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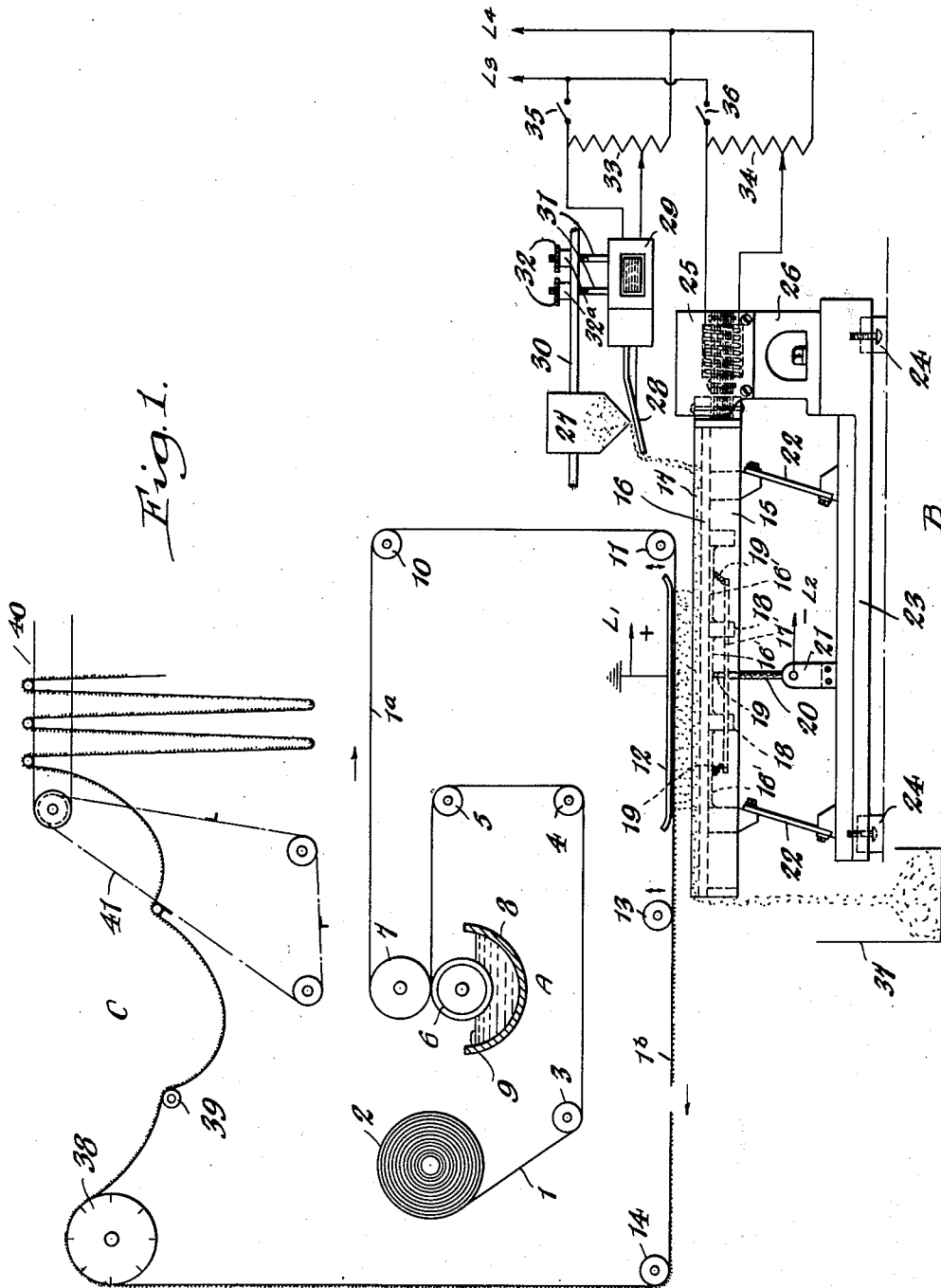
R. L. MELTON ET AL

