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APPARATUS AND METHOD OF ELECTROSTATIC POWDERING

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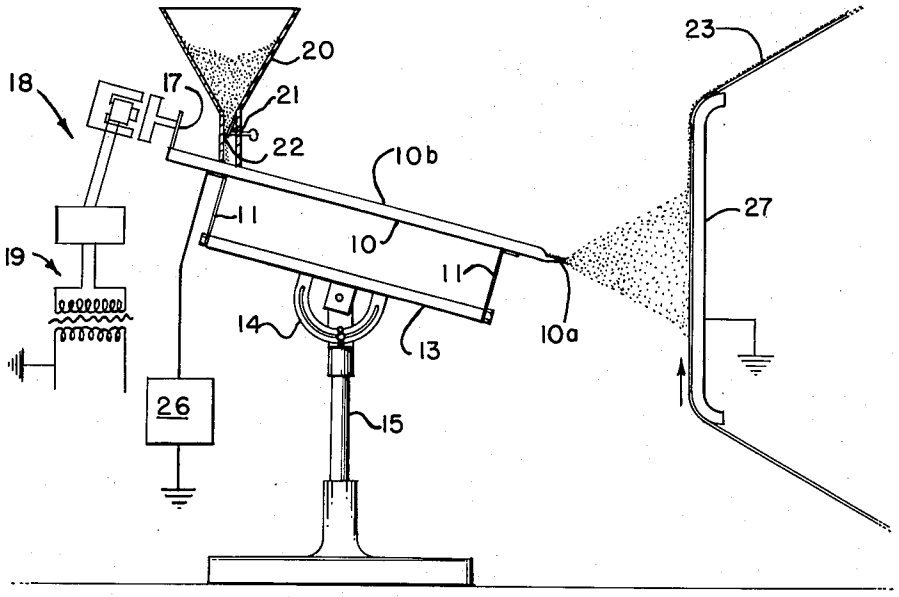
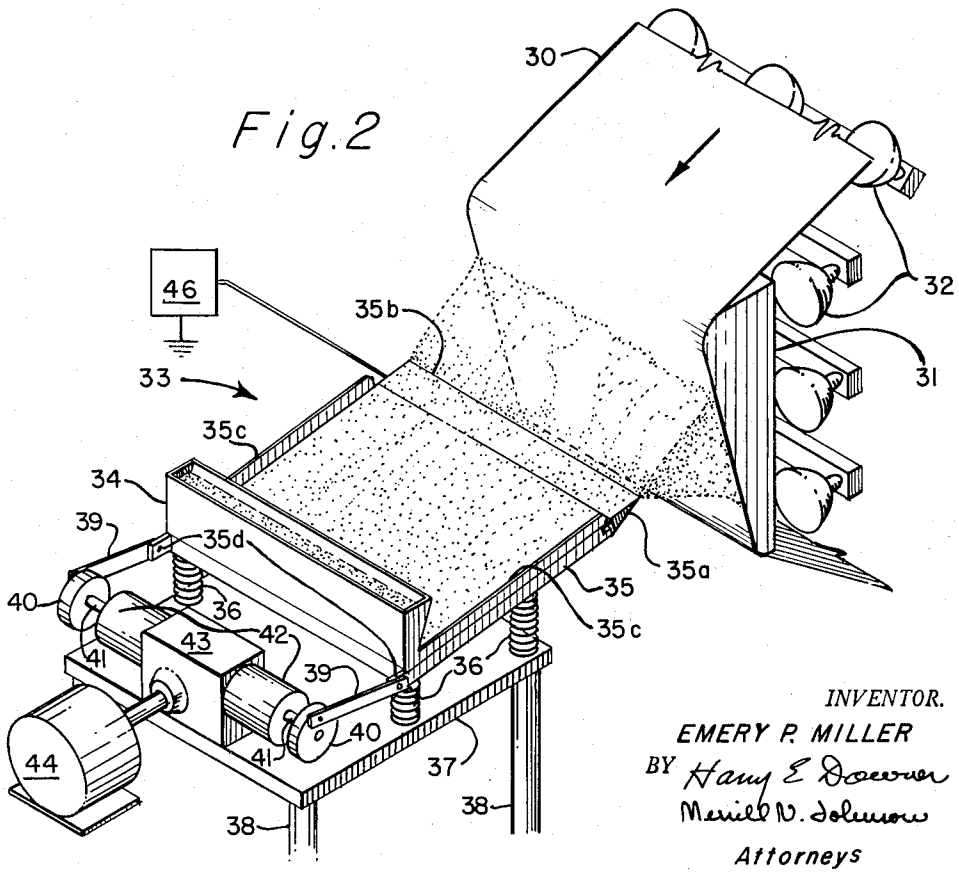


