

March 24, 1959

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2,879,180

MACHINE AND METHOD FOR COATING USING AN EFFUSER RECIPROCATING ABOUT A PATH HAVING CURVILINEAR ENDS

Original Filed June 25, 1949

4 Sheets-Sheet 1

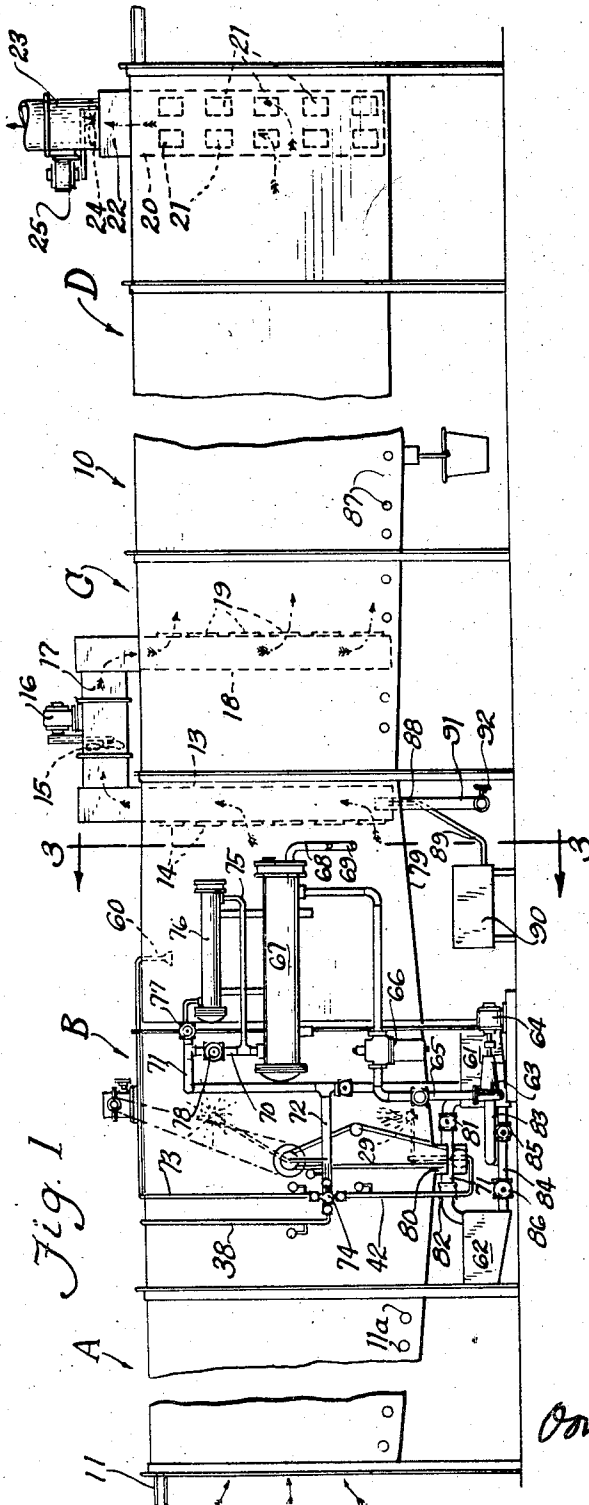


Fig. 1

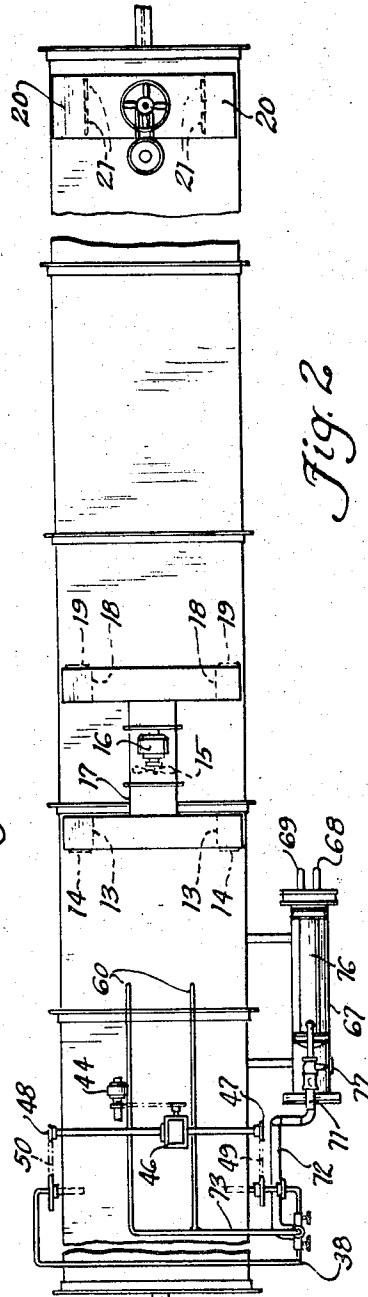


Fig. 2

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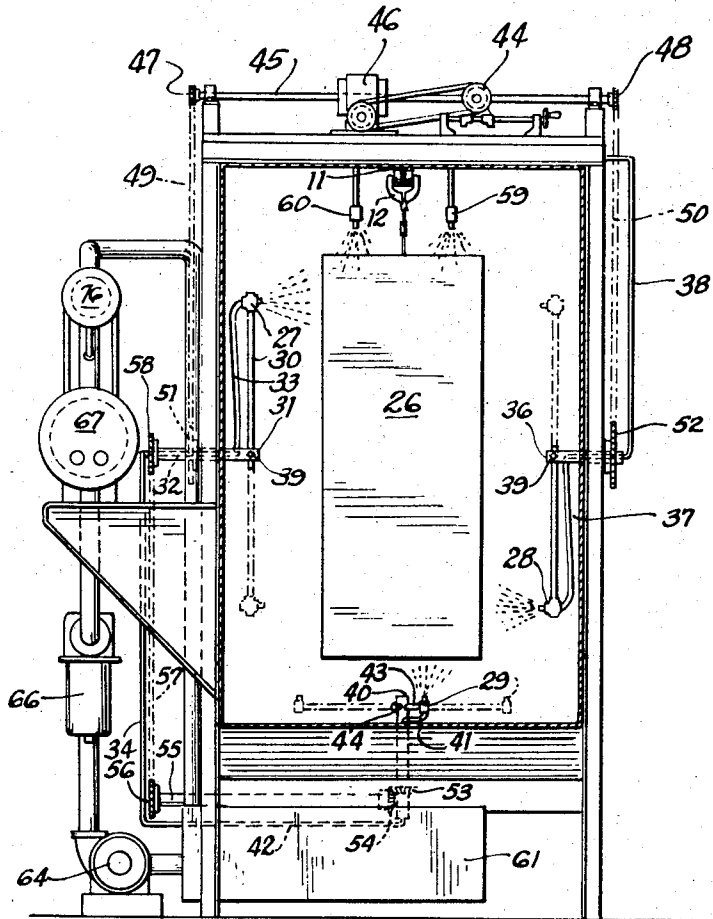


