Dec. 15, 1942. R. F. STRICKLAND ET AL 2,304,859

COATING APPARATUS

Filed Feb. 14, 1940 4 Sheets-Sheet 1

Fig. 1.

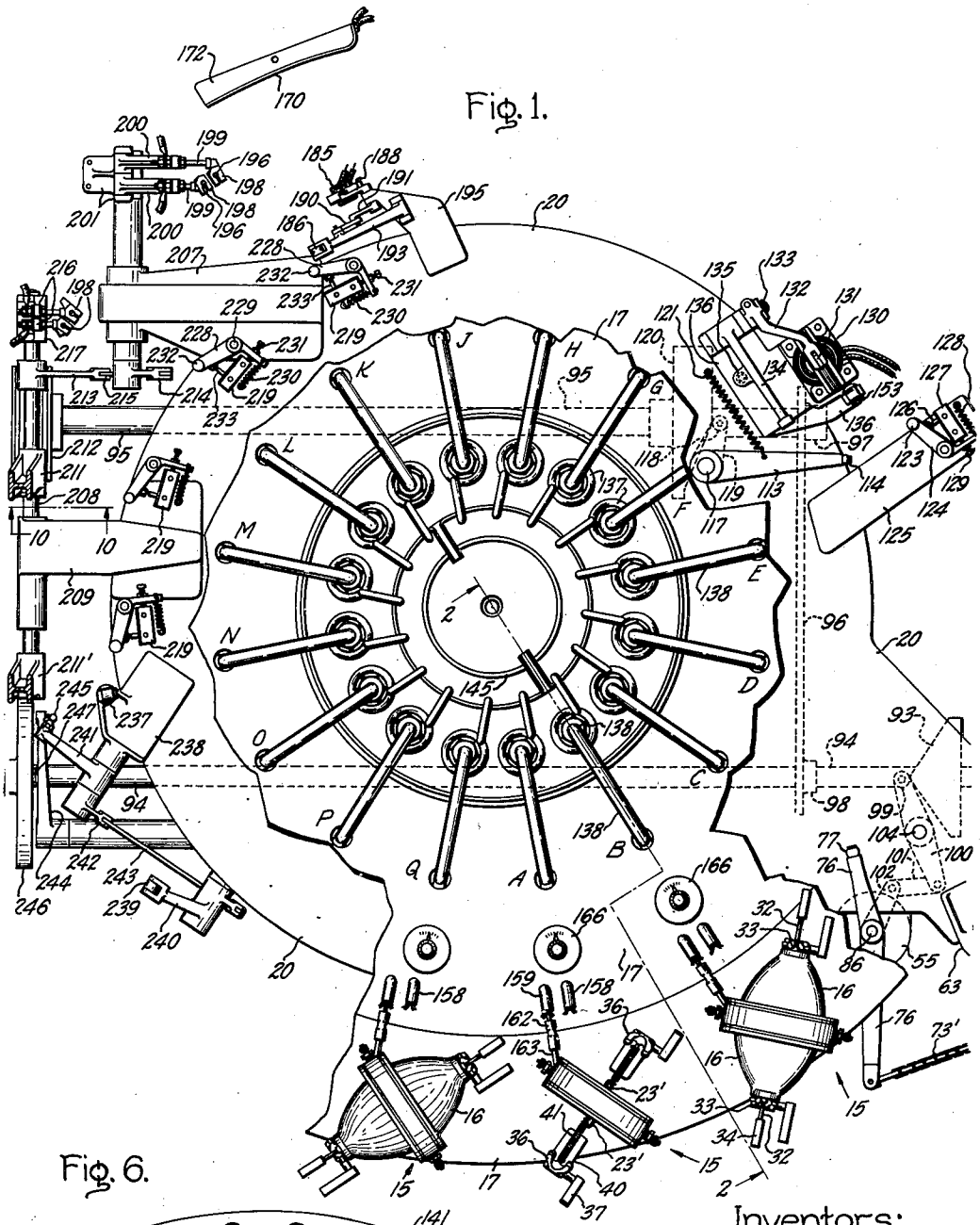
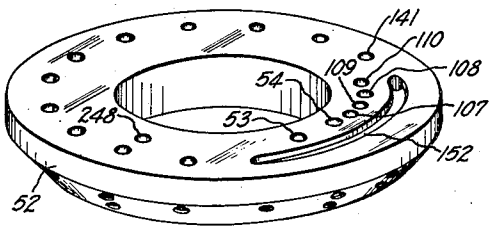


Fig. 6.



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Fig. 3.

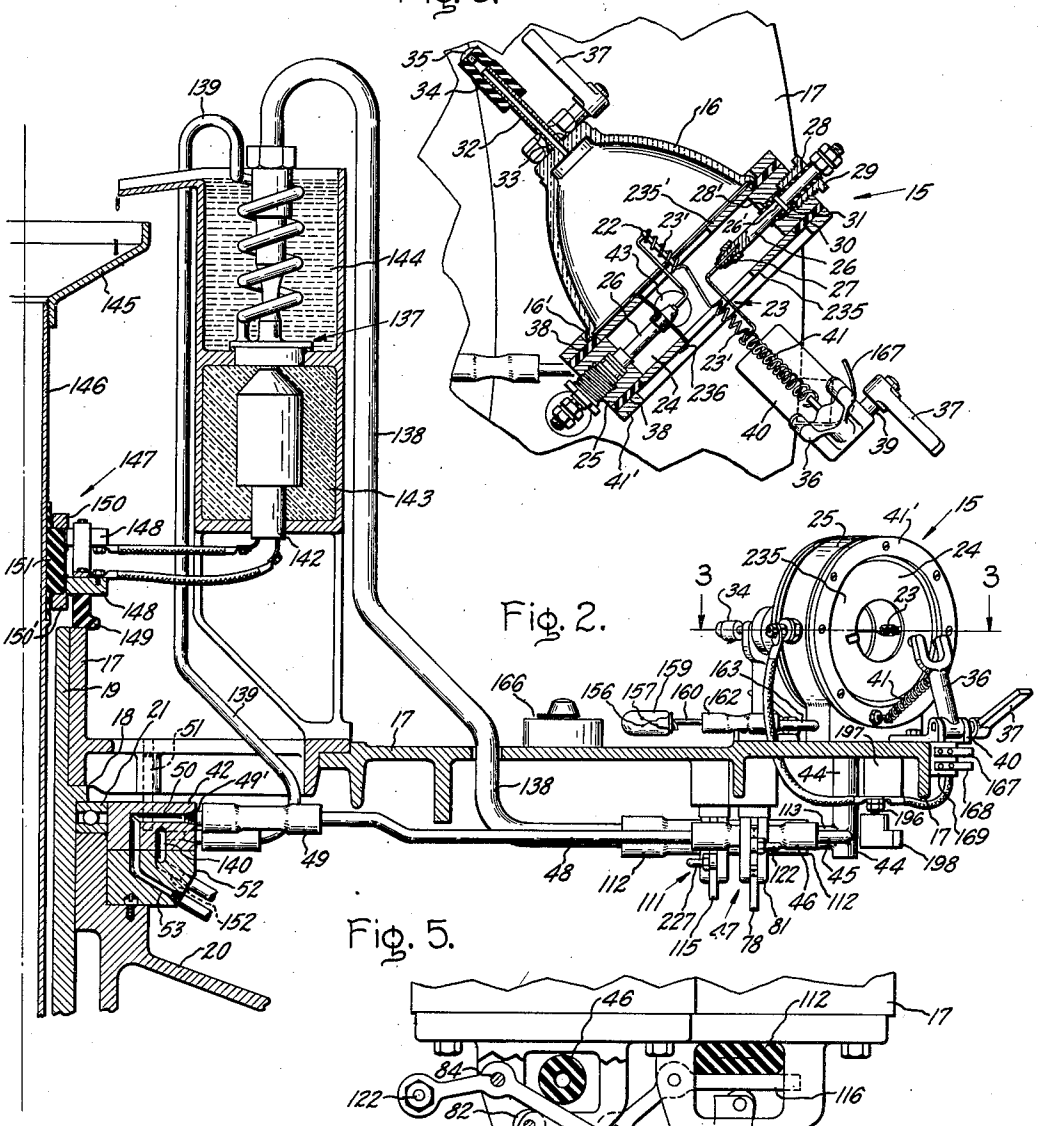
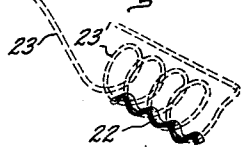


