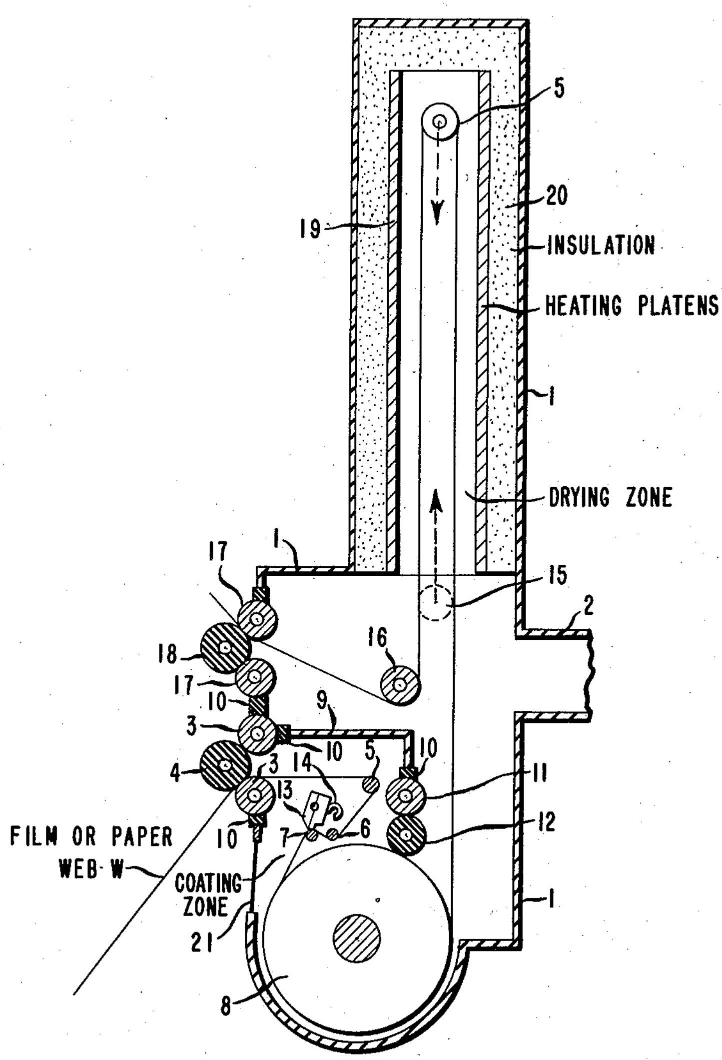
Aug. 11, 1959 R. H. BECK 2,898,882

APPARATUS FOR COATING AND DRYING PHOTOGRAPHIC LAYERS

Original Filed Aug. 20, 1953 2 Sheets-Sheet 1

Fig. 1



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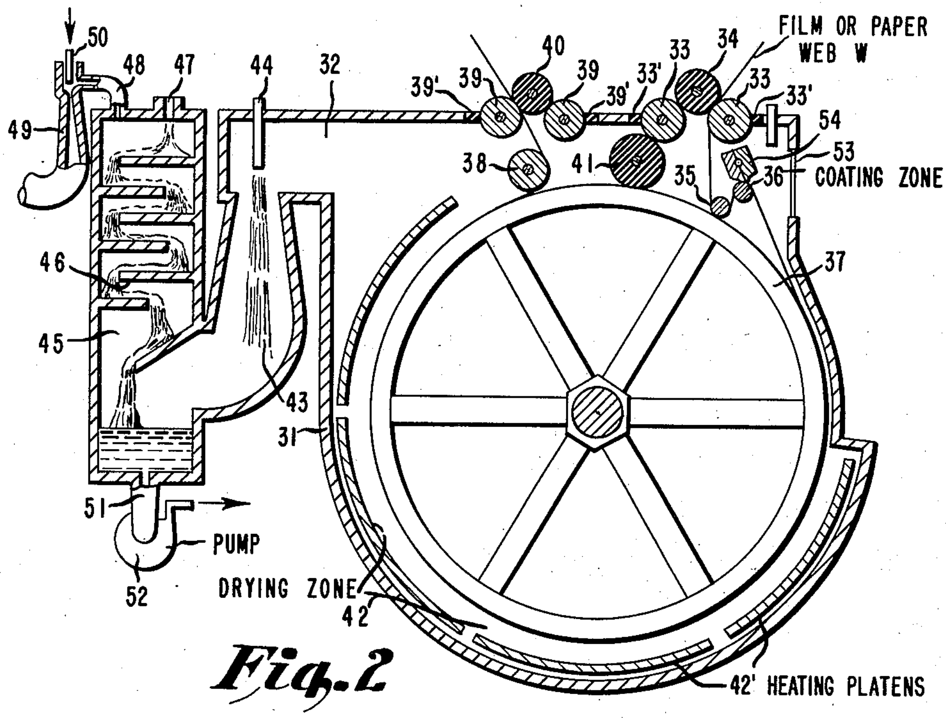

