Feb. 11, 1947. J. J. MALLOY 2,415,512

APPARATUS FOR COATING THE INNER WALLS OF BULBS

Filed Nov. 16, 1943 3 Sheets-Sheet 1

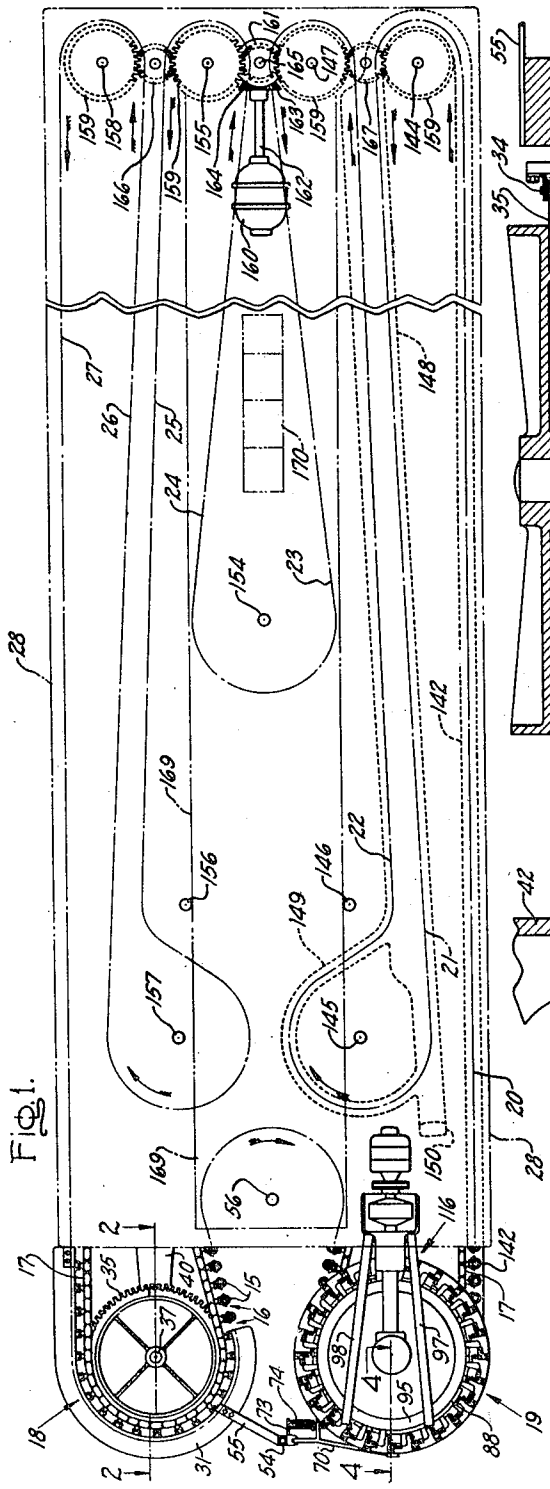


Fig. 1.

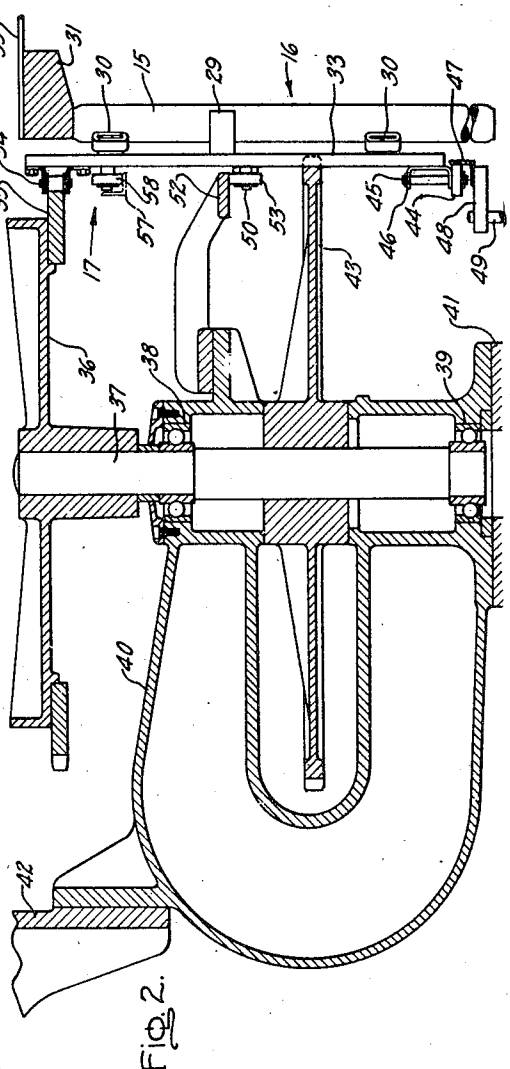


Fig. 2.

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Fig. 4.

