May 2, 1967 R. S. WASHBURN 3,316,879

CONTROL OF FINE PARTICLE MIST EMPLOYING ELECTROSTATIC MEANS

Filed Dec. 20, 1962 2 Sheets-Sheet 1

Fig. 1

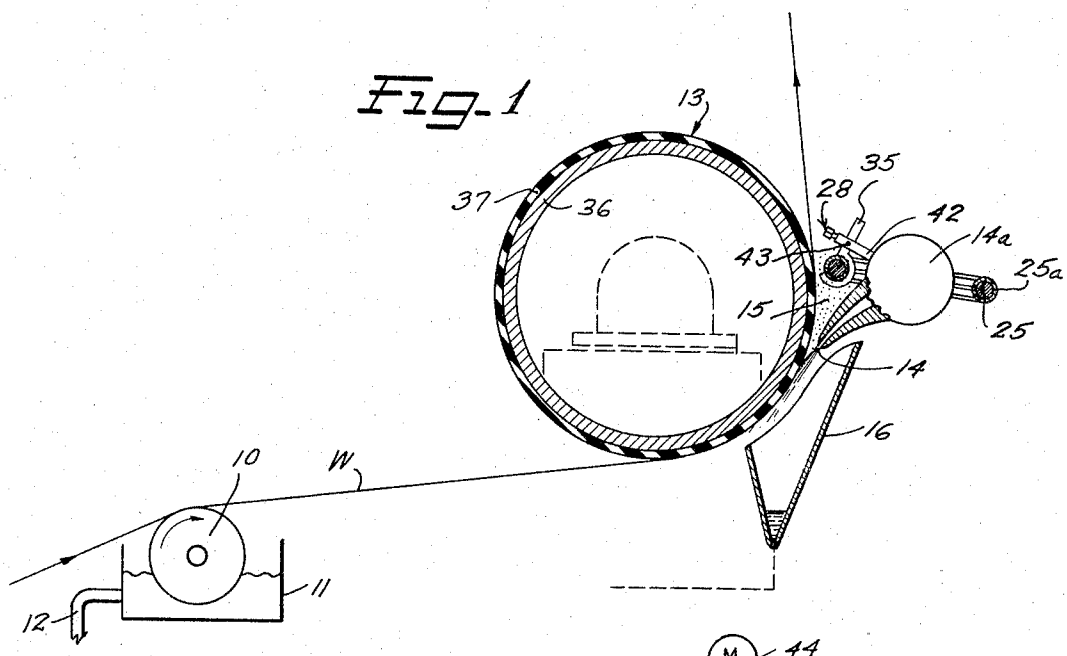
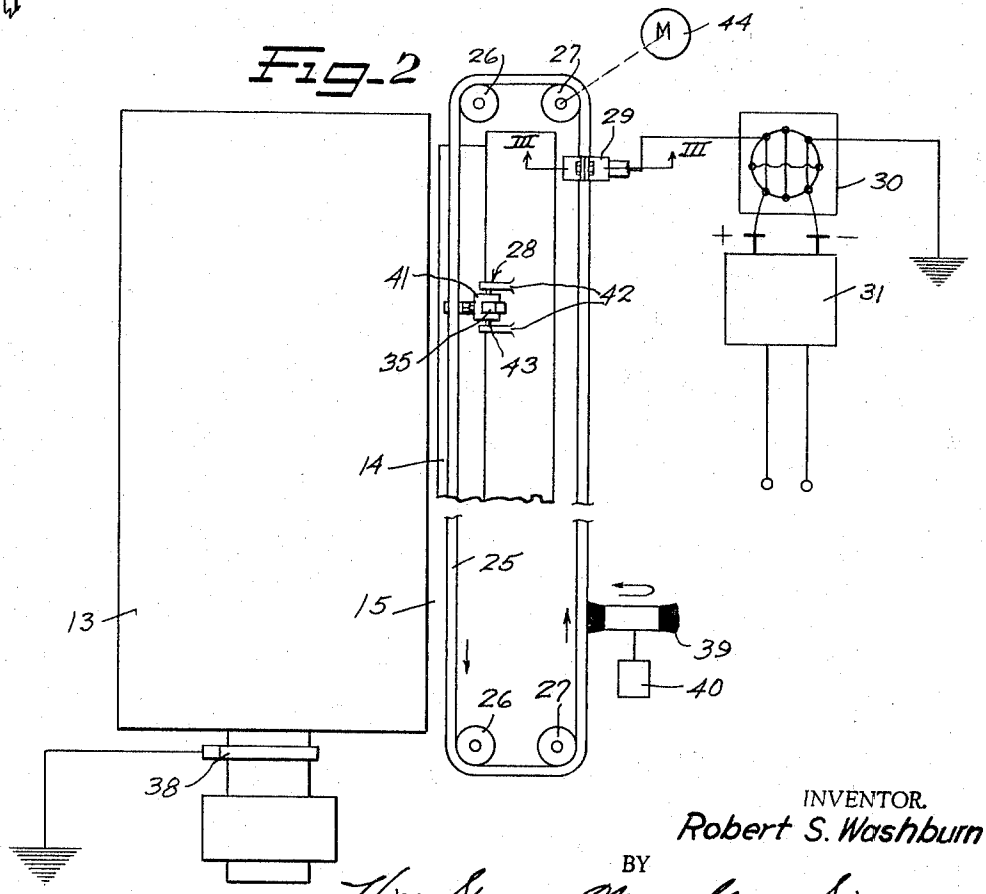