Fig. 1

Fig. 2



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APPARATUS AND METHOD OF ELECTROSTATIC POWDERING

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My invention relates to the powdering of a surface of a sheet or article and particularly to apparatus and methods for electrostatically depositing a powderd material in a uniform, controllable manner on a surface in or moving through an electric field.

Various industrial operations require the more or less uniform application of a dry powder such as starch, soapstone or the like to the surface of an article of manufacture, particularly the surface of a web or roll of sheet material. Where powder is applied to a naturally adherent surface such as that of a roll of unfinished sheet rubber, the powder will remain on the surface without previous treatment. However, other surfaces may require such pre-powdering preparation as heating or moistening.

One of the features of my invention permits such a powdering operation to be carried on with greater control resulting in more uniform application of the powder over the surface being treated. A further feature is the elimination of the carrier air stream conventionally employed to move and/or deposit the powder. Thus, a higher percentage of powder is brought into direct contact with the surface and not borne away by a moving air stream. Another feature is the elimination of the cloud of dust in the atmosphere surrounding and adjacent to the powdering operation.

The method of surface powdering of the present invention comprises, broadly, the establishment of an electrostatic field with a voltage which may be in the order of 75,000 volts between the extended forward edge of a generally flat distributing plate and the surface to be powdered, the electrostatic field preferably being sufficient to establish such edge as an ionizing electrode. The surface to be powdered is desirably spaced far enough away from the edge to permit substantial dispersion of the individual powder particles. The powder used in the process, which may be any finely divided mineral or vegetable material, is fed from a convenient reservoir onto the surface of the distributing plate. The plate, which may be perpendicular to the surface to be treated or with its powder-distributing surface inclined either toward or away from the surface to be treated but preferably with the plate and the surface forming an angle of approximately 85°, is vibrated or oscillated in such manner that the powder spreads out over the plate's surface and moves toward the forward edge of the plate. The rate of feed of the powder to the edge is closely controlled by the regulatable amplitude and other characteristics of the vibrating plate. Powder vibrationally fed toward the edge will become charged normally by contact with the surface of the distributing plate and retaining such charge as it leaves the plate, move under the influence of the electrostatic forces through the field to be deposited upon the surface being powdered.

The manner in which the foregoing and other features and objects of my invention are accomplished will be described now in detail, reference being had to the accompanying drawings in which:

Fig. 1 is a side elevational view, somewhat diagrammatic, showing a preferred embodiment of my invention; and

Fig. 2 is an isometric view, also somewhat diagrammatic, of another embodiment showing further features of the invention.

My invention is capable of many modifications and embodiments. There are shown in the drawings and will now be fully described two specific embodiments which it should be understood are illustrative of the principles of my invention without limiting the invention to these embodiments. The scope of the invention is set forth in the appended claims.

Referring first to Fig. 1, there is provided a substantially flat distributing plate **10** having a forward rectilinear edge **10***a* preferably of knife-like sharpness. Plate **10** is positioned on mounting members **11** made of a resilient material to permit the vibration or oscillation of distributing plate **10**. Bolts **12** connect mounting members **11** to a frame **13**. Frame **13** is tiltably adjustable on brackets **14** which are in electric isolation from ground by insulating columns **15** which are vertically adjustable and may be of hard rubber, plastic or other suitable insulating material.