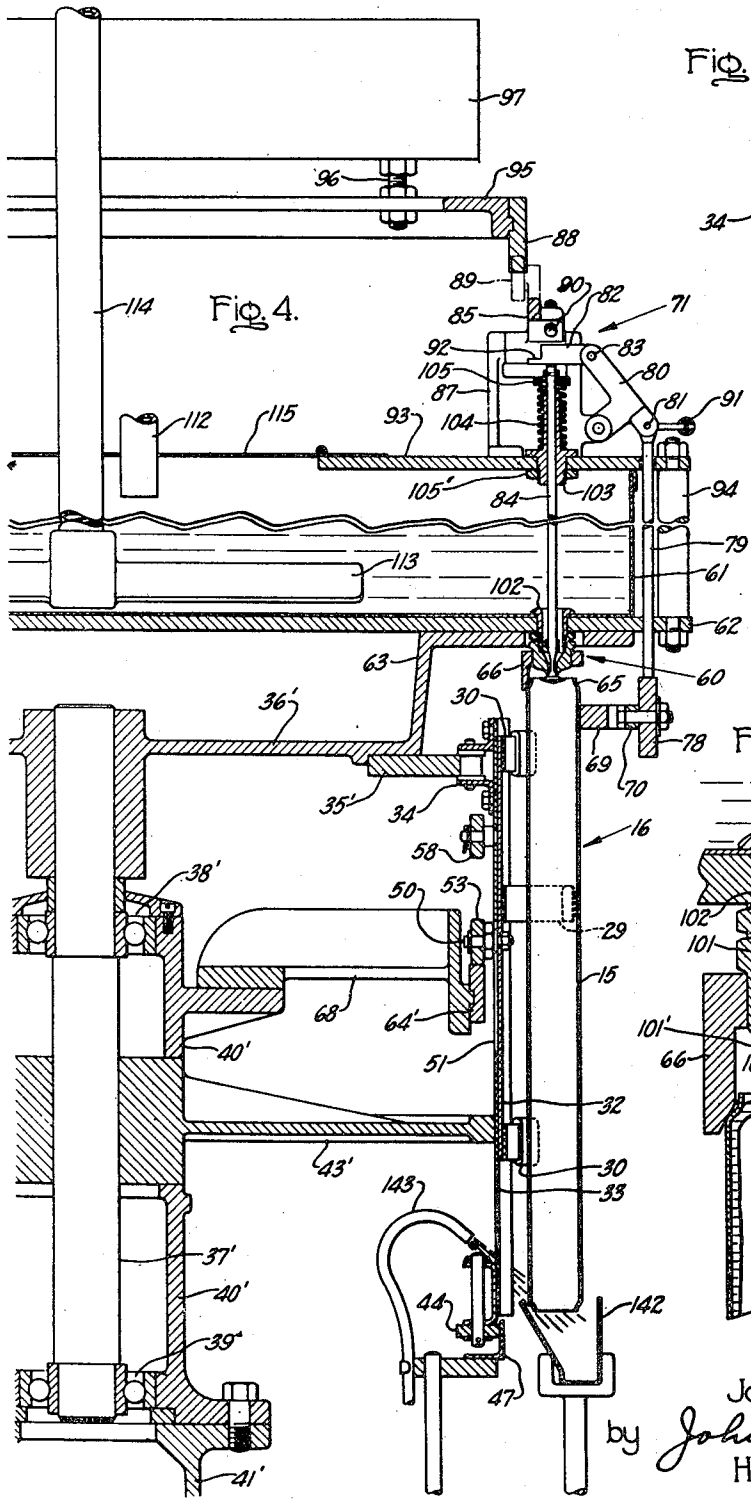


Fig. 3.

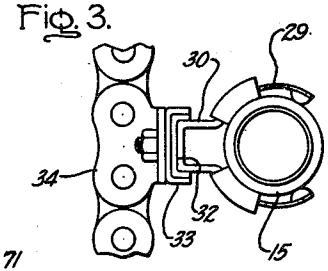
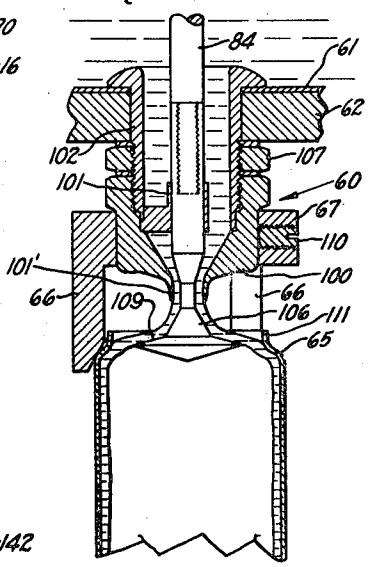


Fig. 5.



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Fig. 8.

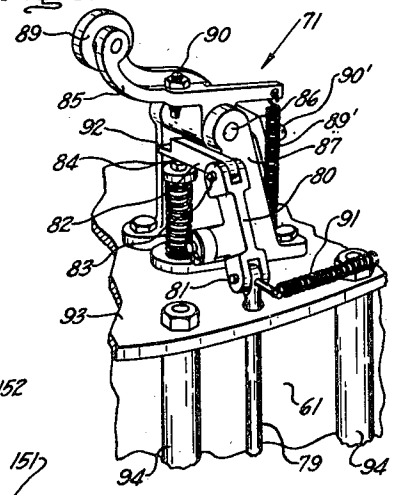
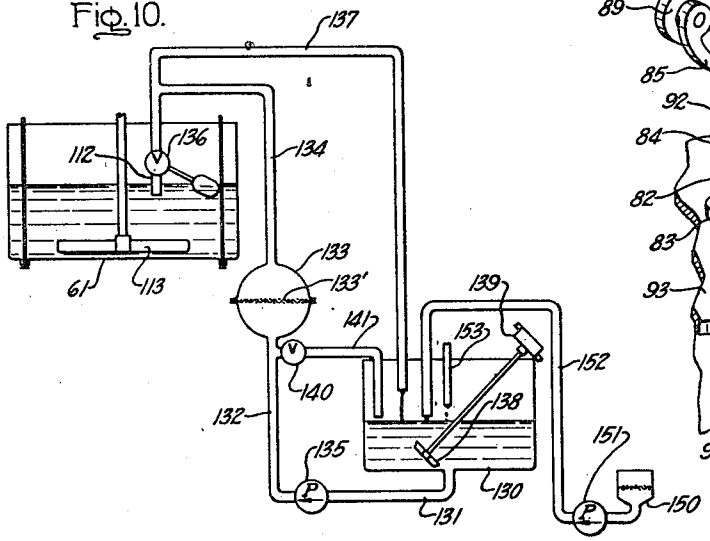


Fig. 10.



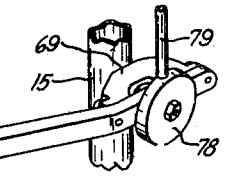
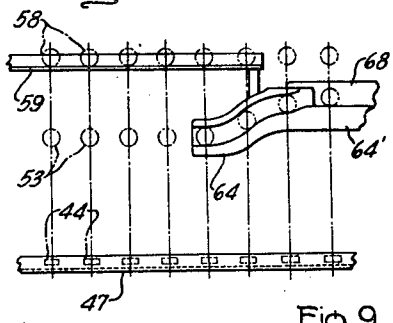


Fig. 7.

Fig. 6.



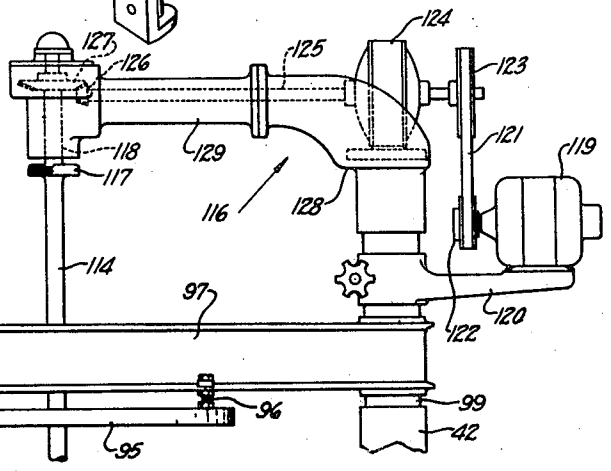


Fig. 9.

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Patented Feb. 11, 1947

2,415,512

UNITED STATES PATENT OFFICE

2,415,512

APPARATUS FOR COATING THE INNER WALLS OF BULBS

John J. Malloy, Cleveland Heights, Ohio, assignor to General Electric Company, a corporation of New York

Application November 16, 1943, Serial No. 510,483

21 Claims. (Cl. 91—43)

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My invention relates to apparatus for applying coatings to the interior of tubular bodies such as the bulbs for fluorescent and incandescent lamps and more particularly to automatic apparatus for applying a coating of fluorescent material to the inner surface of the relatively long tubular bulbs of fluorescent lamps.

The application of coatings to the bulbs of the usual commercial forms of fluorescent and incandescent lamps must be performed economically and as practically as possible, but still must be subject to extremely fine control to assure a coating of uniformly satisfactory and efficient operation characteristics in successive bulbs. The control must, for instance, permit the application of a coating of very definite thickness, permit the distribution of the coating over the full length of the bulb and must avoid the formation of striations and other visual irregularities in any part of the bulb. The coating is in the form of a free flowing liquid suspension at the time of application and is preferably applied to the top end of the bulb so as to flow down over the walls to all parts of the bulb. A considerable excess of the coating fluid is released to the bulb to assure a positive movement of said fluid over the entire inner surface thereof and it drains out the open lower end of said bulb. The viscosity of the coating fluid and the rate of drying determines to a great extent the thickness and distribution of the coating on the bulb.