Fig. 2

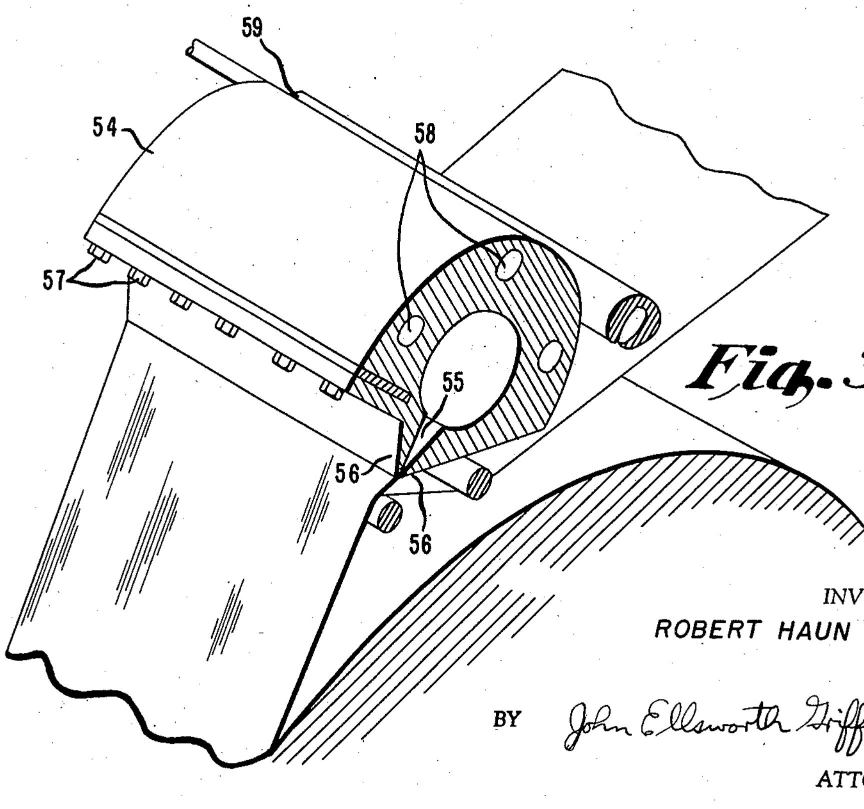

Fig. 3

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APPARATUS FOR COATING AND DRYING PHOTOGRAPHIC LAYERS

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Original application August 20, 1953, Serial No. 375,404, now Patent No. 2,815,307, dated December 3, 1957. Divided and this application March 1, 1956, Serial No. 568,868

11 Claims. (Cl. 118—50)

This application is a division of application Serial No. 375,404 filed August 20, 1953 now Patent Number 2,815,307 granted December 3, 1957.

This invention relates to photography and more particularly to a process and apparatus for coating viscous solutions as layers in photographic elements and drying such layers. More particularly it relates to a process and apparatus for coating and drying viscous aqueous silver halide dispersions in water-permeable colloids. Still more particularly it relates to such a process and apparatus wherein highly reduced pressures are utilized. In an important aspect, the invention relates to a process and apparatus for coating and drying viscous aqueous silver halide dispersions in gelatin at highly reduced pressures.