2,378,025

COATING APPARATUS

Filed May 9, 1942

3 Sheets-Sheet 1



BY

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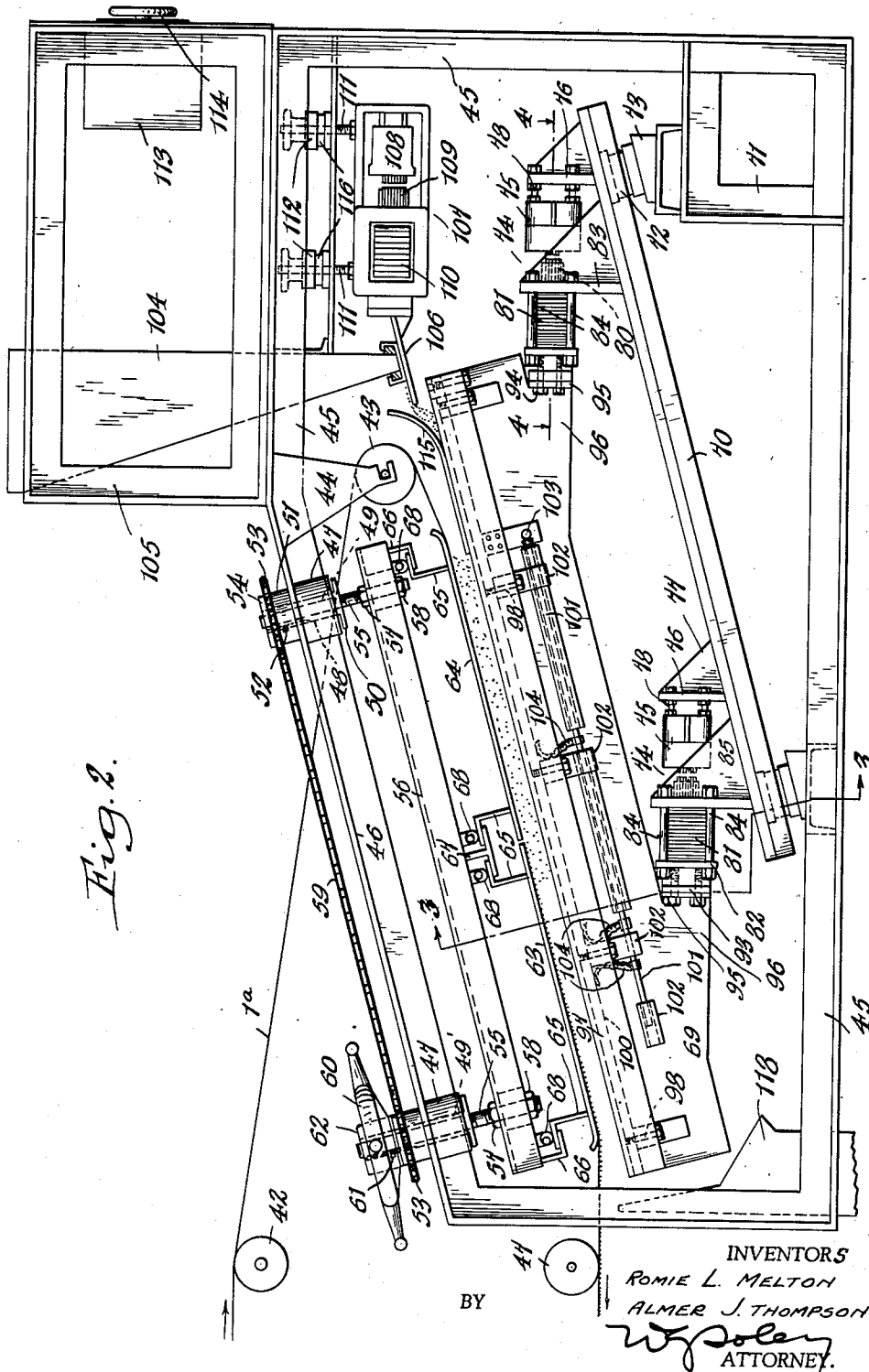
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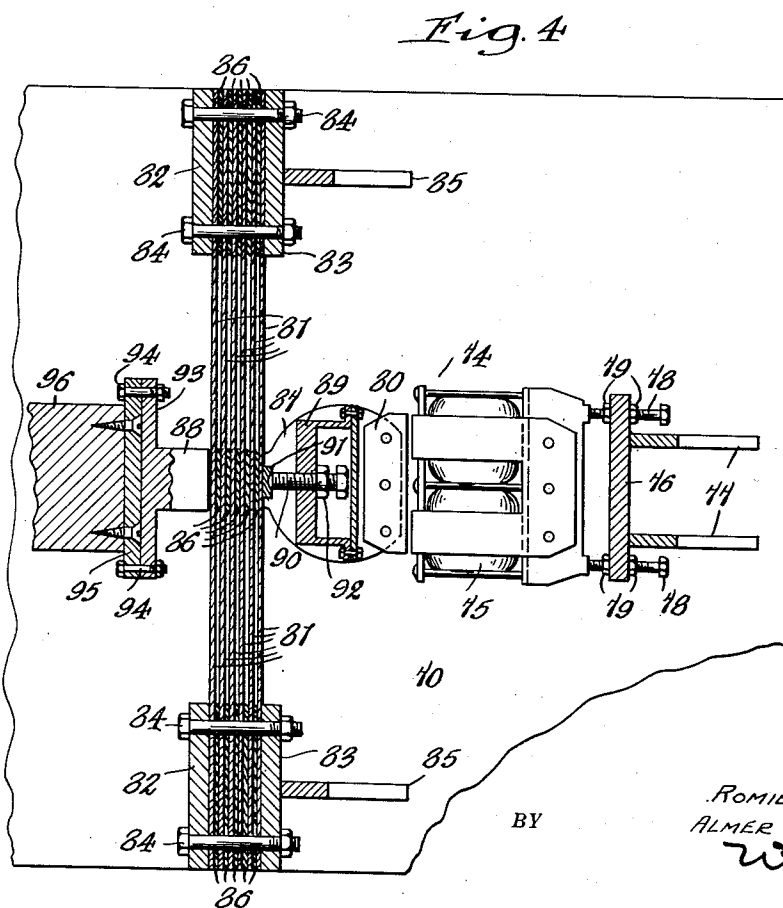
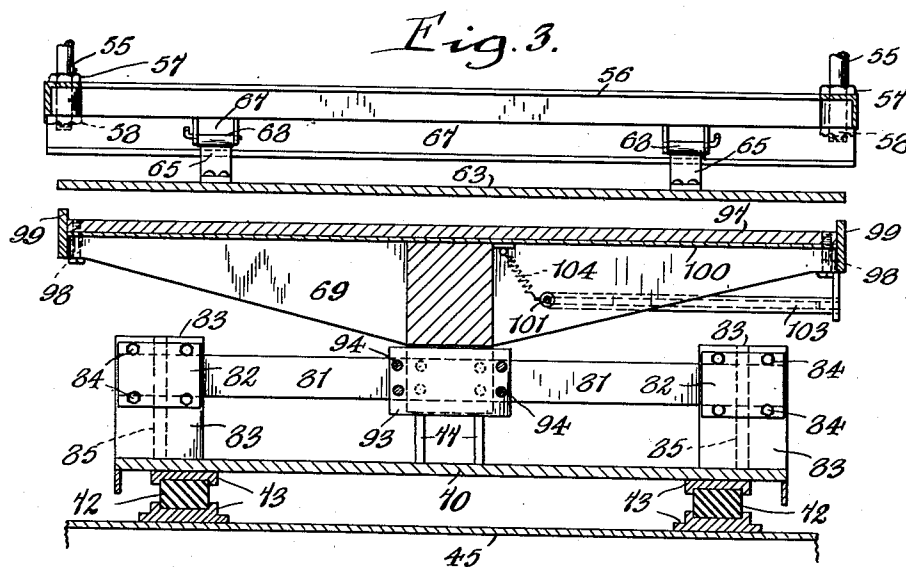
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3 Sheets-Sheet 3