Fig. 3

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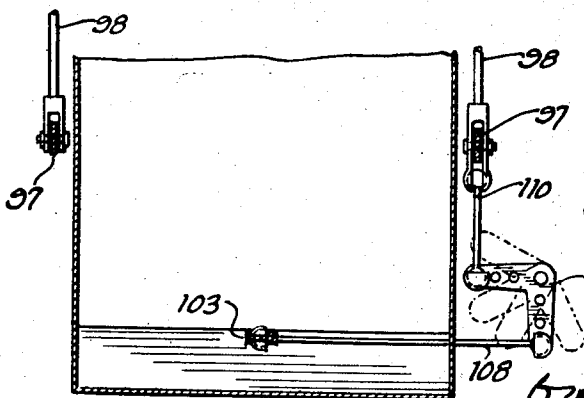
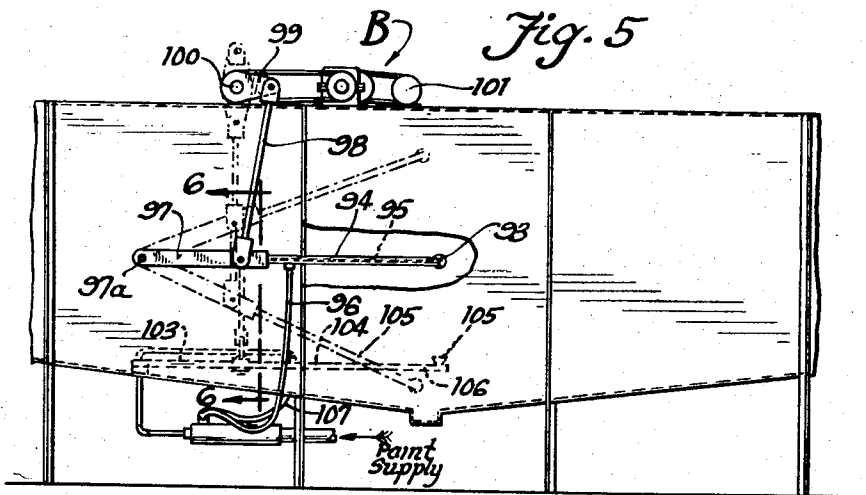
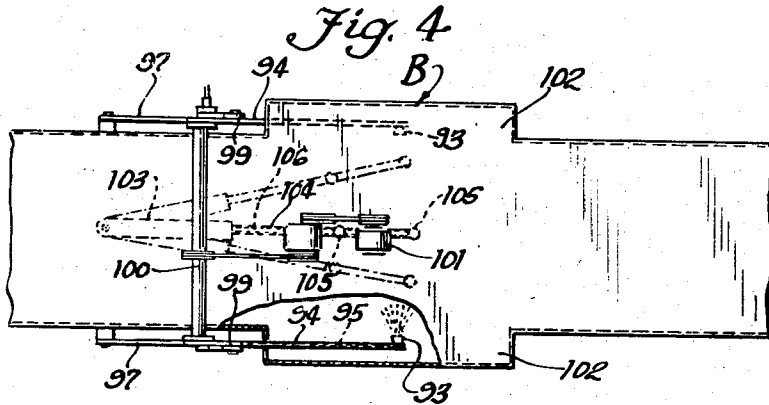
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Original Filed June 25, 1949

4 Sheets-Sheet 3



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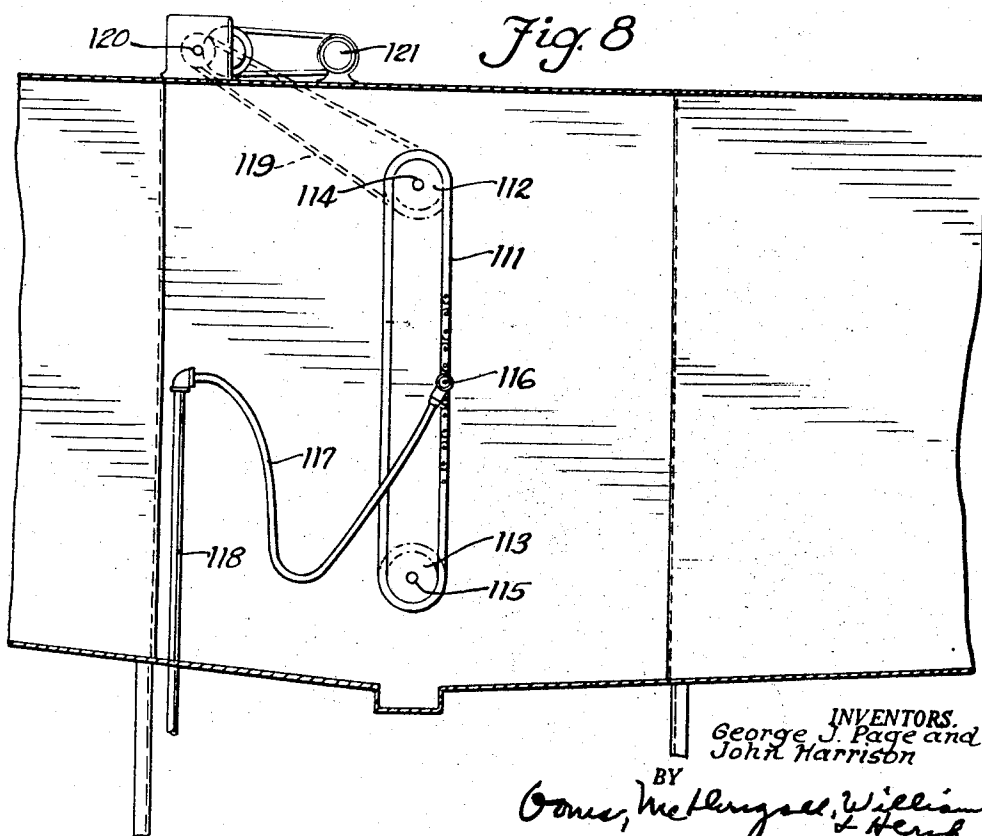
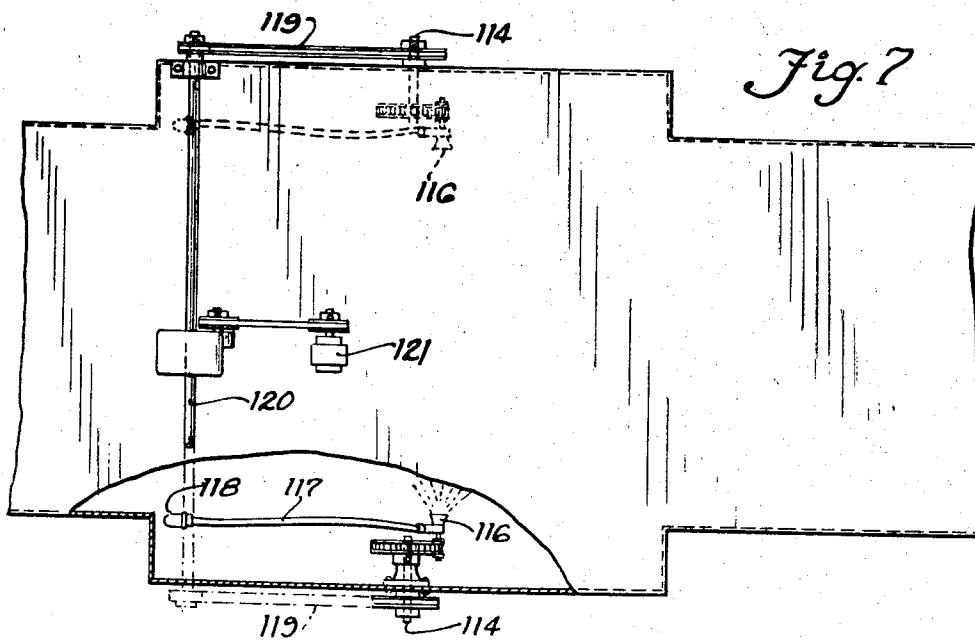
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2,879,180