Photographic films and paper are usually made on a large commercial scale by coating continuous rolls of flexible film base in wide widths, e.g., 36 to 48 inches, with an aqueous dispersion of silver halides in a water-permeable colloid, chilling and setting the liquid emulsion and drying the emulsion layer in a convection type dryer wherein the wet bulb temperature of the air is lower than the melting point of the set emulsion. Two common methods of coating photographic layers are: (1) skim coating in which the web is passed around a coating roll disposed in a coating pan so that the web contacts the liquid emulsion and picks up a thin layer and (2) air jet coating in which emulsion is applied by method (1) and then a thin jet of air is directed against the coating in order to control the amount (thickness) of emulsion adhering to the web. The photographic layer can also be applied by dip coating, by applicator rolls, or from a suitable extrusion hopper. The air jet method has the advantage that aqueous emulsions of higher solids content can be used.

In the procedures described above, setting of the aqueous emulsion layer is accomplished by passing the coated web through a zone in which the wet bulb temperature is below the melting point of the emulsion wherein it sets or gels to a semi-solid condition.

Drying of the webs coated by the foregoing methods is usually done by festooning the web over the moving bars of a festoon dryer. The air velocities and drying conditions in such a dryer are generally moderate and drying times of 30 to 90 minutes are required, depending upon the coating weight of the layer. Spiral chamber dryers and tenter frame dryers have been used and are quite satisfactory but they require rather expensive and large equipment.

In the processes and apparatus just described, the aqueous silver halide colloid dispersions are relatively dilute, having solids contents of about 10% to about 20%. The large amount of water in such dispersions necessitates long drying times and large size apparatus. The drying rate is limited by the air velocities used and by the capacity of the air conditioning equipment required to maintain the wet bulb temperature below the melting point of the emulsion. Under the best of conditions these prior art procedures require from 5 to 10 minutes in order to complete the drying of a section of photographic film. Similar problems are encountered in the coating of photographic paper.

An object of this invention is to provide an improved process for coating and drying photographic webs, e.g., films and papers. Another object is to provide a more rapid method of coating and drying photographic films and papers. A further object is to provide a process of coating films and papers with photographic emulsions of high solids content. Yet another object is to provide such a process which can be readily controlled. A still further object is to provide such a process which can be carried out on a continuous basis and will produce relatively thin, smooth, uniform coatings.

Another object of the invention is to provide improved apparatus for the coating and drying of concentrated aqueous silver halide colloid dispersions. Yet another object is to provide such apparatus which is simple to construct and easy to maintain under continuous operating conditions. A further object is to provide such an apparatus which requires a minimum of space and moving parts. Still other objects will be apparent from the following description of the invention.

The above and other objects are attained, and a commercially practical process of coating and drying emulsions provided by the present invention, which in one of its broader aspects comprises extruding a viscous aqueous dispersion of silver halides in a water-permeable colloid having a viscosity of 2,000 to 100,000 centipoises and a solids content of 20% to 65%, through a narrow, rectangular slot orifice onto a moving web of film or paper traveling at a speed of at least 150 feet per minute and at a linear speed the same or preferably faster than that at which the dispersion is extruded so that the extruded layer of dispersion is drawn down 1 to 200 times in thickness, at a reduced pressure, in the substantial absence of non-condensable vapors but in the presence of added water vapor at a pressure of 20 to 190 mm. of mercury, passing the coated film into a sealed drying zone maintained at a total pressure from 5 to 35 mm. and preferably 15 to 25 mm. of mercury and where the film receives heat during which time the water is evaporated at approximately the boiling point of water corresponding to the vacuum maintained. The film temperature in the drying zone will thus be between 40° F. and 90° F. and the emulsion will be dry after 2 to 15 seconds. The dry film leaves the drying zone through suitable sealing mechanism and is then passed through a suitable windup station for storage and use or into a slitting and cutting mechanism where it is made into rolls of smaller width and length or sheets.

The lips of the rectangular slot orifice are placed about 0.002 to 0.030 inch apart and they are disposed about ¹⁄₁₆ to ³⁄₁₆ inch above the surface of the web to be coated. The angle between the web and the center line of the extrusion lips should be from 0 degree to 60 degrees. Since the coating point is generally above a supporting roller of small diameter or curved bar of small radius the angle is measured from the tangent perpendicular to the axis of such roller or bar at the point of contact of the extruded layer of dispersion.

In carrying out the process the coating zone is provided with suitable sealing means at the point of entrance and at the point of exit of the web from the drying zone. Also in its movement from the coating zone to the drying zone the web is conducted through a restricted opening so that a differential pressure can be maintained between the coating zone and drying zone, respectively.