The distributing plate **10** is connected by rod **17** and suitable linkage to a variable vibrating mechanism **18** powered by an insulated transformer **19**. In the embodiment now being described a simple vibratory motion of plate **10** in the direction of its extent is effected, such vibration having an amplitude in the order of one fiftieth of an inch and a cycle of between 60 and 200 vibrations per second. It is to be understood, however, that the term "vibartion" as used herein is not limited to straight line vibration as just described but includes any one, two, or three dimensional cyclic motion having an amplitude of less than one inch and a rate of many vibrations per minute. The powdered material to be used is contained in a hopper **20** and is fed at a rate regulatable by damper **21** through slot **22** onto the upper surface of distributing plate **10** along a line generally parallel to forward edge **10***a* of plate **10** but somewhat to the rear of said edge. The sides **10***b* of plate **10** are raised to prevent powder from spilling over the sides of the plate as the powder is vibrated forwardly over the plate surface.

The article to be treated, shown in Fig. 1 as a web of unfinished rubber sheeting **23**, is brought from a source (not shown) and carried to a point of accumulation (not shown) in a controlled manner by powered means (not shown). During such movement the sheeting passes in spaced relation to edge **10***a* of plate **10** in a generally upwardly moving vertical position and with edge **10***a* substantially parallel to the surface of sheet **23** and about ten inches therefrom. Where the surface to be powdered is presented in a generally vertical position, any effect of gravity which may result in uneven deposition or the deposit of large agglomerated masses of powder is substantially entirely eliminated.

In the present embodiment distributing plate **10** is shown tilted at an angle of approximately 15° to the horizontal. However, depending upon the type and fineness of the powdered material to be used and the position of the surface to be powdered, it may be desirable to position the distributing plate in various other ways. The positioning of the plate effects, together with the amplitude and cyclic rate of its vibration, the amount of powder which will be deposited on a given area of the surface being treated. It has been found in powdering raw rubber sheeting with soapstone using apparatus as shown in Fig. 1 that satisfactory results could be obtained with distributing plate **10** positioned at an angle to the horizontal of between 5° upwardly (that is, with the powder distributing upper surface of the plate inclined away from

the surface to be powdered) to 20° downwardly toward the surface to be powdered. Best results were obtained with the upper plate surface inclined at an angle of 5° to the horizontal toward the surface to be powdered.

The plate **10** is connected to a source of high voltage **26** which maintains the plate at high potential. This voltage which may be between 50 and 100 kv. is preferably sufficient to create a zone of corona discharge or ionization about edge **10***a*. Since raw rubber sheeting **23** has only slight electrical conductivity, conditions are improved by employing a backing shoe **27** as a terminus of the electrostatic field. This also serves to position sheeting **23** for powdering as the shoe is located immediately behind the sheet material. Shoe **27** is electrically connected to ground so that the electrostatic field will pass through the sheet material to provide an electrostatic field of force over the surface of sheeting **23** as it moves past edge **10***a* of plate **10**. Where the material to be powdered is sufficiently electrically conductive such as a strip of metal foil, the backing shoe may be eliminated.

In the operation of the apparatus sheet material **23** is carried from its source and moved over backing shoe **27** at a controlled rate. Powder from hopper **20** is released by opening damper **21** and the powder fed to the upper surface of distributing plate **10**. Vibration of plate **10** by its connection to vibrating mechanism **18** will cause the powder to advance over the surface of the plate toward edge **10***a*. The powder receives an electric charge mainly by contact with plate **10** and any powder which has not received a charge by direct contact by the time it reaches edge **10***a* will receive its charge by passing through the potential gradient existing adjacent to edge **10***a*. This assures more positive charging of each individual powder particle.

As these powder particles leave the edge due to vibration, gravity or otherwise, they will forthwith become subject to the electrostatic field existing between edge **10***a* and shoe **27**. Since the individual particles of powder will be highly charged to the same polarity they will tend to disperse one from another and at the same time move along the lines of force of the field and become deposited on the surface of sheeting **23**. The naturally sticky condition of the surface of sheeting **23** will cause the deposited powder to remain adhered to the surface of the sheet material without further treatment. Where material or articles which do not have a naturally adherent surface are to be powdered it may be necessary to perform some pre-powdering step such as heating or moistening of the material. Where it is desired to powder both surfaces of the sheet material, a similar apparatus to that just described may be set up on the opposite side of the sheet material after it passes over the initial backing shoe. Where no backing shoe is required, powdering of both sides of the material can be done simultaneously with distributing plates arranged on opposite sides of the sheet material.