Original Filed June 25, 1949

4 Sheets-Sheet 4



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MACHINE AND METHOD FOR COATING USING AN EFFUSER RECIPROCATING ABOUT A PATH HAVING CURVILINEAR ENDS

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Original application June 25, 1949, Serial No. 101,396, now Patent No. 2,661,310, dated December 1, 1953. Divided and this application August 10, 1953, Serial No. 373,124

14 Claims. (Cl. 117—102)

This invention relates to apparatus for and method of painting, although, as will be pointed out hereafter, the apparatus may be employed in applying other fluids to articles. For the purpose of illustration, the use of the apparatus in applying paint will be described specifically for the purpose of rendering clear the character of the apparatus as well as the method.

This application is a division of application Serial No. 101,396, filed June 25, 1949, entitled "Apparatus for and Method of Painting."

In the application of paint industrially to manufactured products, the use of spray guns or spraying apparatus is common but the installations required for painting by the spraying method and by considerations of the health of those who carry on the operations not only are costly initially but the operations of such installations are expensive by reason of power consumption including the supplying and treatment of air in relatively huge quantities and also by reason of space requirements and the waste of paint materials. Furthermore, notwithstanding the use of approved washing and other apparatus calculated to prevent the escape of paint particles to the outside atmosphere, not infrequently property damage occurs at considerable distances from spraying installations by reason of the deposit of paint particles from the atmosphere as upon parked automobiles, for example.

In an effort to overcome some of the disadvantages inherent in the paint spraying of articles industrially, the flowing or jetting of paint in liquid form, as distinguished from atomized paint as in spray painting, has been developed wherein numerous nozzles are arranged in various fixed positions along a paint chamber for jetting liquid paint upon the particles moving through the chamber. Such nozzles direct the liquid paint upon the articles to flood the surfaces thereon to be painted, the excess paint draining off and being returned to a tank for replenishment of solvent or thinner to adapt the paint for re-use. Such nozzles have been so spaced necessarily that the entire surface to be painted would be coated or flooded with paint and, for eliminating the possibility that some areas of the articles would not receive paint, the nozzles have been arranged generally so that areas covered by the nozzles overlap areas of other nozzles. A relatively large quantity of paint is thus directed upon each such surface as compared with the amount actually required to coat the article for insuring that the surfaces to be painted will be fully covered by the paint. This method of painting, known to the trade frequently as "flow coating" is wasteful of paint solvents or thinners which escape from the surplus paint that is flooded on the articles in the painting chambers. A substantial portion of the excess or surplus paint drips from the articles into the drains for recovery of the paint pigments but, as will be seen, the aeration of the paint passing from the nozzles to the articles and from the latter to the drains results in substantial loss of thinner and necessitates replenishment

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of the thinner in restoring the retrieved pigments to the proper viscosity for re-use.

In the flow coating method of painting, the paint is jetted from the nozzles at relatively low pressure as compared with the pressure used in the paint spraying method. Three to five pounds per square inch is usually employed in the flow coating method, such pressure being provided by a pump which effects circulation of the paint from a main supply tank through conduits to the nozzles which, as indicated above, direct the liquid paint in sheet or stream form upon the surface of the articles to be painted.

It is an object of the present invention to provide apparatus for and a method of applying liquid paint at relatively low pressure to articles moving through a paint chamber which will require the circulating or jetting of less paint to insure complete coverage of the articles as compared with the previously described prior method of flow coating and hence will result in proportionately lower solvent or thinner losses.

Another object of the invention is to provide an apparatus comprising a plurality of nozzles for flooding or flow coating articles, preferably moving continuously through a coating chamber, at least some of the nozzles being movable in predetermined or selected paths for jetting liquid paint or other surface treating fluid upon the articles to thereby distribute the fluid over relatively greater areas of the articles as compared with stationary nozzles of the type above mentioned.

Another object of the invention is to provide a tunnel structure through which articles are movable during the paint applying and the drying operations and through which from the intake end thereof to an exhaust duct at the outlet end, a current of air is moved for scavenging the thinner vapors for avoiding the contamination of the atmosphere of the surrounding areas where an attendant or attendants supervise the operation of the painting apparatus.

