. The materials, thorium oxyfluoride and zinc sulfide, are then placed in small pans or crucibles and set in the recesses 4 so that the first recess following the empty position contains thorium oxyfluoride as does every second recess following around the turret. The alternate recesses contain the zinc sulfide. Obviously, any other coating materials lending themselves to the vapor coating process may be substituted as desired. The chamber is then sealed and when a satisfactory vacuum has been reached, a photocell control system such as shown in U. S. Patent 2,338,234 is set in operation. This is for the purpose of observing the growing thickness of each coating layer so that the evaporating operation may be stopped as each layer reaches the thickness desired. The plate 3 is rotated one notch until the first pan containing thorium oxyfluoride comes into position under the heater. The heater wire is turned on and the thorium compound is evaporated until the control meter indicates that the desired thickness has been obtained. The plate is then rotated another notch bringing the next pan which contains zinc sulfide under the heater and the evaporating process is repeated. The process is continued, rotating the plate one notch each time until all have been subjected to the heater. Not all of the pans need be filled with coating material and obviously a larger or smaller number of recesses may be provided in the rotatable plate, depending on the number of layers of coating which it is desired to deposit during a single operation.

The manner in which the indexing means operates in stopping each recess at the desired position is quite simple but effective. When the operator presses the button switch 29, the motor 8 is turned on and the plate 3 starts rotating. The pin 22 slides along the periphery of one of the spiral notches until it strikes a projecting detent 24. This brings the plate 3 to a sudden halt. The operator releases the pushbutton stopping the motor but in order to take up the shock of the sudden stop the clutch 11 has been provided to allow further motion to the motor and large gear 6.

As long as the power is on the motor the pin 22 is held against the projecting tongue 24A of the detent 24 by tension of spring 23. Soon after power to the motor is cut off, tension of the pin

against the detent is relieved and the pin is swung into the area between the trailing edge 30 of the notch and detent 24 by the spring, thus clearing the projecting tongue portion of the detent. When the operator again presses the push button to start the motor and rotate the plate to the next position, the pin 22 is in position to ride under the arched portion 24B of the detent.

The motor used in this apparatus is one particularly adapted to be used under vacuum conditions. Ordinarily, clock mechanism may be used but the lubricating oil soon "gums" and the action becomes erratic. A motor which proved most satisfactory was made by taking an electric clock motor with a bobbin type coil and replacing the coil with one hermetically sealed in a closed metal spool. The vapor pressure produced by the motor was very low and a high vacuum could easily be maintained within the vacuum chamber by exhausting air through the opening of the poppet valve 31.

Although a motor has been shown as the means of rotating the turret, this can be accomplished by other means such as hand operated mechanism. Evaporating units of the type illustrated have been built in which the turret is rotated by means of a gear operated from a flexible shaft. This shaft is brought outside the vacuum chamber through a vacuum tight joint and is connected to a knob on the side of the console. The operator may then bring the various materials under the heater by turning the knob. This type requires no other special indexing mechanism.

The heating mechanism, which is usually left turned on during the entire coating operation, is not limited to the use of a resistance wire as shown in the drawings. For example, infra red rays may be used and projected from any convenient point within the vacuum chamber provided they are focussed at the desired spot. Induction heating may also be used or a radio frequency heating device may be substituted.

The apparatus has particular value in that any desired number of different coating materials may be placed in the recesses and the recesses may be subjected to heat in any desired order. When the plate is rotated from one position to the next the pan holding the material which has just been heated cools off so rapidly that no cut-off shutter is needed. There has thus been described an improved evaporating unit which has particular utility in placing multiple coatings on a surface. It is well adapted to automatic operation and in producing uniform coatings.

I claim as my invention:

1. In a vapor coating apparatus having a rotatable plate and a plurality of coating material holders positioned on said plate, a motor for driving said plate, means for stopping and holding said plate in a desired position while said motor is still operative and for releasing said plate for further movement when said motor is inoperative.

2. In a vapor coating apparatus having a rotatable plate and a plurality of coating material holders positioned thereon, a motor and associated gearing for driving said plate, means for abruptly stopping and holding said plate in a desired position while said motor is operative and means for allowing further motion of said motor and said gearing immediately after the abrupt stopping of said plate whereby the motor and

gearing are cushioned against the shock of said abrupt stopping.

3. In a vacuum vapor coating apparatus, a single heating means operative with respect to coating material holding means adjacent thereto, a plurality of said holding means, and means for shifting each of said holding means into a position at which said heating means is operative thereon without breaking the vacuum in said apparatus.

4. In a vacuum vapor coating apparatus, a single heating means operative with respect to coating material holding means adjacent thereto, a rotatable turret having a plurality of said holding means spaced thereon, and means for shifting each of said holding means into a position at which said heating means is operative with respect thereto without breaking the vacuum in said apparatus.

5. In a vacuum vapor coating apparatus, a work holder, a plurality of coating material holding means in opposed relation thereto, means for heating a single one of said holding means, and means for shifting all of said holding means in succession into operative position with respect to said heating means and in axial alignment with said work holder without breaking said vacuum.

6. In a vapor coating apparatus having a plurality of coating material holders positioned on a rotatable plate, a motor and associated gearing for driving said plate, a pin adapted to slide along the periphery of said plate, means for flexibly holding said pin against said periphery, detent means carried by said plate and cooperating with said pin, a portion of said detent means being designed to engage said pin and thereby stop the rotation of said plate when the pin is in one position and another portion of said detent means being designed to allow said pin to pass by when the pin is in another position, and means for allowing slight further motion of said motor and said gearing immediately after the stopping of said plate.

7. In a vacuum vapor coating apparatus, a work holder, a rotatable turret having a plurality of coating material holding means spaced thereon, means for shifting each of said holding means successively into axial alignment position with respect to said work holder without breaking said vacuum, and a single heating means operative on each of said holding means when said means is brought into said axial alignment position.

8. Apparatus according to claim 7 in which said heating means includes a wire coil.

GLENN L. DIMMICK.

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