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2,378,025

COATING APPARATUS

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16 Claims. (Cl. 91—18)

This invention relates to improved apparatus for applying a coating of abrasive and other elongated particles to a web of such material as paper, cloth, fiber, and the like. It has for an object the provision of apparatus for the manufacture of a superior product. More particularly, the invention relates to an improvement in apparatus for electrostatically projecting elongated particles onto an adhesively coated web which includes vibratory means for conveying the elongated particles into the electrostatic field.

In the coating of certain elongated particles, such as abrasive particles, granular material, fibrous materials, bristles and the like, it is desirable in most instances to apply such elongated particles in an oriented or upstanding position with respect to the backing member. This is true, particularly, with coated abrasive webs since the cutting rate and grinding efficiency of such materials can be greatly increased by causing the individual abrasive particles deposited on the web to be so oriented that the longer dimension of each particle projects substantially normal to the surface of the web. Since abrasive particles, commonly employed in the manufacture of coated abrasive webs, are of irregular shape and have some surfaces or edges that are sharper than others and more suitable for abrading operations it is desirable that these sharper surfaces, edges or points, be so oriented and positioned as to engage the material being abraded.

Various suggestions have been made for the improvement of coating apparatus in an effort to produce an orderly orientation of the elongated particles. The usual "gravity" method of applying abrasive grain by dropping the granules from a hopper onto a web has been superseded to a large extent by coating apparatus in which the particles are projected upwardly against a downwardly facing adhesively coated web. Electrostatic fields have been employed in apparatus for such upward projection as well as in modified apparatus for downward deposition and even sidewise projection.

One form of apparatus that has been found to give satisfactory results is shown in the patent to Melton et al., 2,187,624. This includes relatively large and spaced apart upper and lower electrodes for producing an electrostatic field therebetween, means for passing a downwardly facing adhesively coated web between the electrodes, a feed belt moving over the lower electrode, and means for feeding abrasive granules onto the top surface of the belt, whereby the granules are fed into the electrostatic field in

confronting relationship to the adhesive coating on the web. The granular particles receive sufficient electrostatic charge to cause them to be oriented and forcibly driven upwardly through the strong electrostatic field from the feed belt against the under side of the adhesive coated web.

In such device the bearings of the belt supporting and driving wheels are liable to become worn rapidly because of the filtering into them of fine particles or granules with which they are constantly in contact. Because of the presence of the belt moving relative to the exciting grid or electrode there are variations in the gap potential gradient of the electrostatic field. These in turn cause variations in the speed with which the particles impinge on the adhesive coated web, and consequently variations in the product. Because the particles lie on the belt in an undisturbed or "dead" layer until they are propelled toward the web by the electrostatic field, a field of high electrical potential is required to start the particles from rest and project them against the backing.

In the patent to Melton et al., No. 2,254,016, a similar feed belt is employed, but a supplementary mechanical force is applied to the particles to assist the electrostatic forces in lifting and propelling the particles toward the adhesive coated web. In one modification a rotary beater is employed to strike the under side of the upper run of the feed belt, whereby the particles carried by the belt are mechanically projected upwardly for a short distance. In another modification the feed belt is made of open mesh material. Beneath the upper run of the belt and between the electrodes is a series of gas jets which project gas through the belt and thus project the particles carried thereby upwardly. These devices overcome the disadvantage of having the particles lie inert on the feed belt when fed into the electrostatic field and thus making the field alone accomplish the projecting and orienting of the particles. They do, however, retain the disadvantages above shown to be inherent in the moving feed belt; furthermore, they do not impart a uniform vibration or mechanical propelling force to all the particles on the belt within the electrostatic field, since in the first modification the action of the beater is necessarily localized and in the second modification the gas jets are also localized in their action.

The apparatus of the present invention overcomes these inherent limitations of electrostatic machines employing a feed belt. Briefly, the in-

vention consists of the elimination of the moving feed belt and the provision of a vibrating feed table between the electrodes. This feed table is vibrated in such a manner that particles of material to be coated onto the adhesive coated web, such as abrasive granules, are fed gradually and in an evenly distributed layer into the electrostatic field where they are projected, in oriented arrangement, onto the adhesive coated web. The table is driven by a vibratory motor, and its amplitude of vibration is small. It has no rotary bearings either in its driving or supporting means, and thus there is nothing to be worn by contact with the coating particles. Since the table moves only slightly, it does not introduce the variations in gap potential gradient which the belt does, and thus the potential imposed on the grain can be exactly determined. The mechanical impulses given the particles to be coated on the web by the vibrating table have the important results of breaking up the lumps and aggregates of such particles, spreading the particles evenly, and putting the grain in a position more favorable to "oriented" projection.

