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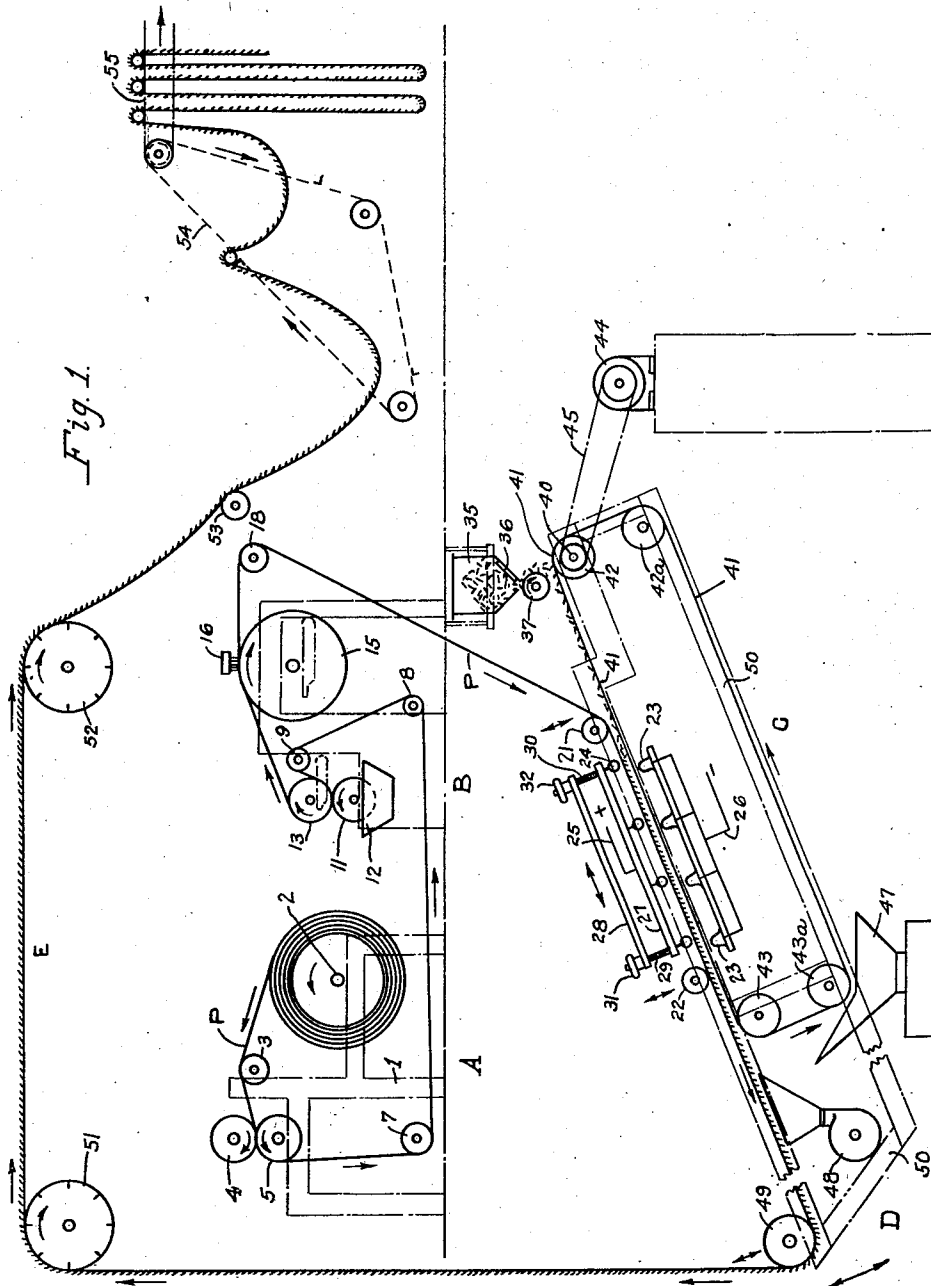
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2,194,253