Fig. 2



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2 Sheets-Sheet 2

Fig_4

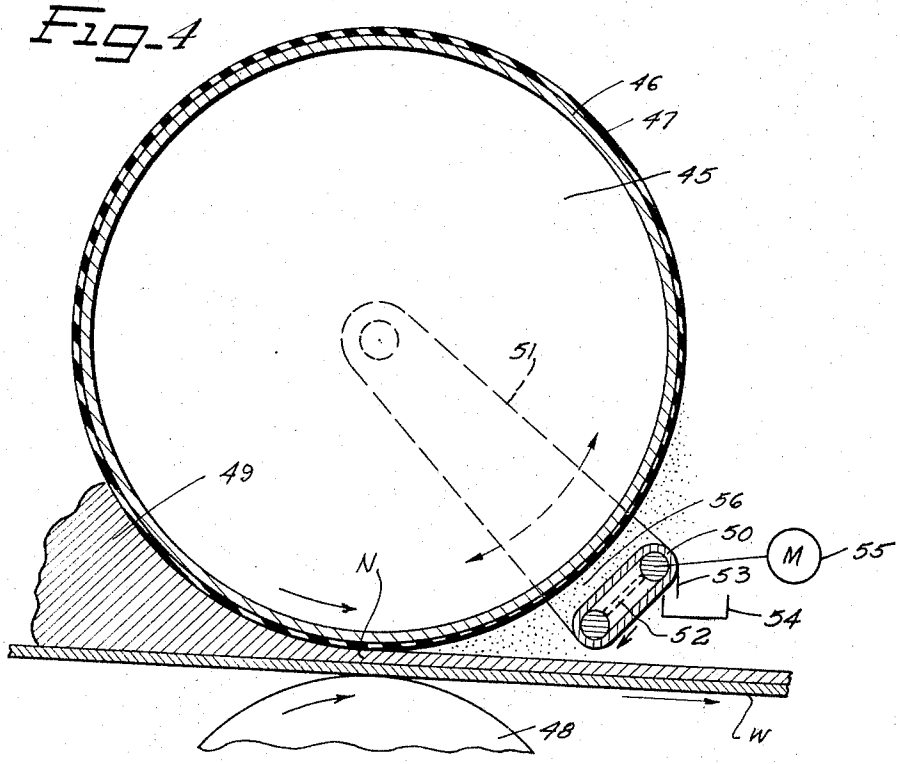


Fig_5

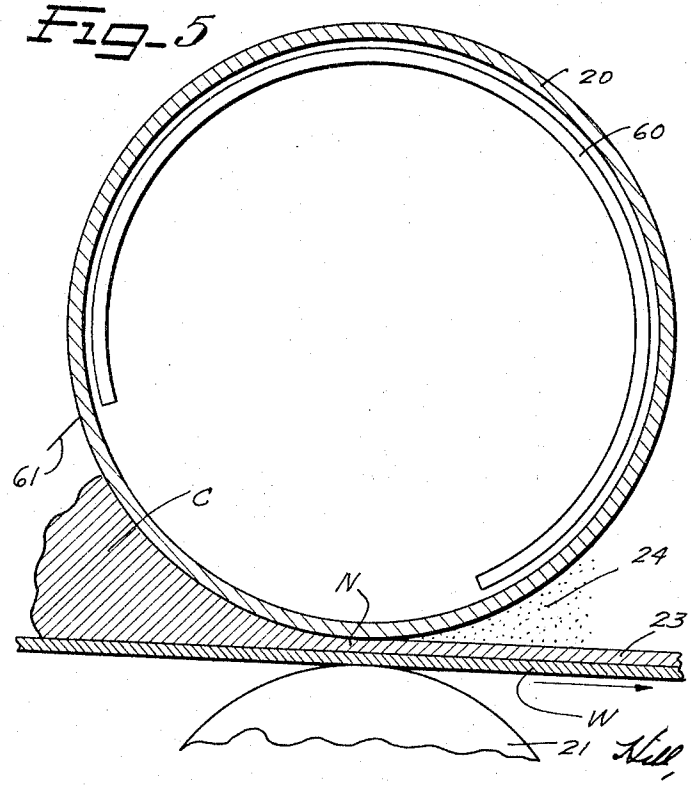
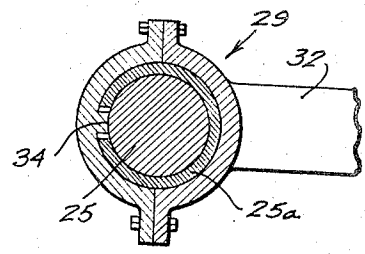


Fig_3



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United States Patent Office 3,316,879
Patented May 2, 1967

3,316,879

CONTROL OF FINE PARTICLE MIST EMPLOYING ELECTROSTATIC MEANS

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Filed Dec. 20, 1962, Ser. No. 246,254
14 Claims. (Cl. 118—639)

The present invention relates to improvements in mechanisms for coating the surface of the paper web and particularly to a method and apparatus for collecting and controlling the fine particle mist that forms on the outgoing side of a coating smoothing device.

Various coating controlling and smoothing devices are used in paper coating mechanisms wherein coating is applied to a continuously travelling web and moved over a backing roll. In one arrangement known as an air knife coater the quantity of coating is controlled and the smoothness is enhanced by an air jet directed from a slot against the coated surface of the web and toward the approaching surface. This results in the formation of a fine particle mist immediately adjacent the air knife. In another type of structure coating applied to the surface is smoothed and leveled by a coating roll which forms a coating nip with a backing roll and a fine particle mist is formed on the off-running side of the coating roll. The instant invention is susceptible of uses in other environments but is particularly well adapted for use with the coating of a moving paper web in an air knife coater and will be described primarily in connection with this use. As above generally mentioned, in the air knife coating process a moving web passes over an applicator roll revolving in a pan of coating material. The excess coating material picked up by the web is removed and the remaining coating material is smoothed out as the web passes in front of an air jet issuing from the slot of an air knife. The paper web normally travels at a high speed and due to air currents caused by the travelling web in the direction of travel of the web, a mist of fine particles of coating material is formed immediately following the air knife. The particles tend to gravitate onto the surface of the freshly coated paper causing marks or imperfections in the smooth coated surface. At higher operating speeds a substantial portion of the particles tends to travel away from the coating apparatus thus contaminating the surrounding atmosphere and creating a hazard to the operator's health and causing the surrounding equipment to be covered with coating material.

