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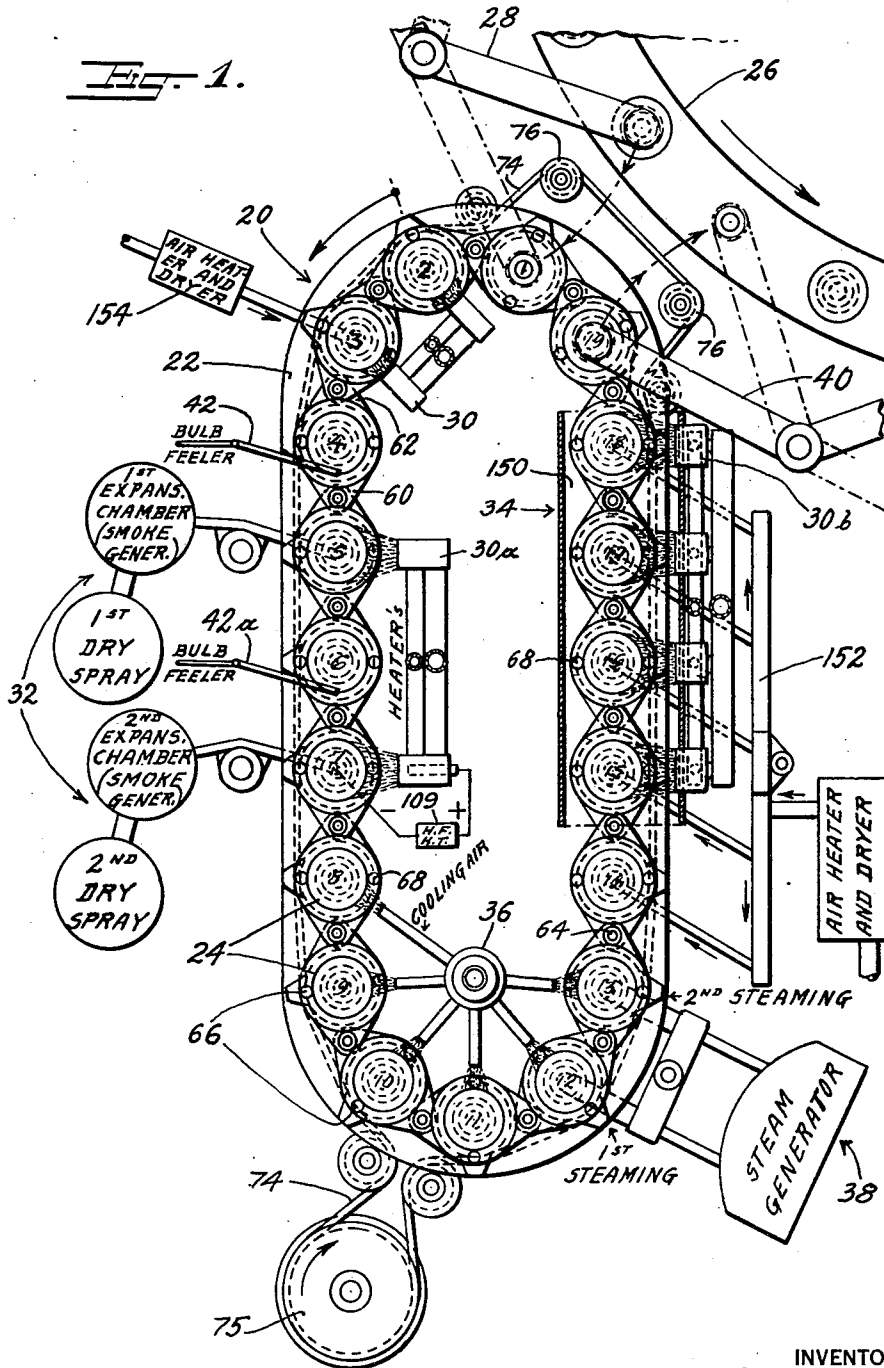
S. A. LOPENSKI ET AL

2,811,131

ELECTROSTATIC COATING MACHINE FOR INCANDESCENT LAMP ENVELOPES

Filed Aug. 13, 1956

7 Sheets-Sheet 1



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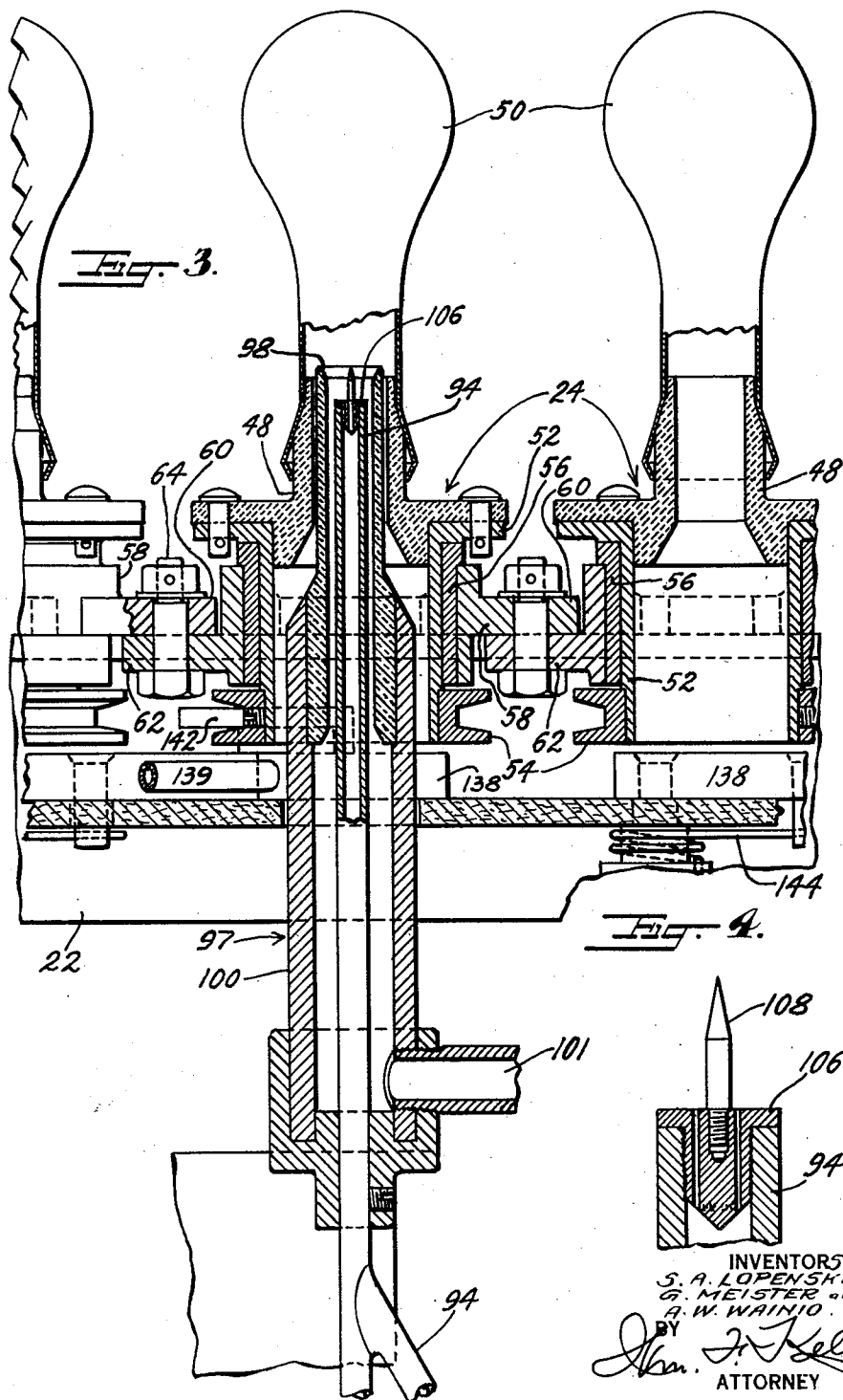
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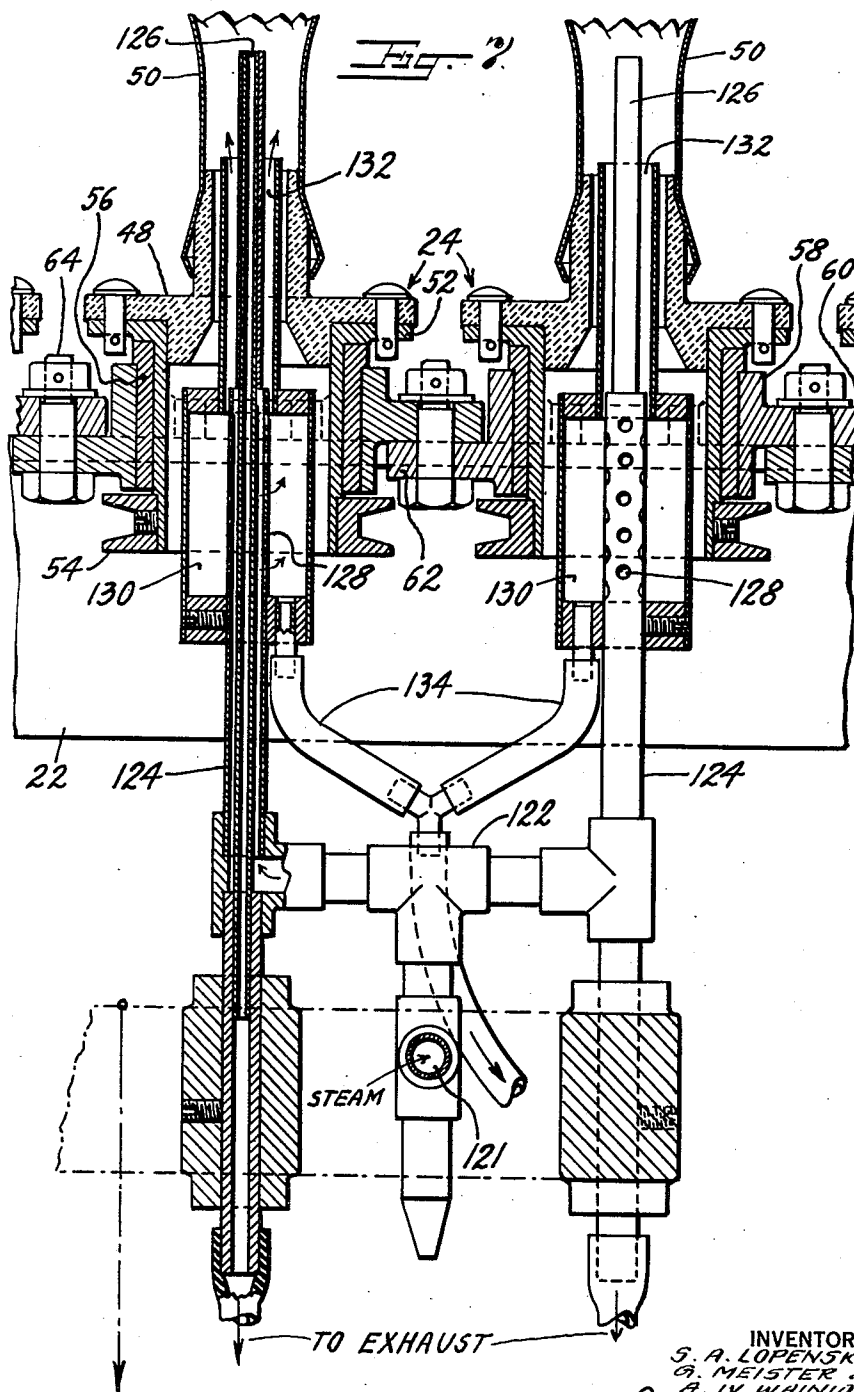
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7 Sheets-Sheet 3