One object of my invention is to provide apparatus for coating lamp bulbs automatically in a satisfactory and desirable manner. Automatically operating apparatus provides the advantages of the exact duplication of all operations and accuracy of control which produces a precise and uniform coating that is not possible on a commercial scale of production by other methods of operation.

Another object of my invention is to provide apparatus for flushing the coating fluid onto the walls of tubular bulbs in a satisfactory and practical manner. The apparatus provides for the introduction of coating material evenly over all portions of the walls of the bulb and is such as to prevent contamination and dried particles of the coating material from being absorbed by the main body thereof and in due course carried into the coating placed on a bulb.

Still another object of my invention is to provide in combiantion automatic apparatus for introducing coating material rapidly into a succession of bulbs and conveying apparatus for presenting the bulbs at a definite position with relation to the coating apparatus and thereafter to drying means. The combination of such apparatus reduces the manual steps of the entire coating operation to the insertion and removal of the bulbs from the conveying apparatus and the inspection of said bulbs. The advantages of such operations are both in providing a definite and uniform coating on the bulbs and the elimination of manual handling and are difficult and desirable inasmuch as said bulbs are often over two inches in diameter and five feet in length.

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Other objects and advantages of my invention will appear in the detailed description which follows of a species thereof shown in the drawings.

In the drawings, Fig. 1 is a diagrammatic plan view of apparatus of my invention for coating tubular fluorescent lamp bulbs on the inside wherein the apparatus outside of the enclosure thereof is shown to scale; Fig. 2 is a vertical section through the loading and unloading turret and bulb conveyor along line 2—2 of Fig. 1; Fig. 3 is a plan view of one head of the bulb conveyor; Fig. 4 is a vertical section through one-half of the bulb coating turret and associated portion of bulb conveyor along line 4—4 of Fig. 1; Fig. 5 is a vertical section on a larger scale through one of the outlet nozzles of the coating apparatus midway in its period of operation; Fig. 6 is a side elevation of the conveyor head supporting rail and head repositioning cam at one side of the bulb coating turret; Fig. 7 is a perspective view of the control finger of the nozzle actuating means; Fig. 8 is a perspective view of the actuating means for one of the nozzles; Fig. 9 is a side elevation of the agitator operating means for the header tank and the nozzle operating cam; and Fig. 10 is schematic drawing of the coating fluid circulating system of my apparatus.

The species of my apparatus disclosed in the drawings is necessarily large and extensive since it provides both for the coating of bulbs for fluorescent lamps which may be over two inches in diameter and five feet in length and the drying of said coating without manual handling in a continuous inline type of operation. The bulbs 15 (Figs. 1 and 2) are manually loaded into the heads 16 of an endless belt type conveyor 17 during the course of movement thereof about the loading and unloading turret 18 and are automatically coated on the inside during the subsequent travel of the heads 16 about the turret 19 of the coating apparatus. Succeeding movements of the heads 16 carry the bulbs 15 back and forth in substantially parallel paths 20 to 27 inclusive within the enclosure 28 during which

the coating dries to a condition where it can not be readily injured in the handling of the bulb in subsequent manufacturing operations. At one speed of operation a period of twenty minutes lapses between the time the bulbs 15 are inserted in the head 16 and the time they emerge from the enclosure 28 at a point adjacent the loading and unloading turret 18 where they are removed from the apparatus.

The insertion of the bulb 15 into the head 16 of the conveyor 17 consists in pushing said bulb 15 between the fingers of the spring clip 29 (Figs. 2 and 3) and into engagement with the upper and lower rests 30 of the head 16, and then sliding said bulb 15 upward until its upper end engages the stop 31. The bulb 15 is then securely held by the head 16 which is comprised of a vertically disposed channel shaped slide 32 (Figs. 3 and 4) supporting the spring clip 29 and rests 30, and a channel shaped support 33 attached to the conveyor chain 34 providing ways for the slide 32.

The heads 16 are mounted at regular intervals along the conveyor chain 34 which is directed along the desired paths of movement by various sprockets at spaced locations within the apparatus and at the loading station passes about the sprocket 35. The full weight of the chain 34 and heads 16 at this location is supported by the sprocket 35 which is fastened to the hub 36 on the idler shaft 37 which, in turn, is mounted in the bearings 38 and 39 within the yoke 40 mounted on a pedestal 41 (only partially shown) and the frame 42 (also only partially shown) of the enclosure 28. The lower end of the head 16 is kept from being pushed from its position directly below the upper end thereof during the loading of the bulb 15 by being present in a notch in the periphery of the spider 43, and by the engagement of the roller 44 on the pin 45 held by bracket 46 with the guide rail 47. The bracket 48 and standard 49 and similar brackets and standards along the length of the guide rail 47, which extends along the entire path of movement of the conveyor 17, are the means of supporting said rail 47 from the base (not shown) of the apparatus.

The weight of the slide 32 of the head 16 is normally sufficient to cause it to remain in its lowered position within the channel of the support 33 at which position the stud 50 extending from the back of the slide 32 rests at the base of a longitudinal slot 51 (Fig. 4) in the support 33. However, the slide 32, during the course of movement of the head 16 about the loading turret 18, is held down in position by the presence of the flat cam 52 extending from the yoke 40 over the roller 53 on the end of the stud 50. The insertion of the bulb 15 can not disturb the position of any part of the head 16 although considerable pressure is exerted in pushing the bulb 15 into the head 16 and adjusting it up into the proper position against the stop 31. Support for the stop 31 is provided in the enclosure 28 (Fig. 1) and the standard 54, to the latter of which it is attached by means of the arm 55.

The motion of the conveyor 17 which is brought about through motion of the chain 34 is constant and carries the heads 15 through the loading positions and thence along a straight path into the enclosure 28 and around a sprocket (not shown) on the shaft 56. In the course of this movement, the weight of the heads 16 of the conveyor 17 is transferred from the sprocket 35 to a stationary bar or rail (indicated at 57, Fig. 2) onto which the roller 58 on the support 33 is carried. A corresponding bar 59 (Fig. 6) extends along the succeeding course of travel of the conveyor 17 which advances it from engagement with the sprocket on the shaft 56 to the coating turret 19 where the chain 34 passes onto the sprocket 35' (Fig. 4). As shown in Fig. 6, the conveyor 17 is also guided along this course of movement by the rail 47 which engages the roller 44 on the lower part of the head 16.

The movement of the conveyor heads 16 into engagement with the coating turret 19 advances the bulbs 15 into position below the outlet nozzles 60 (Fig. 4) in the bottom of the header tank 61 of the coating apparatus which nozzles 60 provide both for the release of the coating fluid from the tank 61 and the distribution of said fluid over the inner walls of the bulb 15. The support for the conveyor heads 16 in the coating turret 19 corresponds closely to that of the loading and unloading turret 18 in that the chain 34 of the conveyor 17 is carried by the sprocket 35' held by the hub 36' and the lower end of the heads 16 are guided along their path of movement by a portion of the rail 47 and by the notched spider 43' which passes about a portion of said head 16. The hub 36' and notched spider 43' are mounted at spaced points along the idler shaft 37' which is supported by the bearings 38' and 39' carried by the upper and lower parts of the yoke 40' (only partially shown). The yoke 40', in turn, is mounted on a pedestal 41' and attached to a portion of the enclosure 28 as in the turret 18 although not completely shown in this connection.