The particles on the feed table are constantly in motion, being fed into the electrostatic field in a series of rapid forward hops, similar to saw teeth in outline. This hopping action keeps the granules in suspension, and there is no sliding contact with the table surface. Abrasive wear on the table is therefore negligible. More important than this is the fact that such motion imparted to the granules keeps them "alive," gives them an initial motion and thus prevents electrostatic "sticking" of such granules. As a consequence, an electrostatic field of much lower potential is required with the vibrating feed table than with the belt feeder of the patent to Melton et al., 2,187,624. This both makes the equipment required much cheaper and decreases the chance of leakage in the electrostatic field. The hopping action of all the particles on the feed table is uniform, regardless of their position longitudinally in the field, and thus the particles are coated on the web more uniformly than with the use of the apparatus of the patent to Melton et al., 2,254,016.

In order that the invention may be more clearly set forth and made more understandable reference is made to the accompanying drawings in which:

Figure 1 is a diagrammatic side elevation of one form of coating apparatus embodying the present invention;

Figure 2 is a side elevation of another form of device for electrostatically applying the particle coating;

Figure 3 is a cross-sectional view taken along the line 3—3 of Figure 2; and

Figure 4 is a cross-sectional view taken along the line 4—4 of Figure 2.

Referring to the embodiment of the invention illustrated in Figure 1, there is shown means A for supplying an adhesively coated web, means B for applying elongated particles to the adhesive side of the web, and means C for drawing the coated web through the coating apparatus and into a drying zone or chamber.

The means A for supplying an adhesively coated web comprises a roll 2 of a suitable web backing material 1 and supporting rolls 3, 4 and 5 for guiding the web to the adhesive applying rolls 6 and 7. Adhesive roll 6 is positioned to dip into a pan 8 of adhesive 9, and roll 7 maintains contact between the web 1 and the adhe-

sive roll 6. Supporting rolls 10 and 11 guide the adhesively coated web 1a into the electrostatic coating means B.

This coating means comprises means for setting up an electrostatic field, means for guiding the adhesively coated web in a fixed path in said field, and vibrating table means for feeding the particles to be coated on said web into confronting relationship with the web. The web is fed, adhesive side down, in contact with the upper electrode 12 which is of good electrical conductivity, and which is shown connected to the ground and to the positive side L₁ of a source of electromotive force. The effective potential of this source may be 20,000 volts or more, depending on electrode spacing, type of particles to be projected, etc. The source of electromotive force may produce a continuous unidirectional current, an intermittent, unidirectional current, or a pulsating current such as that which commonly is called alternating current. When a pulsating current is employed, the duration of the pulsations should be great enough to project and orient the particles effectively. Ordinarily, and for more efficient operation, the lower electrodes are connected to the negative terminal and the upper electrode is connected to the positive terminal of the source of high electromotive force and is grounded also as a precautionary measure. The polarity of the electrodes may be reversed, however, if it is so desired. Guide rolls 11 and 13 are vertically adjustable and provide a means of varying the spacing of the web from the lower electrode and also to maintain the web in the proper line of travel. Situated a proper distance beneath the web, the distance depending upon the size of particles to be coated upon the web and the electrostatic potential employed, is a vibrating feed table 15 made of electrically non-conducting material and having a deck or top 16 of non-conducting material such as dry knot-free wood, "Bakelite," "Micarta," and the like, and upstanding sides 17 to keep the particles from escaping off the sides of the deck. Below the deck are located means for distributing a high potential charge substantially uniformly over deck 16. Such means may be a metal sheet or metal sheets, of good electrical conductivity, in contact with under side of deck 16, and connected to the side of the high potential source of electromotive force opposite from that to which the upper electrode is connected. In the device shown in Figure 1 this electrode is composed of three separate portions 16' connected by bus bar 17', supported in insulators 18, and flexible connectors 19, for the purpose of allowing the length of the electrostatic field to be changed by disconnecting any of the electrode portions 16'. The bottom electrode can, however, be made in one piece, of the same length as the upper electrode 12 or shorter if desired. Flexible wire 20 connects bus bar 17' to the high potential lead wire L₂ through a terminal on insulating means 21 on the base of the device.

The electrostatic field existing between top electrode 12 and the bottom electrode composed of the electrode portions 16' has lines of force which in the main extend between electrodes in the shortest possible line. Since the electrodes in this modification are parallel with the top of the feed table, the lines of force extend in a direction perpendicular to the top surface of the feed table. At the right and left hand ends of the field, defined roughly between the ends of upper electrode 12, the lines of force bulge outwardly for a

short distance beyond the ends of the upper electrode.

The feeding table 15 is supported for vibratory motion by spring steel supports 22, which extend between the bottom of the table and base 23 at an angle to the vertical, as shown in Fig. 1. Base 23 is supported by resilient means such as rubber blocks 24, which isolate the vibration from the foundation. The table 15 is vibrated by an electromagnetic vibrating device 25, contained in sub-frame 26 bolted to base 23. Such vibrating device is well-known, and comprises a reciprocating armature of magnetic material and a wound stator which, when connected to a source of alternating current, alternately pulls and releases the armature. The latter is connected to the table 15, and thus vibrates it longitudinally. By reason of the angle at which the spring supporting members 22 are disposed, the table on its momentary release by the stator travels to the left, in Fig. 1, with a slight vertical component, whereby the material conveyed thereby is given the forward saw tooth motion before referred to. The particulate material on the feed table thus is given successive rapidly recurring positive feeding impulses in a direction at an acute angle to and across the lines of force of the electrostatic field between electrodes.

To feed the particles on to table 15 there is provided a hopper 27 with a vibrating feed gate 28 disposed at an angle to the horizontal, as shown, and vibrated in a horizontal plane by the magnetic driving unit 29 connected to a source of alternating current. Hopper 27 is supported on frame part 30; driving unit 29 is also supported thereon by the resilient rubber washers 32a and is made vertically adjustable by means of threaded rods 31 and nuts 32.