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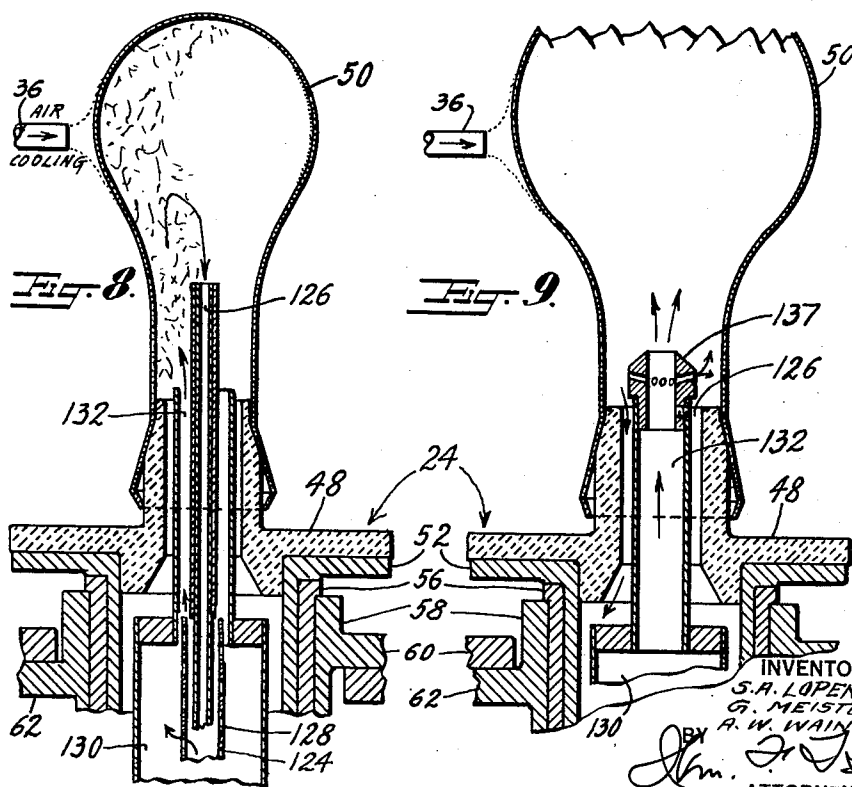
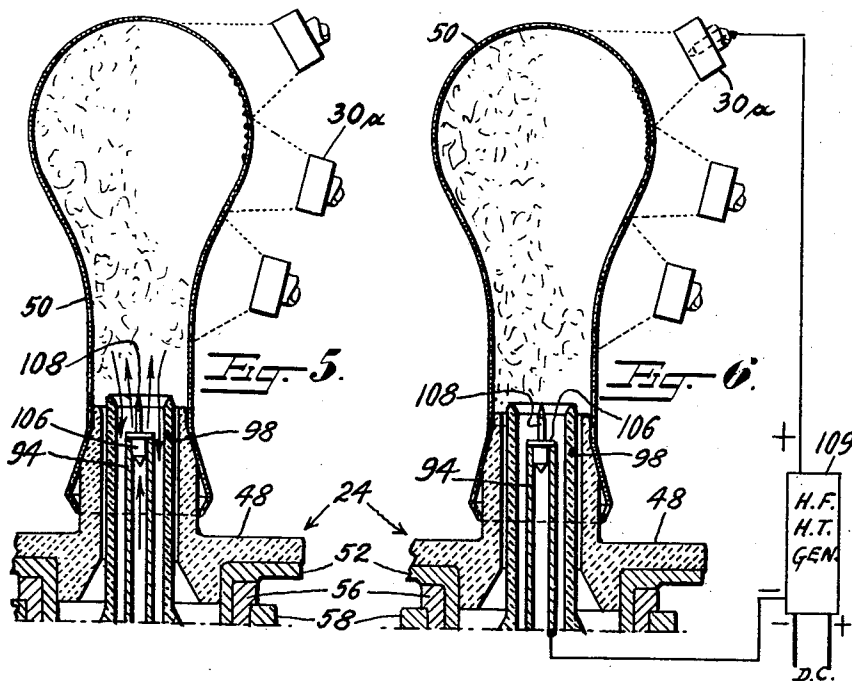
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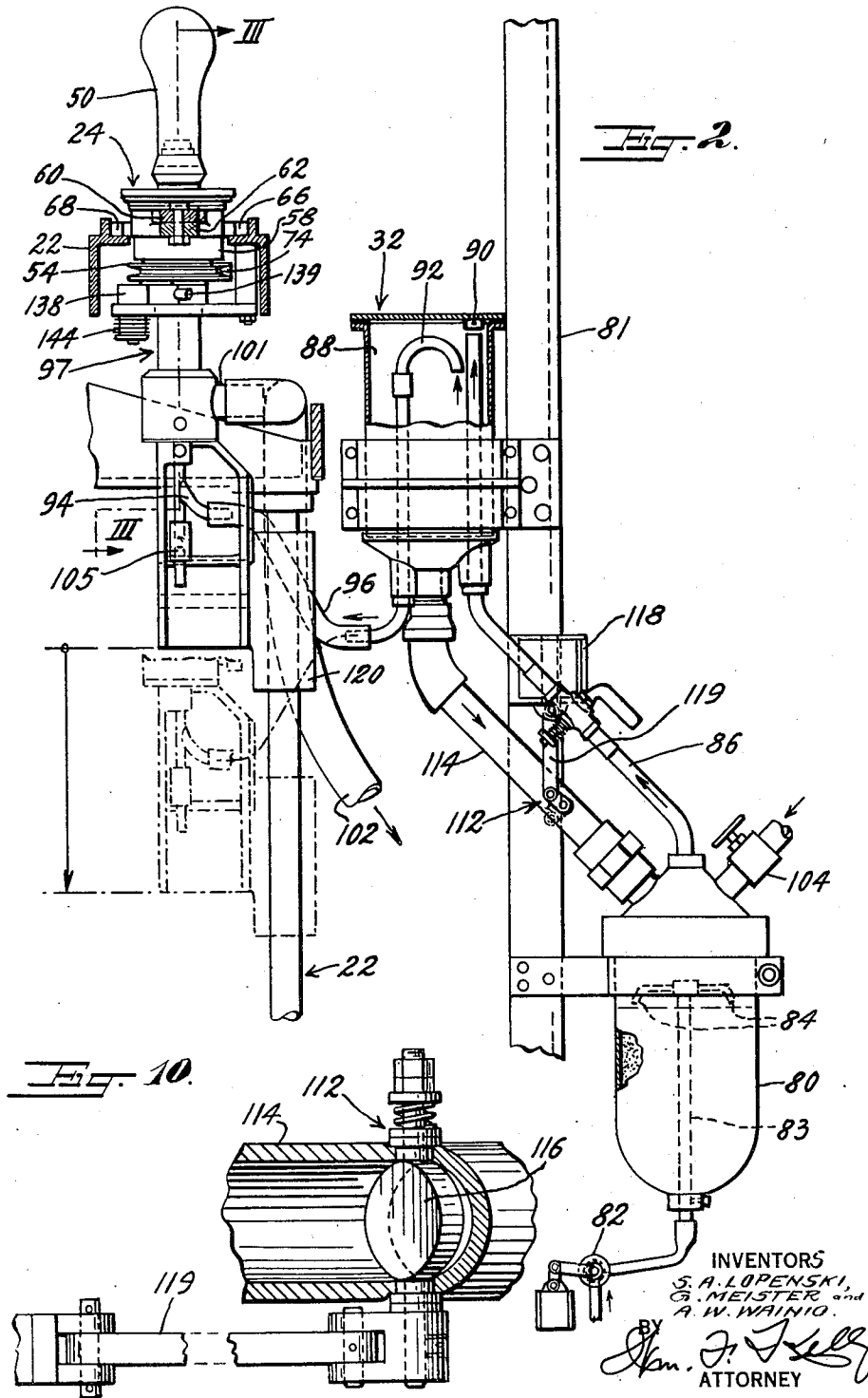
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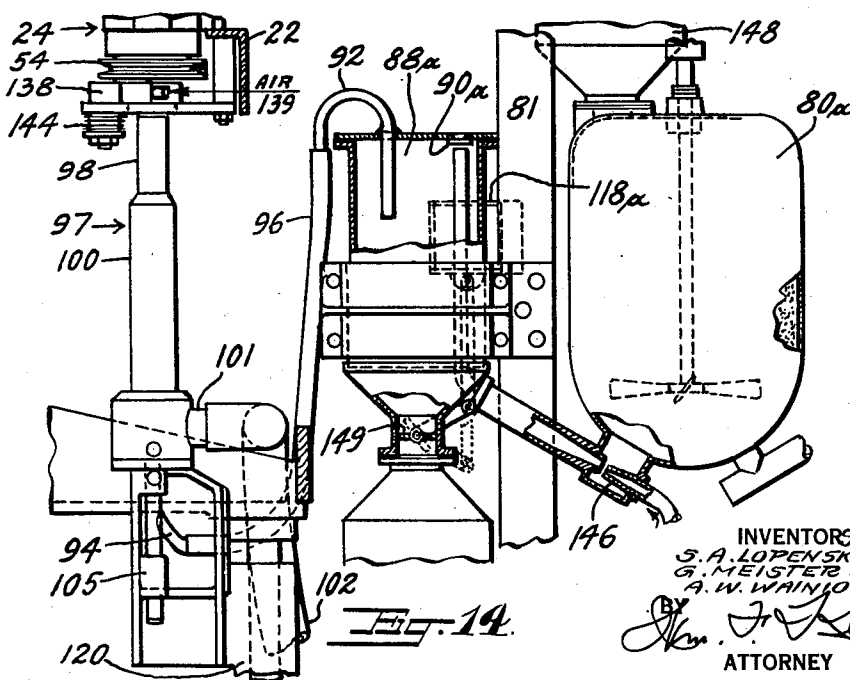
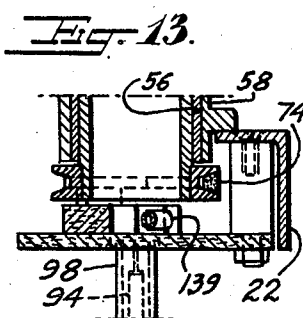
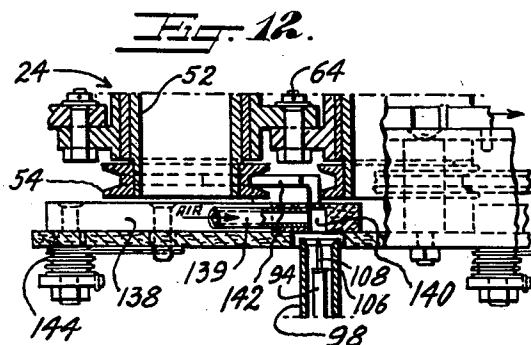
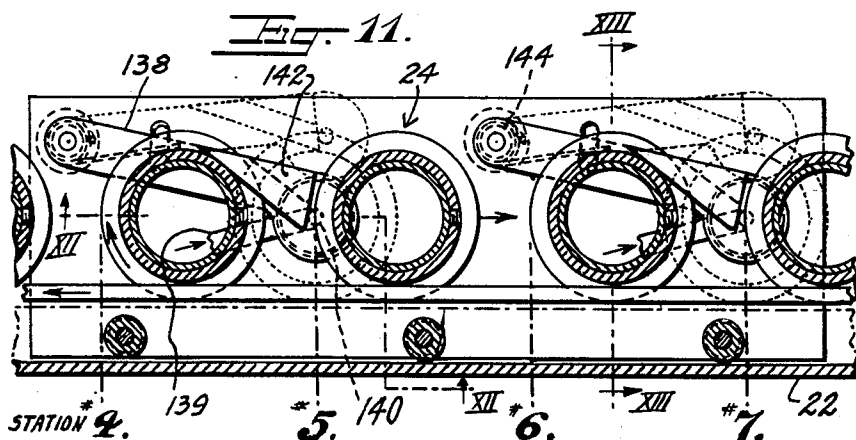
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7 Sheets-Sheet 6