The nozzles 60 and header tank 61 have a course and speed of movement coresponding to the heads 16 as the tank 61 is mounted on the plate 62 carried by the extending portion 63 of the hub 36' holding sprocket 35' and provide an outlet for the coating fluid over the regularly spaced positions taken by the heads 16 of the conveyor 17. When the conveyor 17 advances into the immediate vicinity of the coating turret 19, the upper end of the bulbs 15 are below the plane of all parts of the nozzle 60 but as these paths converge, the roller 53 of the conveyor head 16 passes into a channel in the cam 64 (Fig. 6) causing the movable slide 32 and bulb 15 to be raised. This motion of the bulb 15 carries the top end thereof up about the nozzle 60 to a point where the shoulder 65 (Figs. 4 and 5) on said end is against the angular face of three pins 66 extending from spaced points on the collar 67 and positions the bulb 15 both vertically and centrally with respect to the nozzle 60. The vertical motion is excessive and causes the clip 29 and the rests 30 to slide up along the bulb 15 very slightly. At the limit motion, the roller 53 is carried over onto the straight section 64' of the cam 64 which extends around the turret 19 to a corresponding point on the opposite side thereof. Both portions of the cam 64 are supported by a plurality of arms of the bracket 68 (Fig. 4) which is attached to a flange on the upper arm of the yoke 40'.

The succeeding steps in the operation of the apparatus occur when the conveyor head 16 advances the bulb 15 into engagement with the curved shoe 69 of the control finger 70 (Figs. 1, 4 and 7) at which time said finger 70 places the nozzle opening means 71 mounted above the header tank 61 in condition to be effective. In instances where a bulb 15 is not carried by the head 16 and not engaged by the shoe 69, the finger 70 which is fastened to a pin 72 pivoted in the

bracket 73 on the standard 54 (Fig. 1) will swing to a position nearer the center of the coating turret 19 because of the biasing effect of the spring 74 and will have no effect on the inoperative condition of the nozzle opening means 71. At this limit of motion the branch 75 of the finger 70 rests against the stop nut 76 on the pin 77 extending from the bracket 73. However if the shoe 69 engages a bulb 15, the finger 70 will be farther outward from the center of the coating turret 19 than otherwise and the roller 78 will be in the path of movement of the lower end of the push rod 79 of the nozzle opening means 71 and will lift said push rod 79 to a different position in the course of rotation of the coating turret 19. The effect of this operation is to turn the lever 80 (Figs. 4 and 8) of the nozzle opening means 71 to which the push rod 79 is attached by pin 81 so that the wedge 82, which is attached to said lever 80 by pin 83, is moved longitudinally and the thicker portion thereof is placed over the upper end of the metering pin 84 of the nozzle 60. With the wedge 82 in this position, the almost immediate downward movement of the arm 85 which is pivoted on the pin 86 held by bracket 87 and which now engages the cam 88 through roller 89 carries the screw 90 against said wedge 82 causing the said wedge 82 and metering pin 84 to move downward an amount required to produce the desired flow of coating fluid from the nozzle 60 to the bulb 15. The pull of the contraction force of the spring 91 which extends between posts in adjacent pairs of push rods 79 and the friction produced between the screw 90 and the wedge 82 are sufficient to hold said rod 79 and the wedge 82 in place after the lower end of the push rod 79 passes beyond the roller 78 of the control finger 70.

In instances when a bulb 15 is not held by the head 16, the movement of the arm 85 will be of no consequence as the wedge 82 will have remained in its original position where the thinner portion 92 is over the upper end of the metering pin 84 and sufficient clearance is provided for the full movement of the screw 90. At such times the lower end of the push rod 79 passes to one side of the roller 78.

The nozzle opening means 71 retains its relation with the nozzle 60 during the rotation of the turret 19 as it is mounted on the circular plate 93 covering the outer portion of the open top of the header tank 61 which plate 93 is supported on a plurality of posts 94 extending upward from the edge of the plate 62. The brackets 87 of each of the nozzle operating means 71 are mounted on the plate 93 directly below the ring 95 supporting the cam 88 which ring 95 (Figs. 1, 4 and 9) is held in place by four studs 96 extending from the bars 97 and 98 in turn mounted on the standard 99 of the frame 42 (only partially shown) of the enclosure 28.

The flow of coating material to the lamp 15 from the nozzle 60 is controlled by the vertical adjustment of the metering pin 84 which extends up through the center of the orifice cap 100, (Fig. 5), the guide 101 and the orifice tube 102 of said nozzle 60 and the header tank 61 to a second guide 103 (Fig. 4) opposite the operating means 71 therefor. The metering pin 84 is under the constant influence of a spring 104 located between a cap 105 on the upper end thereof and the guide 103 which is clamped tightly in an opening in the plate 93 by the nut 105'. The expansion force of the spring 104 is sufficient to keep the frusto-conical end portion 106 of the metering

pin 84 up tight against the seat formed by lip 101' on the end of the orifice cap 100 and prevent any flow of the coating fluid from the header tank 61 during the greater period of rotation of the coating turret 19.

When the nozzle operating means 71 is actuated and the metering pin 84 is moved down, the coating material contained within the header tank 61 flows through the orifice tube 102, which is clamped tightly in an opening in the bottom of the header tank 61 and the plate 62 by the nut 107, the opening in the orifice cap 100 and over the conical and skirted portions 106 and 109 respectively of the metering pin 84 to the walls of the bulb 15. The coating material flows around the legs (three) of the guide 101 which extend into notches in the end of the orifice tube 102 and pass in a uniform uninterrupted stream over the full periphery of the lower portions 106 and 109 of the metering pin 84 to the bulb 15 where it follows the inner wall thereof. Since the upper end of the bulb 15 is positioned by the engagement of the pins 66 on the collar 67 with the shoulder 65 thereof and said collar 67, in turn, is fastened to the orifice cap 100 of the nozzle 60 by screw 110, the flow of coating fluid directed by metering pin 84 will in every instance engage the walls of the bulb 15 at a definite point with relation to said shoulder 65 regardless of slight variations in the length of the reduced end portion 111 of the bulb 15. It is preferred that the coating fluid pass from the skirt 109 of the metering pin 84 which is at fifteen degrees to the horizontal to the curved part of the reduced end portion 111 of the bulb 15 since the flow is then very smooth and free of bubbles. This relation of parts is also preferred since the stream of coating fluid strikes a portion of the bulb 15 which is subsequently covered by the base of the finished lamp and is therefore concealed as the force of the stream often causes the resultant coating to be thinner where it strikes the walls of the bulb 15.

The quantity or dosage of the coating fluid introduced in each bulb 15 is controlled both through the vertical movement of the metering pin 84, which can be adjusted by turning the screw 90 of the operating means 71 in or out of arm 85, and through the period of time said metering pin 84 is held in the open position by the presence of the cam 88 over the arm 85. Normal operation procedure provides that the metering pin 84 have .185 inch of movement and that the cam 88 extend for sixty degrees of the rotation of the turret 19.