Fig. 2.

Fig. 5.

Fig. 4.



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Fig. 7.

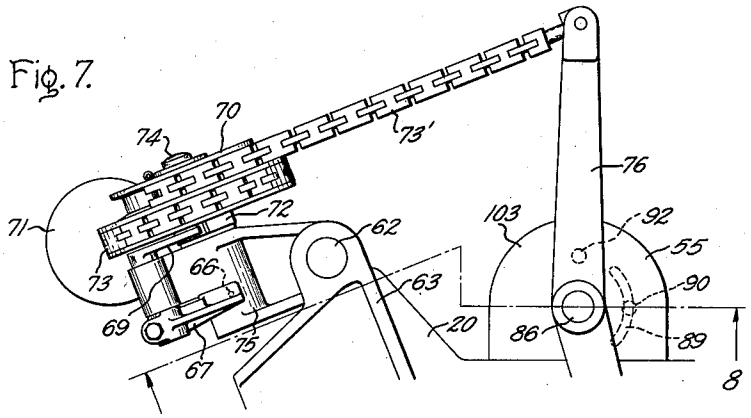


Fig. 8.

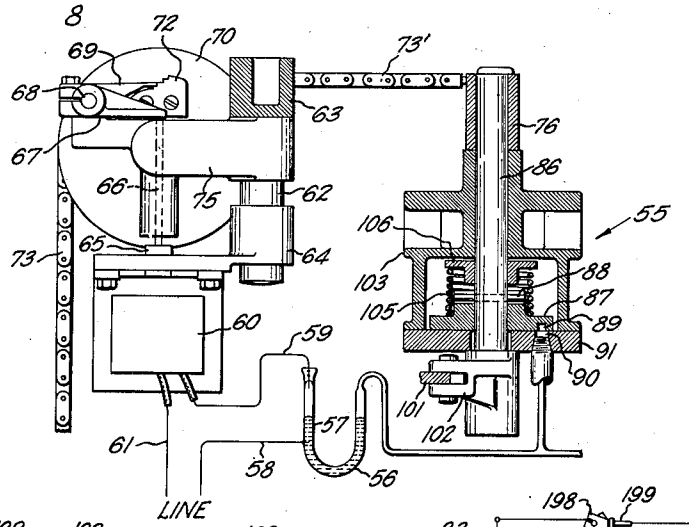
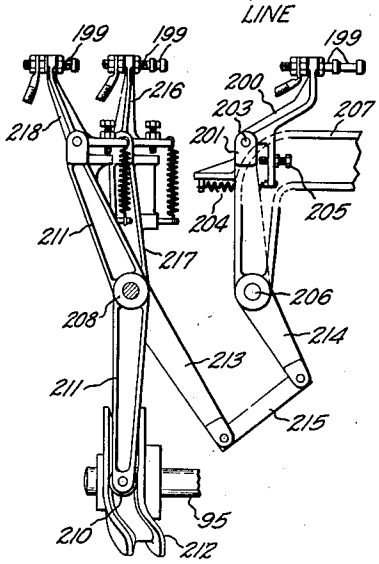


Fig. 10.



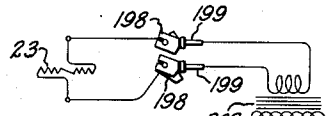
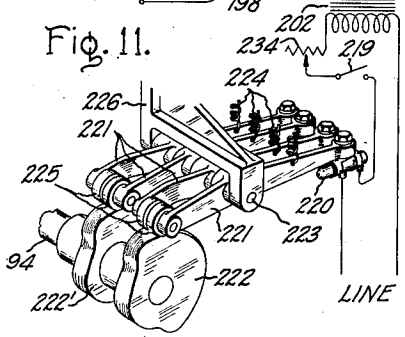


Fig. 11.