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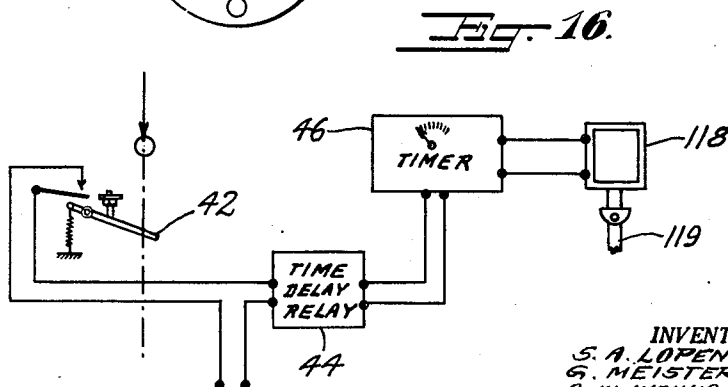
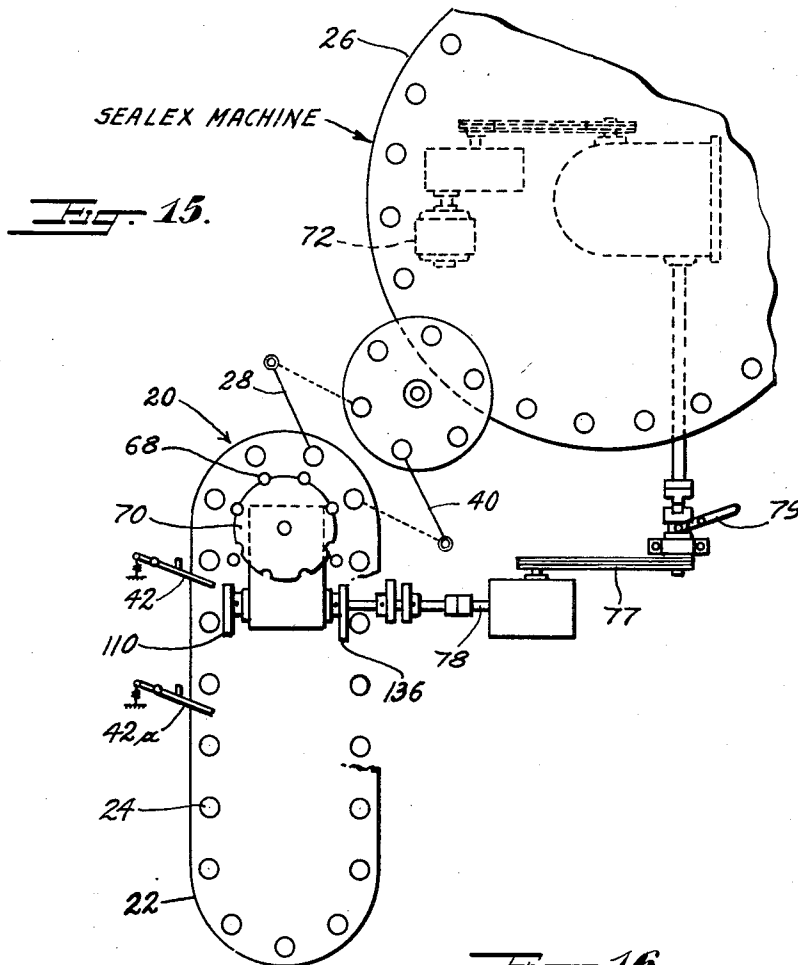
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2,811,131