Accordingly a primary objective of the invention is to provide an improved mechanism and method for collecting the particles and preventing them from either being deposited on the freshly coated web or floating away in the surrounding atmosphere.

A further object of the invention is to provide a mechanism and method for creating an electrostatic field of such polarity that the mist particles are attracted or moved to means for capturing and removing the particles.

A still further object of the invention is to provide an apparatus and method for use in a paper coating mechanism wherein the particles in a fine particle mist are captured and collected and prevented from uncontrollably floating to adjacent surfaces and wherein the captured particles are continually disposed of during operation to permit continuous operation of the machine without requiring cleaning or servicing.

A further object of the invention is to provide a mechanism for creating an electrical potential necessary for the establishment and maintenance of an electrostatic field including means to vary the intensity of the field and the location thereof so as to avoid the danger of sparking between the field and any object of different potential, and to control the collection of particles.

Other objects, advantages and features will become more apparent with the teaching of the principles of the invention in connection with the disclosure of the preferred embodiments thereof in the specification, claims and drawings, in which:

FIGURE 1 is a side elevational view shown partially in section and shown in somewhat schematic form of a paper coating mechanism embodying the principles of the present invention;

FIGURE 2 is a schematic top plan view of the mechanism of FIGURE 1;

FIGURE 3 is an enlarged fragmentary detailed sectional view taken substantially along line III—III of FIGURE 2;

FIGURE 4 is a side elevational view shown partially in section and somewhat in schematic form of another embodiment of the invention; and

FIGURE 5 is a side elevational view shown partially in section and somewhat schematic form of another embodiment of the invention.

On the drawings:

FIGURES 1 and 2 show an air knife coating apparatus wherein a web of paper W that is to be coated enters the machine at the left and in continuous travel passes over a coating applicator roll **10**. The lower portion of the roll **10** is submerged in a coating pan **11** containing a fluid coating composition introduced by means of the supply pipe **12**. After coating the underside of the web, the web W proceeds in an arcuate path over the surface of a rotatably mounted backing roll **13** arranged to expose the coated surface of the web to the action of an air jet nozzle assembly **14***a* having a nozzle **14**. After the impinging air from the nozzle **14** has removed the excess of the coating from the surface of the web W to a predetermined extent, the web continues upwardly along the backing roll **13** to conventional mechanism for drying or other processes.

At the off-running side of the air jet **14** a fine particle mist of coating material is generated in the zone shown at **15**. This is caused by various factors and is primarily the result of coating particles being dragged upwardly beyond the air jet by air currents accompanying the travelling web W. The removed coating material which is removed by the air knife is collected by a receiving trough **16** below the air knife. The currents of air travelling with the web plus the air turbulence within the trough collector **16** leaves at least some of the particles airborne. A coating machine of this type operates at a relatively high speed so that this condition exists, and the particles which are airborne become partially dried and tend to deposit on the coated surface of the web W. The deposit of the separated partially dried particles on the yet undried coating on the web W creates an undesirable surface effect.

Another type of coating mechanism is illustrated in FIGURE 5 wherein a coating nip defining means is provided by a coating roll **20** and a support roll **21** forming a nip N between them. In the coating process, a paper web W passes through the nip N moving in the direction indicated by the arrow adjacent the web. A constant supply of fluid coating material C is provided on the oncoming side of the nip. The coating material may be provided by various suitable means which will be appreciated by those skilled in the art and this mechanism need not be shown in detail. The coating is applied and smoothed on the upper surface of the web in a smooth layer **23** having a finished upper surface.

At the off-running side of the nip N, a fine particle mist of coating material is generated in the zone shown at **24**. This mist is caused primarily by the adherence

of the coating to the surface of the coating roll **20** with very small particles being adhered to the surface and centrifugally thrown off. The particles will tend to move toward the web by the effect of gravity and because they are moving in that direction due to being thrown off of the roll **20**.