Electrical voltage control devices 33 and 34 are connected to a source of alternating current L₃, L₄. The control devices regulate the amplitude of vibration of feed gate 28 and of table 15, respectively, and thus govern the rate and quantity of the particles or granular material delivered to the electrostatic field. Switches 35 and 36 are provided to start and stop the magnetic driving units 29 and 25, respectively. A bin 37 is provided to catch whatever particles remain on the feed table and are finally fed off the far end thereof.

The means C draws the particle coated web 1—b from the coating apparatus into a drying chamber, not shown. Such means comprises, as shown in the drawings, a supporting roll 14, a suction drum 38, an idler roll 39, a rack 40 for supporting the web 1—b, and an endless conveyor 41 for festooning and transporting loops of the web to the rack 40.

In Figs. 2, 3, and 4 there is shown a modification of the means for feeding and applying the particles to an adhesively coated web. In such modification a web 1—a with an adhesive coating on the top face thereof is fed over guide roll 42 in the direction of the arrow. The web then progresses around guide roll 43, supported by bracket 44 on frame 45 of the device, so that the adhesive coating faces downwardly. The uncoated back of the web is maintained in contact with the top electrode (shown in Fig. 2, by way of illustration only, as composed of two portions 63 and 64) of the electrostatic coating means, and, after being coated with the granular material in the manner to be described, passes out of the device, guided by roll 47.

The frame 45 of the electrostatic coating unit is made in any conventional manner as, for ex-

ample, by welding together channel or I beams. It is constructed generally in the shape of a parallelepiped, but has the top surface slanted off, at one side, as shown at 46 in Fig. 2. On this slanted portion of the frame are secured a plurality of bosses 47; in the modification shown there are four such bosses one at each corner of such slanted portion 46 of the frame. There is provided a central hole 48 through each boss and an aligned hole through the frame for the purpose of allowing an elongated nut 49 to fit therein. This nut is provided at the bottom thereof with a flange 50, and at the top has a bearing member 51 keyed thereto, as at 52. Sprocket 53 is secured to member 51, as by projections on the upper end of member 51 fitting in holes in the sprocket. A nut 54 is provided to screw on to the top of elongated nut 49 to retain bearing 51 in adjusted position and sprocket 53 in place. The elongated nut 49 is provided with a screw threaded bore to receive screw threaded rod 55. The lower end of rod 55 is likewise screw threaded, and projects through a hole in the top of the electrode supporting frame 56, which is made of welded angle iron. Top and bottom nuts 57 and 58 secure rod 55 to frame 56 and make possible individual adjustment of the carrier relative to each rod, and therefore allow initial alinement of the electrode carrier. Turning of sprocket 53 rotates elongated nut 49 and thus advances or retracts rod 55. To allow the quick adjustment of the carrier 56 to different parallel planes, all sprockets 53 of the adjusting means are connected by a chain 59. A hand wheel 60 is connected to one nut 49', which in this case is made long enough for that purpose, as by key 61 and nut 62 screwed to the upper end of nut 49'.

The upper electrode is made of material of good electrical conductivity, such as a metal, and in this modification is composed, for reasons of convenience, of two parts 63 and 64. Each part has secured on its upper face, near each end thereof, an upstanding L-shaped bracket 65. The brackets 65 are securely held in position on the frame carrier 56 by virtue of being clamped between portions of brackets 66, secured to electrode carrier 56 near the ends thereof, portions of T bracket 67, secured near the center of electrode carrier 56, and eccentric clamping means 68, located, as shown, at each bracket. The upper electrode is connected through the machine frame to the grounded side of a high potential source of electromotive source by means not shown.

The inclined particle feeding table 69 is parallel to the upper electrode and supported on similarly inclined frame 70. This frame is supported at its lower end on a cross channel member of main frame 45 and at the upper end on a channel member supported by a pedestal 71 within the main frame. Frame 70 is carried on resilient supports such as blocks of rubber 72 held by top and bottom cup-like members 73, secured respectively, to frame 70 and frame 45. For the purpose of vibrating table 69 in such manner that the particles fed thereby describe a saw tooth movement, it is driven by electromagnetic vibrator means, indicated generally by the character 74. In the particular device shown, two such means are employed with their stators connected to the same alternating current source, so that they vibrate in synchronism. It is obvious, however, that for a small table one such means would suffice, and that for a larger table more than two such means can be used. Means 74, which may be generally of the type shown in the U. S. patent

to Francis, No. 2,161,342, comprises a wound stator 75 connected to a source of alternating current (not shown), adjustably supported on vertical plate 76, which is attached to frame 70 and braced thereon by gussets 77, by means of four bolts 78 which pass freely through holes in plate 76 and are screw threaded into bosses on the frame of the stator. Horizontal adjustment of the stator is accomplished by loosening nuts 79 (see Fig. 4) on bolts 78 moving the stator to the desired position, and then tightening the nuts to lock the stator in position. An armature 80 of laminated magnetic material is alternately attracted and released by the stator 75. The armature is secured to the centers of a plurality of spring leaves or vibrator bars 81, the ends of which are clamped rigidly between plates 82 and 83 by means of bolts 84. Plates 83 are attached to frame 70, and are braced thereon by gussets 85. Between adjacent leaves 81 at their ends and at the center are located thin spacer members 86, to eliminate sliding friction between leaves when the spring vibrates horizontally.