By means of the present improvements when used for painting articles of a type suitable for such mode of paint application, not only is there a substantial saving in thinners or solvents over prior methods of industrial application of coating materials but the original installation and the operation thereof generally are less costly from the standpoint of power consumption, floor space, and labor requirements and, as compared with the spray coating method, health hazards to the workman and likelihood of property damage to areas adjacent the installations have been eliminated or the conditions vastly improved.

Other objects of the invention will be apparent from the consideration of the following specification and accompanying drawings wherein:

Figure 1 is a broken side elevation of a tunnel and associated structure of a character adapted for use in carrying out the improved method of applying paint or other coating compositions or surface treating fluids to articles industrially;

Figure 2 is a broken top plan view of the structure shown in Figure 1;

Figure 3 is an enlarged sectional view taken approximately on line 3—3 of Figure 1;

Figure 4 is a broken top plane view of a portion of a tunnel showing a modified form of mechanism for moving the fluid applying nozzles; Figure 5 is a broken elevational view of the structure shown in Figure 4; Figure 6 is a sectional view taken on line 6—6 of Figure 5; Figure 7 is a broken plane view of a further modified nozzle operating mechanism; Figure 8 is an elevational view of the structure shown in Figure 7.

In Figure 1 of the drawings, a tunnel structure is shown indicated generally by the numeral 10, this structure comprising a suitable supporting framework, not shown in detail, for supporting sheet metal walls which

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define the tunnel. Extending along the upper part of the tunnel, which is open at opposite ends, is a supporting track 11 for an endless conveyor 12, not shown in detail, but being of any approved type capable of conveying to and through the tunnel the articles to be painted. Such articles are of numerous types, such as cabinets (wood or metal), refrigerator casings, castings and numerous other articles. The conveyor 12 preferably is of the endless type, the return run of the conveyor outside the tunnel not being shown.

In applying paint or coating material by the improved method, the conveyor moves at a proper rate for carrying the articles continuously through the tunnel from left to right as viewed in Figure 1 and during the passage of the articles, suspended from the conveyors in selected positions for facilitating drainage of excess paint from their surfaces, the articles pass in succession through tunnel zones for effecting a proper conditioning of the articles as to temperature generally, a paint applying zone where the articles are coated, a heating zone in which the drainage of the surplus paint from the articles is augmented, and a drying zone. These zones are of such length that the articles receive appropriate treatment as they progress through the tunnel. In Figure 1 of the drawing, a tempering zone A is indicated which is provided with means for assuring that the articles to be painted are at the proper temperature as they enter the coating zone. Frequently, in industrial plants, articles of metal are "degreased" or washed prior to painting and after washing they pass through a drying tunnel. The present tunnel may receive articles directly from the last mentioned drying tunnel and, in some instances, the articles may be at a proper temperature for painting in which instance the zone A of the tunnel 10 may be omitted. However, in Figure 1 zone A of the tunnel is shown as being provided with temperature conditioning means which may be in the form of steam pipes indicated diagrammatically at 11^a for preheating the entering articles. In tunnel installations where the articles to be painted are or are likely to be at a temperature above that required for best painting results, the tunnel section A may be provided with means for reducing the temperature of the articles such as by the provision of cooling ducts (not shown) within the section A, for example. The succeeding zone or section of the tunnel is indicated by the letter B and is the zone where the coating material, such as paint, is applied to the articles and in which the major portion of the surplus paint drains from the articles and is recovered for re-use. The next adjacent section is indicated by the letter C and generally is the zone where the articles are subjected to a temperature controlled atmosphere. Where the applied liquid is paint, the atmosphere of zone C generally is heated for the purpose of causing the remaining surplus paint to drip more freely from the painted articles thereby eliminating the formation of bubbles or pin holes such as sometimes cause an "orange peel" appearance. In some instances the atmosphere of zone C may be reduced to a predetermined degree where a cool or refrigerated atmosphere produces desired results by controlling fluidity or the action of the solvents employed. The paint that drips from the articles in zone or chamber C may be recovered periodically, but generally it is too viscous to drain back into the paint circulating system. The last zone, indicated by letter D, is a drying zone which is of adequate length whereby the articles passing therethrough will be adequately dried for removal from the conveyor or for entrance to a second tunnel for receiving a second coat or if preferred for transfer again to the entrance end of the same tunnel for such subsequent coat.

For the purpose of avoiding contamination of the atmosphere surrounding the tunnel by the vapors of solvents or thinners or of the other coating or fluid constituents, means are provided for inducing a flow of air

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longitudinally through the tunnel in the direction of the movement of the articles, that is, from left to right as viewed in Fig. 1. In Fig. 1, such circulating means is shown as comprising a pair of vertical ducts 13 having air intake openings 14, the ducts being mounted adjacent the inner side walls of the oven. A booster fan 15 operated by a motor 16 draws air into the ducts 13 through the inlet openings 14 and forces the same through a horizontal duct 17 at the top of the tunnel and thence downwardly through vertical ducts 18 whence the air passes through outlet openings 19 in the direction of the travel of the articles. The two pairs of ducts 13 and 18 are located adjacent opposed side walls of the oven to provide adequate intermediate space between the ducts of each pair for the passage of the articles through the oven. At the outlet end of the oven there is provided a pair of vertical ducts 20 disposed along opposite side walls of the oven and having at their inwardly directed faces inlets 21. The upper ends of the ducts communicate by a horizontal conduit 22 with an exhaust duct 23. A fan 24 operable by a motor 25 draws air and evaporated thinner through the openings 21 whence they are exhausted through the duct 23 to the outside atmosphere. The above described air circulating and air exhaust means induces a flow of air into the inlet end of the tunnel which carries through the tunnel the vaporized thinner or solvent and discharges the air and thinner vapors through the exhaust 23 thereby avoiding the contamination of the ambient atmosphere.

Within the section or zone B, the coat-applying nozzles are located for applying the coating or fluid material, such as paint, to the articles as the same move from left to right within the section. The nozzles within section B that apply the major portion of the coating to the articles are made movable so that paint jetted from such nozzles will be applied over a larger portion of the surfaces of the articles than where such nozzles are stationary. Since fewer movable nozzles are required for adequately coating an article moving through the painting zone than where stationary nozzles are employed, less paint need be jetted through the nozzles and since less paint is subjected to the atmosphere within the tunnel (assuming a given pressure and nozzle capacity), less thinner loss occurs and generally a more economical paint-applying method is provided. Likewise, the movable nozzles give the respective jets of paint a greater tendency to spread out and flow upon the surface and to seek out surface formations which might escape being coated were the nozzles stationary.