The total pressure in the coating zone should be high enough to prevent the water and any water-soluble solvents in the aqueous dispersion being coated from boiling at the coating temperature which, with photographic gelatin emulsions, is usually about 90° F. to 110° F.

Air is purged from the coating zone before the coating operation commences by introducing a current of water vapor, e.g., saturated steam while evacuating the two zones by means of a vacuum pump or aspirator. Water vapor is introduced into the coating zone continuously during the coating operation and the added water vapor and any air which leaks into the system and any water or volatile solvents which evaporate from the emulsion are drawn off by means of a vacuum pump or aspirator.

When the aqueous coating solution contains a water-soluble solvent which has a relatively high vapor pressure, such as methyl alcohol, ethyl alcohol, and acetone, vapors of such solvents and/or water can be added to the coating zone.

Referring now to the accompanying drawings which constitute part of this specification,

Fig. 1 is a schematic, sectional view in elevation of one type of vacuum coater and dryer of this invention,

Fig. 2 is a schematic, sectional view in elevation of an alternative type vacuum coater and dryer of this invention, and

Fig. 3 is a perspective view with parts in section of the coating support roller and vapor induction tube.

The coating and drying apparatus shown in Fig. 1 of the drawings consists of an enclosed chamber **1** which is provided with an eduction pipe **2**. The chamber is divided into two zones, a coating zone and a drying zone. A continuous web of photographic film base or paper from a source not shown passes through one wall of the chamber into the coating zone. This wall is provided with two hard surfaced (e.g., metal) rollers **3** which have resilient sealing means at their ends. A horizontal resilient roller **4** presses against the surface of horizontal rollers **3** and when the web is introduced between one of the rollers **3** and resilient roller **4**, the admission of any significant amount of air into the coating chamber is prevented. The web passes in a horizontal plane over horizontally disposed roller **5** then downwardly under horizontal roller **6**, then upwardly over horizontal coating support roller **7**, then downwardly around a relatively large drum **8**, which can be provided with means for regulating its temperature. The film then passes upwardly into the drying zone. The coating zone is separated from the drying zone by means of an L-shaped baffle **9** which is provided at its ends with suitable resilient sealing means **10** which contact with the hard surface sealing roller **3** and another horizontally disposed hard surface sealing roller **11** between the surface of which and the surface of the drum **8** there is disposed another horizontally mounted resilient sealing roller **12**.

The outer wall of the chamber **1** is curved and spaced a slight distance from the surface of the drum, thus acting as a baffle and providing a means of maintaining a pressure difference between the coating zone and the drying zone. Above the web supporting roller **7** there is disposed an extrusion hopper **13** which is provided with a narrow slot orifice for extruding the viscous aqueous silver halide dispersion onto the surface of the web. This extrusion hopper is similar to that described more fully below in the apparatus of Fig. 2 being shown in detail in Fig. 3. The emulsion is fed into the hopper at a constant rate by means of a metering pump. It preferably is first passed through a heat exchanger which maintains the temperature uniform. The hopper may also be provided with temperature regulating means.

A horizontally disposed vapor tube **14** is placed adjacent to the coating support roller **7** so that solvent vapor or other condensable vapor can be introduced into the coating zone near the coating point. The absolute pressure in the coating zone is regulated by the amount of condensable vapor added.

The web W after leaving the coating zone passes upwardly then over a horizontally disposed guide roller **15** which is journaled in bearings on a frame which can be moved upwardly or downwardly in the drying zone to vary the length of film between heating elements (described below). The web then passes downwardly under a horizontal guide roller **16** then laterally between hard surface sealing roller **17** and resilient sealing roller **18**, which in turn, presses against another horizontal hard surface sealing roller **17** which has a construction similar to roller **3**. The upper end of the drying zone is provided with heating platens **19** which are provided with suitable means for heating them to an elevated temperature, e.g., 300° F. to 1000° F. These platens may contain electrical resistance elements (e.g., infra-red heating platens) or may be provided with tubes for circulating a heat exchange fluid. Between the heating platens and the walls of the chamber, there is provided suitable insulation **20**. It may be composed of any suitable insulation such as refractory insulating brick or aluminum foil. An inspection window **21** is provided in the wall of chamber **1** opposite the coating point.