In accordance with the principles of the present invention an electrostatic field is created in the areas indicated by the numerals **15** and **24** in FIGURES 1 and 5 respectively, which are the areas having the fine particle mist. The nature of the electrostatic field is such that its polarity is at all times opposite to the charge on the particles which will have an electrostatic charge, as to move them away from the web.

As shown in FIGURES 1 and 2 an elongated continuous electrode **25** provides a continuously moving surface for collecting the particles and carrying them away from the zone **15**. The electrode is shown in the form of a continuous belt **25** which is rectangularly arranged to travel over rollers **26** and **27**. The rollers **26** are positioned to stretch a portion of the belt longitudinally parallel to the backing roll **13** so as to provide a collecting surface for collecting the particles. The rollers **27** are also arranged to provide a length of the belt extending parallel to the roll but are spaced from the roll to provide a length along which the particles can be removed after having been collected on the belt **25**.

The electrode belt **25** is charged with a variable high voltage, low amperage electric current impressed by means of a sliding contact **29**. The sliding contact is connected to a terminal of a high voltage source **31** by means of a selector switch **30**. The other terminal of the high voltage source is connected to a ground by the selector switch **30**. The selector switch **30** may be of conventional design and serves the purpose of connecting the electrode **29** to either the positive or the negative terminal of the high voltage source. As suitably protected by guards, the electrode may be uninsulated. The source **31** may be a generator providing a rectified controllably variable output in the range of 10,000 to 50,000 volts. The voltage will be varied in accordance with particle size and charge to obtain adequate attraction of the particles without arcing across to the roll **13**.

The backing roll **13** around which the web W travels usually is comprised of a metal shell **36** with a rubber or insulative material covering **37**. The backing roll is rotatably mounted in bearings by means of journals. At least one of the journals is equipped with a slip ring sliding contact **38** by means of which the backing roll is grounded. The bearings are suitably insulated from their base by means of insulating material.

It will thus be seen that a high electrical potential difference between the electrode **25** and the backing roll **13** is maintained. In the event that the particles are negatively charged, the electrode **25** will be charged positively by means of the switch **30** and the particles will be attracted to the electrode and deposited thereon. The endless electrode will slowly travel in the direction indicated by the arrow and before the areas of the travelling belt electrode **25** are returned to the particle mist area they are cleaned by means of a rotating brush **39** driven by a motor **40**. Other cleaning means of course may be provided for dispensing of the collected particles.

In order to avoid the danger of sparks jumping from the electrode belt **25** to the backing roll **13** or to the air knife assembly **14***a*, adjusting means for the electrode belt **25** may be provided as indicated at **28**. To obtain suitable adjustment of the electrode within the mist area it is suspended from a bracket **35** which is slidably mounted in a slide **41** which is adjustable and which is pivotally mounted from plates **42** by means of a pin **43**. This permits adjusting the position of the electrode belt **25** relative to the roll **13** and the supporting rollers **26** move accordingly.

In order to protect operating personnel from receiving electrical shocks from the electrode belt **25**, insulating material may be provided on the belt. As shown in FIGURE 1 the belt is surrounded by a layer **25***a* of insulating material. As shown in FIGURE 3, the insulating material **25***a* has a gap in one side so as to provide a connection between the electrode belt **25** and the sliding contact **29**. This connection is provided by an inwardly extending lug **34** which electrically connects to the internal conductive portion of the belt **25**. The electrode **29** includes a support bracket **32** with a clamp for supporting the lug **34**.

The electrode belt **25** may be driven continuously or intermittently by a motor **44**.