After the roller 89 passes from the end of cam 88, the contraction force of spring 89' extending between a portion of arm 85 and a part of bracket 87 turns said arm 85 until the stop screw 90' on another part of said arm 85 engages the back of bracket 87 so that the metering pin 84 can return to its closed position. The force with which the coating fluid is discharged into the bulb 15 is of no consequence as it is determined by the pressure head created by the height of the coating fluid in the header tank 61 and is kept constant by the automatic release of additional fluid from the pipe 112 (Fig. 10) to the header tank 61.

During the entire course of operation of the apparatus each bulb 15 must receive a like application of the coating fluid in order that a uniform deposit of the finely divided fluorescent material, which is held in suspension therein, be applied in every instance. To this end, means are provided in the propeller 113 for agitating the

coating fluid within the header tank 61 to prevent settling out of the fluorescent materials. The propeller 113 which is fastened to the lower end of a shaft 114 passing up through the cover 115 over the header tank 61 takes a constant rotative motion through its connection with the supporting and operating means 116 (Fig. 9) and can be separated from said means 116 for cleaning by unscrewing the collar 117 of the coupling joining the flanges of the shaft 114 and the shaft 118 of said means 116. The rotative motion of the driving means 116 originates in the electric motor 119 mounted on the bracket 120 extending from the stationary standard 99 of the enclosure 28 and is transferred to the driving shaft 118 through the belt 121, the pulleys 122 and 123, a commercial form of speed reducer 124, the shaft 125 and the bevel gears 126 and 127. The bracket 128 on the top end of the standard 99 provides the support for the speed reducer 124 whereas the arm 129 which is attached to a portion of bracket 128 provides the support for the shafts 118 and 125.

Because of the relatively rapid rate with which the bulbs 15 are treated in the apparatus and consequent rapid use of the coating fluid, and the necessity of keeping the fluid level constant within the header tank 61, automatic means are provided for supplying additional coating fluid to the header tank 61 from a storage tank 130 (Fig. 10) located at a convenient position to one side of the apparatus. The coating fluid is drawn out of the storage tank 130 by the pipe 131 and forced through pipe 132, the screen 133' of the filter 133, pipe 134 to the inlet pipe 112 in the header tank 61 by a pump 135 and is released to the header tank 61 as required by the float controlled valve 136 which is connected in pipe 112. An excess of the coating fluid is conducted to pipe 112 by this system so that a return pipe 137 is provided to carry any unused coating fluid back to the storage tank 130. The above piping system has the dual purpose of conducting the desired coating fluid to the header tank 61 and of circulating the coating fluid at all times so that the fluorescent material can not settle out during moments when little of said fluid is required by said header tank 61. The coating fluid within the storage tank 130 is not subject to settling as it is agitated by the rotation of the paddle wheel 138 which is connected to the compressed air driven motor 139.

After periods of operation it may be desirable to clean off any solid particles of the fluorescent material carried by the coating fluid from the screen 133' of the filter 133 to permit the full flow of said fluid through said filter. This operation is brought about by stopping the pump 135 so as to stop the flow of the coating fluid in the usual direction through the supply circuit and then to open the valve 140 connected to the drain pipe 141 so that the direction of movement of the coating fluid is reversed in said circuit and flushes the materials on the screen of the filter through the valve 140 and pipe 141 to the storage tank 130 or, if desired, to any other means to which the pipe 141 can be connected.

Normal operation of the coating apparatus closes the nozzle 60 before the coating fluid flows the full length of the bulb 15 but the interval the nozzle 60 is open is sufficiently long to allow a considerably larger quantity of the coating fluid than is required to enter the bulb 15. The coating fluid is flushed onto the inner walls of the bulb 15 and flows down said walls in a flood which finally reaches the open bottom end thereof where it drains to the trough 142. At one point along the trough 142, which extends around the end of the coating turret 19 and along the succeeding path of movement of the bulb 15, the fluid passes from the bulb 15 in a sufficient quantity to form a bubble over the lower end of said bulb 15 excepting that a jet of air from a pipe 143 mounted along the edge of the trough 142 is directed against said end to burst it. The presence of the bubble over the end of the bulb 15 appears to prevent the free circulation of air through said bulb 15 and is believed objectionable because of striations and other irregularities appearing in the coating when it is allowed to persist. The bubble only tends to form during the first period of drainage from the bulb 15 and does not tend to reappear after it passes from the effective range of the air jet.

The succeeding course of travel of the heads 16 of the conveyor 17 advances the roller 53 on the slide 32 thereof into a declining portion of the cam 64 which corresponds to that portion of said cam (shown in Fig. 6) on the opposite side of the coating turret 19 and causes the slide 32 and the bulb 15 to be lowered from operative relation to the nozzle 60. There is no interference of parts, therefore, as the course of movement of the heads 16 of the conveyor 17 separates from that of the turret 19 and passes along a straight path into the enclosure 28. The subsequent period of travel of the head 16 allows the bulb 15 to drain and the coating material to dry in an atmosphere relatively free of dirt and dust and preferably a few degrees above ambient temperature.

The course of travel of the conveyor 17 carries the bulbs 15 through an opening in the end wall of the enclosure 28 which is complete on the other three sides and the top so as to permit the control of the atmosphere therein and follows a straight path 20 along the side of the enclosure to a driving sprocket on shaft 144 which sprocket reverses its path of motion. During this interval the excess coating fluid within the bulb 15 drains out into the trough 142 which extends along this path 20 and which is inclined so that coating fluid received by it flows in the direction of movement of the bulb 15. Continued movement of the heads 16 of the conveyor 17 carries the bulb 15 along path 21, around idler sprockets on the shafts 145 and 146 and returns the conveyor 17 to a second driven sprocket on the shaft 147 adjacent shaft 144. During these intervals, the bulb 15 drains to the wider portion 148 of the trough 142 which lies under the straight paths 20 and 21 and the branch 149 of the trough 142 which lies under the curved path of travel thereof. The coating fluid received by the wider portion 148 of the trough 142 is relatively thick and not free flowing but is recoverable as it is washed down to the drain 150 at the lowermost end thereof by the flood of free flowing coating fluid passing through it from the trough 142 around the turret 19 and along the path 20. The recovered coating fluid is, as shown in Fig. 10, drawn from the drain 150 by the pump 151 and forced up through pipe 152 to the supply tank 130 where it mixes with the main supply thereof and is subject to use. Any of the vehicle of the coating fluid that may have evaporated in the course of the coating operation and movement of the coating fluid down in the trough 142, so as not to be recoverable, is replaced by the controlled release of additional

vehicle from the pipe 153 which is connected to a supply thereof.

Succeeding movements of the carrier 17 advances the bulb 15 from a point opposite the driving sprocket on shaft 147 along the straight path 23 to an idler sprocket on the shaft 154 where it reverses its direction of movement and passes again to a driven sprocket on shaft 155. Still further movements of the conveyor 17 carry the bulb 15 along path 25, around idler sprockets on the shafts 156 and 157, along path 26, around the driven sprocket on shaft 158 and along the path 27, all of which are located within the enclosure 28 and keep the bulb 15 within the confined atmosphere therein until the coating on said bulb 15 is comparatively dry. The enclosure 28 is sufficiently long to permit a relatively high rate of operation of the conveyor 17, and consequently the entire apparatus, and completely encloses the single drive means of the apparatus which is connected to the driving shafts 144, 147, 155 and 158. The rotative driving motion is imparted to these shafts 144, 147, 155 and 158 through a corresponding gear 159 on the upper end of each shaft and originates in an electric motor 160 which drives a gear 161 meshing with the two innermost gears 159 on shafts 147 and 155 through the shaft 162, bevel gears 163 and 164 and shaft 165. The outermost gears 159 on shafts 144 and 158 are driven through the gears 166 and 167 respectively from the adjacent gears 159 on shaft 144 and 158 respectively.