ELECTROSTATIC COATING MACHINE FOR INCANDESCENT LAMP ENVELOPES

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Application August 13, 1956, Serial No. 603,636

11 Claims. (Cl. 118—49.1)

This invention relates to the manufacture of incandescent lamps and, more particularly, to an automatic machine for electrostatically coating incandescent lamp envelopes and this application is a continuation-in-part of application Serial No. 385,078, filed October 9, 1953, titled "Electrostatic Coating Machine for Incandescent Lamp Bulbs," now abandoned, by Lopenski, Meister and Wainio, the inventors herein, and owned by the assignee of the present application.

Incandescent lamp envelopes are normally provided with some type of light-diffusing coating in order to reduce the glare or so-called hot spot of the filament. The most usual type of diffusing coating is achieved by etching with an acid wash, for example, the interior surface of an incandescent lamp bulb. More recently, light-diffusing coatings comprising silica have been used. This silica is normally very finely divided and scatters the light in such a manner as to give the coated bulb a substantially uniform appearance over its entire surface.

Silica coatings on incandescent lamp envelopes have been achieved by burning ethyl orthosilicate in accordance with U. S. Patent No. 2,545,896 to Pipkin and by flushing processes. The burned ethyl orthosilicate method for manufacturing lamps as disclosed by Pipkin is costly as ethyl orthosilicate is a fairly expensive compound and the burner nozzles tend to accumulate caked silica, necessitating frequent cleaning. The flush coating processes for depositing silica entail the use of a nitrocellulose binder, for example, to impart to the flush the desired viscosity. In addition, the use of a flush technique for applying silica presents a handling problem, particularly where the numbers of bulbs coated run into the millions.

In order to overcome the foregoing and other difficulties of and objections to the practices of the prior art, it is the general object of this invention to provide an automatic machine for electrostatically applying a finely-divided, light-scattering material, particularly silica, to the interior surface of an incandescent lamp bulb.

It is a further object to provide a smoke-producing mechanism which operates in conjunction with the automatic machine and which will generate a smoke of coating material for deposition onto the lamp bulb.

It is another object to provide a cleaning mechanism which operates in conjunction with the nozzle of the smoke-generating mechanism in order to minimize any imperfections in the bulb coating.

It is still another object to provide a smoke-generating means for operation in conjunction with the automatic machine, which generator will produce a very even smoke of finely-divided coating material.

It is a still further object to provide a hot dry air flushing means which operates in conjunction with the automatic machine and which is desirable to improve the quality of the completely fabricated lamps.

It is an additional object to provide a steaming mechanism which operates in conjunction with the automatic machine in order to increase the adherence of the coating material for the bulb.

2

It is yet another object to provide optimum conditions for the operation of the automatic coating machine.

The aforesaid objects of the invention, and other objects which will become apparent as the description proceeds, are achieved by providing a machine for automatically depositing a finely-divided, light-scattering coating material onto the interior surface of an incandescent lamp bulb. In the operation of this machine, the bulbs are indexed through a plurality of work stations and are first heated so as to render them substantially uniformly electrically conductive. The coating material is then sprayed as a dry spray into the heated bulbs and an electric field applied to assist in depositing a portion of the sprayed material. During this operation the bulbs being coated and the spraying nozzle are rotated with respect to one another. The coated bulbs are then lehrd to remove substantially all moisture which may be contained therein and preferably the coated bulbs are simultaneously flushed with hot dry air while lehring to remove more completely any residual moisture. After coating, the spraying nozzle is blown clean so that uncoated material will not remain within the nozzle to be deposited in agglomerate form and thereby impair the quality of the coating. There is also provided a bulb-steaming operation after coating and prior to lehring, wherein a cloud of steam is injected into the coated bulb in order to mat down the coating and cause it to adhere better to the bulb. In addition, optimum conditions for the operation of the automatic coating machine are given.

For a better understanding of the invention, reference should be had to the accompanying drawings wherein:

Fig. 1 is a diagrammatic plan view of the automatic electrostatic coating machine of this invention;

Fig. 2 is a side elevation, partly in section, of the coating material smoke-producing unit as can be used at stations "5" and "7" of the machine as shown in Fig. 1;

Fig. 3 is an enlarged sectional view of the smoke-feed and return assembly, taken on the line III—III of Fig. 2, in the direction of the arrows;

Fig. 4 is an enlarged sectional view of the smoke-injector nozzle tip, shown in Fig. 3;

Fig. 5 is a sectional elevation of the silica-injector-nozzle assembly and a portion of a bulb-receiving head at station "5" or "7" of the machine;

Fig. 6 is a view similar to Fig. 5, but showing the connections for the high-voltage means at the coating stations "5" and "7";

Fig. 7 is a sectional elevation of the steam-injector unit at stations "12" and "13" of the machine shown in Fig. 1;

Fig. 8 is a sectional elevation showing a portion of the bulb-receiving head and the discharge conduit and return conduit of the steam-injector unit at stations "12" and "13" of the machine of Fig. 1;

Fig. 9 is a view similar to Fig. 8, but showing an alternative embodiment of the steam-injector unit;

Fig. 10 is an enlarged view, partly in section, of a butterfly valve which is employed in the smoke-producing unit shown in Fig. 2;

Fig. 11 is a sectional plan view of the air-blast powder-tube cleaner which is positioned at stations "5" and "7" of the machine shown in Fig. 1;

Fig. 12 is a sectional elevation taken on the line XII—XII of Fig. 11 in the direction of the arrows, showing details of the air-blast powder-tube cleaner;

Fig. 13 is a sectional elevation taken on the line XIII—XIII in Fig. 11 in the direction of the arrows;

Fig. 14 is an elevational view, partly in section of an alternative embodiment of a smoke-generating mechanism;

Fig. 15 is a diagrammatic plan view of the drive mechanism for the machine;

Fig. 16 is a diagrammatic view of the timing circuit

which may be used to actuate the smoke-generating mechanism.