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COATING APPARATUS

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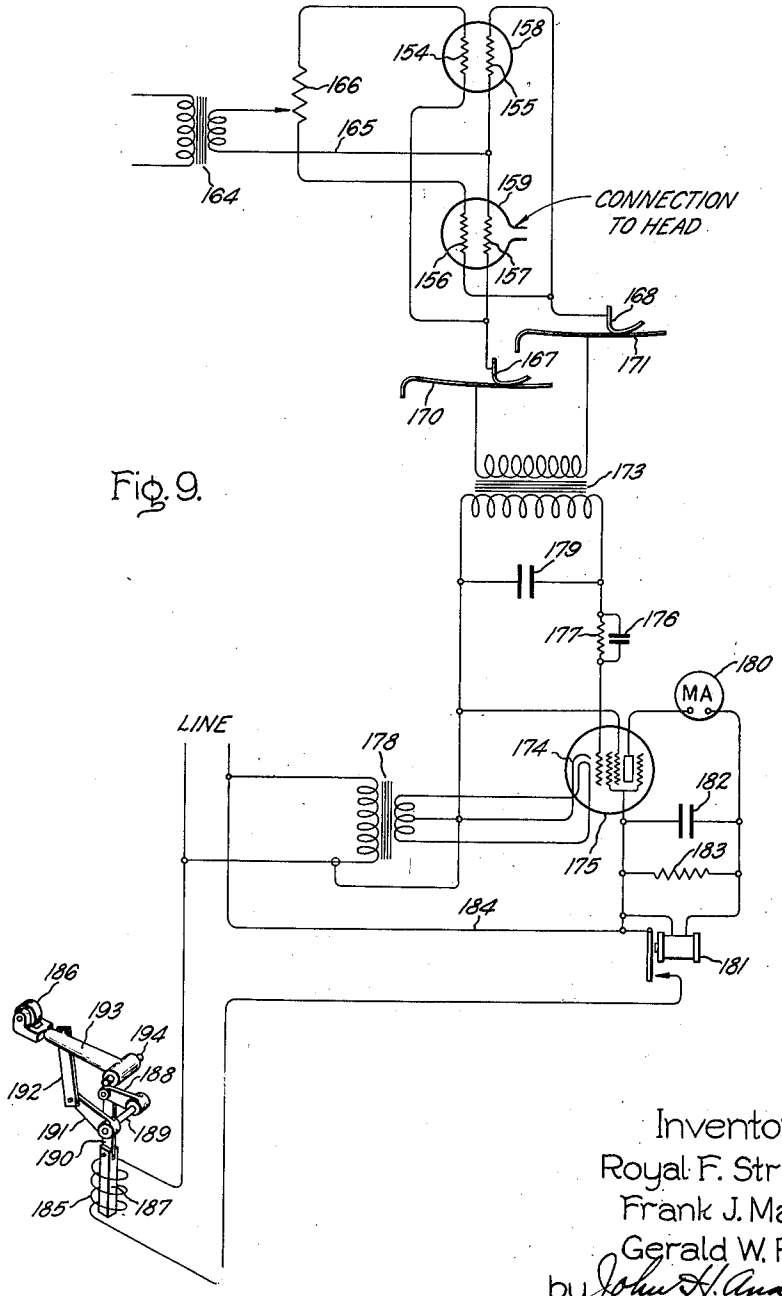


Fig. 9.

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Patented Dec. 15, 1942 2,304,859

UNITED STATES PATENT OFFICE

2,304,859

COATING APPARATUS

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Application February 14, 1940, Serial No. 318,962

13 Claims. (Cl. 91—12.2)

Our invention relates to apparatus for coating a body or base member with reflecting materials, and more particularly to automatically operable apparatus for causing the evaporation, in an evacuated space, of a reflecting material, such as aluminum, and its subsequent condensation onto the interior surfaces of the vitreous enclosures or bulbs for incandescent lamps or similar articles.

Heretofore, as far as we are aware, the deposition of a metallic reflecting coating by vaporization onto a supporting body or base member for purposes of producing a specular reflector has involved laboratory procedure and has been done in a relatively slow uneconomical manner. The principal object of our invention is to provide apparatus for this purpose having a high rate of production and requiring only the feeding and the removal of the articles to be coated, and the insertion of the reflecting material. Such apparatus must produce a satisfactory reflecting coating with a high degree of regularity in order to be commercially practicable.

Another object of our invention is to provide apparatus for the satisfactory coating of cup-shaped vitreous bodies such as used for the reflector sections of incandescent lamps of the type disclosed in Patent 2,148,314, D. K. Wright, assigned to the assignee of the present invention. Such bodies are difficult to coat evenly because of their shape, and must have a very uniform coating because of their nearness to the light source which causes any defects to be very conspicuous.

Another object of our invention is to provide, in combination with the above type coating apparatus, means for automatically preventing the heating of the reflecting material and the consequent vaporization thereof should the space in which the vaporization takes place be improperly evacuated. According to our invention, the supporting body or base member to be coated is evacuated directly so that it, together with a portion of the apparatus, constitutes the vacuum chamber and any incorrect positioning of the said body or base member produces a leaking condition. Such a condition may also be produced when, for some reason, one of said bodies has not been inserted in the apparatus or when an imperfect body which allows air to leak in is carried by the apparatus. Such a condition is objectionable because the quality of the vacuum affects the distribution of the coating material to a considerable extent. Moreover, if the vacuum is poor enough, the heater for vaporizing the coating material is injured and must be replaced before the apparatus can be used again.

Other objects and advantages of our invention will appear from the following detailed description of a species thereof and from the accompanying drawings.

In the drawings, Fig. 1 is a plan view of apparatus comprising our invention with the major portion of a turret, comprising part of the apparatus, broken away to show the underlying mechanism; Fig. 2 is a vertical section of the apparatus taken along line 2—2 of Fig. 1; Fig. 3 is a horizontal section, taken along the line 3—3 of Fig. 2, of one of a plurality of heads carried by said turret; Fig. 4 is a perspective view, on an enlarged scale, showing a strip of metal to be vaporized supported by a heater coil therefore which is shown in dotted lines; Fig. 5 is an end view of a pinch clamp shut-off means provided for each head; Fig. 6 is a perspective view of the lower half of a rotary valve for controlling exhausting and gas filling operations of the head; Fig. 7 is a plan view of operating means for a pinch clamp closing portion of a leak detecting mechanism; Fig. 8 is a vertical section therethrough along the line 8—8 and in the directions indicated; Fig. 9 is a diagrammatic view of a vacuum-quality testing mechanism and pinch clamp closing means operated thereby; Fig. 10 is a side view of the first three of a number of contact-making mechanisms engaged by the heads, as viewed from line 10—10 Fig. 1; and Fig. 11 is a perspective view of switching means for controlling the operating period of the heaters in combination with a diagram of the other parts in the electrical circuit to one of said heaters.