It is usually preferred that air be circulated through the bulbs 15 while they are within the enclosure 28 to promote the drying of the coating although the force of the circulated air must be relatively slight at certain times to prevent injury to said coating. In this particular instance, air conducting manifolds are mounted over paths 20, 21, 26 and 27 in such a position as to direct various amounts of air down through the top end of the bulbs 15 during their course of movement therealong and means are provided for supplying air a few degrees above ambient temperature to said manifolds. No other means is required for controlling the circulation and temperature of air in the enclosure 28 although a duct 169 lying along the center of the floor thereof and having openings on opposite sides is provided to draw out the vehicle laden air to an exhaust stack 170 extending out the top of the enclosure 28 so as to prevent its escape to immediate vicinity of the apparatus. The controlled conditions within the enclosure 28 in one instance dries the coating on the inside of the bulb 15 to such an extent that it can be handled without injury and will remain dust-free although the bulb 15 has remained within the enclosure 28 only twenty minutes. At the end of the drying period the conveyor 17 carries the heads 16 through an opening in the end of the enclosure 28 to the loading and unloading turret 18 where the bulb 15 is removed therefrom.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. Apparatus for coating the inner walls of tubular bulbs comprising a coating turret comprised of a header tank rotatable about a vertical axis for holding a coating fluid, and a plurality of outlet nozzles located in the bottom of said tank at regularly spaced points along a path about the axis of rotation thereof, a conveyor comprised of a plurality of heads each adapted to hold a bulb in a vertical position and means for advancing the heads into operative relation below the nozzles of the coating turret, thence along a portion of the rotative path of movement thereof and along an extended course of movement, an enclosure about the extended course of movement of the conveyor, and means for actuating the conveyor and rotating the coating turret so as to cause the bulbs in succeeding heads of the conveyor first to be flushed by coating fluid discharged by said nozzles and then to be dried in the atmosphere within the enclosure.

2. Apparatus for coating the inner walls of tubular bulbs comprising a coating turret comprised of a header tank rotatable about a vertical axis for holding a coating fluid, and a plurality of outlet nozzles located in the bottom of said tank at regularly spaced points along a path about the axis of rotation thereof, a conveyor comprised of a plurality of heads each adapted to hold a bulb in a vertical position and means for advancing the heads into operative relation below the nozzles of the coating turret, thence along a portion of the rotative path of movement thereof and along an extended course of movement, an enclosure about the extended course of movement of the conveyor, means attached to the coating turret and engaging the conveyor for causing the movement of said conveyor to rotate said turret so that the bulbs and nozzles retain the proper relation to each other and means for actuating the conveyor to cause the bulbs in succeeding heads of the conveyor first to be flushed by coating fluid discharged by said nozzles and then to be dried in the atmosphere within the enclosure.

3. Apparatus for coating the inner walls of tubular bulbs comprising a coating turret comprised of a header tank rotatable about a vertical axis for holding a coating fluid, and a plurality of outlet nozzles located in the bottom of said tank at regularly spaced points along a path about the axis of rotation thereof, a conveyor comprised of a plurality of heads each with a vertically movable slide adapted to hold a bulb in a vertical position and means for advancing the heads to positions below the nozzles of the coating turret, thence along a portion of the rotative path of movement and along an extended course of movement, an enclosure about the extended course of movement of the conveyor, means for raising the slides of the conveyor heads for an interval during the period said heads are aligned with the outlet nozzles to carry the upper ends of the bulbs over the ends of said nozzles and means for actuating the conveyor and rotating the coating turret so as to cause the bulbs in succeeding heads of the conveyor first to be flushed by coating fluid discharged by said nozzles and then to be dried in the atmosphere within the enclosure.

4. Apparatus for coating the inner walls of tubular bulbs comprising a coating turret comprised of a header tank rotatable about a vertical axis for holding a coating fluid, and a plurality of outlet nozzles located in the bottom of said tank at regularly spaced points along a path about the axis of rotation thereof, a conveyor, for advancing said bulbs into operative relation below the nozzles of the coating turret, thence along a portion of the rotative path of movement thereof and along an extended course of movement, comprised of a chain, and a plurality of heads each having a vertically movable slide for holding a bulb in a vertical position, a support attached to the chain providing ways for and means of

retaining said slide, means extending from the slide for permitting the adjustment thereof, a stationary cam mounted below the coating turret for engaging and raising the slide adjusting means of the heads to lift the slides and carry the upper ends of the bulbs over the ends of said nozzles, an enclosure about the extended course of movement of the conveyor and means for causing movement of the conveyor and corresponding motion in the coating turret so as to cause the bulbs in succeeding heads of the conveyor first to be flushed by coating fluid discharged by said nozzles and then to be dried in the atmosphere within the enclosure.

5. Apparatus for coating the inner walls of tubular bulbs comprising a coating turret comprised of a header tank rotatable about a vertical axis for holding a coating fluid, a plurality of outlet nozzles located in the bottom of said tank at regularly spaced points along a path about the axis of rotation thereof, and means mounted adjacent the nozzles for positioning the end of the bulb with respect thereto, a conveyor comprised of a plurality of heads each adapted to hold a bulb in a vertical position and adjust the position of said bulb vertically and means for advancing the heads to positions below the nozzles of the coating turret, thence along a portion of the rotative path of movement thereof and along an extended course of movement, an enclosure about the extended course of movement of the conveyor, means located adjacent the coating turret for causing the heads to raise the bulbs to carry the upper ends thereof over the ends of the nozzles and into engagement with the positioning means and means for actuating the conveyor and rotating the coating turret so as to cause the bulbs in succeeding heads of the conveyor first to be flushed by coating fluid discharged by said nozzles and then to be dried in the atmosphere within the enclosure.

6. Apparatus for coating the inner walls of tubular bulbs having reduced shouldered ends comprising a coating turret comprised of a header tank rotatable about a vertical axis for holding a coating fluid, a plurality of outlet nozzles located in the bottom of said tank at regularly spaced points along a path about the axis of rotation thereof and a plurality of pins having angular faces mounted about the nozzles adapted to engage the shoulders on the ends of the bulbs to position them with respect to the nozzles, a conveyor comprised of a plurality of heads each adapted to hold a bulb in a vertical position and adjust the position of said bulb vertically and means for advancing the heads to positions below the nozzles of the coating turret, thence along a portion of the rotative path of movement thereof and along an extended course of movement, an enclosure about the extended course of movement of the conveyor, means located adjacent the coating turret for causing the heads to raise the bulbs to carry the upper ends thereof over the ends of the nozzles and the shoulders of said bulbs into engagement with the angular faces of the pins to place the said bulbs in operative relation to the nozzles, and means for actuating the conveyor and rotating the coating turret so as to cause the bulbs in succeeding heads of the conveyor first to be flushed by coating fluid discharged by said nozzles and then to be dried in the atmosphere within the enclosure.