Armature 80 is attached to a member 87 which is C-shaped in vertical section to provide parallel vertical members 88 and 89. Member 88 contacts the spring on one side thereof, whereas the other side is contacted by abutment member 91, held in clamped position by bolt 90 which has threaded engagement with portion 89 of member 87. Lock nut 92 secures bolt 90 in clamping position. The spring leaves 81 are made of a strong, resilient material such as spring steel. For a given distance between the spring supports 82, the width and thickness of the spring leaves and the total number of spring leaves in each of the two spring assemblies employed is so chosen that when the feed table is mounted on the two spring assemblies, as shown in Figure 4, and stator winding 75 has impressed upon it the operating alternating current, the armatures 80 intermittently approach but do not strike their respective stators 74. Thus the table vibrates smoothly and silently, and the mechanism is free from self-destructive jarring.

Part 88 terminates in a flange 93, to which is secured, by means of bolts 94, plate 95, which is attached to a projection 96 of table 69 by conventional means such as screws or bolts. In the modification employing two vibrator units, as shown in Figs. 2, 3 and 4, the weight of the table 69 is carried entirely by the leaf springs 81.

Table 69 is constructed of a suitable electrically insulating material, such as dry seasoned knot-free hard wood, suitably braced longitudinally and laterally. A deck 97 is secured to the upper surface of table by bolts 98 located along the edges of the deck, and is provided with upstanding edge members 99 of insulating material. Deck 97 is made of a material which is so poorly conducting that not enough current can flow along or through it to cause arcing between the bottom and top electrodes, yet is sufficiently conducting to allow a small leakage current to supply negative charges to the granular material in order that the particles may be repulsed from the table across the electrostatic field toward the grounded upper electrode. Such materials include dry knot-free wood, and fibrous material bonded with an insulating resin such as "Bakelite" or "Mica-arta." A thin layer 100 of a metal of good electrical conductance is provided on the under surface of the deck, for the purpose of spreading the charging current evenly over the deck or electrode 97. Such layer may be a preformed plate or, conveniently, may be sprayed on as with a

metal spray gun. In the modification shown the metal layer is divided at the lateral table braces; the separate parts of the layer are electrically connected with the side of the high potential source of current, opposite to that to which the upper electrode is connected, by means of bus bar 101, which is supported by suitable insulators 102 and fed by the supply cable 103. The supply cable and bus bar are insulated at points where they are near metallic parts of the device. Flexible electrical leads 104 are connected by suitable means to the bus bar 101 and to the sections of the metal layer 100 under the table deck. The layer of metal on the bottom surface of the bottom electrode may, if desired be made in one piece instead of separate parts as shown.

As in the case of the apparatus shown in Figure 1, the electrostatic field between upper electrode 63, 64 and lower electrode 100 has its lines of force throughout its extent with the exception of the ends of the field disposed directly across the electrodes. Thus, in the main, the lines of force are substantially perpendicular to the top surface of the feed table, since both the upper and lower electrodes are parallel to such surface. As was explained in connection with Figure 1, and as set out below in the discussion of the function of baffle 115, the lines of force at the edge of the field defined roughly by the ends of upper electrode 63, 64 bulge outwardly somewhat in a direction away from the field. The feed table gives the particulate material thereon successive rapidly recurring positive feeding impulses in a horizontal direction. Such direction is at an acute angle to and across the lines of force of the electrostatic field.

To feed the particles on to the table 69 there is provided a hopper 104 located in an upper extension frame 105 supported on the main frame 45. The bottom of the hopper is provided with an inclined feed gate 106, which is vibrated in a horizontal plane by the magnetic driving unit indicated generally at 107, which is similar to units 74 for vibrating table 69. Wound stator 108 of driving unit 107 is connected to a suitable source of alternating current, of a frequency, for instance, of 25 or 60 cycles per second, and alternately attracts and releases armature 109, which is connected to the center of leaf spring 110, and which carries at its left end (Fig. 2) the feed gate 106.

The feed gate 106 and driving unit 107 are adjustably mounted on frame 45 by means of threaded rods 111 and nuts 112 and resiliently supported by the rubber washers 116. Means are provided to vary the voltage and consequently the current supplied to the two table driving units 74 and the feed gate vibrating unit 107. Such means is similar in each case to that shown diagrammatically in Fig. 1, at 33 and 34, for controlling the table vibrating means and the hopper feed gate. Of course, in the present modification, the two units 74 are connected in parallel and are controlled by the same means. The voltage control means are conveniently located in frame 105. One such means, an auto-transformer or "Variac" 113, with hand wheel 114, is shown in Fig. 2. Two such controls 113 are employed in the device of Fig. 2, one for unit 107 and one for both units 74.

A curved baffle plate member 115, of "Micarta" or other poorly conducting material, is mounted on the side rails 99 of the vibrating feed table and extends the full width thereof. This baffle cooperates with the table top 97 and side walls 99

to form an enclosed duct which confines the movement of the granular particles until after they have passed through the curved edge of the electrostatic field and reached a point of maximum field intensity. Thus the projection of the particles is prevented until after they have become fully charged and conditioned for maximum velocity of projection and orientation. Precoating of the adhesively coated web 1-a before it enters the zone beneath the electrode 64 is also prevented.

The baffle also overcomes the tendency of the granules to be repelled outwardly as they enter the margin of the electrostatic field which is caused by the "edge effect" or natural bulging of the electrostatic lines of force along the edge of the electrode members. Without such a baffle the granules are repelled to such an extent, particularly when high voltages are employed, that they are not carried into the field but build up a ridge or mound along the entrance thereto. This difficulty is completely overcome by the baffle member 115 since the particles are in fact fed through an electrically charged duct and not subjected to the attraction of the oppositely charged electrode 64 until after passage through the edge of the electrostatic field.

A hopper 118 is provided adjacent the lower end of table 69 to receive the particles which have not been deposited on the web by the electrostatic field.