COATING APPARATUS

Filed Oct. 27, 1932

2 Sheets-Sheet 1



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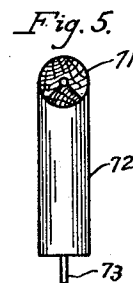
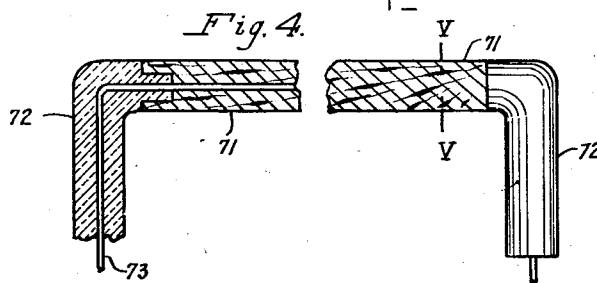
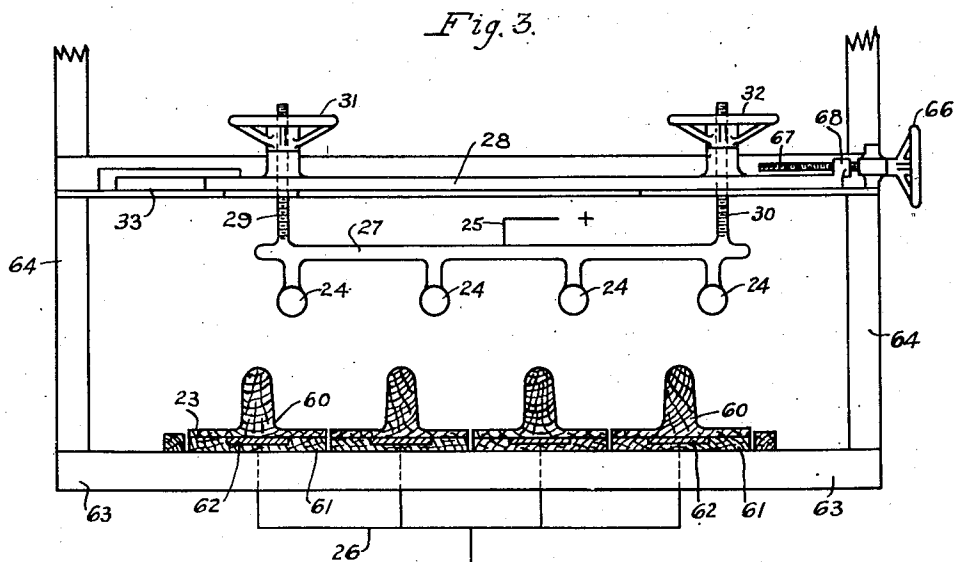
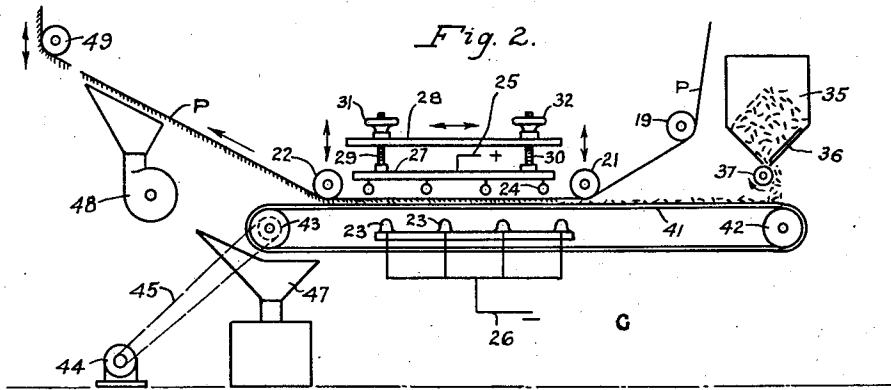
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COATING APPARATUS

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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

2,194,253

COATING APPARATUS

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Application October 27, 1932, Serial No. 639,837

10 Claims. (Cl. 91-18)

This invention relates to improved apparatus for the manufacture of granular coated webs of such materials as paper, cloth, or the like and has for an object the provision of improved machinery for securing a superior product, greater efficiency, and/or lower cost of production, of coated articles.