FIGURE 4 shows another arrangement of the invention wherein the endless electrode belt **25** of FIGURES 1 and 2 has been replaced by an endless metallic conveyor band **50**. In the arrangement a backing roll **45** has a metal shell **46** with a rubber coating **47**. Another roll **48** forms a nip N with the roll **45** and coating is supplied at **49** on the oncoming side of the nip to provide a smooth layer on the travelling web W. A coating mist is created in the area **56** on the off-running side of the nip and the coating mist particles are collected on the surface of the belt **50**. The belt **50** is connected to a suitable high voltage power source similar to the source described in connection with the structure of FIGURES 1 and 2. The conveyor band **50** receives the particles on its surface and is driven by a suitable motor **55** so as to carry the particles on the surface of the band up over the top thereof, as illustrated in FIGURE 4. The particles are scraped off by a doctor means **53** and fall downwardly into a collector **54**. The band is supported on a mount **51** which permits it to be adjustably positioned in an arcuate path with respect to the roll **45**, preferably through an angle of 90°. This permits adjustment for optimum positioning for collection of the particles.

In FIGURE 4 the electrical connection to the band **50** is not shown. In another form of arrangement the band **50** may be formed of an insulating material with an electrostatic field generated by a conductor shown by the broken line element **52** within the band. In this arrangement the conductor **52** will be stationary and connected to the electrical source at the opening at the end of the band **50**. It will be understood that either arrangement may be used, i.e. the conductive band, or the non-conductive band with a conductor within.

In the arrangement of FIGURE 5 the electrode collector is omitted and an electrostatic field is created around the periphery of the roll **20**. This may be achieved by mounting an electrical plate **60** within the hollow roll **20** so that it creates an electric field of a polarity opposite to the particles to thereby attract the particles to the surface of the roll **20**. The particles are thus drawn and captured by the moving roll itself in a layer on the surface of the roll. If permitted to remain on the surface of the roll particles will be carried around to join the fluid coating supply C and be submerged and mixed with the liquid coating.

In some instances it may be desirable to remove the particles from the roll **20** and particle removing means are then provided in the form of a doctor **61**. This doctor or scraper **61** is positioned in engagement with the outer surface of the roll for separating the particles from the roll and the particles may drop down upon the moving web W to be covered by the liquid coating **23** which is applied to the web. Or, if desired, a collecting pan, not shown, may be placed below the scraper **61**.

It is also contemplated that the particles on the roll surface **20** in the arrangement of FIGURE 5 may be electrically moved from the roll surface. This may be accomplished by providing a charged member at a location which would attract the electrically charged particles and cause them to leave the surface of the roll **20** such as at the location of the scraper **61**. For example, another closely adjacent parallel rotating roll could be provided

with a charged surface so that it would continually present a fresh surface to the roll **20** and carry the particles away whereupon they would be removed from the collecting roll at another location.

With respect to the endless electrical belt **25** shown in FIGURES 1 and 2, it will be understood that the electrode may be constructed in the form of a single rod comprised of sections which are combined rods and tubes so that the sections may telescope, and the telescoping portions periodically or continually may be moved by mechanisms at the end of the electrode. The mechanism also may be provided with sliding scrapers which are moved across the electrode so as to remove particles adhered thereto.

Thus it will be seen that I have provided an improved coating mechanism which meets the objectives and advantages hereinabove set forth. The mechanism is well adapted to be rugged in construction and reliable in operation for continuous long operating life without attention or adjustment. The mechanism is not subject to wear and is compact and inexpensive to construct and may be used with newly designed equipment or existing paper coating machines.

The drawings and specification present a detailed disclosure of the preferred embodiments of the invention, and it is to be understood that the invention is not limited to the specific forms disclosed, but covers all modifications, changes and alternative constructions and methods falling within the scope of the principles taught by the invention.

I claim as my invention:

1. In a paper coating machine wherein a mist of coating particles is formed after the coating is applied to a travelling web, the combination comprising, an electrode positioned in said mist, and means for charging said electrode with a high voltage for collecting the particles on the electrode.

2. In a paper coating machine wherein a mist of coating particles is formed after the coating is applied to a travelling web, the combination comprising, a collecting surface positioned for collecting particles from the mist, and means for electrically attracting the particles to said surface.

3. In a paper web coating mechanism, the combination comprising, a backing roll supporting a travelling paper web, means for applying a layer of coating to the web, means for smoothing the coating on the web with a mist of particles formed adjacent the web surface following said smoothing means, and a charged electrode positioned in said mist attracting particles to the electrode.