The two modifications of the device disclosed, namely that, shown in Fig. 1 and that shown in Figs. 2, 3, and 4, are both very satisfactory in their performance and exhibit the advantages set out in the earlier part of the specification. The amount of particles fed per unit area of surface to be coated is under control of the operator, and remains constant after the feed hopper gate has been adjusted and the amplitude of the vibrations of the gate determined by setting the voltage control means for its driving unit. The amplitude of vibration of the feed table remains constant for a given setting of the voltage control means for its driving unit or units. Thus for different materials fed onto the table the optimum amplitude of vibration can be chosen to convey the particles, distribute them evenly over the table deck, and to present them in the best condition for being propelled against the web by the electrostatic field.

Other advantages will be apparent from the foregoing disclosure to those skilled in the art, and while specific embodiments have been used to illustrate our invention, it is to be understood that the invention is not limited to those embodiments but is defined by the appended claims.

We claim:

1. Apparatus for the manufacture of particle surfaced webs comprising a particle projector which includes a feeding means having a particle carrying table whose top surface lies substantially in a plane, means to vibrate the particle carrying table in a direction at an acute angle to the plane of the top surface thereof substantially uniformly throughout its extent, said angle being measured between the top surface of the table and the path of its vibration in the direction of feeding of the particles, whereby the particles carried thereby are moved progressively over said surface, means for supporting an adhesive coated web with an adhesive surface downwardly positioned above said particle carrying member, and means to create and maintain a high tension electrostatic field in the space between the top sur-

face of the particle carrying table and the web.

2. Apparatus for the manufacture of particle surfaced webs comprising a particle projector which includes a feeding means having a particle carrying member whose top surface lies substantially in a plane, means to vibrate the particle carrying member in a direction at an acute angle to the plane of the top surface thereof, said angle being measured between the top surface of the particle carrying member and the path of its vibration in the direction of the feeding of the particles whereby the particles carried thereby are moved progressively over said surface, a high tension electrode integral with the particle carrying member, means for supporting and traversing an adhesive coated web with an adhesive surface downwardly positioned above said particle carrying member, an electrode positioned above the web being surfaced, and means for applying a potential difference to said electrodes.

3. Apparatus for the manufacture of particle surfaced webs comprising a particle projector which includes a vibrating feed table to carry and cause particles to move thereover progressively, means for vibrating all portions of said table uniformly, means for supporting and traversing an adhesive coated web with an adhesive surface downwardly positioned above said feed table, means to create and maintain a high tension electrostatic field in the space between the feed table top surface and the web, means to feed particles on to the infeeding end of the feed table, and means cooperating with the top of the feed table to form an enclosed duct through which the particles are fed until they have reached a point of high intensity of the electrostatic field.

4. Apparatus for the manufacture of particle surfaced webs comprising a particle projector which includes a vibrating feed table having a substantially plane top surface to carry and cause the particles to move thereover progressively, means for feeding particulate material on to the infeeding end of the table, means for vibrating the said table substantially uniformly throughout its extent in a direction at an acute angle to the plane of the table top measured in a direction away from the infeeding end of the table, means for supporting and traversing an adhesive coated web with an adhesive surface downwardly positioned above said feed table, and means to create and maintain a high tension electrostatic field in the space between the said feed table top surface and the web, said field substantially terminating at a distance inwardly of the table from the infeeding end of the table.

5. Apparatus for the manufacture of particle surfaced webs comprising a particle projector which includes a vibrating feed table having a substantially plane top surface to carry and cause particles to move thereover progressively, means for feeding particulate material on to the infeeding end of the table, means for vibrating the feed table substantially uniformly throughout its extent in a direction at an acute angle to the table top measured in a direction away from the infeeding end of the table, means for supporting and traversing an adhesive coated web with an adhesive surface downwardly positioned above said feed table, and means to create and maintain a high tension electrostatic field in the space between the feed table top surface and the web, said last named means comprising an electrode positioned below the top surface of the table and an upper electrode above the adhesive coated web, the upper electrode being so positioned that the

infeeding end of the table projects a substantial distance beyond it.

6. Apparatus for the manufacture of particle surfaced webs comprising a particle projector which includes a vibrating feed table to carry and cause particles to move thereover progressively, said feed table having a substantially plane top surface, means for feeding particulate material on to the infeeding end of the table, means for vibrating the feed table substantially uniformly throughout its extent in a direction at an acute angle to the table top measured in a direction away from the infeeding end of the table, means for supporting and traversing an adhesive coated web with an adhesive surface downwardly positioned above said feed table, and means to create and maintain a high tension electrostatic field in the space between the feed table top surface and the web, said last named means comprising a bottom electrode integral with the feed table and an upper electrode positioned above the adhesive coated web, the bottom and top electrodes being so positioned with respect to the table and to each other that the electrostatic field between them extends over the feed table for a substantial part of its length but does not extend over the infeeding end of the feed table.

7. Apparatus for the manufacture of particle surfaced webs comprising a particle projector which includes a vibrating feed table to carry and cause particles to move thereover progressively, said feed table having a substantially plane top surface which is positioned substantially horizontally, resilient supports for the feed table which allow it to vibrate substantially solely at an acute angle to the table top measured in a direction away from the infeeding end of the table, means for vibrating the feed table, means for feeding particulate material on to the infeeding end of the table, means for supporting and traversing an adhesive coated web with an adhesive surface downwardly positioned above said feed table, and means to create and maintain a high tension electrostatic field in the space between the feed table top surface and the web, said electrostatic field covering a substantial part of the length of the feed table but being so positioned that the infeeding end of the table is substantially outside the field.