More specifically, this invention relates to apparatus by the use of which granular materials can be projected upwardly and at an oblique angle to an adhesive coated side of a web.

It has been found heretofore that superior granular coated webs for such uses as abrading can be made by arranging those particles that have a generally elongated shape in such a way that these longer particles project from the web with their longer dimensions normal to the surface of the web. Maximum benefit from particles arranged in this manner results only when at least a substantial proportion of the particles in a mass of abrasive grains are of the elongated type, since these particles that are more or less of the same dimension in all directions can not be oriented with a longer dimension in any particular direction.

We have found that a faster cutting abrasive coated web can be made by projecting the particles upwardly and at an oblique angle with respect to the surface of the coated web because these angularly projected particles embed themselves in the adhesive coating of the web at an oblique angle with respect to the surface of the web regardless of whether they are of an elongated shape or not. Those particles that are of elongated shape impinge upon the adhesive coating in an endwise manner and therefore become oriented with their longer dimension projecting at an oblique angle from the surface of the web. Those particles that are of general irregular shape, of which there usually is a substantial proportion, yet have no one dimension substantially longer than another impinge upon the adhesive coating at an oblique angle instead of at a right angle as is the case when apparatus heretofore known has been used. The general result of this upward and at the same time angular, projection of the particles to the adhesive coated web is a faster cutting abrasive article because substantially all of the particles are arranged on the web like the teeth of a saw and moreover, this result is accomplished without the necessity of preselecting grains of generally elongated shape.

An abrasive cloth or paper of this character if used, for example, as a sanding belt can be driven in the direction of inclination of the particles so

as to secure a very rapid cutting or abrading action. If driven in the opposite direction, the action is more of a polishing or finishing action. Thus, a single belt can be employed for both rapid abrading and finishing.

While the degree of inclination can be varied as desired, we have found that inclination of the grains at about 15° to 75° to the plane of the backing gives the best results for rapid cutting.

A better understanding of our invention can be obtained by reference to the accompanying drawings in which:

Figure 1 is a diagrammatic elevation of apparatus embodying our invention;

Figure 2 is a diagrammatic elevation showing a modification of the grain depositing means;

Figure 3 is an enlarged view of the electrode assembly shown in Figure 1;

Figure 4 is a view partly in section of a modification of the lower electrodes; and

Figure 5 shows a sectional view through the plane V-V of Figure 4.

The apparatus shown in Figure 1 illustrates our invention in connection with apparatus for the manufacture of abrasive coated webs, and includes a means A for holding and dispensing a roll 2 of the web P of paper, cloth or the like, means B for applying adhesive to one face of the web P; means C for applying granular material to the adhesive side of the web P; means D for causing a preliminary set of the adhesive, and means E for drawing the web through the coating apparatus and into the drying chamber.

The means A for holding and dispensing the web P comprises, as shown in the drawings, a frame 1 that supports the roll 2 of web P; an idler roll 3 for guiding the web; printing rolls 4 and 5 for marking the web with any desired legend or identification; and an idler roll 7 for guiding the web.

The adhesive applying means B comprises, as shown in the drawings, idler rolls 8 and 9 for guiding the web; a roll 11 positioned to dip into a pan 12 of adhesive; a roll 13 for maintaining contact between the web P and the roll 11; a drum 15 and an adhesive distributing brush 16 positioned above the said drum 15; and an idler roll 18 for guiding the web as it is brought from the distributing brush.

The means C for applying granular material to the web P comprises, as shown in Figure 1, a hopper 35 with an adjustable gate 36 and a feed roll 37 positioned to deliver granular material to a feed belt 41, of such material as canvas, which is supported by rollers 42, 42a, 43 and 43a, the

upper portion of the feed belt being positioned between electrodes 23 and 24 and nearer to the electrodes 24. The feed belt 41, with its supporting rollers 42, 42a, 43 and 43a, and the electrodes 23 and 24 are all positioned on a carriage 50 which is rotatable about the point 40 for cooperation with the adjustable electrodes 23 and 24 in producing different angles of projection with respect to the web. If desired, the feed belt 41 can have a somewhat corrugated surface for preventing relative movement of the granular material with respect to the belt.