The principles of the invention are broadly applicable to the automatic electrostatic deposition of any finely-divided, light-scattering coating material as can be used for rendering diffusing the interior surface of incandescent lamp envelopes. Many different materials may be used for this purpose, such as calcium carbonate and aluminum oxide, but silica is the most desirable material and since this invention will normally be employed in conjunction with the deposition of silica, it has been so illustrated and will be so described.

With specific reference to the form of the invention illustrated in the drawings, the numeral 20 in Fig. 1 illustrates generally a coating machine for automatically applying a coating of silica to the interior of an incandescent lamp bulb or envelope. This machine comprises a stationary table 22 having carried thereon a plurality of bulb-receiving and bulb-retaining heads 24. These heads are all affixed together in a form of a continuous chain and are adapted to be indexed about the periphery of the table 22, as explained more fully hereinafter. The table 22 has affixed thereabout a plurality of work stations which in the diagrammatic sketch in Fig. 1 are numbered "1" through "19." The heads 24 are adapted to be indexed from work station to work station and in the machine design as illustrated, a work cycle or period from the initiation of one index to the initiation of the next succeeding index is three seconds, with the actual period of movement from one station to the next station, that is the actual period of index, being $\frac{3}{4}$ second. The period for the work or operational cycle can be varied, if desired.

In the operation of the automatic machine, which machine is preferably positioned adjacent a standard Sealex machine 26 for purposes of manufacturing facility, the bulbs may be loaded from the Sealex machine, where they are first monogrammed, onto the loading station designated "1" by an automatic transfer mechanism 28, such transfer mechanisms being well known. If desired, the bulbs may be loaded onto the loading station "1" by hand. The head 24 carrying the now-loaded bulb is then indexed from the loading station "1" and to the bulb-preheating station, which in the embodiment as illustrated and described occupies two work stations "2" and "3." It should be understood that the heating could be accomplished at one work station if the time for an operational cycle were extended or conversely the heating could be extended to more than two work stations. Preheating of the lamps is accomplished by the gas-air burners designated 30, although this preheating may be accomplished by electrical-type heaters if desired. Simultaneously with the preheating of the bulbs, they are preferably interiorly flushed with hot dry air in order to assist in drying and preheating and to remove any possible lint or other foreign matter which may be present in the bulb and which would deleteriously affect the coating.

After passing the preheating work stations "2" and "3," the bulbs are indexed through a bulb-feeler station "4," explained more fully hereinafter, and then are indexed to a coating station. In the embodiment as illustrated, two coating stations "5" and "7" have been provided, although only one or more than two coating stations may be utilized, if desired. Smoke-generating units 32 are located at each of the coating stations. After coating the bulbs may be directly indexed to the lehring stations designated "15," "16," "17," and "18" where they are heated by a bulb lehr 34. It may be desirable, although it is not necessary, to steam the coated bulbs in order to cause the coating material to adhere more firmly to the bulb wall and in such a case, the coated bulbs may be indexed from the coating station "7" through a bulb cooling mechanism 36, which is located at stations "8," "9," "10," "11." The cooled bulbs are then indexed through stations "12" and "13" where the interior of the

bulbs are steamed by a steaming mechanism 38. After being lehrred the bulbs are then transferred, either by hand or by an automatic transfer mechanism 40, onto the Sealex machine 26 where the bulbs are completely fabricated into finished lamps.

Summarizing the foregoing operational steps, the bulbs are first loaded onto the machine 20, preheated and desirably blown clean of any foreign matter, electrostatically coated with silica, lehrred and then removed from the automatic machine. It may be desirable in some cases to cool the coated bulbs, then steam the cooled bulbs in order to make the material adhere better. Each of these operational steps will be considered in detail in the following description.

Heating of the bulbs by the heating mechanism 30 is effected in order to render the bulbs substantially uniformly electrically conductive. This conductivity is due to the negative temperature coefficient of resistance of glass and for the usual soda-lime type of glass, it has been found that a temperature of approximately 100° C. for the heated bulb is quite suitable in order to achieve the desired uniform electrical conductivity for the bulb for succeeding operations. This temperature of heating, however, is in no way limiting and may be varied considerably with the soda-lime glass and if other types of glass are to be utilized, the temperature of heating may be varied still more. Even with the usual soda-lime glass, heating temperatures varying from around 80° C. up to around 200° C. have been used with satisfactory results, although these temperature examples are not meant to be limiting and may be extended. The constructional features of the hot, dry-air flush mechanism for blowing air into the bulbs simultaneously with the preheating are generally similar to the construction of the smoke-feed and return assembly of the smoke-generating means 32 and will be described in succeeding paragraphs. This hot dry air which may be blown into the bulbs at the preheating station may be at a temperature of about 100° C., although the temperature of this air is not critical and may be varied considerably.

After the bulbs are indexed from the last preheating station "3" they pass through a bulb-feeling station "4." This bulb-feeling station "4" may be used either to detect the absence of a bulb and to deenergize the smoke-generator 32 at station "5," or the bulb-feeling station "4" may be used to actuate a timer, which, in turn may be used to actuate the operation of the smoke generator 32 at the coating station "5." In the latter case, the bulb feeler 42, shown in Figs. 1 and 16, actuates a time-delay relay 44 (see Fig. 16), which in turn may be adjusted with a manual timing adjustment 46 (see Fig. 16 for timer circuit). This timer will actuate the smoke generator 32 at station "5" when the bulb is in position on this station.

After indexing from the bulb-feeler station "4," the bulbs enter the first coating station "5" and a bulb carried by one of the heads 24 is shown in Fig. 3. Each of the heads 24 are identical and each comprises a hollow lava chuck 48 having an exterior configuration which is adapted to receive the neck portion of a bulb 50. The chuck 48 is bolted or otherwise secured to metal sleeve 52 having a pulley 54 secured at the lower portions thereof. This sleeve 52 is adapted to rotate within an outer sleeve bearing 56 so that the lava chuck 48 which carries the bulb 50 may be rotated with respect to the remainder of the head 24. The head body portion 58 which holds the bearing 56 is not symmetrical, but is so designed that the leading portion has an extending flare 60 which is above the trailing portion 62, as viewed in Fig. 3. The leading portion 60 of one head 24 overlaps the trailing portion 62 of the preceding head 24 and the two heads are bolted together by a connecting bolt 64 at their overlapping portions in order to form a continuous chain of heads, as hereinbefore indicated. Orientation of the heads 24 in the proper positions on the table 12 as they

5

move thereabout is maintained by two rollers 66 and 68, as indicated in Fig. 1. The innermost roller 68 is affixed to the head 24 and facilitates indexing by an indexing spider 70, as illustrated in Fig. 15, which indexing spider 70 contacts roller 68 to index the heads 24. The outermost roller 66 contacts a roller guide (see Fig. 2) affixed to the table 22 in order to maintain the heads in proper position on the table 22. The indexing spider 70 is driven by a common drive 72 (see Fig. 15) as explained more fully hereinafter.