In the species of our invention shown in the drawings, a plurality of heads 15 are provided for carrying the vitreous cups 16 through the various steps in the cycle of operation thereof. Only three of the heads 15 appear in Fig. 1, although a plurality (sixteen) of such heads are mounted at regular intervals at the periphery of the two-part turret 17 which rests on the flange 18 (Fig. 2) of the hollow center column 19 of the apparatus. The center column 19 extends upward from stationary frame 20 of the apparatus which spreads outward underneath the entire center portion of the turret 17 as shown in Fig. 1 and is supported by the engagement of the lower face of said flange 18 with the ball bearing 21 on said frame 20. The motion of the turret 17 occurs in repeated indexing movements in a counter-clockwise direction produced

by a central driving means (not shown) which engages the lower end of the center column 19 and which provides for the operation of mechanisms at the various stations taken by the heads 15.

The cycle of operation of the apparatus begins at station A at which an operator inserts a piece of the coating material to be vaporized and the vitreous cups 16 which are to be coated. Each head 15 accommodates two of the cups 16 at one time and, accordingly, the operator first inserts a body 22 of the coating material into each of the two coiled portions 23'—23' of the (tungsten) heater 23 (Fig. 3) which are located on opposite sides of the head 15. The body 22 of the coating material in this particular instance, amounts to a thin strip of aluminum weighing .044 gram which, as shown in Fig. 4, is bent back on itself and corrugated so that each corrugation engages a turn of the coil 23'. The said heater coils 23' are located along the central axis of the central opening 24 in the ring or drum-shaped body portion 25 of the head 15. The ends of the heater 23, as shown in Fig. 3, are located in openings in the split ends of the rods 26 which are drawn tight thereabout by the tapered sleeves 27 and are adapted to be easily removed therefrom following the unscrewing of the sleeves 27 to allow replacement of the heater 23. The rods 26 function both to support the heater 23 and carry electrical energy to it and each rod is mounted in insulating bushings 28 and 28' located respectively, in the threaded compression sleeve 29 and an opening in the body portion 25 of the head 15. The said sleeves 29 allow the rubber washers 30 and 31 to be pressed against the flange 26' on the rod 26 and seal the said opening in the body portion 25.

The vitreous cups 16, now inserted into the head 15, may be those used for the reflector section of a lamp of the type disclosed in Wright Patent 2,148,314, hereinbefore referred to. At this particular stage in the manufacture of the lamp, each cup is provided with a vitreous exhaust tube 32 sealed over an opening in the center of the end portion of the cup, and metal terminal elements 33 (two, in this instance) sealed over openings at diametrically opposite points on said end portion from the exhaust tube 32. The terminal elements 33 hermetically seal the openings in the cup 16 directly associated therewith, but the exhaust tube 32 does not, so that a stopper such as provided by the rubber tube 34 which is closed off by the plug 35 is preferably slipped over the end thereof to seal the only remaining opening in the cup 16 before it is inserted into the apparatus.

Insertion of each cup 16 is permitted only after the holder 36 is pulled back by pressure on the arm 37, and consists in resting the outer rim or edge of the cup against a rubber sealing gasket 38 on the face of the boy 25 of the head 15. The holder 36 and the arm 37 are mounted on the rod 39 carried by the bracket 40 and are then allowed to turn back so that the holder 36 engages said cup and keeps it in position. To allow this movement of the holder 36, the cup 16 must be orientated so that the lowermost terminal element 33 falls in the center opening in the holder 36. The closing movement of the holder 36 is produced by the contraction of the spring 41 which extends between a bolt in the lower part of the head 15 and said holder 36 and does not change the position of the bracket 40 which is attached directly to the turret 17. The gasket 38 is held in place on the body 25 of the head 15 by the ring 41' which is engaged by bolts screwed into said body 25 and extending through the gasket 38 and the ring 41'. The center aperture in the ring 41' is just large enough to allow easy passage of the outwardly flared edge 16' of the cup 16 and serves to position said cup so that the heater 23 is at the exact center of the opening therein. The time interval of the movements of the turret 17 are such that the head 15 is moved to station B directly following the insertion of both metal strips 22 and both cups 16.

The indexing movement of the head 15 into station B starts the cycle of operation of the apparatus as the upper half 42 of the rotary valve which is located below the center of the turret 17 (Fig. 2) is turned therewith and connects a source of vacuum to said head 15. The hollow interior of the body 25 of the head 15, and the cups 16, are connected to the rotary valve through the passage 43 in said body 25 which continues into the tube 44 extending downward through the turret 17, the pipe 45 which extends sidewardly from tube 44, the rubber tube 45 which is part of the valve or pinch clamp 47, the pipe 48 and the rubber tube 49 which makes the connection to the pipe nipple 49' extending from the passage 50 in the upper half 42 of the rotary valve. Each head 15 is similarly connected to a passage in the rotating upper half 42 of the rotary valve which is made to turn with the turret 17 by the pin 51 and depends on the movements of said upper half 42 with respect to the lower half 52, shown in detail in Fig. 6, for the proper sequence of operations necessary to clear the interior of the cups 16 of gas and vapor. At station B, the passage 50 is aligned with a passage 53 in the lower half 52 of the rotary valve connected to a source of vacuum (not shown) and it is not until the head 15 is indexed to station C (only indicated in Fig. 1) that the succeeding operation also brought about by movement of the upper half 42 of the rotary valve takes place.

The movement of the rotary valve occurring during this latter index aligns the passage 50 with passage 54 which connects the head 15 to the valve 55 of the pinch clamp closing apparatus shown in Figs. 1, 7 and 8 and, as diagrammatically shown in Fig. 8, to the manometer 56 which make up the leak detecting mechanism. These parts function only when the head 15 is not closed off by the cups 16 as may happen, for example, when one or both of the cups 16 have not been inserted or have been improperly inserted therein or when an imperfect cup 16 produces a leaking condition. Should the head 15 be leaking, the mercury 57 in the monometer 56, which is already connected to one side of the electrical line by the wire 58, moves upward and into contact with the wire 59 completing the circuit through the coil of the solenoid 60 which is connected to the other side of the line by wire 61. The solenoid 60 is mounted on the rod 62 extending from the bracket 63 on the frame 20 through the bracket 64 and through movement of its armature 65 controls all further operations of the leak detecting mechanism.