The movement of the nozzles may be varied as to velocity whereby a given installation or arrangement of nozzles within the painting zone may be regulated for obtaining satisfactory results in the coating of articles of different forms or shapes or of surface characteristics. Likewise, the movable nozzles preferably are adjustable for varying the range of application of the coating material upon the articles, particularly in instances where the nozzles are rotatable, as shown in Figs. 1, 2 and 3 of the drawings. In Fig. 3, an article 26 is shown suspended by the carrier 12, the article represented being, for example, a cabinet requiring painting on its exterior surface. For the purpose of illustration, three movable nozzles are provided, the nozzles being indicated by the numerals 27, 28 and 29. Each of the nozzles is shown as being rotatable about a given axis for jetting or sheeting liquid paint upon the article 26 as it moves through the paint-applying zone B. Nozzle 27 is shown as being supported by a radial arm 30 adjustably mounted on a rotatable shaft 31 journaled suitably in the side wall or frame structure of the tunnel and having an axial passage 32 extending from the outer end of a flexible duct 33 which carries the coating composition to the nozzle under a relatively low pressure supplied by means hereinafter disclosed. A pipe 34 supplies the liquid paint to the intake end of the shaft 31. On the opposite side of the oven is located nozzle 28

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carried by an arm 35 which is mounted for radial adjustment in a shaft 36 which may be journaled in the side wall or the frame of the oven. The shaft 36 is provided with a passage similar to that above described for supplying liquid paint to a flexible duct 37 that conveys the paint to the nozzle 28. The paint is supplied to the passage in the shaft 36 by a duct 38. The arms 30 and 35 which carry the nozzles 27 and 28 respectively preferably are made radially adjustable with reference to the shafts 31 and 36 for changing the diameter of the annular path described by the nozzles as they rotate. In the drawings, set screws 39 are shown for holding the arms 30 and 35 in radially adjusted positions.

The nozzle 29 is located above the bottom wall of the tunnel and is supported adjustably by a rotatable shaft 40 having an axial passage therein through which paint may be supplied to a flexible duct 41 which carries the paint to the nozzle 29. A pipe 42 shown for conveying paint from a source of supply to the shaft 40. The nozzle 29 is supported by a radially adjustable arm 43 which may be secured in an adjustable position on the shaft 40 by a set screw 44, for example. The nozzles mentioned may be rotated by any appropriate means.

In the drawings, we have shown a motor 44 located on the top of the tunnel which effects rotation of a transverse shaft 45 by means of a variable drive mechanism 46, adjustment of which enables the shaft 45 to be rotated at selected speeds. The ends of the shaft 45 are shown provided with pinions 47 and 48 which by means of chains 49 and 50, respectively, drive sprockets 51 and 52 located on the shafts 32 and 36 for rotating the latter, as above described. The shaft 40 is shown provided with a beveled gear 53 driven by a beveled pinion 54 mounted on a shaft 55 carrying a sprocket 56 which is driven by a chain 57 which, in turn, is operated by a sprocket 58 mounted on a shaft 32. The nozzles 27 and 28 will, as they rotate, eject liquid paint over the entire side surfaces of the article 26 as the same moves through the painting zone. The nozzle 29 likewise will apply paint over the entire lower surface of the article 26. As the article approaches the range of paint application provided by the nozzles, the advancing end of the article will be coated as will the trailing end of the article as such end comes within the paint disbursing range of such nozzles. For the purpose of applying paint to the upper surface of the nozzle, in the particular installation shown in the drawings, we have shown a pair of stationary nozzles 59 and 60 which are arranged to spray paint over the adjacent surface of the articles as it moves through the painting zone. As shown in Fig. 1, the nozzles 59 and 60 are located to the right of the path of rotation of the movable nozzles 27 and 28. We have found that application of excess paint by nozzles 59 and 60 produces a secondary flooding of the side surfaces that facilitates drainage of the paint from the surfaces previously acted on by the nozzles 27 and 28.

In any given installation, the nozzles are so located as to insure the application of paint to the entire surfaces of the articles to be painted. Such surface may be interior surfaces in many instances where openings are available for the entrance of paint from the nozzles as well as for drainage of excess paint from such surfaces. It will be seen that the adjustment of the rotatable nozzles adapts the particular apparatus shown to the coating or the painting of articles of different sizes. In industrial painting, a given installation generally is used for painting articles of like form, such as, for example, metal cabinets. Castings or machine parts may likewise be coated by means of apparatus embodying the present improvements. Hence, once the proper adjustment of the nozzles has been made for coating metal cabinets, of a particular size and design; for example, no further adjustment of the nozzles is required ordinarily although such adjustments may be desirable in adapting the coating apparatus to cabinets of different sizes or different styles. Hence it will be understood that where the installation is being used for the

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painting of panels or sheets, the upper and lower nozzles described above may be omitted and that, in some instances, the rotatable nozzle carrying arms may be provided with more than one nozzle located at different radial distances from the respective shafts.

Inasmuch as the proper application of paint industrially to manufactured articles necessitates not only relatively rapid application of the paint and drainage of excess paint thereof and subsequent drying in the matter of minutes, it is desirable that the paint be conditioned as to temperature and viscosity before its application to the articles for accomplishing the above results. The paint that drips from the articles in the painting chamber desirably is recovered for re-use as a matter of economy and, since such recovered paint will have lost some of its thinner by evaporation within the paint-applying chamber, it is desirable that means be provided preferably for reconditioning the paint by the addition of thinner thereto. For the purpose of supplying preconditioned paint constantly to the nozzles, we have shown a paint tank 61 and a thinner tank 62 which may be located beneath the tunnel, if desired. Paint within the tank 61 is forced by a pump 63, operated by a motor 64 through a pipe 65 to a motorized filter 66 and thence into a heat exchanger 67. The heat exchanger 67 is provided for reducing the temperature of the paint where such becomes desirable. For the purpose of reducing the paint temperature, water, for example, may be circulated through the tubes of the heat exchanger from a suitable source as by means of pipes 68, 69. Where the heat exchanger 67 is used in a particular installation for reducing the temperature of the paint, the paint passes from the exchanger 67 through a duct 70 to a pipe 71 whence it flows to pipe 72 which communicates with distributor pipes that convey the paint to the several nozzles. For example, pipe 73 conveys the paint to overhead nozzles 59, 60; pipe 42 supplies paint to the lower nozzle 29 and pipe 38 supplies paint to nozzle 28 and pipe 74 conveys paint to the nozzle 27.