A better understanding of the construction of a suitable electrode can be had by reference to Figure 3, which shows in detail one modification of electrode structure suitable for use in our apparatus. The electrodes 23, as shown in Figure 3, are formed of pieces of wood 60 and 61 between which is placed a metal conducting plate 62. We have found it advantageous to use a distributing plate 62 in order to cause the charging current to divide and spread substantially evenly over the wooden electrode and also to reduce the unit density of leakage current upwardly through the wood to its top surface. We prefer to enclose the metal plate rather than have it attached to the bottom of the electrode in order that leakage in other directions than that toward the upper surface of the electrode may be reduced. A good insulating material, such as glass, can be used instead of wood for the lower piece 60 of the electrode 23.

As shown in Figure 3, the electrodes are supported on frame members 53 which are hung from a support 33 by means of hanger bars 64 of highly insulating material such as hard rubber. The upper electrodes 24, which can be of any good conducting material, are attached to the bar 27. The bar is hung from the support 28 by means of the screws 29 and 30 which are threaded into adjusting nuts 31 and 32, respectively. The support 28 is slidably mounted on the frame member 33 and is adjustable along a plane parallel to the lower electrode 23. Such adjustment is provided by means of a handwheel 66 and screw threaded shaft 67, journaled on the frame 33 and engaging a threaded projecting portion 68 of the support 28. The lower electrodes 23 are interconnected by means of the conductors 26 while the upper electrodes 24 are interconnected by means of the bus bar 27.

Figures 4 and 5 illustrate a modified form of electrode suitable for use as a lower electrode in our apparatus. As illustrated in the drawings, it comprises a cylinder 71 of poorly conducting material, end pieces 72 of highly insulating material and a conductor 73 running through the end pieces and through the cylinder.

On the carriage 50 also are mounted rolls 21, 22 and 49, which rolls are adjustable as a unit, for positioning the web between the feed belt 41 and the upper electrodes 24, and a source 48 of air of low velocity and relatively large volume for assisting in causing a preliminary set of the adhesive.

The modification of the grain depositing means C, as shown in Figure 2 differs from that shown in Figure 1 in that the various units are not mounted on a rotatable carriage such as that shown in Figure 1. The guide roll 49 shown in Figure 2 is made vertically adjustable in order to properly position the web while the adhesive is receiving a preliminary set to preserve the arrangement of the particles.

A source of electromotive force, not shown

specifically in the drawings, but indicated by the positive (+) and the negative (—), symbols, also is included in the means C for applying granular material to the web P. The source of electromotive force, which is capable of producing an effective potential difference of about 30,000 volts and more, can be one that produces a continuous unidirectional current, or a pulsating current such as intermittent unidirectional current, or a current such as is commonly called alternating current. The duration of each pulsation, when pulsating current is produced by the source of electromotive force, should be such that the particles will become charged and projected from the feed belt. We have found that apparatus built in accordance with our invention operates more effectively when the lower electrodes are connected to the negative terminal of the source of the electromotive force and the upper electrode is connected to the positive terminal. This positive terminal is also grounded as a precautionary measure. The polarity of the electrodes 23 and 24 can be reversed, however, if it is so desired.

The means C for applying granular material to the web P comprises also a variable speed driving means 44 and 45 for moving the feed belt 41 around the pulleys 42, 42a, 43 and 43a, and a hopper 47 for catching the excess grain discharged by the feed belt 41.

The means D for causing the adhesive to acquire a preliminary set comprises, as shown in the drawings, an idler roll 49 and a fan blower 48 for supplying a large volume of air at a low velocity to the adhesive and granular coated side of the web P.

The means E for drawing the web P from the coating apparatus into the drying chamber comprises, as shown in the drawings, one or more suction drums 51 and 52; an idler roll 53; a rack 55 for supporting the web P, and an endless conveyor 54 for transporting loops of the web P to the rack 55.