In a practical apparatus of the type schematically shown in Fig. 1, the drum may be 2 to 4 feet in diameter and the drying zone 8 to 20 feet in height. The remaining rollers may have diameters proportional, as shown in the drawing, to such drum diameters.

The coating and drying apparatus shown in Fig. 2 of the drawings consists of a U-shaped chamber **31** which has a lateral eduction duct for vapor removal in the upper part of the chamber **32**. There are disposed in the upper wall of the chamber horizontal hard-surface sealing rollers **33** and intermediate resilient sealing roller **34**. Web W passes between the circumferential surfaces of the resilient sealing roll and the hard-surface sealing roll then downwardly under guiding roller **35**, then upwardly over coating support roller **36**, then downwardly and upwardly around drum **37** for the major portion of its diameter then under guiding roller **38** and upwardly between hard surface sealing roller **39** and resilient sealing roller **40**, which in turn, is pressed against an additional hard-surface sealing roller **39**. Each of the sealing rollers **33**, **34**, **39**, and **40** are journaled in suitable bearings mounted on the frame for the chamber **31**. Their ends and one face are provided with resilient sealing means to prevent the free ingress of air between the atmosphere and the chamber. Sealing means **33'** and **39'** are provided in the walls of the chamber to press against the peripheral surfaces of rollers **33** and **39**, respectively.

A horizontal resilient sealing roller **41** is placed between the surface of drum **37** and one of the sealing rollers **39** or **33** (as shown) in order to separate the coating zone from the drying zone of the chamber. The lower curved wall of chamber **31** is U-shaped and, in general, follows the contour of the drum. It is maintained close to the drum, for example, about ⅛ of an inch therefrom from the point where the web passes onto the drum for a substantial distance so as to form a narrow confining passage for the web. This narrow passage, with sealing roller **41**, serves to separate the coating zone from the drying zone so that the zones can be separately heated or exhausted to different temperatures and pressures.

In the lower portion of the chamber the lower U-shaped wall of the chamber **31** is spaced from the surface of the drum in order to form a U-shaped drying zone **42**. Curved heating elements **42'** are placed in this zone and may be fastened to the walls by any suitable means. These heating elements can be electrically heated platens or platens heated by means of tubes through which a heat-regulating fluid is circulated. The upper part of chamber **31** opposite the coating zone that has the eduction opening **32**, which is preferably a rectangular or circular tube, communicates with an aspirator expansion chamber **43**. High pressure steam is passed through aspirator tube **44** which passes into the aspirator expansion chamber and withdraws vapors from the coating and heating zones. The aspirator expansion chamber communicates with a cooling chamber **45** which is provided with suitable horizontal staggered baffles **46**. Water is passed through pipe **47** into the cooling chamber where it passes downwardly over the baffles and absorbs the vapors passing into the chamber. Any remaining vapors pass upwardly through pipe **48** which connects with aspirator **49** and high pressure steam is injected into this aspirator by a suitable tube **50**. The lower end of the cooling chamber is provided with an outlet tube **51** which communicates with a pump **52**.

Above coating support roller **36** there is provided an extrusion hopper **54**, details of which are more fully described below with regard to Fig. 3. Adjacent to the extrusion hopper there is provided a vapor tube **59** for the introduction of water vapor or other condensable vapor near the coating point. In the wall opposite the extrusion hopper there is provided a window **53** so that the point of coating can be observed. The emulsion is fed into the hopper at a constant rate by means of a metering pump. It preferably is first passed through a heat exchanger which maintains the temperature uniform. The hopper is also provided with temperature regulating means.

The drum in the type of apparatus shown in Fig. 2 may be 8 to 20 feet in diameter and the other rollers proportional in size to the drum, as indicated in the drawing.

The apparatus shown in Fig. 2 is not limited to an aspirator for removing vapors from the drying zone as a vacuum pump or other suitable vacuum producing means can be connected to the eduction opening **32**. Other means of producing the vapors may be employed such as tubular heat exchangers.