When the circuit to the solenoid 60 is closed and the armature 65 is moved, the rod 66 is forced upward turning the arm 67, the shaft 68 on which it is mounted and the latch 69 so that the pulley 70 is freed and the weight 71 turns it in a counter-clockwise direction. The latch 69 normally is located behind the notched block 72 on the pulley 70 in position to prevent the weight

71 which is attached thereto by the chain 73 from turning said pulley 70. The pin 74 on which said pulley 70 is mounted, the shaft 68 and the rod 66 are all mounted in portions of the bracket 75 attached to the rod 62. The rotative motion of the pulley 70 is transferred through the chain 73' to the lever 76 (Figs. 1, 7 and 8) which functions both to close the pinch clamp 47 and to operate the valve 55. The pinch clamp 47 is engaged through the roller 77 on the end of the lever 76 which moves so as to engage and turn the cam 78 thereof which in turn forces the lever 79 (Fig. 5) upward against the rubber tube 46 squeezing it shut. The cam 78 is pivoted on the pin 80 between the front and back portions of the bracket 81 and is turned so that the roller 82 on the pin 83 carried thereby is brought against the lever 79 and the thicker portion of said cam 78 is carried into position between pin 80 and said lever 79. The lever 79 is also located between front and back portions of the bracket 81 but is pivoted on the pin 84. The pin 85 functions as a stop and limits the movement of the cam 78 in both directions. In this manner, the leaking head 15 is closed off and the influx of air into the evacuating system is stopped.

Operation of the valve 55 is brought about through the shaft 86 on which the lever 76 is mounted which extends downwardly to the disc 87 which it engages through the pin 88. Before operation of the leak detecting mechanism, the disc 87 is arranged so that groove 89 (Figs. 7 and 8) is located over the aperture 90 in the bottom plate 91 of the valve 55 which is connected to the vacuum line between the manometer 56 and the head 15 and does not function except to seal off said aperture 90. Should the lever 76 and disc 87 be turned, the groove 89 is also carried over the other aperture 92 in the bottom plate 91 and the source of vacuum connected thereto draws out the air in the system back to the closed stop cock 47. In this way, the manometer 56 is returned to its open circuit position in preparation for the resetting of the remainder of the leak detecting mechanism and the indexing of another head 15 into station B.

The resetting of the remainder of the leak detecting mechanism occurs before the next index and is brought about by rotation of the cam 93 (Fig. 1) on the front cam shaft 94 in the lower portion of the frame 20. The cam shaft 94 is driven by the back main drive shaft 95 through the chain 96 and sprockets 97 and 98 indicated and takes place in proper time relation to the other operations of the apparatus as the indexing means (not shown) for the turret 17 is preferably operated thereby. The roller 99 engaged by the cam 93 in resetting the mechanism is positively connected to the operating shaft 86 of the lever 76 and the valve 55 through the lever 100, link 101 and arm 102 and is only in position to be engaged when the mechanism requires resetting. The bracket 103 supporting the bottom plate 91 of the valve 55 and the pin 104 supporting the lever 100 are attached to the frame 20. The disc 87 is pressed tightly against the bottom plate 91 to prevent leakage by the spring 105 which butts against the collar 106 on the shaft 86.

In the course of the next two succeeding indexing movements of the head 15 which advance said head into station D and then E, repeated flushing and exhausting operations are brought about providing the head 15 does not leak and pinch clamp 47 is not closed. The indexing in both cases first carries the passage 50 in the upper half 42 of the rotary valve connected to the head 15 over a passage (either 107 or 108) which admits a flushing gas to the head 15 and then causes it to come to rest over a passage (either 109 or 110) which is connected to the evacuating means (not shown). The passages 107 and 108 are connected in this instance to a supply of clean dry air, although nitrogen can be used equally as well for flushing if desired. The evacuating means connected to passages 109 and 110 is preferably the same as that connected to the head 15 at station B.

The next indexing movement of the head 15 carries it into station F and into operating relation to means for opening a second valve or pinch clamp 111 (Figs. 2 and 5) which controls a second exhaust system therefor. The pinch clamp 111 is connected to the head 15 through the rubber tube 112, and the pipe 113 which projects from the side of the tube 44 and is opened by a turning movement of the arm 113 (Fig. 1) which carries the roller 114 against the cam 115 of said pinch clamp 111. The pinch clamp 111 corresponds in construction to the pinch clamp 47 adjacent which it is mounted and the arm 113 engages and turns the cam 115 thereof so that the lever 116 is allowed to move down and the rubber tube 112 can return to full round condition. The arm 113 is mounted on the upper end of the shaft 117 supported by the frame 20 and is actuated by the following movement of the roller 118 on the arm 119 on the lower end of said shaft 117 along the face of cam 120. The cam 120 is mounted on the main drive shaft 95 and the contracting force of the spring 121 which extends between a post in the frame 20 and the arm 113 causes the movement to occur as the cam 120 permits.

Should the head 15 entering station F be open to the atmosphere as indicated by a closed pinch clamp 47, the pin 122 on the outer end of the lever 79 thereof will be in a lower position than normal and will engage and push the roller 123 (Fig. 1) back out of position. The roller 123 is one part of the mechanism at this station which prevents the pinch clamp 111 from being opened and the exhaust system connected therefrom from being contaminated by the influx of air under these particular conditions. As shown in Fig. 1, the roller 123 is mounted on the lever 124 which is mounted on the plate 125 extending from the frame 20 and which is turned so that it engages the control pin 126 of the totally inclosed switch 127. The lever 124 is normally turned by the contracting force of the spring 128 which extends between one end thereof and a post in the plate 125 so that the stop screw 129 engages the end of the switch 127 and when shifted causes said switch 127 to complete a circuit through the solenoid 130 to the line. In such cases, the armature of the solenoid 130 which is connected to arm 132 by a link 131 turns the arm 132, the shaft 133 on which it is mounted and the arm 134 so that the latter is lowered into the path of movement of the arm 113 and prevents it from moving far enough to open pinch clamp 111. The spring 135 which butts against the arm 134 and bracket 136 is compressed during this operation and the expanding force thereof returns said arm 134 and the means connected thereto to their normal position when the head 15 is indexed from station F and the switch 127 is permitted to open again. The solenoid 130 and the shaft 133 are supported by the bracket

136 which is attached to the frame 20 at this point.

Following the opening of the pinch clamp 111 under normal conditions of operation, the head 15 and the cups 16—16 carried thereby are drawn on by the second exhaust system. This system includes a mercury pump 137 (Figs. 1 and 2) for each head 15 which is connected to the rubber tube 112 of the pinch clamp 111 by the pipe 138 and through the pipe 139 to the passage 140 in the upper half 42 of the rotary valve. The mercury pump 137 in general conforms to those shown in United States Patent 1,676,302 to van der Poel which issued July 10, 1928, and is backed up by other exhausting means (not shown) connected to the passage 141 in the lower half 52 of the rotary valve.