4. In a paper web coating mechanism, the combination comprising, a metal backing roll having a cover of an electrical insulating material, means for applying a layer of coating to the web, means for smoothing the coating on the web with a mist of particles formed adjacent the web surface following said smoothing means, and a charged electrode positioned in said mist attracting particles to the electrode.

5. In a paper web coating mechanism, the combination comprising, a metal backing roll having a cover of an electrical insulating material, means for applying a layer of coating to the web, means for smoothing the coating on the web with a mist of particles formed adjacent the web surface following said smoothing means, a charged electrode positioned in said mist attracting particles to the electrode, and means for removing particles from the electrode during operation of the machine.

6. In a paper web coating mechanism, the combination comprising, a backing roll supporting a travelling paper web, means for applying a layer of coating to the web, an air knife positioned opposite the backing roll for smoothing the coating with a mist of particles being formed on the off-running side of the knife, an elongated surface extending longitudinally along the roll for collecting said particles, and electrical means for attracting the particles to the surface.

7. In a paper web coating mechanism, the combination comprising, a backing roll supporting a travelling paper web, means for applying a layer of coating to the web, means for smoothing the coating on the web surface with a mist of particles formed adjacent the web surface following the smoothing means, a moving member having a travelling surface exposed to said mist at a first location for collecting particles and carrying them to a second location, means for attracting particles to said member at said first location, and means for removing the particles from said surface of the member at said second location.

8. In a paper web coating mechanism, the combination comprising, a backing roll supporting a travelling paper web, means for applying a layer of coating to the web, means for smoothing the coating on the web with a mist of particles formed adjacent the web smoothing means, a moving member having a travelling surface with an area exposed to the mist at a first location for collecting particles and carrying them to a second location, means for imparting an electrical charge to said member to collect particles from said mist, and means for removing the particles from the surface at said second location.

9. A paper web coating mechanism comprising in combination, a backing roll for supporting a travelling paper web, means for applying a layer of coating to the web, means for smoothing the coating on the web with a mist of particles formed adjacent the web surface following the smoothing means, a collecting surface positioned for collecting particles from said mist, means for electrically attracting the particles to said surface, means for cleaning the particles from said surface, and means for adjustably positioning said surface relative to said backing roll.

10. In a paper coating mechanism, a pair of rolls defining a paper coating nip therebetween for receiving and applying coating to a moving paper web, means maintaining a coating at the oncoming side of the nip whereby a mist of electrically charged particles is formed at the off-running side of the nip, and means at the off-running side of the nip to electrically attract said particles so that they will not be deposited on the moving web.

11. In a paper coating mechanism, a pair of nip defining means for receiving a moving paper web between them, means for maintaining fluid coating at the oncoming side of the nip whereby a mist of electrically charged particles is formed at the off-running side of the nip, electrode means at the off-running side of the nip to electrically attract said particles, and means for removing said particles from said electrode means.

12. In a paper coating mechanism, a pair of nip defining means for receiving a moving web between them, means maintaining fluid coating at the oncoming side of the nip whereby a mist of electrically charged particles is formed at the off-running side of the nip, and an electrically charged endless electrode positioned at the off-running side of the nip for capturing the charged particles.

13. In a paper coating mechanism, a pair of rolls defining a paper coating nip therebetween for receiving and applying coating to a moving web, means maintaining coating at the oncoming side of the nip whereby a mist of electrically charged particles is formed at the off-running side of the nip due to adherence with the roll at the coated side of the web, and means connected to the roll on the coated side of the web to impart an electric charge to said roll to attract the charged particles against the surface of the roll.

14. In a web coating machine having a backing roll over which a web carrying a coating of liquid composition is passed, an air jet to adjust the thickness and smoothness of the coating whereby a mist of electrically charged particles is formed at the offgoing side of the air jet, and means at the off-running side of the jet to electrically attract said particles.

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