Referring now to Fig. 3, the induction hopper **54** has a horizontal throat **55** which connects with a source of viscous aqueous solution, e.g., an aqueous silver halide dispersion. The throat communicates with lips **56** which are spaced a short distance apart, e.g., 0.002 inch to 0.030 inch. One or both of these lips may be made adjustable so that the width of the opening between the lips can be closely adjusted. It may be fastened to the hopper by means of screws **57**. The hopper is also provided with channels **58** through which a heat exchanging fluid can be circulated to control the temperature of the hopper. The lips of the hopper should be accurately machined and highly finished and they should be as nearly parallel as possible so as to result in a uniform thickness of the extruded emulsion. The upper surface of the bottom hopper lip is placed about $\frac{1}{16}$ to $\frac{3}{16}$ inch from the surface of the web.

Vapor tube **59** is placed adjacent to the hopper so that water vapor or other condensable vapor is projected under the hopper between the web and the extruded layer of silver halide dispersion.

Suitable sealing means for the ends of the rolls **3**, **4**, **12**, **17**, **18**, **33**, **34**, **39**, and **41**, etc. for seals **10**, **33′** and **39′** of the two above-described types of apparatus, are described in Minton U.S. Patent No. 1,633,121. This patent also discloses suitable sealed journalled bearings which are useful for mounting the sealing rolls in the apparatus of the invention.

Various gears, belts or chains and attendant mechanisms which are connected to a suitable source or sources of power can be used to drive the drum and coating roller. They can be synchronized with each other and with suitable web windup and feed devices. Rapid change mechanisms, etc., to permit substituting a new roll of web and splicing it to the end of the old roll, can be supplied to make the operation continuous over long periods of time.

The heating elements or platens used in the above apparatus should be constructed so that they do not emit any substantial amounts of actinic light which would expose and thus affect the coated layer deleteriously. These platens may be electrically heated and should provide uniform concentration of radiant energy over the entire surface exposed.

An important feature of each of the above apparatus resides in the use of a coating support roller of relatively small diameter, e.g., from ¼″ to ¾″. The use of such small diameter support rolls is unique and gives surprising and unexpected results. Thus, it has been found that with rollers of these small diameters more than a four-fold increase in coating speed can be attained than with coating support rollers with twice the diameter or more. For example, in test measurements with one viscosity of silver halide emulsion coating, speeds of 96 to 129 feet per minute were attained with a roller of ¼″ in diameter, whereas coating speeds of 21 to 30 feet per minute were attained with a roller of 1½″ in diameter. The smaller diameter coating roller enables one to use a wider angle of nip between the locus of the path of the extruded film and the tangent to the roller surface. A stationary curved coating bar of equally small radius can be used in place of the roller if desired. It has been found that a wider angle of nip admits of faster coating speeds and substantially eliminates entrapment of noncondensable vapor between the emulsion and base.

The operation of the above combined coating and drying apparatus and the above processes will be more fully described in the following examples.

Example I

An aqueous gelatino silver iodobromide emulsion of the X-ray type (50% by weight solids content) is extruded through an emulsion hopper onto a thin gelatin substratum on a cellulose acetate film base having a thickness of about 8 mils and a width of about 45″, to a coating weight of about 103 milligrams of silver halide per square decimeter, in an apparatus of the type shown in Fig. 1 of the drawing. The air is removed from the apparatus by introducing a jet of steam while evacuating the drying chamber to a pressure of 18 to 40 mm. of mercury. The coating zone is maintained at a temperature of 95° F. to 110° F. and saturated steam is introduced into the coating zone to maintain a partial pressure of water of 42 to 66 mm. of mercury. The lips of the coating hopper are spaced 0.005 to 0.010 inch apart and they are disposed about ⅛ inch from the point of contact with the web on the coating support roller which has a diameter of ¾ inch. The emulsion is extruded at the rate of 40–80 feet per minute and the web is moved past the coating point at the rate of 400 feet per minute. The infra-red heating platens in the drying zone are maintained at a temperature of about 1000° F. The length of the heating platens is about 10 feet and any given point on the film is maintained in the drying zone about three seconds. As the coated film emerges from the coating and drying apparatus, it is found to be smooth, firm and of uniform photographic quality, with properties similar to a film dried in air in the conventional manner.