In the embodiment as illustrated, the bulbs are designed to be rotated at work stations "2" through "18" inclusive, such bulb rotation being effected by means of a V-belt 74 as shown in Fig. 1. This V-belt is driven by a driving pulley 75 and cooperates with the driven pulley 54 (see Fig. 3) on each head 24 to rotate the heads 24 with respect to the table 22. At the loading station "1" and unloading station "19" it is desirable that the loaded bulbs 50 do not rotate with respect to the table 22 and the V-belt 74 is removed from the heads at these stations by means of idler pulleys 76 (see Fig. 1). Rotation of the bulbs with respect to the table 22 is not necessary, but is desirable in order to facilitate machine design as bulb preheating at stations "2" and "3," for example, may be accomplished by a single row of gas-air burners 30 which will heat a rotating bulb evenly. Alternatively if the bulbs were not rotated at the work stations the air burners designated 30, in Fig. 1, for example, could be positioned on both sides of the bulbs 50 as they were indexed through the work stations in order to effect a relatively even heating.

In Fig. 5 are illustrated gas-air burners 30a as used at station "5," which burners are positioned so as to effect an even heating over the entire bulb surface as the bulb is rotated under these burners. The same burner designs as illustrated in Fig. 5 may be used at the stations designated "2," "3," "5," "7," and "15" through "18."

In the embodiment as illustrated and described, the electrostatic coating machine 20 is driven by a common drive motor 72 which also drives a Sealax machine 26 positioned adjacent the coating machine (see Fig. 15). The common drive motor 72 is connected by chain and gears 77 to the spider 70 and the shaft 78 which drives the spider has cams keyed thereto for imparting a reciprocating motion to mechanisms at the various work stations, as will be explained in detail hereinafter. The motor 72 may be disengaged by a clutch 79 to stop the automatic coating machine 20.

In Fig. 2 is illustrated the smoke-generating unit 32 at the station "5" and the two smoke-generating units at stations "5" and "7" are identical. As illustrated, the smoke unit 32 comprises a silica reservoir 80 which is affixed to a stanchion portion 81 of the table 22. Dry air under pressure is admitted to the reservoir through the air valve 82, through the air conduit 83 and through the dispersing nozzles 84. This air picks up silica in the reservoir 80 and directs it through a reservoir conduit 86 into an expansion chamber 88. A target 90 is provided in the expansion chamber and the air stream carrying the silica is forced against this target 90 where agglomerates of the finely-divided silica particles are broken up and the heavier particles or remaining agglomerates drop to the bottom of the expansion chamber 88. The remaining finely-divided silica, which by this time is formed into a smoke carried by air under pressure, is forced into a feed conduit 92 which connects with the smoke nozzle conduit 94 by means of a flexible tube 96.

Constructional details for the smoke nozzle conduit 94 are shown in Fig. 3. The smoke-feed and return assembly 97 and the powder-feed and return lines associated therewith include an outer sleeve having a porcelain or other non-conducting end section 98 which is affixed to a metallic sleeve 100, for purposes of support. Coaxially disposed within the outer sleeve is the smoke-nozzle conduit 94. The metallic sleeve 100 is fastened at its lower

6

extremity to the nozzle conduit 94 and the smoke-feed and return assembly 97 which is formed by the outer sleeve and the nozzle conduit are reciprocally movable within the heads 24 as they are located at the coating stations "5" and "7." Positioned near the bottom portion of the metal sleeve portion 100 of the outer sleeve is a smoke outlet 101 and this may be connected to the silica reservoir 80 by means of a flexible conduit 102, as shown in Fig. 2. The connection of flexible conduit 102 with the reservoir 80 may be made on the inlet side of the powder makeup valve 104 or, alternately, a separate smoke collector may be provided. It is desirable, however, that the excess smoke be disposed in some way in order that the working conditions around the automatic machine are not contaminated as only a portion of the silica smoke which is blown into the bulbs is deposited on the bulb walls. A nozzle-conduit cleanout 105, which is normally closed, may be provided at the lower section of the nozzle conduit 94.

The smoke-nozzle conduit 94 terminates in a nozzle assembly 106 which is shown in enlarged view in Fig. 4, and this nozzle assembly desirably is removable for cleaning. In the embodiment as illustrated, the nozzle assembly 106 has 8 apertures or nozzles each having a diameter of 46 mils and centrally disposed between the individual nozzles is a probe 108 which assists in creating the electrostatic field, as explained hereinafter.

In Fig. 6 is shown the electrical connection for the high voltage which is applied between the probe 108 and the exterior of the lamp envelope being coated in order to direct a portion of the material which is sprayed into the bulb of the bulb wall and to assist this material to adhere to the bulb wall. This probe 108 may be eliminated, if desired, and the voltage applied between the nozzle assembly 106 and the bulb wall. In the embodiment as illustrated, the D. C. power source 109 is of a pulsating type, since this type of commercially-available high voltage D. C. source is cheaper, but a non-pulsating type of D. C. power source could also be used. The voltage which is applied between the probe 108 and the gas-air burners 30a, which effect electrical connection with the exterior surface of the bulb by means of the conducting gas flame, is not particularly critical and may vary from about 8 kv. to about 25 kv. and as a specific example a potential of 15 kv. may be used. It is not material whether the positive side of the D. C. source is applied to the gas burner or the negative side of the D. C. source is applied to the burners 30a as the material deposition is generally independent of this.

In the operation of the coating cycle, air at a pressure of 12 lbs., for example, is forced through the air conduit 83 and picks up finely-divided silica which is forced by the air pressure through the reservoir conduit 86 against the target 90 where agglomerates are broken up. The smoke of powder is then forced through the feed conduit 92, the flexible connection 96, and into the smoke-nozzle conduit 94 and through the nozzle assembly 106, which has been reciprocally moved so that it extends within the neck of the bulb 50 through the chuck, as illustrated in Fig. 3. Reciprocation of the nozzle assembly 106 and associated feed lines is effected by means of a coating stroke cam 110 which is keyed to the driving shaft 78 (see Fig. 15). The cam 110 is connected to the smoke-feed and return assembly 97 through standard linkage (not shown).

Simultaneous with forcing the powder through the feed conduits and the nozzle assembly 106 and into the bulb 50, a butterfly-valve assembly 112, which is shown in enlarged view in Fig. 10, is closed in order to close the return conduit 114 which connects the bottom of the expansion chamber 88 with the silica reservoir 80, so that the large silica agglomerates which are not placed into powder smoke form may be returned to the silica reservoir 80. This is necessary so that the path for the silica powder from the reservoir 80 through to the nozzle

assembly 106 will not be short circuited by the return line 114. This closure is effected by a spring-biased butterfly valve 116, which is closed by the action of a butterfly valve solenoid 118, acting through a connecting means such as a linkage 119. The butterfly valve solenoid is in turn actuated by the time-delay relay 44 (see Fig. 15). The air pressure at the air valve 82 at the inlet to the silica reservoir 80 may be from 2 to 20 lbs. and as a specific example it may be 8 lbs., the air pressure determining in part the amount of silica deposited on the bulb. With such an arrangement as illustrated and when coating a 100 watt size bulb, approximately 100 mg. of finely-divided silica will be forced through the nozzle assembly 106 and into the envelope. (Such a bulb has an internal surface of about 28 square inches.) Simultaneously, the high voltage D. C. potential is applied between the probe 108 and the exterior surface of the glass bulb 50 and this will cause about half (50 mg.) of the finely-divided silica to deposit on the envelope wall. The undeposited portion of the silica will pass through the return conduit which is formed by the outer sleeve comprising the porcelain sleeve end 98 and metallic support 100 and the powder will pass through the flexible conduit 102 to the inlet side of the makeup valve 104 (connections not being shown), so that when the makeup valve 104 is opened to admit more silica to the silica reservoir 80, this powder can be reused. Alternately, as indicated hereinbefore, a separate smoke collector can be utilized on the return conduit 102. As indicated in Fig. 2, the nozzle assembly 106 and the smoke-feed and return assembly 97 are reciprocable on the frame of table 22 and are guided on the frame by means of a sliding guide 120. In Fig. 2 the smoke-feed and return assembly 97 is shown in the elevated position in solid lines and the depressed position, which is the usual position during indexing between stations, is shown in dotted lines in Fig. 2.

The injection of the silica smoke into the heated lamp at the coating station is illustrated in Fig. 5 wherein the silica smoke is forced through the smoke-nozzle conduit 94, through the smoke-nozzle assembly 106, into the bulb and the residual smoke which is not deposited returns through the porcelain sleeve 98 and associated return conduits. Simultaneous with the injection of the smoke into the bulb, a high voltage as specified is placed between the nozzle assembly 106, conducting probe 108 and the exterior of the heated bulb wall.