Inasmuch as it is generally required that the temperature of the paint be increased prior to application to the articles, the heat exchanger 67 will, in such instances, not be employed for cooling but where forming a part of the apparatus will serve merely as a part of the conveying system between the pump and the nozzles. From pipe 70, the paint or a portion of it, may be by-passed by pipe 75 to a heat exchanger 76 provided with steam coils for heating the paint or portion thereof that passes through the exchanger. The portion of the paint that passes through the exchanger 76, under control of valves 77 and 78, passes into pipe 71 for distribution to the nozzles as above described. If desired, instead of circulating the paint through heat exchanger 67 when no cooling action is required, the paint may be by-passed from the filter 66 to the pipe 70.

The paint that drips from the articles in chamber B flows along the inclined floor 79 of the chamber to a sump 80 communicating with which is a duct 71 controlled by the valves 81 and 82 for returning the paint either to the paint tank 61 or to the thinner tank 62. The intake of the pump 63 is shown communicating with a duct 83 which, in turn is connected with a pipe 84 extending from the paint tank 61 to the thinner tank 62 and provided with control valves 85 and 86. Hence by closing valve 85, for example, the pump will draw thinner from the thinner tank 62 when valve 86 is open and will draw paint from paint tank 61 when valve 85 is open and valve 86 is closed. The provision of means for circulating thinner through the paint distributing system is desirable for flushing out purposes from time to time as where changes are to be made in the color or character of the paint to be used or preceding shut down periods. The liquid, thinner or paint that collects in the sump 80 may be drained into the thinner tank 62 or into the paint tank 61 as preferred and by regulating valves 85 and 86 properly, a proper quantity of thinner may be added to the paint as the

same is forced by the pump through duct 65 through the filter 66. By the arrangement shown, substantial latitude is provided for the handling of the recovered paint and adding thereto the requisite thinner and restoring the paint to the proper viscosity before re-use.

After the articles have been coated during progress through chamber B, it is desirable generally to reduce the viscosity of the paint on the articles to accelerate dripping, particularly to cause the paint which tends to collect along the lower edges of the articles to drip therefrom. This chamber C may be designated generally as a temperature regulated chamber since the temperature affects the viscosity of the paint from the articles. When the installation is designed for use of paints the viscosity of which is reduced by heat, the chamber may be provided with steam pipes 87 or other means for applying heat to freshly painted articles as they move through the chamber to cause residual surplus paint to drip from the articles. The paint on the articles dries as they progress through the drying chamber D to the end of the tunnel, as will be understood. In using certain surface treating fluids it may be desirable to reduce the temperature of the applied fluids and in such installations cooling or refrigerating ducts may be provided in chamber C for effecting those results.

The means above referred to supplying a saturated thinner vapor to the atmosphere in chamber C is for illustrative purposes only since other modes of supplying the vapor may be utilized, as for example, generating solvent vapor by the application of heat to an appropriate thinner containing receptacle and conducting the generated vapor into the chamber.

Where, as shown in Figs. 1 to 3 inclusive, the nozzles move in rotary paths during the application of paint or the like to articles moving through the coating chamber, the nozzles tend to apply the paint in annular bands of a width depending on the adjustment or paint spreading character of the nozzles and the distance from the surfaces being coated. Since the articles move rectilinearly during the application of the paint, the bands are not truly circular but are elongated in the direction of movement of the articles, the rate of rotation of the nozzles being such as to cause each band to overlap, slightly at least, the preceding band to effect complete coverage of the respective surface of the article as it moves into and through the range of the nozzles.

As the articles move from left to right in the structure shown in Fig. 1, the nozzles 27 and 28 preferably rotate in a clockwise direction as viewed from the left in Fig. 3, that is, the nozzles move from left to right in the upper portions of their orbital paths. Since the nozzles in the upper portions of their orbits move generally in the same direction as the articles being painted, the velocity of the nozzles in the upper arcs, relative to the rate of movement of the articles, is less than in the lower portions of the orbits where they move generally in a counter direction with respect to the movement of the articles and hence more paint per unit area will be applied to the articles at the upper portions of the nozzle orbits than in the lower portions. Such application of paint in greater volume per unit area to the upper portions of the surfaces being painted provides adequate paint for flowing down over the surfaces to provide a uniform coating while the reduction of the volume of paint applied per unit area to the lower portions of the surfaces reduces the excess that must be drained off gravitationally with the aid of heat in chamber C or by the supplemental aid of thinner-enriched atmosphere provided by atomization of thinner by the nozzles 88 or by other appropriate means.

In the improved method and apparatus, rotary nozzles, similar to nozzles 27 and 28, are preferred in applying coating to vertical or steeply inclined surfaces such as the side and end walls of the cabinet shown in Fig. 3. While nozzle 29 also is shown as being rotary, a stationary nozzle or nozzles may be employed for coating the lowermost

surfaces of the articles, or, in some instances, an oscillating or reciprocating nozzles may be employed in lieu of a rotary nozzle, particularly for applying coating to a lateral or lower surface of an article, as described hereinafter. However, the movable nozzles are of advantage as pointed out above since they distribute the paint over a greater area in a given time unit than do stationary nozzles (other things being equal) while the centrifugal action produced by the rotary nozzles projects paint streams in trajectories that, entering openings in cabinet walls, will strike on and flow over interior surfaces not accessible by streams projected by stationary nozzles. Hence painting interior walls, as well as exterior walls, of some articles is possible with the present improvements, as will be seen.