7. Apparatus for coating the inner walls of tubular bulbs comprising a bulb loading and unloading turret, a coating turret located adjacent

the first-mentioned turret comprised of a header tank rotatable about a vertical axis for holding a coating fluid, and a plurality of outlet nozzles located in the bottom of said tank at regularly spaced points along a path about the axis of rotation thereof, a conveyor comprised of a plurality of heads each adapted to hold a bulb in a vertical position and means for advancing the heads around a portion of the loading and unloading turret, thence into relation below the nozzles of the coating turret and along a course of movement therebetween, an enclosure about said course of movement for drying the coated bulbs, and means for actuating the conveyor and rotating the loading and unloading, and coating turrets.

8. Apparatus for coating the inner walls of tubular bulbs comprising a coating turret comprised of a header tank rotatable about a vertical axis for holding a coating fluid, and a plurality of outlet nozzles located in the bottom of said tank at regularly spaced points along a path about the axis of rotation thereof, a conveyor for advancing said bulbs into operative relation below the nozzles of the coating turret, thence along a portion of the rotative path of movement thereof and along an extended course of movement, comprised of a chain, and a plurality of heads each having means for holding a bulb in a vertical position and rollers attached to the holding means adapted to support and guide said holding means during movement of the conveyor, rails mounted along the path of movement of the conveyor about the coating turret and the extended course thereof engaging the rollers of the heads for keeping the heads to the same path of movement of the chain and for supporting said heads for at least a portion of said movement, an enclosure about the extended course of movement of the conveyor, and means for causing movement of the conveyor and corresponding motion in the coating turret so as to cause the bulbs in succeeding heads of the conveyor first to be flushed by coating fluid discharge by said nozzles and then to be dried in the atmosphere within the enclosure.

9. Apparatus for coating the inner walls of tubular bulbs comprising a coating turret comprised of a header tank rotatable about a vertical axis for holding a coating fluid, and a plurality of outlet nozzles located in the bottom of said tank at regularly spaced points along a path about the axis of rotation thereof, a conveyor comprised of a plurality of heads each adapted to hold a bulb in a vertical position and means for advancing the heads into operative relation below the nozzles of the coating turret, thence along a portion of the rotative path of movement thereof and along an extended course of movement, an enclosure about the extended course of movement of the conveyor, means for actuating the conveyor and rotating the coating turret so as to cause the bulbs in succeeding heads of the conveyor first to be flushed by coating fluid discharged by said nozzles and then to be dried in the atmosphere within the enclosure, a trough mounted below the path of movement of the heads about the coating turret and along the extended course of movement thereof and inclined downward from said turret for catching the excess coating fluid draining out of the bottom of the bulbs, and means connected to the lowermost portion of the trough along the course of movement of the heads for recovering and re-

turning the excess coating fluid to the header tank.

10. Apparatus for coating the inner walls of tubular bulbs comprising a coating turret comprised of a header tank rotatable about a vertical axis for holding a coating fluid, a plurality of outlet nozzles located in the bottom of the tank at regularly spaced points along a path about the axis of rotation thereof, metering pins extending upward through the nozzles and through the header tank for controlling the flow of coating fluid through the nozzles, nozzle opening means engaging the upper ends of the metering pins for adjusting said pins to produce a flow of coating fluid from the nozzles during a portion of the rotation of the coating turret, a conveyor comprised of a plurality of heads each adapted to hold a bulb in a vertical position and means for advancing the head into operative relation below the nozzles of the coating turret, thence along a portion of the rotative path of movement thereof and along an extended course of movement, an enclosure about the extended course of movement of the conveyor and means for actuating the conveyor and rotating the coating turret so as to cause the bulbs in succeeding heads of the conveyor first to be flushed by coating fluid discharged by said nozzles and then to be dried in the atmosphere within the enclosure.

11. Apparatus for coating the inner walls of tubular bulbs comprising a coating turret comprised of a header tank rotatable about a vertical axis for holding a coating fluid, a plurality of outlet nozzles located in the bottom of the tank at regularly spaced points along a path about the axis of rotation thereof, metering pins extending upward through the nozzles and through the header tank for controlling through longitudinal motion the flow of the coating fluid through the nozzles, a guide for the metering pin mounted about the upper end portion thereof, means mounted adjacent the upper ends of the metering pins for normally holding said pins in the closed position, and nozzle opening means engaging the upper ends of the metering pins for adjusting said pins to produce a flow of coating fluid from the nozzles during a portion of the rotation of the coating turret, a conveyor comprised of a plurality of heads each adapted to hold a bulb in a vertical position and means for advancing said bulbs into operative relation below the nozzles of the coating turret, thence along a portion of the rotative path of movement thereof and along an extended course of movement, an enclosure about the extended course of movement of the conveyor and means for actuating the conveyor and rotating the coating turret so as to cause the bulbs in succeeding heads of the conveyor first to be flushed by coating fluid discharged by said nozzles and then to be dried in the atmosphere within the enclosure.

12. Apparatus for coating the inner walls of tubular bulbs comprising a coating turret comprised of a header tank rotatable about a vertical axis for holding a coating fluid, a plurality of outlet nozzles located in the bottom of the tank at regularly spaced points along a path about the axis of rotation thereof, metering pins extending upward through the nozzles and through the header tank for controlling through longitudinal motion the flow of the coating fluid through the nozzles, guides for the metering pins mounted about the upper end portions thereof, means mounted adjacent the upper ends of the metering pins for normally holding said pins up in their closed position, nozzle opening means engaging the upper ends of the metering pins for adjusting said pins downward to produce a flow of coating fluid from the nozzles during a portion of the rotation of the coating turret, a conveyor comprised of a plurality of heads each adapted to hold a bulb in a vertical position, means for advancing the heads into operative relation below the nozzles of the coating turret and then beyond the nozzles, and means engaging a bulb in a head of the conveyor in operative relation to an outlet nozzle for controlling the operation of the nozzle opening means to prevent the discharge of the coating fluid therefrom when a bulb is not in place about said nozzle.

13. Apparatus for coating the inner walls of tubular bulbs comprising a coating turret comprised of a header tank rotatable about a vertical axis for holding a coating fluid, a plurality of outlet nozzles located in the bottom of the tank at regularly spaced points along a path about the axis of rotation thereof, metering pins extending upward through the nozzles and through the header tank for controlling through longitudinal motion the flow of the coating fluid through the nozzles, guides for the metering pins mounted about the upper end portions thereof, spring means for normally holding said pins in the closed position, a stationary cam mounted over the header tank, and nozzle opening means located adjacent the upper ends of each of the metering pins and engaging the cam for adjusting said pins to produce a flow of coating fluid through the nozzle corresponding to a difference in shape of the portion of the cam engaged thereby, a conveyor comprised of a plurality of heads each adapted to hold a bulb in a vertical position and means for advancing said bulbs into operative relation below the nozzles of the coating turret, along a portion of the rotative path of movement thereof and along an extended course of movement, an enclosure about the extended course of movement of the conveyor and means for actuating the conveyor and rotating the coating turret so as to cause the bulbs in succeeding heads of the conveyor first to be flushed by coating fluid discharged by said nozzles and then to be dried in the atmosphere within the enclosure.