The projecting means shown in Figures 1, 2 and 3 of the drawings comprises a plurality of electrodes interconnected to form an upper electrode surface and another plurality of electrodes interconnected to form a lower electrode surface. We have found it desirable in apparatus for the purpose disclosed in this application to make both the upper and lower electrode surfaces of a number of smaller units rather than as a large unit in each case, because it is desired to set up an electrostatic field that passes through the feed belt and the web P at an oblique angle. Two large area electrodes when placed close together will set up a field between them that is normal to their surfaces, even though one of the electrodes is not positioned squarely above the other, and since there is not sufficient space between the upper and lower electrodes to permit of an appreciable angular relationship between the web and the field, it is impossible to produce orientation at any angle appreciably different than 90°. By making the upper and lower electrodes of separate small units and positioning these small units in each group at a distance greater than the distance between the interacting units of the upper and lower electrodes, an electrostatic field can be set up that will intersect the web P at an oblique angle. The upper and lower electrode surfaces are each made of separate units for the additional reason that it becomes possible thereby to increase or decrease the breadth of the field by adding or taking away units as the case may be.

We have found that the upper electrode units

can be made of any good conducting material such as metal, but that the lower electrode units serve in a particular manner and preferably are made of a material that will hold back the flow of current that ordinarily would take place when a large potential difference is applied to the ordinary electrodes and yet will permit some current to flow to the upper surface of the lower electrodes.

The material of which these lower electrodes is made is of considerable importance in the successful operation of machines built in accordance with our invention. It appears that a poor conductor of electricity is required for these electrodes because some leakage is required in order to provide sufficient current to charge the particles that are brought into the electrostatic field by the feed belt 41. Materials that insulate and substantially prevent passage of the current at the potentials we prefer to use are not satisfactory because they prevent the projection of the particles from the feed belt to the adhesive coated web. Metal or other good conducting materials permit substantially free and unrestricted passage of the current when the applied electromotive force is sufficient to produce ionization of the air between the electrodes, and cause spark-over or arcing. Such arcing or spark-over is detrimental to the manufacture of satisfactory abrasive coated webs since each spark-over or arc not only causes a bare streak to occur because relatively few or no particles are projected during the time the arc or spark-over is taking place but also causes interruption of the service from the high tension equipment. Thus, the material we prefer to use in making the electrodes is neither a good conductor nor a good insulator at the potentials we prefer to employ, and for this reason we designate the preferred type of material as a poor conductor. The metals have been given as illustrations of good conductors. Hard rubber is an illustration of a good insulator at the voltages we prefer to use.

One material we have found to be satisfactory for the lower electrodes is ordinary dry, knot-free pine. It appears that dry pine will conduct sufficient current at the voltages we prefer to use to provide sufficient current to charge the granular particles to the degree necessary for their projection by the electromotive force applied to the electrodes.

Other woods than pine and other materials than wood can be used for the lower electrodes. Laminated materials in which one or more of the laminae are of the type of the material referred to above as good insulators are not satisfactory, but composite materials, such as cotton fabrics bonded with resinous materials, such as "Bakelite" or "Redmanol", are suitable for the lower electrodes of our apparatus. It is preferred, however, that when materials of this general character are used, the fibers be so positioned that they lie in such a direction that when the material is formed into an electrode, they will carry the current lengthwise toward the active surface of the electrode.

Our copending application, Serial No. 647,244, filed December 14, 1932, discloses and claims electrodes of poorly conducting material and their use in other types of apparatus than that employed for the manufacture of granular coated webs.

In the normal operation of the apparatus illustrated in Figure 1, a roll of the uncoated web P, such as paper or cloth, is rotatably mounted on

the frame 1 and the web is threaded over the roll 3 and between the printing rolls 4 and 5 and thence in contact with the idler rolls 7, 8 and 9 to the pressure roll 13 and the adhesive roll 11. The adhesive roll 11 dips into liquid adhesive 5 contained in the adhesive tank 12 and, on the upward movement of travel of the roll 11, a layer of adhesive is applied to the web.

The adhesive coated web P passes between the brush drum 15 and a vibrating brush 16 which evenly distributes the adhesive and smooths out any ridges. The web is then guided by the idler rolls 18, 19 and adjustable roll 21 into an electrostatic field set up between the electrodes 23 and 24.