In Figs. 4 and 5 mechanism is shown for oscillating certain of the nozzles of the apparatus, such as the lateral nozzles 93. An oscillating nozzle or nozzles may be provided in lieu of the rotary nozzle 29 of Fig. 3 if desired. Thus in the structure shown in Figs. 4 and 5 each of the nozzles 93 is mounted on an arm 94 in communication with an axial passage 95 that supplies paint or other liquid to the nozzles by means of a flexible duct 96 from a source of the fluid under pressure, such as a pump previously described. The arm 94 is carried by a rocking bar 97 pivotally mounted at 97^a to a portion of the tunnel frame. A connecting rod 98 is attached to the bar and to a crank arm 99, carried on one end of the rotary shaft 100 journaled at the top of the tunnel and which is operated by a motor 101 through suitable variable drive mechanism. As a nozzle 93 is oscillated in use it jets the liquid upon successive articles moving through the tunnel as above described, the rate of oscillation with respect to the movement of the articles from left to right being such as to effect application of the fluid in over-lapping paths to insure coverage of the surface portions of the article acted on by the nozzle. As shown in Fig. 4 the chamber B is provided with off-set portions 102 in or adjacent which the nozzles move, suitable passages in the forward wall of each off-set portion being provided with an elongated aperture for accommodating the respective arm 94.

In Figs. 4 and 5 the upper nozzles shown in Fig. 3 are omitted for the sake of simplicity as are the temperature conditioning means, air circulating means and other features of the tunnel apparatus above described. Where oscillating nozzles are employed at the sides of the tunnel as shown in Figs. 4 and 5, means for reciprocating a lower nozzle or nozzles may be employed if desired or a reciprocating nozzle may be employed in the structure shown in Fig. 3 in lieu of the lower rotary nozzle 29. In Fig. 6 an oscillatable member 103 is shown carrying a tubular arm 104 provided with two nozzles 105 each communicating with an axial duct 106 to which paint or other liquid is supplied by a flexible tube 107 from a pressure source. The member 103 can be operated by any suitable means to move the nozzles transversely of the path of travel of the articles to jet paint upon the lower surfaces of the articles. The member 103 is shown as being operable by a link 108 connected to a bell crank lever 109 which in turn is operated by a rod 110 pivotally connected to the adjacent bar 97.

The movable nozzles at the side of the tunnel may be reciprocated by suitable mechanism if desired rather than oscillated as shown in Figs. 4 and 5 or rotated as shown in Figs. 1 to 3 where all the advantages of the rotatable nozzles are not required due to the character of the work to be done. In Figs. 7 and 8 chains 111 are shown mounted on upper and lower sprockets 112, 113 at each side of the tunnel, the sprockets being mounted on upper and lower horizontal rotatable stub shafts 114 and 115, respectively, that may be suitably supported by the frame of the tunnel. A nozzle 116 is swiveled to each chain, as to an extended link pin thereof and is supplied with paint or other fluid by a flexible tube 117 to which, from a

source such as has been referred to above, receives the fluid from a pipe 118. The chains 111 are operated by a chain 119 operating sprockets 112 secured to the upper stub shafts 114 and driven from a rotatable shaft 120 that is operable by a motor 121 through a variable speed drive mechanism.

The nozzles 116, in the structure shown, follow the path of the chains 111 and apply the paint or other liquid being used, in paths that are vertical generally. While the centrifugal forces of the magnitude and character of the rotating nozzles are not available in reciprocating nozzles of the type described for throwing the stream of paint issuing from the nozzles onto the surfaces, centrifugal action occurs to some extent when the nozzles are reciprocated back and forth over a curvilinear path, as with the nozzles 93 shown in Figures 4 and 5, or when the nozzles swing about an arcuate path for return movement, as for example when nozzles 116 swing about the turntables as shown in Figure 8. The paint or liquid issuing in a constant stream from the nozzles are also thrown with a type of centrifugal action but which may be more accurately defined as a whipping action at the ends of the strokes to throw the streams of paint angularly beyond the path of movement of the nozzles and onto surfaces and into crevices heretofore inaccessible by normal air pressure spraying or dip coating processes. The throwing or whipping action which occurs at the ends of the strokes and the centrifugal actions available when the nozzles are reciprocated back and forth through an arcuate path can be accented beneficially by angular disposition of the nozzles in the plane of reciprocating movement and preferably by the use of a pair of nozzles directed toward the work at opposite angles from the perpendicular to the work. Reciprocal movement of the streams of paint issuing from the nozzles may also be secured to provide the advantages described from nozzles which rock back and forth about a pivot substantially perpendicular to the plane of the work to whip the paint upon the surfaces and into the crevices beyond the angular position of the nozzles.

The apparatus shown has been described particularly with respect to the application of paint or coating materials to articles industrially. However, it will be seen that apparatus of the character shown may be used for other purposes requiring the use of other surface treating fluids. For example, water or other washing fluid may be jetted upon articles by the improved apparatus for cleansing or stripping purposes, or paint remover or the like may be used for removing paint or other coating materials from articles moving through the tunnel or even etching fluid may be jetted from appropriate nozzles for etching the surfaces of articles or unmasked portions thereof.

While various controls may be employed for controlling or regulating temperatures of the several zones of the tunnel, particularly in zones C and D, these have not been shown but it will be clear from the foregoing description that the temperature of the paint or other coating or fluid applied to the articles, as well as the temperature of the articles themselves, may affect the quality of the final results. It will also be obvious that in some installations, depending on the size, shape and other characteristics of the article being treated, the relative location of the several nozzles may be varied from that shown and that other changes may be made all within the spirit of the invention defined by the following claims.

We claim:

1. In the method of painting surfaces of articles, the steps of mounting the article in a position to eliminate pockets which might prevent drainage of excess liquid paint from the surfaces thereof, advancing the mounted article rectilinearly through a housing, reciprocating an effusor about a path having curvilinear ends within said housing which is substantially perpendicular to the direction of movement of the article through the housing

and offset from the path thereof but directed towards the article as it passes therethrough, feeding liquid paint composition in a continuous solid stream under pressure to the effusor whereby the liquid composition is ejected as a solid stream and is thrown substantially exclusively by the combination of said pressure and centrifugal force onto the surfaces of the article as it passes through the housing, and balancing the rate of movement of the article through the housing with the volume of liquid paint thrown from the effusor to flood the surfaces of the article with paint composition.

2. The method as claimed in claim 1 in which the effusor is mounted to direct a stream of fluid angularly with respect to its path of movement and the article moving through the housing.