14. Apparatus for coating the inner walls of tubular bulbs comprising a coating turret comprised of a header tank rotatable about a vertical axis for holding a coating fluid, a plurality of outlet nozzles located in the bottom of the tank at regularly spaced points along a path about the axis of rotation thereof, metering pins extending upward through the nozzles and through the header tank for controlling through longitudinal motion the flow of the coating fluid through the nozzles, guides for the metering pins mounted about the upper end portions thereof, spring means for normally holding said metering pins up in their closed position, and nozzle opening means located adjacent the upper ends of each of the metering pins comprised of actuating means movable toward and away from the end of one of said pins but not in engagement therewith, a wedge movable to a position over the end of the metering pin so as to be engaged by said actuating means to move said pin downward and allow the coating fluid to pass from the nozzle, a conveyor comprised of a plurality of heads each adapted to hold a bulb in a vertical position, means for advancing the heads into operative relation below the nozzles of the coating turret and

then beyond the nozzles, nozzle control means mounted adjacent the path of movement of the conveyor about the coating turret comprising finger means normally in the path of the bulbs in said heads but movable therefrom by engagement with a bulb, means coupling said finger means with said wedge during the rotation of the coating turret when the finger means is displaced by a bulb to cause the wedge to be moved into position over the end of the metering pin and permit the nozzle actuating means to move the metering pin.

15. Apparatus for coating the inner walls of tubular bulbs comprising a coating turret comprised of a header tank rotatable about a vertical axis for holding a coating fluid, a plurality of outlet nozzles located in the bottom of the tank at regularly spaced points along a path about the axis of rotation thereof, a conveyor comprised of a plurality of heads each adapted to hold a bulb in a vertical position and means for advancing said bulbs into operative relation below the nozzles of the coating turret, thence along a portion of the rotative path of movement thereof and along an extended course of movement, an enclosure about the extended course of movement of the conveyor, means for actuating the conveyor and rotating the coating turret so as to cause the bulbs in succeeding heads of the conveyor first to be flushed by coating fluid discharged by the nozzles and then to be dried in the atmosphere within the enclosure, and means located below the coating turret for directing a jet of air at the stream of coating fluid flowing out the end of the bulbs to prevent the formation of a bubble.

16. Apparatus for coating the inner walls of tubular bulbs comprising a coating turret comprised of a header tank rotatable about a vertical axis for holding a coating fluid, a plurality of outlet nozzles located in the bottom of the tank at regularly spaced points along a path about the axis of rotation thereof, metering pins extending upward through the header tank for controlling the flow of coating fluid through the nozzles, and nozzle opening means engaging the upper ends of the metering pins for adjusting said pins to produce a flow of coating fluid from the nozzles during a portion of the rotation of the coating turret, a source of supply of the coating fluid, means for replenishing the coating fluid in the header tank from the source thereof as rapidly as it is used, a conveyor comprised of a plurality of heads each adapted to hold a bulb in a vertical position and means for advancing said bulbs into operative relation below the nozzles of the coating turret, thence along a portion of the rotative path of movement thereof and along an extended course of movement, an enclosure about the extended course of movement of the conveyor and means for actuating the conveyor and rotating the coating turret so as to cause the bulbs in succeeding heads of the conveyor first to be flushed by coating fluid discharged by said nozzles and then to be dried in the atmosphere within the enclosure.

17. Apparatus for coating the inner walls of tubular bulbs having reduced shouldered ends comprising a coating turret comprised of a header tank rotatable about a vertical axis for holding a coating fluid, a plurality of outlet nozzles located in the bottom of the tank at regularly spaced points along a path about the axis of rotation thereof, means mounted adjacent the nozzles for engaging the shoulders on the ends

of the bulbs to position them with respect to the nozzles, and metering pins extending upward through the nozzles and through the header tank for controlling the flow of coating fluid through the nozzles, nozzle opening means engaging the upper ends of the metering pins for adjusting said pins to produce a flow of coating fluid through the nozzles during a portion of the rotation of the coating turrret, a conveyor for advancing the bulbs into position below the nozzles and along an extended course of movement having a plurality of vertically adjustable heads for holding the bulbs in a vertical position, means located adjacent the coating turret for raising the heads to carry the upper ends of the bulbs over the nozzles and the shoulders of said bulb against the positioning means, an enclosure about the extended course of movement of the conveyor, and means for actuating the conveyor and rotating the coating turret so as to cause the bulbs in succeeding heads of the conveyor first to be flushed by coating fluid discharge by said nozzles and then to be dried in the atmosphere within the enclosure.

18. In apparatus of the class described for coating the interior surface of a tubular bulb, means for holding the bulb in a vertical position, means for flushing a sufficient quantity of coating liquid into the top of the bulb so that it flows down the walls thereof and drains out the bottom thereof in sufficient quantity to form a bubble over the lower end of the bulb, and means for directing a jet of air at the stream of coating liquid flowing from the bottom of the bulb to prevent the formation of such a bubble.

19. Apparatus of the class described for coating the interior of tubular bulbs comprising a coating turret including a header tank rotatable about a vertical axis for holding a coating fluid, a plurality of outlet nozzles mounted on the bottom of the tank at regularly spaced points along a path about the axis of rotation thereof, metering pins extending upward through the nozzles and through the header tank for controlling the flow of coating fluid through the nozzles, means to support bulbs in vertical alignment with said nozzles and to carry them along with said nozzles during rotation of said header tank, and nozzle opening means engaging the upper ends of said metering pins for actuating said pins to produce a flow of coating fluid from the nozzles into the bulbs during a portion of the rotation of the coating turret, said nozzle opening means being constructed and arranged to hold said metering pins in open position for a predetermined length of time to thereby permit delivery of a predetermined quantity of coating fluid into each bulb.

20. Apparatus of the class described for coating the interior of tubular bulbs comprising a coating turret including a header tank rotatable about a vertical axis for holding a coating fluid, a plurality of outlet nozzles mounted on the bottom of said tank at regularly spaced points along a circular path, metering pins extending upward through the nozzles and through said tank and having flared heads at their lower ends for opening and closing the nozzles and directing the flow of coating fluid therefrom, means to support bulbs in vertical alignment with said nozzles with their upper ends surrounding the said heads of said metering pins and to carry said bulbs along with said nozzles during rotation of said tank, and nozzle opening means engaging the upper ends of said metering pins to move said pins downward and hold the nozzles open for a predeter-

mined time during a portion of the rotation of the coating turret.

21. In apparatus of the class described for coating the interior of a tubular bulb having a reduced shouldered end, a verticaly disposed discharge nozzle for a coating liquid, support means for said nozzle, a metering pin extending vertically through said nozzle and having a flared head at its lower end for opening and closing the nozzle and directing the flow of liquid laterally therefrom, locating means around said nozzle constructed and arranged to engage the exterior surface of the shoulder on the upper end of said bulb to accurately position the bulb relative to said nozzle, and means for moving said metering pin downward a predetermined amount to open said nozzle and carry the flared head portion of

the metering pin within the upper bulb end adjacent the shoulder thereon to a position at which the coating liquid is directed at said shoulder by said head portion of the metering pin.

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