The mercury pumps 137 are operated by the effect of the electrical heating unit 142 in the lower portion thereof which is enclosed in the insulated chamber 143 and the cooling effect of the water in the tank 144 which is constantly being replenished from a source not shown and which overflows to the funnel 145 and pipe 146. The electrical current for the heating unit 142 is conducted thereto from the commutator 147 which comprises the brushes 148 on the insulating bracket 149 carried by the turret 17 and the metal rings 150 and 150' carried by the insulating collar 151 on the pipe 146. The rings 150 and 150' are engaged by the brushes 148 which are pressed thereagainst by springs (not shown) and are the stationary members of the commutator as the pipe 146 extends down through the hollow column 19 to the frame 20 and a drain for the cooling water. The electrical connections to the rings 150 and 150' are made through wires (not shown) passing down between the pipe 146 and the hollow column 19.

The exhausting operation of the second exhaust system is continuous during the operation of the apparatus and the control and connection of the system to heads 15 depends on the pinch clamp 111. As shown in Fig. 6, a passage is provided in the lower half 52 of the rotary valve corresponding to passage 141 at each station taken by the head 15 except between stations A to E inclusive where the slot 152 is provided for connecting the mercury pumps 137 to another exhaust means so that they are kept in proper functioning order at all times.

The indexing movement of the head 15 from station F to G wipes the cam 78 of pinch clamp 47 on the stationary roller 153 causing it to turn and close off the exhaust line controlled thereby so that said head 15, from this time on, is drawn on only by the second exhaust system. The roller 153 is mounted on a yoke supported by the bracket 136.

No operation, other than the exhausting of the head 15 by the second exhaust system, occurs during the movements thereof from stations G to J, but during the index from station J to K, the quality of the vacuum therein is tested by the apparatus shown diagrammatically in Fig. 9. The test apparatus is divided into three parts, the first of which comprises the resistances 154, 155, 156 and 157 which are mounted in pairs in the vitreous envelopes 158 and 159 and which are connected in a Wheatstone bridge circuit with the resistances in each envelope in diagonally opposite legs thereof. The envelope 159 is sealed except for the tube 160 which, in combination with the rubber tube 162 and pipe 163, connects it to the interior of the head 15 whereas the envelope 158 is preferably evacuated and sealed. Both envelopes 158 and 159 are mounted on the turret 17 adjacent the head 15 so as to receive the same ambient temperature changes and are provided with coiled tungsten resistances like those used as filaments in incandescent lamps. The current is introduced in the bridge from the transformer 164 by the lead 165 connected to the resistances 155 and 157 and the potentiometer 166 connected to the resistances 154 and 156 which permits said bridge to be balanced. Once the bridge has been balanced with the head 15 properly evacuated, any improper condition of the vacuum causes heat to be conducted more rapidly from the resistances 156 and 157 to unbalance the bridge.

This unbalanced condition is not used except during the indexing movement of the head 15 from station J to K when the brushes 167 and 168 (Figs. 2, 3 and 9) which are mounted on the insulating block 169 at the periphery of the turret 17 and which are connected to the ends of the opposite arms of the bridge contact the separated metal bands 170 and 171 on the stationary shoe 172. The shoe 172 is made of an insulating material and together with the vacuum tube amplifying means shown connected thereto forms the second part of the test apparatus. This means is mounted adjacent the turret 17 in a position not shown and amplifies the off-balance condition of the bridge so that it can cause the pinch clamp 111 and the head 15 to be sealed from the second exhaust system if the vacuum is faulty. The amplifying means comprises the transformer 173, the primary which is connected to the metal take-off bands 170 and 171 and the secondary of which is connected to cathode 174 of the vacuum tube 175 and through the condenser 176 and the resistance 177 to a grid thereof. The other parts of the amplifier comprise the transformer 178 which is connected to the line and to the cathode heating filament and which has a center tap on the primary connected to said cathode 174, the condenser 179 which is connected across the secondary of transformer 173, the milliammeter 180 which is connected to the plate of the vacuum tube 175 and the actuating coil of the relay 181 and the condenser 182 and resistance 183 connected between the leads from said coil. The plate and third grid of the vacuum tube 175 are placed at the proper potential by the lead 184 from one side of the line which is connected to the plate through the coil of the relay 181 and directly to the third grid. The function of the parts of the amplifying means is believed to be apparent and it is readily discernible that a change in the balance of the bridge due to improper vacuum in the head 15 and space trapped by the cups 16—16 can cause a relatively great increase in the flow of current in plate circuit of the vacuum tube 175 which produces a higher reading on milliammeter 180 and actuates the relay 181.

The relay 181 controls the operation of the third part of the test apparatus in that it completes the line circuit to the solenoid 185 (Figs. 1 and 9) which indirectly raises the roller 186 so that the cam 115 of pinch clamp 111 strikes it during the indexing motion and takes the closed position. The armature 187 of the solenoid 185 is connected to the arm 188 on the shaft 189 by the link 190 and when actuated turns said shaft 189 so that arm 191 and link 192 are moved into alignment with each other and lever 193 carrying the roller 186 is raised. The lever

193 is pivoted on the pin 194 held by the bracket 195 extending from the frame 20 which also supports the shaft 189. Since the test apparatus only closes the pinch clamp 111 when a faulty head 15 is indexed into position, the second exhaust system will normally continue to draw on the head 15 as it passes into station K.

Station K is the first of four consecutive so-called flashing stations in which the heater 23 is connected to a source of electrical energy and raised in temperature under normal conditions. The supporting rods 26 for the heater in each case are connected by wires to the studs 196 (Figs. 1 and 2) extending the insulating block 197 on the turret 17 below each head 15 and the electrical connections are made thereto at each of the four stations by means engaging separate angular contact surfaces of the blocks 198 on the lower ends thereof. At station K, as shown in Figs. 1 and 10, the contacts 199 are carried into engagement with the blocks 198 by movement of the levers 200 and the arm 201 on which they are mounted and connect the secondary of the transformer 202 shown diagrammatically in Fig. 11 thereto. The contacts 199 are insulated by suitable washers and sleeves from the levers 200 which are pivotally mounted on the pin 203 carried by the arm 201 and which turn on said pin 203 against the contracting force of the springs 204 to absorb the excess movement of arm 201. Each spring 204 extends from a post in a projecting portion of the arm 201 and through a passage therein to the lowermost part of the lever 200 whose position prior to the engagement of the contacts is established by the stop screw 205. The arm 201 is mounted on a shaft 206 supported by the bracket 207 extending from the frame 20 and is actuated from the shaft 208 which is similarly supported by the bracket 209 and which is actuated by the engagement of the roller 210 on the lever 211 with the cam 212 on the main drive shaft 95. The motion of shaft 208 is transferred to shaft 206 through the arms 213 and 214 on respective shafts which are joined by the link 215. At station L, levers 216 and the arm 217 which is mounted on the shaft 208 perform the same function as levers 200 and arm 201 respectively, while at station M, levers 218 and lever 211 perform these functions. At station N, levers not shown corresponding to levers 218 and an arm only partially shown at 211' corresponding to the upper part of lever 211 carry the contacts 199 into engagement with the blocks 198 and the head 15.