3. In the method of painting surfaces of articles, the steps of mounting the article in a position to eliminate pockets which might prevent drainage of excess liquid paint from the surfaces thereof, advancing the mounted article rectilinearly through a housing, reciprocating an effusor about a path having curvilinear ends within said housing which is substantially perpendicular to the direction of movement of the article through the housing and offset from the path thereof but directed towards the article as it passes therethrough, feeding liquid paint composition in a continuous solid stream under pressure to the effusor whereby the liquid composition is ejected as a solid stream and is thrown substantially exclusively by the combination of said pressure and centrifugal force onto the surfaces of the article as it passes through the housing, balancing the rate of movement of the article through the housing with the volume of liquid paint thrown from the effusor to flood the surfaces of the article with paint composition, and maintaining the temperature of the paint composition at a constant level for reduction in viscosity.

4. In the method of painting surfaces of articles, the steps of mounting the article in a position to eliminate pockets which might prevent drainage of excess liquid paint from the surfaces thereof, advancing the mounted article rectilinearly through a housing, reciprocating an effusor about a path having curvilinear ends within said housing which is substantially perpendicular to the direction of movement of the article through the housing and offset from the path thereof but directed towards the article as it passes therethrough, feeding liquid paint composition in a continuous solid stream under pressure to the effusor whereby the liquid composition is ejected as a solid stream and is thrown substantially exclusively by the combination of said pressure and centrifugal force onto the surfaces of the article as it passes through the housing, balancing the rate of movement of the article through the housing with the volume of liquid paint thrown from the effusor to flood the surfaces of the article with paint composition, and maintaining an atmosphere of solvent vapors in a drainage area immediately following the area of paint application whereby drying of the paint on the surfaces of the article is retarded to enable the excess paint to drain more completely and cleanly from the surfaces of the article.

5. In the method of painting surfaces of articles, the steps of mounting the article in a position to eliminate pockets which might prevent drainage of excess liquid paint from the surfaces thereof, advancing the mounted article rectilinearly through a housing, reciprocating an effusor about a path having curvilinear ends within said housing which is substantially perpendicular to the direction of movement of the article through the housing and offset from the path thereof but directed towards the article as it passes therethrough, feeding liquid paint composition in a continuous solid stream under pressure to the effusor whereby the liquid composition is ejected as a solid stream and is thrown substantially exclusively by the combination of said pressure and centrifugal force onto the surfaces of the article as it passes through the

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housing, balancing the rate of movement of the article through the housing with the volume of liquid paint thrown from the effusor to flood the surfaces of the article with paint composition, and maintaining an atmosphere of solvent vapors in a drainage area immediately following the area of paint application and also maintaining said drainage area at elevated temperature whereby the viscosity of the paint on the surfaces of the article is maintained at a low level while drying of the paint composition is retarded so as to enable the excess paint on the surfaces of the article to drain quickly and substantially completely from the surfaces thereof.

6. Apparatus for the treatment of surfaces of an article with a liquid composition comprising a housing, conveyor means for moving an article at a predetermined rate rectilinearly through the housing, an effusor mounted within the housing for continuous reciprocal movement about a path having curvilinear ends all lying in the same plane and arranged substantially perpendicular to the direction of movement of the article through the housing and offset from the path thereof but facing towards the article as it passes through the housing, a liquid composition supply source, pressure means for placing said liquid composition under pressure, means conveying a continuous solid stream of liquid composition under pressure from said supply source to said effusor during reciprocal movement to eject the liquid composition as a solid stream from the effusor to throw said liquid solely by the combination of pressure and centrifugal force onto the surfaces of the article in amounts balanced with the rate of movement of the article to flood the surfaces thereof with an excess of the liquid composition.

7. Apparatus as claimed in claim 6 which includes means in the bottom wall of the housing for collecting the excess liquid which drains from the article and means for returning said drainage to the liquid supply source.

8. Apparatus as claimed in claim 6 in which the effusors are positioned to eject the stream of liquid at an angle with the perpendicular from the path of movement.

9. Apparatus for painting of surfaces of an article with a liquid paint composition comprising a housing having a paint applicator section, a drainage section and a section for setting the paint on the surfaces of the article, conveyor means for moving the article at a predetermined rate rectilinearly through the sections of the housing, the paint applicator section having an effusor mounted for reciprocal movement about a path having curvilinear ends and all lying in the same plane substantially perpendicular to the direction of movement of the article and offset therefrom but facing towards the article as it passes through the housing, a source of supply of liquid paint composition, and means for conveying a continuous solid stream of liquid paint composition under pressure from said supply source to said effusor dur-

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ing reciprocal movement to eject the liquid paint composition as a solid stream from the effusor and by centrifugal force onto the surfaces of the article in amounts balanced with the rate of movement of the article to flood the surfaces thereof.

10. Apparatus as claimed in claim 9 in which the paint and drainage section contains a drainage floor for collecting the paint which flows from the surfaces of the article as it passes through said sections.

11. Apparatus as claimed in claim 9 which includes means for maintaining an atmosphere of solvent vapors in said drainage section to enhance the removal of excess paint composition from the surfaces of the article.

12. Apparatus as claimed in claim 9 which includes means for circulating air through the housing in the direction of movement of the article.

13. In the method of treating surfaces of an article with a liquid composition comprising the steps of mounting the article in position whereby it is relatively free of pockets which might prevent drainage of excess liquid from the surfaces thereof, advancing the article rectilinearly, reciprocating a liquid effusor about a path curvilinear in at least portions thereof and substantially perpendicular to the direction of movement of the article and offset from the path thereof but facing towards the article during movement, feeding the liquid composition in a continuous solid stream under pressure to the effusor whereby the liquid composition is ejected as a solid stream and is thrown by the combination of said pressure and centrifugal force onto the surfaces of the article as it passes by, and balancing the rate of movement of the article and the volume of liquid thrown from the effusor to deposit liquid composition onto the surfaces of the article in amount sufficient to cause drainage from said surfaces.

14. The method as claimed in claim 13 in which the path about which the effusor is reciprocated is formed with curvilinear end sections.

References Cited in the file of this patent

UNITED STATES PATENTS

691,075	Rigaud	Jan. 14, 1902
1,710,953	Sullivan	Apr. 30, 1929
1,785,864	Haferkamp	Dec. 23, 1930
1,816,596	MacLean	July 28, 1931
2,003,778	Willis	June 4, 1935
2,083,633	Brackett	June 15, 1937
2,203,851	Tucci	June 11, 1940
2,501,672	Gerin	Mar. 28, 1950
2,581,957	Jones	Jan. 8, 1952
2,658,008	Williams	Nov. 3, 1953
2,661,310	Page et al.	Dec. 1, 1953

OTHER REFERENCES

"Finish," April 1951 (pages 26-28 and 59 relied on).