It is apparent that a plate having an extended edge as described to which the powder is fed by controllable vibrations results in a much more even and uniform feed of the powder to the electrostatic field than could be achieved in previous systems. The use of such an edge also results in a feeding of the powder from an extended zone substantially coextensive with the width of the surface to be treated thereby contributing considerably to uniformity of deposition over the entire width of the surface being powdered.

Fig. 2 shows another embodiment of my invention particularly adapted for applying food starch to the surface of a roll of waxed paper **30**. The waxed paper is fed from a roll (not shown) and moved generally downward over the surface of a backing shoe **31** which is tilted backwardly at an angle of approximately 10° to the vertical, that is, as paper **30** moves downwardly past the powder distributing mechanism **33** it will move away from the mechanism at an angle of about 10° to the vertical.

In order to maintain the waxed surface of paper **30** in an adherent, powder-retaining condition the paper may be heated, preferably to a temperature of approximately 150° F., by suitable means such as infra-red lamps **32**. Heating coils in or behind plate **31** may also be used.

The powder distributing mechanism shown generally as **33** consists of an elongated reservoir **34** containing a supply of dry powdered food starch. Positioned beneath reservoir **34** is a distributing plate **35** made of polyethylene or other suitable insulating material and having a blade-like forward portion **35***a* of conducting material. Forward portion **35***a* has a substantially uniform, sharply beveled edge **35***b*. Plate **35** may be provided with powder retaining sides **35***c* of insulating material. Plate **35** is maintained at rest with its edge **35***b* elevated and the plate surface inclined at an angle of approximately 5° to the horizontal. The plate is mounted on a plurality of helical spring supports **36** so that the plate may be more or less freely vibrated in a manner to be described. Supports **36** rest firmly on a base **37** which is positioned upon columns **38**.

A pair of lugs **35***d* on the rear of plate **35** are connected to rods **39** which are in turn eccentrically connected to wheels **40** which are rotatably connected by shaft **41** journalled in bearings **42**. Shaft **41** may be rotated in bearings **42** through gear box **43** which is connected to a source of rotary power **44**. Rotation of shaft **41** and wheels **40** causes the eccentric motion of rods **39** which impart a two dimensional oscillatory or vibratory motion to the upper surface of plate **35**. The extent of the motion may be varied by changing the radius of wheel **40**, while the rate of vibration may be varied by changing the speed of power source **44**. Suitable motion causes particles of starch dropped in controlled amount through an elongated slot in the bottom of reservoir **34** onto the upper surface of plate **35** to be "jumped" or moved upwardly along the surface of the plate and thus fed toward edge **35***b* in a generally uniform manner.

Forward portion **35***a* of plate **35** is maintained at high potential by connection to the high voltage terminal of a voltage source **46**. By constructing plate **35** principally of insulating material, all of powder distributing mechanism **33** except forward portion **35***a* may be maintained at ground without requiring relatively complicated apparatus for maintaining the entire distributing mechanism at high voltage. The voltage of plate portion **35***a* is preferably sufficient to create an ionizing zone about edge **35***b* and in any event to establish an electrostatic field with a substantial voltage drop between edge **35***b* and backing shoe **31** which is maintained at ground as shown.

The starch is fed from reservoir **34** onto the surface of distributing plate **35** and the vibratory motion imparted to plate **35** serves to move the starch upwardly over the surface of the plate to be fed at a substantially uniform rate along the extent of edge **35***b*. The starch is electrostatically charged principally by contact with plate portion **35***a* and is moved under the influence of the electrostatic forces from plate **35** and deposited on the exposed waxed surface of paper **30**. This surface, which may be made more adherent by heating, retains the powder. The powdered paper thereupon moves over shoe **31** to be stored or further processed as desired.