At each of these stations K, L, M and N, electrical current does not pass through the heater 23 directly upon the connection of the secondary of the transformer 202 thereto, as the primaries of said transformers are not connected to the line until later by the switching means shown in Fig. 11 and then only if the head 15 and cups 16—16 are properly evacuated and switch 219 is closed. The switching means comprises a mercury switch 220 of conventional design in one lead of the line connection to the primary of the transformer 202 in each instance and a lever 221 for supporting and tilting said switch 220. The levers 221 are operated in pairs by the cams 222 and 222' on a portion of the cam shaft 94 extending to the right farther than shown in Fig. 1 and are turned about the pin 223 by the contracting force of the springs 224 under the direction of the following movement of the rollers 225 on the forward end of levers 221 which engage said cams 222 and 222'. The pin 223 is carried by the bracket 226 which is attached to an adjacent part of the frame 20 which also holds the upper ends of the springs 224.

The switches 219 which are in the line leads to the transformer 202 are, as shown in Fig. 1, of totally enclosed form and are mounted on the frame 20 in position to be operated by the pinch clamp 111 when the head 15 takes positions K, L, M and N. If the head 15 is not evacuated to the degree desired, pinch clamp 111 will have been closed on reaching these positions and the pin 227 extending from the lever 116 thereof will be lower than normal and will displace the levers 228 and operate the switches 219. Normally, each switch 219 is closed and the lever 228 is turned about the pin 229 by the contracting force of the spring 230 to the limit allowed by the stop screw 231 but when the pin 227 is down it engages the roller 232 on the end of said lever 228 and swings it against the control pin 233 of said switch 219. This operation opens the switch 219 and prevents the circuit from being closed when the mercury switch 220 is tipped.

At station K, the heater is not raised to a temperature high enough to vaporize the metal body 22 held by the coils but only to about 600° C. so as to drive off the moisture and dissipate any other type of contamination which can be carried off by the exhaust system. The control of this temperature is afforded by the rheostat 234 in the primary circuit to the transformer 202. At the succeeding stations L, M and N, the heaters 23 are raised to about 2000° C. and in some instances even to a higher temperature so as to heat the bodies 22 of metal in the coils 23' thereof and cause them to be vaporized. The vaporizing of the metal takes place very rapidly and in most instances is completely brought about before the head 15 enters the last flashing station. As the heater coils 23'—23' are at approximately the centers of the cups 16—16, the vaporized metal condenses on the interior thereof in a relatively uniform deposit which forms a very efficient light reflecting coating. The proper distribution of the metal over the interior of the cups 16 is assisted by the baffles or partitions 235—235' which apparently prevent the metal vaporized by one heater coil from depositing on the cup on the opposite side of the head 15 and assist in the proper withdrawing of the atmosphere and impurities from the space adjacent the rim of the cups 16—16. The baffles 235—235' which are the subject matter of a separate application of Carl Lenz Serial No. 318,963 filed February 14, 1940, engage the gaskets 38—38 and the body 25 of the head 15 and are held in place by the spring clip 236.

Following the last flashing operation and the indexing movement of the head 15 from station N, the cam 115 of pinch clamp 111 moves against the stationary roller 237 (Fig. 1) and said pinch clamp 111 is closed. The roller 237 is held by a yoke carried by the bracket 238 extending from the frame 20. By closing off the pinch clamp 111, the second exhaust system is permanently stopped from drawing on the head 15 at any further time in this cycle of operation of the apparatus.

Station O is an idle station and it is not until the head 15 is indexed into station P that the next and final operation of the apparatus takes place. At station P, the pinch clamp 47 is opened by movement of the roller 239 on the lever 240 against the cam 78 thereof which is shifted so that the dry air connected thereto through the rotary valve is allowed to enter the head 15 and the cups 16—16. The lever 240 is pivoted on a pin projecting from the frame 20 and is actuated

by the interconnected arms 241 and 242, the latter of which engages said lever 240 through the link 243 and the former of which is connected to the lever 244 by the rod 245. The lever 244 is pivoted on a pin extending from the frame 20 and is operated by the face or box cam 246 on the cam shaft 94 which it engages through the roller 247. The dry air is conducted through the pinch clamp 47 at this time since the passage 50 in the upper half 42 of the rotary valve is now aligned with the passage 248 (Fig. 6) in the lower half 52 thereof which is connected to the source of supply of said air (not shown).

The entrance of the dry air into the cups 16—16 allows them to be easily removed at station Q by the operator after the holders 36 and 36 have been moved back.

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

1. Apparatus for depositing a reflecting coating on the inner surfaces of a pair of cup-shaped bodies comprising a hollow head member having side portions each shaped to engage and form an air-tight seal with the edges of said cup-shaped bodies and having a connecting passage for permitting the space enclosed by said bodies to be exhausted, and electric heater coils mounted within said head and projecting into the space enclosed by said bodies along the axis through said head and bodies, and means for heating said coils to vaporize bodies of the coating material placed therein so that the vapor condenses on the inner surfaces of said cup-shaped bodies.

2. Apparatus for depositing a reflecting coating on the surface of a base member comprising a head having an opening therein over which the base member is placed and a connecting passage for permitting said opening and the space enclosed by said base member to be exhausted, electrical heating means mounted on the head in the opening therein and arranged to carry a quantity of vaporizable coating material, means for connecting said heating means to a source of current to preliminarily heat it to a degree insufficient to vaporize said coating material but sufficient to expel contaminating substances from the heating means and from the coating material associated therewith, said contaminating substances being withdrawn through said connecting passage, and means for subsequently causing said heating means to be heated sufficiently to vaporize the coating material so that it condenses on the surface of said base member.

3. Apparatus for depositing a reflecting coating on the surface of a base member comprising a head having an opening therein over which said base member is placed, electrical heating means located in said opening, a carrier for advancing the head to a plurality of stations in turn, an exhausting means, means at at least one of said stations for connecting the opening in said head and the space enclosed by said base member to said exhausting means, a second exhausting means mounted on the carrier, means for connecting said second exhaust means to said head at a following station, and means, operable upon movement of said carrier, for connecting the heating means of said head to a source of current at another station for vaporizing a body of the coating material associated therewith so that it condenses on the surface of said base member.