Example II

A gelatino silver iodobromide emulsion of the type described in Example I is prepared and coated onto a film element of the type described in that example but in an apparatus of the type shown in Fig. 2 of the drawing. The air is first removed from the apparatus by aspirators which maintain a vapor pressure of 6 to 10 mm. of mercury in the drying zone. Steam is admitted to the coating zone at a rate to maintain a pressure of 60 to 70 mm. in such coating chamber. The drum is approximately 10 feet in diameter and heated to a temperature of 105° F. to 110° F. and the heating platens are heated to a temperature of 900° F. to 1000° F. The coated film remains in the drying zone for about three to four seconds. As it emerges from the drying zone, it is found to be smooth, firm and of uniform photographic quality. The film has properties similar to a film dried in air in the conventional manner.

The apparatus described above is not limited to the use of electric means for heating the platens nor to the passage of a heated exchange fluid through ducts or tubes, as induction heating may be used. The drum can be heated by means of induction coils or by passing a heat exchange fluid through channels or ducts near its surface or by other suitable means.

In place of the extrusion hoppers, there can be substituted a pair of closely fitting rollers. The viscous solution is fed into the nip of such rollers and forced between them to form a film.

The invention is, of course, not limited to the coating of film and paper with aqueous gelation silver halide emulsions but is useful in coating aqueous silver halide dispersions in other water-permeable colloids as described above. Thus, it can be used in the coating of aqueous ethanol solutions of polyvinyl acetal color formers of the type described in Jennings et al. U.S. Patent 2,397,864 and Blanchard U.S. Patent 2,551,091.

The invention is useful in preparing multilayer photographic film elements including multicolor films both positive and negative, printing papers, double-coated X-ray films, motion picture films, portrait films, and papers, etc. It is not only useful in coating the light-sensitive silver halide colloid layers but can be used in coating light-filter layers, and antihalation layers containing dyes and pigments which absorb the desired wavelengths of light, as well as antiabrasion layers and sublayers from aqueous solutions, including aqueous ethanol solutions. In these layers gelatin or the other colloids described above may constitute the film-forming binding agent. The coating solutions may have a solids content of 25% to 60%.

An advantage of the invention resides in the fact that photographic film and paper may be coated and dried in an extremely short time as compared with prior art methods. Thus, the film can be dried in three to five seconds at relatively low temperatures. The high drying rate admits of considerable savings in labor and in fixed overhead for the photographic manufacturer. The apparatus has the advantage that it is very compact and requires only a fraction of the building space usually required for the convection type of dryer.

The elimination of the convection drying chambers and attended equipment results in considerable power savings which are normally required for refrigerating large quantities of air, operating large blowers, reheating the refrigerated air, recovering solvents, etc.

The process of the present invention requires relatively small quantities of added vapor, e.g., steam. Relatively small amounts of electric power, steam and other utilities are required for the operation of the vacuum coating and drying apparatus of this invention as compared with the convection type coater and dryer of equivalent capacity.

The invention has the further advantage that dust particles are not likely to come into contact with the wet coating material. Also the extremely short travel of the wet emulsion within a sealed chamber makes dust collection extremely unlikely.

The problem of static generation within the dryer is eliminated due to the fact that gases are more easily ionized at low pressures. Thus, it has been found that static charges, which might harm the sensitized emulsion, do not build up within the evacuated dryer.

Film dried in vacuum at temperatures below 90° F. has a low surface resistivity (5×10^{12}) so that it will not be abnormally susceptible to static troubles later on in its manufacture or use. Film dried in so short a time by any other method would have a high surface resistivity and would be likely to pick up static marks in handling subsequent to the drying operations. Still other advantages will be apparent from the above description of the invention.

What is claimed is:

1. A coating and drying apparatus comprising an enclosed chamber having a passage for the removal of vapors from said chamber and the maintenance of a highly reduced pressure in said chamber, sealing rollers in a wall of such chamber for feeding into and withdrawing from said chamber a thin flexible web while preventing the ingress or egress of vapors, said chamber being partitioned into a coating zone and drying zone by the aid of a drum for transporting the coated web into the drying zone, a narrow confined passage surrounding said drum between said zones, an extrusion device mounted above a curved coating support member in said coating zone, for extruding a layer of coating material onto the web as it passes over the member, said curved member being of small radius and heating means in said drying zone adjacent to the path of the coated surface of said web, said heating means positioned to effect drying of said layer of coating material after extrusion.

2. An apparatus as set forth in claim 1 wherein said device is a hopper with a narrow slot orifice and said member is a roller.