It should be noted that as in all powdering operations control of the humidity in and about apparatus embodying my invention should be maintained as generally excessive moisture which may cause an undesirable agglomeration of the powdered material is to be avoided. The surface and forward edge of distributing plates **10** and **35** should be maintained particularly free of excess moisture and to this end, if desired, heating elements may be established within or beneath the plates. The entire system may also be enclosed within a booth in order to permit closer control of the humidity of the atmosphere in and adjacent to the powdering operation.

I claim:

1. Apparatus for powdering a surface of an extended sheet comprising a generally flat plate having an extended edge, means for mounting said plate generally horizontally to permit its vibration, means for moving the sheet to be powdered in a generally vertical plane parallel to and spaced from the extended edge of said plate, means for establishing an electrostatic field between the extended edge of said plate and the surface of the sheet to be powdered, means for supplying powder to a portion of the upper surface of said plate remote from its extended edge, means for vibrating said plate to feed the powder to the extended edge thereof for electrostatic deposition on the surface of the sheet.

2. Apparatus as set forth in claim 1, wherein the plate is inclined with its upper surface toward the surface of the sheet to be powdered at an angle of between 0° and 20° to the horizontal.

3. Apparatus for powdering the surface of non-conducting sheet material comprising a generally horizontal flat distributing plate having an extended edge of knife-like sharpness, a generally flat backing electrode with a generally vertical face spaced from and parallel to the extended edge of said plate, means including a high voltage source for establishing an electrostatic field between the edge of said plate and the backing electrode, said field being of sufficient strength to create an ionizing zone about said extended edge, means for moving the material to be coated over the face of said backing electrode with its surface to be powdered toward and extended edge of said plate, means for supplying powder to the upper surface of said plate, means for vibrating said plate at an amplitude of less than one inch and a rate of many cycles per minute to feed the powder toward the extended edge of said plate for electrostatic deposition on the surface of the material moving over the face of said backing electrode.

4. Apparatus as set forth in claim 3, wherein the distributing plate is inclined with its upper surface toward said backing electrode at an angle of 5° to the horizontal.

5. A method of applying powder to a surface of an extended sheet comprising moving said sheet along a substantially vertical path, establishing an electrostatic field over the surface of said sheet, said field having an extended ionizing zone remote from but coextensive with the surface, supplying powder to a region adjacent said ionizing zone, vibrating the powder to move it at a controlled rate into the ionizing zone of said electrostatic field, and electrostatically moving the powder from said zone through said field and depositing the powder on the surface of said sheet, said field constituting the sole force for depositing the powder.

6. The method as set forth in claim 5, wherein the amplitude of vibration is less than one inch and the rate of vibration is many cycles per minute.

7. A method of applying powder to the surface of waxed paper or the like, comprising heating said paper to a temperature sufficient to make the waxed surface of the paper powder-adherent, establishing an electrostatic field between an extended horizontal ionizing terminus and an extended vertical plate terminus, moving the heated paper vertically over said plate terminus with its heated waxed surface facing said ionizing terminus, supplying powder to a region remote from said field but adjacent said ionizing terminus, vibrating the powder to move it at a controlled rate toward the ionizing terminus of said electrostatic field, and electrostatically moving the powder through said field for deposition on the powder-adherent surface of the paper, said electrostatic field constituting the sole force for depositing the powder on the surface of the waxed paper.

8. A method of applying powder to an extended surface of sheet material comprising moving said sheet along a predetermined path, establishing adjacent to said surface an electrostatic field of non-uniform gradient with an extended zone of high gradient remote from and substantially parallel to said surface, supplying powder to a point outside said field on an extended surface generally normal to said predetermined path, vibrating said last-named surface to move the powder thereon at a controlled rate along said surface and into the extended field zone of high gradient, and electrostatically dispersing the powder in said field and electrostatically depositing the powder on the moving surface of the sheet material, the electrostatic field constituting substantially the sole force for both dispersing and depositing the powder.

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