4. Apparatus for depositing a reflecting coating on the surface of a base member comprising a head having an opening therein over which said base member is placed, electrical heating means located in said opening, a carrier for advancing the head to a plurality of stations in turn, means controlled by the movements of the carrier and connected to the opening in said head for causing a preliminary exhausting, a flushing and then a more complete exhausting of said opening and the space enclosed by said base member, and means, operable upon movement of said carrier, for connecting the heating means of said head to a source of current at another station for vaporizing a body of the coating material associated therewith so that it condenses on the surface of said base member.

5. Apparatus for depositing a reflecting coating on the surface of a base member comprising a head having an opening therein over which the base member is placed, electrical heating means located in said opening, a carrier for advancing the head to a plurality of stations in turn, an exhaust means, means including a valve mounted on the carrier for connecting the opening in said head and the space enclosed by said base member to said exhaust means, means located along the path of movement of the carrier for opening and closing said valve at different points along said path, a second exhausting means mounted on said carrier, means including a second valve for connecting said head and said second exhausting means together, means located further along the path of movement of the carrier for opening and closing the said second valve in order at different points along said path, and means, operable upon movement of said carrier, for connecting said heating means to a source of current at another station for vaporizing a body of the coating material associated therewith so that it condenses on the surface of said base member.

6. Apparatus for depositing a reflecting coating on the surface of a base member comprising a head having an opening therein over which the base member is placed electrical heating means located in said opening, a carrier for advancing the head to a plurality of stations in turn, an exhausting means, means at a plurality of said stations for connecting the opening in said head and the space enclosed by said base member to said exhausting means, means for connecting said heating means to a source of current at another station for vaporizing a body of the coating material associated therewith so that it condenses on the surfaces of said base member, means at one of said exhausting stations for testing the quality of the vacuum held by the head and for closing off the connection thereto when unsatisfactory vacuum is indicated, and means, operable upon the closing off of said vacuum connection, for preventing the completion of the electrical circuit to the said heating means.

7. Apparatus for depositing a reflecting coating on the surface of a base member comprising a head having an opening therein over which the base member is placed, electrical heating means located in said opening, a carrier for advancing the head to a plurality of stations in turn an exhausting means, means at a plurality of said stations for connecting the opening in said head and the space enclosed by said base member to said exhausting means, means for connecting the heating means of said head to a source of current at another station for vaporizing a body of the coating material associated therewith so that it condenses on the surface of said base member, means at one of said exhausting stations for

testing the quality of the vacuum held by the head and for closing off the vacuum connection thereto when unsatisfactory vacuum is indicated, a displaceable member mounted on the carrier and arranged to be repositioned by the closing off of said vacuum connection, a normally closed switch located at the same station as the said electrical connection-making means and connected in the circuit thereto, and means mounted adjacent the said switch and engaged by said displaceable member when it is repositioned for opening the said switch and preventing the completion of the electrical circuit to the said heating means.

8. Apparatus for depositing a reflecting coating on the interior surfaces of a plurality of cup-shaped bodies comprising a rotatable turret, a plurality of heads mounted at the periphery of the turret, each of said heads having an opening therein over which one of said bodies is placed and electrical heating means located in said opening, means connected to said openings in the heads and the spaces enclosed by said bodies for permitting the exhausting thereof during the rotation of the turret, and means located adjacent the periphery of the turret for connecting the heating means of a plurality of heads in turn to a source of current, upon rotation of said turret to vaporize a body of the coating material associated therewith so that it condenses on the inner surfaces of said cup-shaped bodies.

9. In a device of the class described, a hollow head member having side portions shaped to engage and form an air-tight seal with the edges of a plurality of bodies held thereagainst in opposed relationship whereby the said hollow head member and said bodies conjointly form an air-tight enclosure, an exhaust connection to said head member, means carried by said head member within said enclosure for supporting a quantity of vaporizable coating material, and means for heating said last-mentioned means to vaporize said coating material so that it condenses on the surfaces of said bodies.

10. In a device of the class described, a hollow head member having side portions shaped to engage and form an air-tight seal with the edges of a pair of bodies held thereagainst in opposed relationship whereby the said hollow head member and said bodies conjointly form an air-tight enclosure, an exhaust connection to said head member, means carried by said head member within said enclosure for supporting a quantity of vaporizable coating material adjacent each of said bodies, and means for heating said last-mentioned means to vaporize said coating material so that it condenses on the surfaces of both of said bodies.

11. In a device of the class described, a head comprising a hollow ring-shaped portion having its opposite sides shaped to engage and form an air-tight seal with the edges of a pair of bodies held thereagainst in opposed relationship whereby the said ring-shaped portion and said bodies conjointly form an air-tight enclosure, an exhaust connection to said ring-shaped head portion, means carried by said ring-shaped head portion within said enclosure for supporting a quantity of vaporizable coating material, and means for heating said last-mentioned means to vaporize said coating material so that it condenses on the surfaces of both of said bodies.

12. In a device of the class described, a head comprising a hollow ring-shaped portion having its opposite sides shaped to engage and form an air-tight seal with the edges of a pair of bodies held thereagainst in opposed relationship whereby the said ring-shaped portion and said bodies conjointly form an air-tight enclosure, an exhaust connection to said ring-shaped head portion, conductive support members extending into the interior of said ring-shaped portions from opposite sides thereof and transversely of the axis thereof, and an electrical heater element within said ring-shaped head portion supported at its ends by, and electrically connected to, said support members, said heater element being constructed and arranged to support and vaporize a quantity of vaporizable coating material so that it condenses on the surfaces of both of said bodies.

13. In a device of the class described, a head comprising a hollow ring-shaped portion having its opposite sides shaped to engage and form an air-tight seal with the edges of a pair of bodies held thereagainst in opposed relationship whereby the said ring-shaped portion and said bodies conjointly form an air-tight enclosure, an exhaust connection to said ring-shaped head portion, conductive support members extending into the interior of said ring-shaped portion from opposite sides thereof and transversely of the axis thereof, and an electrical heater element within said ring-shaped head portion supported at its ends by, and electrically connected to, said support members, said heater element comprising intermediate portions extending substantially axially of said ring-shaped head portion and beyond the said sides thereof, said intermediate heater portions being constructed and arranged to support and vaporize a quantity of vaporizable coating material adjacent each of said bodies to thereby coat both of said bodies.

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