3. In a coating and drying apparatus which can be maintained at low pressure, the combination of (1) an extrusion hopper having an elongated slot orifice, said orifice being formed by a pair of orifice lips positioned from 0.002 inch to 0.030 inch apart, said extrusion hopper and said orifice lips adapted to extrude between said orifice lips a thin film of a viscous aqueous dispersion; (2) a web support roller from ¼ to ¾ inch in diameter, said web support roller adapted to guide a flexible web over and partially around said web support roller, said web support being positioned near and below said orifice with the distance of said orifice lips being from 1/16 to 3/16 inch above said flexible web as said flexible web passes over and partially around said web support roller, said orifice and said web support roller so positioned with respect to each other that there is formed an angle of from 0 to 60 degrees between (*a*) the center line of said orifice lips in the direction of travel of said thin film as it leaves said orifice and (*b*) a line perpendicular to the axis of said web support roller and tangent to said web support roller at the point of first contact of said thin film with said flexible web; and (3) means for moving said flexible web over and partially around said web support roller and past said orifice.

4. Apparatus as set forth in claim 3 additionally having a tube positioned adjacent said extrusion hopper and adapted to inject a condensable vapor near said extrusion hopper.

5. A coating and drying apparatus comprising an elongated vertical chamber having a curved bottom wall portion adapted to receive a large revolvable drum, a partition in a lower section of said chamber cooperating with said drum to divide the chamber into a coating zone and a drying zone, web-guiding rollers above the drum for guiding a web past an extrusion coating member and onto said drum, a curved coating support member a short distance below said member, said curved member being of small radius, the curved wall portion being spaced a slight distance from the drum for about one-half its circumference to provide a narrow passage, a vertical drying zone above said drum, means for guiding the web upwardly and downwardly in said latter zone, heating elements in said drying zone adjacent the path of travel of said web, means for guiding said web into and from the coating zone and drying zone, respectively, including sealing rollers to prevent any substantial ingress or egress of vapors and a passage in said chamber to remove vapor and reduce the pressure in said coating and drying zones.

6. A coating and drying apparatus comprising an elongated vertical chamber having a curved bottom wall portion adapted to receive a large revolvable drum, a

partition in a lower section of said chamber cooperating with said drum to divide the chamber into a coating zone and a drying zone, web-guiding rollers above the drum for guiding a web past an extrusion coating hopper and onto said drum, said rollers including a coating support roller of small diameter a short distance below said hopper, the curved wall portion being spaced a slight distance from the drum for about one-half its circumference to provide a narrow passage, a vertical drying zone above said drum, means for guiding the web upwardly and downwardly in said latter zone, heating elements in said drying zone adjacent the path of travel of said web, means for guiding said web into and from the coating zone and drying zone, respectively, including sealing rollers to prevent any substantial ingress or egress of vapors and an eduction opening in said chamber to remove the vapor and reduce the pressure in said coating and drying zones.

7. An apparatus as set forth in claim 6 wherein said heating elements are electrically heated platens which do not emit significant amounts of actinic radiations.

8. An apparatus as set forth in claim 7 wherein said drum is 2 to 4 feet in diameter, said drying zone 8 to 20 feet in length and said coating support roller ¼ inch to ¾ inch in diameter.

9. A coating and drying apparatus comprising a U-shaped chamber, a large diameter drum in the curved lower part of said chamber, a coating zone above said drum, web-guiding rollers above said drum for guiding a web past an extrusion coating hopper and onto said drum, said rollers including a coating support roller of small diameter a short distance below said hopper, the chamber walls adjacent said coating zone being spaced a slight distance from said drum for a substantial distance to provide a narrow confining passage for the web, the remaining curved portion of the walls being spaced a substantial distance from the drum surface to provide a drying zone, heating elements in said drying zone along the path of web travel, sealing means to separate the other end of the drying zone from the coating zone, a passage in at least the drying zone to remove vapor and reduce the pressure in said zones and means for guiding said web into and from the coating and drying zones, respectively, including sealing rollers to prevent any substantial ingress or egress of vapors.

10. An apparatus as set forth in claim 9 wherein said heating elements are electrically heated platens which do not emit significant amounts of actinic radiations.

11. An apparatus as set forth in claim 9 wherein said drum is 8 to 20 feet in diameter and said coating support roller ¼ inch to ¾ inch in diameter.

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