8. Apparatus for the manufacture of particle surfaced webs comprising a particle projector which includes a vibrating feed table to carry and cause particles to move thereover progressively, said feed table having a substantially plane top surface which is located at an acute angle to the horizontal, resilient supports for the feed table which allow it to vibrate in a substantially horizontal plane but restrain it from substantially all other movement, means for vibrating the table in a horizontal plane, means for feeding particulate material on to the upper end of the table, means for supporting and traversing an adhesive coated web with an adhesive surface downwardly positioned above said feed table, and means to create and maintain a high tension electrostatic field in the space between the feed table top surface and the web, said electrostatic field covering a substantial part of the length of the feed table but being so positioned that the upper infeeding end of the table is substantially outside the field.

9. Apparatus for the manufacture of particle surfaced webs comprising means to create and maintain a high tension electrostatic field having lines of force which in the main are parallel to each other, a vibrating material feeding table

lying within the electrostatic field so that the top material feeding surface thereof lies substantially normal to the lines of force, said table having an infeeding end, means to vibrate the table substantially solely in such direction to the lines of force that material thereon is given successive forward feeding impulses in a direction across the lines of force of the field, means for feeding particulate material on to the table at the infeeding end thereof, and means for supporting and traversing an adhesive coated web with an adhesive surface downwardly positioned above said feed table.

10. Apparatus for the manufacture of particle surfaced webs comprising means to create and maintain a high tension electrostatic field of substantial extent, the lines of force of which are in the main parallel to each other, a vibrating feed table having substantially a plane top surface so located that a substantial part thereof lies in the field so that the lines of force are substantially normal to the said top surface, the feed table having an infeeding end so located that the field strength at that point is substantially ineffective, means for supporting the feed table so that it may vibrate substantially solely in a direction at an acute angle to the lines of force of the field, means for vibrating the feed table whereby the material is fed into and through at least part of the field in a series of saw-tooth shaped hops, the material being given repeated positive impulses in a direction across the lines of force of the field, means for feeding material on to the infeeding end of the table, and means for supporting and traversing an adhesive coated web with an adhesive surface downwardly positioned above said feed table.

11. Apparatus for the manufacture of particle surfaced webs comprising means to create and maintain a high tension electrostatic field having lines of force which in the main are parallel to each other, said means comprising top and bottom electrodes of substantial extent, said electrodes being parallel to each other, a vibrating material feeding table lying within the electrostatic field so that the top material feeding surface is parallel to the top and bottom electrodes, means to vibrate the table substantially solely in a direction at an acute angle to the lines of force to give the material thereon successive forward feeding impulses in a direction across the lines of force, means for feeding particulate material on to the table at the infeeding end thereof and means for supporting and traversing an adhesive coated web with an adhesive surface downwardly positioned above the feed table.

12. Apparatus for the manufacture of particle surfaced webs comprising means to create and maintain a high tension electrostatic field having lines of force which in the main are parallel to each other, said means comprising top and bottom electrodes of substantial extent which in the main are parallel to each other, a vibrating material feeding table lying within the electrostatic field so that the top material feeding surface thereof lies substantially normal to the lines of force, said feeding table having an infeeding end which lies substantially outside the effective field, means to vibrate the table substantially solely in a direction at an acute angle to the lines of force to give the material thereon successive forward feeding impulses in a direction at an acute angle to the lines of force, means for feeding particulate material onto the table at the infeeding end thereof, and means for supporting

and traversing an adhesive coated web with an adhesive surface downwardly positioned above said feed table.

13. Apparatus for the manufacture of particle surfaced webs comprising means to create and maintain a high tension electrostatic field having lines of force which in the main are parallel to each other, said means comprising parallel top and bottom electrode members of substantial extent, a vibrating material feeding table lying within the electrostatic field so that the top material feeding surface thereof lies substantially horizontal and substantially normal to the lines of force, said table having an infeeding end, means to vibrate the table substantially solely in a direction at an acute angle to the lines of force to give the material thereon successive forward feeding impulses in a direction across the lines of force, means for feeding particulate material on to the table at the infeeding end thereof, and means for supporting and traversing an adhesive coated web with an adhesive surface downwardly positioned above said feed table.

14. Apparatus for the manufacture of particle surfaced webs comprising means to create and maintain a high tension electrostatic field having lines of force which in the main are parallel to each other, said means comprising top and bottom electrodes of substantial extent which lie parallel to each other and which incline to the horizontal at an acute angle, the vibrating material feeding table lying within the electrostatic field so that the top material feeding surface thereof lies substantially parallel to the electrodes and substantially normal to the lines of force, means to vibrate the table substantially solely in a horizontal direction to give the material thereof successive forward feeding impulses in a direction across the lines of force, means for feeding particulate material on to the table at the upper end thereof, and means for

supporting and traversing an adhesive coated web with an adhesive surface downwardly positioned above said feed table.

15. Apparatus for the manufacture of particle surfaced webs comprising a particle projector which includes a feeding means having a particle carrying top surface, means to vibrate the feeding means in a direction at an acute angle to the top surface thereof, said angle being measured between the top surface of the feeding means and the path of its vibration in the direction of feeding of the particles whereby the particles carried thereby are moved progressively over said top surface, means for supporting an adhesive coated web with the adhesive surface downward positioned above said particle carrying member, and means to create and maintain a high tension electrostatic field in the space between the top surface of the feeding member and the web.

16. Apparatus for the manufacture of particle surfaced webs comprising a particle projector which includes a feeding means having a particle carrying top surface, means to vibrate the feeding means in a direction at an acute angle to the plane of the top surface thereof, said angle being measured between the top surface of the feeding means and the path of its vibration in the direction of feeding of the particles whereby the particles carried thereby are moved progressively over said top surface, means for supporting an adhesive coated web with the adhesive surface downward positioned above said particle carrying member, and means to create and maintain a high tension electrostatic field in the space between the top surface of the feeding member and the web, said last named means comprising a high tension electrode attached to the feeding means as an integral part thereof.

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