Granular particles are distributed from the grain hopper 35 onto the feed belt 41, the position of which is such that it is parallel to the web P in the space between the upper electrodes 24 and the lower electrodes 23. The variable speed driving mechanism 44 moves the feed belt 41 through the space between the electrodes in the same direction that the web P is moved.

In the modification shown in Figure 1, different degrees of angularity of the particles with respect to the web are produced by rotating the carriage 50 about its axis 40 to such a position that the web makes the same angle with the vertical as the angle at which it is desired to have the particles take with respect to the web. The upper group of electrodes is then shifted parallel to the web until they are so positioned that a substantially vertical field will be established between the upper and lower electrodes when the electromotive force is applied.

Different degrees of angularity are secured with the modification shown in Figure 2 by the simple expedient of shifting the upper group of electrodes horizontally to the right or left, as the case may be, and adjusting the guide roll 49 up or down, as required to position the web at the same angle with the vertical as it is desired to have the particles take with respect to the web.

The granular material, as it moves into and through the field, becomes electrically charged and leaves the belt to move upwardly toward the adhesive coated web as a spray or rain of particles spaced apart from one another. The upwardly moving particles strike the adhesive coated web and become attached thereto.

The forces produced by the electric field turn those particles that are of elongated shape so that their major axes are parallel to the lines of force of the field. These oriented, elongated particles, as well as those particles that have no dimension materially greater than the other are caused to move upwardly by the same electric forces.

Observation of the space between the upper and lower electrodes, when the machine is in operation, shows a distinct bluish color and freedom from localized arcing or spark-over. The bluish coloration indicates that a corona field exists between the upper and lower electrodes. The grain particles on the belt may receive their negative electrostatic charges by conduction through the fibers of the belt, by induction, or by the corona discharge from the bottom electrode through the belt, and possibly by a combination of these. Whatever is the mechanism of the transmission of electrostatic charges to the grains, the fact remains that the granular particles receive sufficient electrostatic charge to cause them to be forcibly driven upwardly through the strong electrostatic field from the

feed belt against the under side of the adhesive coated web. As pointed out above, the elongated particles not only are projected upwardly but are oriented and projected.

5 In operating our apparatus, we prefer to space the electrodes 23 and 24 about one inch apart and to apply a potential difference of between 30,000 and 100,000 volts. The potential difference applied to the electrodes is adjusted to such
10 value that the abrasive particles on the feed belt 41 become charged and are propelled toward the upper plate 24 and strike the adhesive coating on the web P with sufficient force to partially embed themselves and adhere thereto. We have
15 found, other factors remaining constant, that the electromotive force required to electrostatically propel the charged granules into engagement with the adhesively coated web varies in proportion to the size or mass of the granules; that is,
20 a higher electromotive force is required for large grain than for a smaller size. For grits of from 50 to 200 mesh and finer, we have found that potential differences of from 30,000 to 50,000 volts are suitable. Coarser grits require higher volt-
25 ages and in the case of grits as large as 16 mesh, an electromotive force of about 90,000 volts may be required to orient and propel the granular material from the feed belt to the adhesive coated web. Thus, by means of the variable voltage
30 apparatus, the potential difference applied to the electrodes can be adjusted to such a value that grain of a certain specific size will be electrically deposited on the adhesive coating, whereas any grain of a larger size, which might be present on
35 the feed belt, will remain and be carried into the bin 47.

We have found that inasmuch as the grain is raised from the feed belt by electrostatic forces and that the quantity of grain that is raised is
40 controllable by adjustment of the potential difference supplied to the electrodes, an excess of grain on the feed belt is desirable for the production of a uniform coating on the web. If it is found that the density of the coating being ap-
45 plied to the web is lighter than desired, an increase in the potential difference applied to the electrodes will cause more grain to rise and become embedded in the adhesive coating of the web. Conversely, if a heavier coating than is
50 desired is being deposited on the adhesive coated web, a decrease in the potential difference applied will operate to make the coating less dense. After being coated with granular material, the web is then moved through a zone in which the adhe-
55 sive is given a preliminary set in order to fix the particles in the positions they took when they were deposited upon the adhesive coated web. The position of the granular coated web while it is moving through this zone is such that the
60 grains hang substantially vertically like tiny pendulums. Those grains that have been oriented in the desired positions remain so oriented because of gravitational attraction, and those grains that impinged upon the adhesive coating at any
65 other angle than the desired angle are pulled into the desired positions by the action of gravity. Thus, gravity is utilized not only to preserve a particular orientation but to produce the desired orientation.