It is necessary to rotate the nozzle 106 and the bulb 50 with respect to one another during the coating operation in order that the powder will be deposited evenly on the bulb. In the embodiment as illustrated, the bulb 50 has been shown as rotatable with respect to the stationary-nozzle assembly 106, although the nozzle assembly could, if desired, be rotated with respect to a stationary bulb. As an example, the bulb 50 may rotate at a speed of 5 r. p. s. with respect to the nozzle assembly 106, although this speed may be varied considerably.

The amount of silica which will be deposited normally will be about half of that blown into the bulb, under the aforementioned specific example of coating conditions. This will deposit about 50 mg. of finely-divided silica on the bulb wall, which is normally sufficient for good light diffusion. The amount of silica deposited, however, may be varied considerably with varying coating conditions, both with regard to the amount of material blown into the uncoated bulb and with regard to the percentage of the material which is deposited. Under the aforementioned conditions, only one coating station need be utilized, but varying conditions of operation will often necessitate the use of two coating stations, as are illustrated on the diagrammatic showing in Fig. 1.

After leaving the coating station "5" the bulb passes through a second bulb-feeler station "6" at which the bulb feeler 42a is identical with the first bulb feeler 42 at station "4." The bulb is then indexed through a second coating station "7" which is identical with the first coating

station and the bulb may then be indexed directly to the Lehr 34 at station "15," if desired.

It may be desirable, in some instances, to steam the inside of the bulb 50 or at least the lower portion or so-called neck of the bulb in order to increase the adherence of the silica, such steaming tending to mat down the silica and make it adhere better. If this is desired, the bulb is indexed through cooling stations "8" through "11" as illustrated in Fig. 1 and cooling air is played upon the bulb by means of a cooling manifold 36 as it is indexed through these stations. This is necessary so that the later steaming will condense on the bulb interior.

At stations "12" and "13," the now-cooled bulbs are interiorly steamed in order to mat down or densify the coating and the steaming mechanism construction is shown in Fig. 7. Steam is generated in a conventional-type steam generator 38 (see Fig. 1) and is admitted into the inlet port 121 as shown in Fig. 7 by means of a flexible connection (not shown). While steaming has been shown at stations "12" and "13," it may be desirable to steam only at one station "12," for example. In the embodiment as shown, however, steaming is accomplished at two stations and the steam is carried from the inlet port 121 through a T-connection 122 into the steam conduits 124, which conduits are coaxially arranged with steam-return conduits 126. The steam passes from the steam conduits 124 through expansion ports 128 which form a cloud of steam in steam expansion chambers 130, where condensate is removed. This permits the steam to be forced into the bulbs 50 through the steam-feed conduits 132. Each steam-return conduit 126 is centered within the steam-feed conduit 132 and is connected to a standard exhaust system so that the steam will be withdrawn from the bulb without excessive condensation on the sides thereof, which would form condensate patterns and impair the quality of the coating. Steam which is condensed in the expansion chambers 130 is removed by means of a condensate line 134 attached to the bottom of expansion chambers 130.

The steam conduits and return lines and associated flexible connections are adapted to be reciprocally introduced into the bulbs when they are on station in a manner similar to the reciprocating action for the smoke-generating assemblies, as shown in Fig. 2. Reciprocation is effected through conventional linkage (not shown) by means of a steam-injection cam 136 which is keyed to the shaft 73, as shown in Fig. 15. The injection of the steam into the cooled bulbs at the steaming station is illustrated in Fig. 8 wherein a cloud of steam is injected through the steam-feed conduit 132, into the coated bulb and back through the steam-return conduit 126. In the embodiment as illustrated, the cooling air is continued during the steaming operation in order to accelerate the wetting down of the coating material, although it is not necessary to continue bulb cooling during this operation if adequate numbers of steaming positions are available.

In Fig. 9 is illustrated an alternative embodiment of the steam-injecting mechanism which may be used for coating larger-size bulbs or for coating only the lower portion or so-called neck of the bulb 50. In this embodiment, a steam nozzle 137 is provided at the terminal of the steam-feed conduit 132. Other than this, the constructional features are generally the same as in the preferred embodiment.

In order to remove any excess silica which may have accumulated in nozzle 106, in the powder-feed lines 94 and in the powder-return lines 98, it is very desirable to remove these collected materials by means of a blow-back arrangement wherein any collected materials are blown clean from these lines between indexing. If such a blow-back is not utilized, the coating powders, particularly in the case of silica, may have a tendency to form agglomerations in the coating lines, which agglomerations would be picked up on the next coating cycle and deposited as such in the lamp, which would impair the quality of the coating. The blow-back arrangements which are posi-

tioned at each of the coating stations which are utilized, stations "5" and "7" in the case of the embodiment illustrated and described herein, are shown in Figs. 11, 12, and 13. Each blow-back arrangement comprises a spring-biased arm 138 which moves into air-delivering proximity to the nozzle assembly 106 when the heads 24 are being indexed from stations "5" and "6" and from stations "7" to "8" and the nozzle assembly 106 and associated feed lines are reciprocated to a downward position as shown in dotted lines in Fig. 2. Each arm 138 carries a flexible air conduit 139 which is connected to a standard-type air compressor and air is delivered to a discharge port 140 which is centered above the nozzle assembly 106 during the blow-back operation. The flow of air from the discharge port 140 may be continuous or it may be controlled by a solenoid valve (not shown) and actuated when the port is in air-delivering proximity to the nozzle assembly 106. Movement of the arm 138 into the proper position for blow-back is controlled by the indexing of the head 24 and the groove of the pulley 54 on the head 24 contacts the arm 138 to hold the arm out of alignment with the nozzle when the heads are on station and when the nozzle is reciprocally moved within the heads. Between index and when on station, the pulley-contacting portion 142 on the arm 138 holds the arm in the position shown in dotted lines in Fig. 11. As the pulley 54 is indexed with the head 24 the arm-biasing spring 144 causes the discharge port 140 to swing into alignment with the depressed nozzle assembly 106, shown in solid lines in Fig. 11. The resulting blast of air will drive any powder, which may have remained in the nozzle 106 and associated feed and return conduits, back into the expansion chamber 88 and into the powder collector respectively.

As an alternative embodiment for the smoke generator, the silica pick-up nozzles 84 may be replaced by a venturi arrangement 146 as shown in Fig. 14 wherein air is forced under pressure through the venturi 146 which causes the silica to be picked up and forced against a target 90a as in the beforementioned embodiment. This venturi 146 forces air through a constricted orifice producing a partial vacuum which picks up silica to form a silica smoke. The agglomerates which collect in the bottom of the alternative expansion chamber 88a may be separately removed or may be fed back into the makeup port 148 of the alternative silica reservoir 80a. More than one venturi may be connected to this reservoir, if desired. Other than these indicated differences, the construction of the alternative embodiment of the silica-smoke generator is substantially the same as the embodiment which is illustrated in Fig. 2. An expansion-chamber butterfly valve 149 is provided in the bottom of expansion chamber 88a, and is normally closed. This expansion-chamber butterfly valve 149 may be opened by a solenoid 118a during blowback to clean out the expansion chamber 88a.

After passing the steaming station the bulbs are indexed through the lehring mechanism 34, which in the embodiment as illustrated occupies stations "15" through "18." Lehring is preferably accomplished by a tunnel arrangement 150 which may be heated by gas-air burners 30b or by electric-infrared type heaters, if desired. The temperature of lehring may vary considerably and a suitable lamp will still be produced. For example, the lehring temperatures may vary all the way from about 300° C. up to the strain point of the glass, which is about 485° C., and even these temperatures may be extended. It has been found that a lehring temperature of about 450° C., however, is quite suitable for producing a satisfactory lamp.