70 Apparatus constructed in accordance with our invention has the advantage that it is simple to construct, easy to operate, and flexible as to adjustment to meet different conditions. There are no complicated mechanical movements nor
75 delicate parts to get out of order. When once

adjusted to produce the desired type of coating it operates with no more attention than is required in the ordinary type of coating machine and when adjustments are necessary, they can be made very simply by changing the applied
5 potential difference or by changes in the relative positions of the various parts of the apparatus.

Raising or lowering of the frame 50, which carries with it the grain depositing apparatus, and a slight shift in the relative positions of the
10 upper and lower electrodes, is all that is necessary to produce webs in which the grains are positioned at different angles. When the frame 50 is more nearly horizontal than vertical, the elec-
15 trodes 23 and 24 being positioned to produce a substantially vertical field, the particles are deposited upon the adhesive coated web at an angle very much smaller than the angle at which they are deposited when the frame is in a position less
20 nearly horizontal. The ease with which this change from a small angle to a relatively large angle, or vice versa, can be made is of great advantage.

The control of the density of the coating on the web by the change in field intensity or by the
25 use of a different number of lower electrodes, either large or small, also is of considerable advantage because it permits close adherence to standards of quality as to weight of grain per unit of surface and also because it makes it
30 possible to eliminate coarse grits that might get into the grain mixture.

Another simple adjustment that can be made with apparatus made in accordance with our in-
35 vention is the alteration of the density of the granular coating by moving the web closer to the feed belt. The grains are projected upwardly as a rain or spray, not as a body, and not all of the particles raised by the electrostatic forces are projected the same distance. By mov-
40 ing the web closer to the feed belt, those particles which would otherwise fall back to the feed belt are caught by the adhesive coating and held.

Apparatus constructed in accordance with our
45 invention has the advantage that gravitational attraction serves to assist in the orientation of the particles on the web and to preserve the desired orientation once it has been secured. The position of the web while the adhesive is yieldable
50 is such that the particles tend to turn into vertical positions if they are not already arranged in that direction, and since the web is at the preferred angle with respect to the vertical the particles therefore assume the preferred angularity.
55 This advantageous use of gravitational force has not been found in any of the machines heretofore known for applying granular materials to webs.

Other advantages will be apparent from the
60 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.
65

We claim:

1. Apparatus for the manufacture of granular coated webs comprising means for supporting an adhesive coated web with an adhesive side
70 downward, a plurality of interconnected electrodes spaced apart from each other and positioned above said web, a plurality of interconnected, electrodes spaced apart from each other and positioned below said web, the inter-
75 acting electrodes on either side of the web being

so positioned that a line drawn through the longitudinal axes of any pair of interacting electrodes will intersect the plane of the web at an oblique angle, and means located above said lower electrodes and below said web for supporting granular material.

2. Apparatus for the manufacture of granular coated webs comprising means for movably supporting an adhesive coated web with an adhesive side downward, a plurality of interconnected electrodes spaced apart from each other and positioned above said web, a plurality of interconnected electrodes spaced apart from each other and positioned below said web, the interacting electrodes on either side of the web being so positioned that a line drawn through the longitudinal axes of any pair of interacting electrodes will intersect the plane of the web at an oblique angle, and movable means located above said lower electrodes and below said web for supporting granular material.

3. Apparatus for the manufacture of granular coated webs comprising means for supporting an adhesive coated web with the adhesive side downward, a plurality of interconnected electrodes spaced apart from each other and positioned above said web, a plurality of interconnected electrodes spaced apart from each other and positioned below said web, the interacting electrodes on either side of the web being so positioned that a line drawn through the longitudinal axes of any pair of interacting electrodes will intersect the plane of the web at an oblique angle, means located above said lower electrodes and below said web for supporting granular material, and means for applying a potential difference to the upper and lower electrodes, said apparatus being adapted to electrostatically project granular material against the downwardly facing adhesive surface of said web.

4. Apparatus for the manufacture of granular coated webs comprising means for movably supporting an adhesive coated web with the adhesive side downward, a plurality of interconnected electrodes spaced apart from each other and positioned above said web, a plurality of interconnected electrodes spaced apart from each other and positioned below said web, the interacting electrodes on either side of the web being so positioned that a line drawn through the longitudinal axes of any pair of interacting electrodes will intersect the plane of the web at an oblique angle, movable means located above said lower electrodes and below said web for supporting granular material, and means for applying a potential difference to the upper and lower electrodes, said apparatus being adapted to electrostatically project granular material against the downwardly facing adhesive surface of said web.

5. Apparatus for the manufacture of granular coated webs comprising means for movably supporting an adhesive coated web with an adhesive coated side downward, a plurality of interconnected electrodes of good conducting material spaced apart from each other and positioned above said web, a plurality of interconnected electrodes of poorly conducting material spaced apart from each other and positioned below said web, the interacting electrodes on either side of the web being so positioned that a line drawn through the longitudinal axes of any pair of interacting electrodes will intersect the plane of the web at an oblique angle, movable means located above said lower electrodes and below said web for supporting granular material, and means

for applying a potential difference to said upper and said lower electrodes, said apparatus being adapted to electrostatically project granular material against the downwardly facing adhesive surface of the web.

6. An apparatus for the manufacture of granular coated webs comprising a plurality of electrodes of good conducting material spaced apart from each other and positioned above a plurality of electrodes of a material having sufficient conductivity to permit a leakage current to flow therethrough, but of sufficient resistance to prevent spark-over or arcing to the upper electrodes, means for applying a potential difference to the said upper and lower electrodes, means for supporting an adhesive coated web between said electrodes and with an adhesive coated surface downward, the interacting electrodes on either side of the web being so positioned that a line drawn through the longitudinal axes of any pair of interacting electrodes will intersect the plane of the web at an oblique angle, movable means located above said lower electrodes and below said web for supporting granular material, and means for applying a potential difference to said upper and said lower electrodes, said apparatus being adapted to electrostatically project granular material against the downwardly facing adhesive surface of the web.

7. Apparatus for the manufacture of granular coated webs comprising electrostatic means for projecting the granular material vertically upward, means for movably supporting an adhesive coated web at an oblique angle with respect to the vertical and with an adhesive coated side downward to receive the upwardly projected granular material, and means for causing the adhesive to acquire a preliminary set located adjacent to said electrostatic projecting means and in a position subsequent thereto with respect to the direction of movement of said web.

8. Apparatus for the manufacture of granular coated webs comprising the electrostatic means for projecting granular material upwardly at an oblique angle with respect to the vertical, means for movably supporting an adhesive coated web in a horizontal position with an adhesive coated surface facing downward to receive the upwardly projected granular material, and means for causing the adhesive to acquire a preliminary set without disturbing the positions of the deposited granules, said means being located adjacent to said electrostatic projecting means and in a position subsequent thereto with respect to the direction of movement of said web.

9. In combination, means for electrostatically projecting granular material upwardly comprising a plurality of electrodes of good conducting material spaced apart from each other and positioned above a plurality of electrodes of poor conducting material and spaced apart from each other and means for applying the potential difference to the said upper and lower electrodes, means for supporting an adhesive coated web between said upper and said lower electrodes with an adhesive coated surface downward, said electrostatic projecting means and said web supporting means being positioned with respect to each other to cause the projected granular material to be deposited on the web at an oblique angle with respect to the surface of said web, means for supplying granular particles between said web and the said lower electrodes and means for causing the adhesive to acquire a preliminary set located adjacent to said electrostatic means for project-

ing granular material upwardly and in a position subsequent thereto with respect to the direction of movement of said web.

10. Apparatus for the manufacture of granular coated webs having particles oriented at an oblique angle, comprising electrostatic means for projecting the granular material upward, means for movably supporting an adhesive coated web

at an oblique angle with respect to the upward projection of said granules and with an adhesive side downward to receive the upwardly projected granular material.

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