Simultaneous with lehring as the bulbs are indexed through the work stations in the lehring tunnel 150, it is desirable to flush the bulbs with dry hot air in order to remove more completely any residual moisture which may remain in the bulbs. Such an air-flushing arrangement may be identical with the coating apparatus which is shown in Fig. 3, except that the nozzle assembly 106

is unscrewed from the conduit 94. This conduit 94 then becomes an air-blowing conduit and is connected to a hot-air manifold 152 (see Fig. 1). Air is then flushed through the bulbs and is exhausted through the return conduit and into the atmosphere. The temperature of this hot dry air flush may vary over wide limits ranging all the way from about 150° C. up to the temperature of the lehr or greater, provided the strain point of the glass is not greatly exceeded. For the standpoint of manufacturing convenience and later lamp performance, it has been found that a temperature of approximately 250° C. is very satisfactory for the hot dry-air flush.

An identical air-flushing arrangement may also be used at station "3" in order to remove lint from the uncoated bulbs and to assist in drying and in preheating the bulbs 50 before the coating operation. At this station the air may be supplied by a second hot-air supply 154 (see Fig. 1), although this dry air need not be heated over 100° C.

After indexing from the lehring tunnel 150, the bulbs are unloaded at station "19" either by conventional transfer mechanism 40 or by hand.

Briefly reviewing the operation of the automatic machine, the bulbs 50 are first loaded at a loading station either by hand or by automatic transfer mechanism and are preferably loaded directly from a Sealex machine in order to facilitate manufacture. The bulbs are then indexed through one or more preheating work stations and are preferably interiorly flushed during this preheat in order to assist in drying and heating the bulbs and in order to remove any foreign materials which may be present. The bulbs are then indexed through at least one coating station where a smoke of finely-divided coating material, preferably silica, is introduced into the bulbs and a part of the smoke which is blown into the bulbs is deposited by means of an electrostatic field. The undeposited smoke is collected. The bulbs may then be lehrd to remove any possible moisture which may be present in the coated bulbs and preferably are simultaneously flushed with hot dry air while lehring. Alternatively, the bulbs may first be cooled after coating and then steamed to mat down the coating in order to increase the adherence of the coating material for the bulb wall, after which the bulbs are lehrd as before. The coated and lehrd bulbs are then removed from the automatic coating machine either by standard transfer mechanism or by hand and are preferably placed upon a standard Sealex machine in order to fabricate the still hot bulb into a lamp. In order to remove any possible residual powder which may have collected in the smoke-generating apparatus and in the delivery conduits for the smoke, it is desirable to blow any residual powder from these smoke-feed conduits when the bulbs are being indexed in order that the final coatings will not be impaired by such residual powders.

It will be recognized that the objects of the invention have been achieved by providing an automatic machine for electrostatically applying a finely-divided, light-scattering material, preferably silica, to the interior surface of an incandescent lamp bulb. This automatic machine incorporates a smoke-generating mechanism which is adapted to be automatically cleaned during the operation of the machine in order to inhibit deposition of any residual powders which would impair the coating. Also, a hot-air flushing mechanism, which is designed to flush the coated bulbs automatically in order to remove more completely any residual moisture, has been provided and if the adherence of the coating for the envelope is to be increased, an automatic steaming mechanism to mat down the coating has been provided. Further, optimum conditions for the operation of the automatic coating machine have been provided.

While in accordance with the Patent Statutes one best-known embodiment of the invention has been illustrated and described in detail, it is to be particularly understood that the invention is not limited thereto or thereby.

We claim:

1. An electrostatic coating machine for incandescent lamp bulbs comprising, a stationary table having a plurality of stations, a conveyor on said table, a plurality of bulb-receiving and bulb-retaining heads carried by said conveyor, said conveyor-carried heads being adapted to be indexed between said stations and to remain for a predetermined period at each station, the period from initiation of each index to the next succeeding index constituting an operation cycle, at least one of said stations constituting a heating station and having a heating means for heating each uncoated bulb received by said heads to render said bulbs substantially uniformly electrically conductive, at least one of the stations following said heating station constituting a coating station and having a dry-spraying mechanism terminating in a nozzle for spraying a smoke of finely-divided light-scattering material into the interior of each of said heated bulbs, high-voltage means cooperating with said spray mechanism for applying an electric field between said nozzle and the exterior surface of each of said bulbs simultaneous with the spraying of said bulbs, at least one of the stations following said coating station constituting a lehring station and having a lehring means for lehring said coated bulbs to remove at least a substantial portion of any moisture contained therein, means for indexing said conveyor from station to station, and means for effecting a rotation between said bulbs and said spraying nozzle when spraying said material smoke.

2. A machine as specified in claim 1 wherein a cooling station is provided after said coating station and having a cooling means for cooling said heated bulbs, a steaming station is provided following said cooling station and before said bulb lehring station, and said steaming station having a steam injector means for injecting a cloud of steam into said coated and cooled bulbs for increasing the adherence of said coating material to said bulbs.

3. A machine as specified in claim 1 wherein a cooling station is provided after said coating station and having a cooling means for cooling said heated bulbs, a steaming station is provided following said cooling station and before said bulb lehring station, and said steaming station having a steam injector means for injecting a cloud of steam into the lower portions of said coated and cooled bulbs for increasing the adherence of said coated material to said envelope in the lower portions of said coated bulbs.

4. A machine as specified in claim 1 wherein said bulbs are coated at said coating station with finely-divided silica.

5. A machine as specified in claim 1 wherein said bulbs are heated at said heating station to approximately 100° C., said bulbs are coated at said coating station with finely-divided silica, and said bulbs are lehring at said lehring station at a temperature of approximately 450° C.

6. An electrostatic coating machine as specified in claim 1 wherein a hot air flushing means is provided at said lehring station to flush said bulbs with dry hot air simultaneous while lehring in order to remove more completely any moisture contained within said coated bulbs.

7. A machine as specified in claim 6 wherein said bulbs are heated at said heating station to approximately 100° C., said bulbs are coated at said coating station with finely-divided silica, said bulbs are lehring at said lehring station at a temperature of approximately 450° C., and said bulbs are simultaneously flushed during lehring with hot dry air at a temperature of approximately 250° C.

8. A machine as specified in claim 1 wherein said dry-spraying mechanism comprises, a smoke-generating mechanism for creating a smoke of said material, a nozzle adapted to be in smoke-delivering proximity to the interior of said heated bulbs when same are on coating station, a nozzle conduit connecting said nozzle to said smoke-generating mechanism, a smoke-return conduit one end of which is open and adjacent said nozzle, a smoke collector connected to the other end of said smoke-return conduit, and means for actuating said dry-spraying mechanism at least once during each said operation cycle between each conveyor index to spray said material into said head-retained bulbs.

9. A machine as specified in claim 8 wherein said nozzle is adapted to be reciprocally introduced within said bulb-receiving and bulb-retaining heads while said heads are on said coating station.

10. A machine as specified in claim 8 wherein a blow-back mechanism is provided to cooperate with said dry-spraying mechanism, a blow-back port provided in said blow-back mechanism, said blow-back port adapted to be positioned in substantial alignment with said nozzle and said smoke-return conduit at least once during each operation cycle of said conveyor and while said nozzle is not positioned to deliver said material smoke into said bulbs, and means to force a stream of gas from said blow-back port into said aligned nozzle and said smoke-return conduit, whereby excess coating material collected in said nozzle conduit and said return conduit is substantially removed.

11. A machine as specified in claim 8 wherein said smoke-generating mechanism comprises, a silica reservoir, a compressed-air operable smoke-producing means for generating a smoke of finely-divided silica, a silica-smoke expansion chamber, a first conduit means having an outlet and connecting said expansion chamber with said smoke-producing means, smoke-target means within said expansion chamber and in smoke-receiving proximity to the outlet of said first conduit means for breaking up silica agglomerates and for removing larger silica particles from said smoke, and a second smoke-conduit means connecting said expansion chamber with said nozzle.

References Cited in the file of this patent

UNITED STATES PATENTS

1,655,290	Phelps et al. _____	Jan. 3, 1928
1,900,104	Hageman et al. _____	Mar. 7, 1933
2,538,562	Gustin et al. _____	Jan. 16, 1951
2,569,852	Green _____	Oct. 2, 1951
2,626,874	Pipkin _____	Jan. 27, 1953
2,716,620	Green et al. _____	Aug. 30, 1955