Jan. 23, 1962 K. SITTEL 3,017,982

METHOD AND APPARATUS FOR HANDLING CHARGED PARTICLES

Filed July 12, 1957 2 Sheets-Sheet 1

FIG. 1.

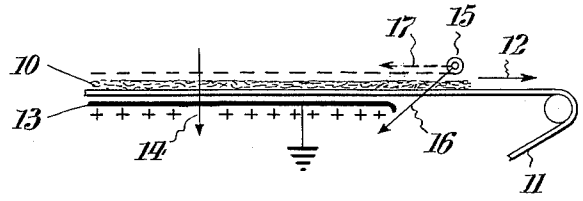


FIG. 2.

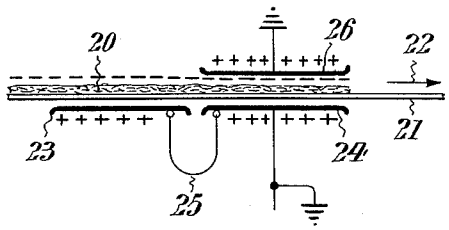


FIG. 3.

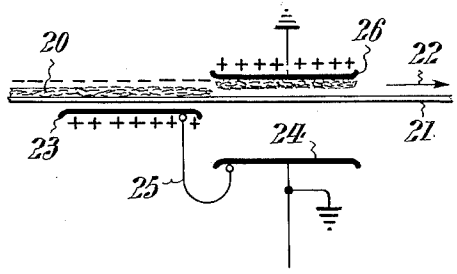


FIG. 4.

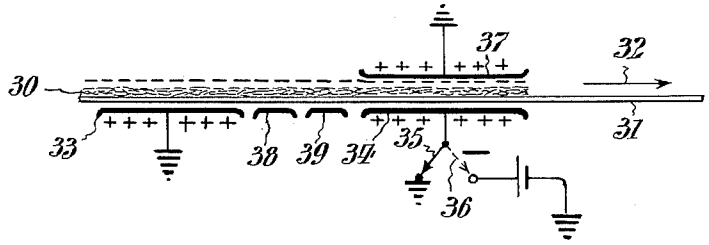
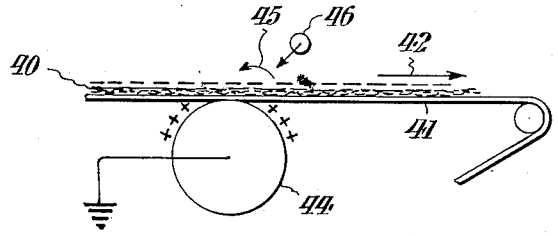


FIG. 5.



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Filed July 12, 1957 2 Sheets-Sheet 2

FIG. 6

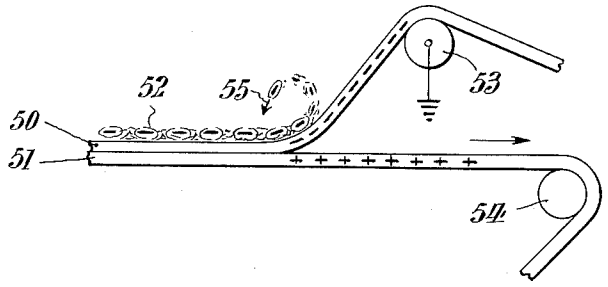


FIG. 7

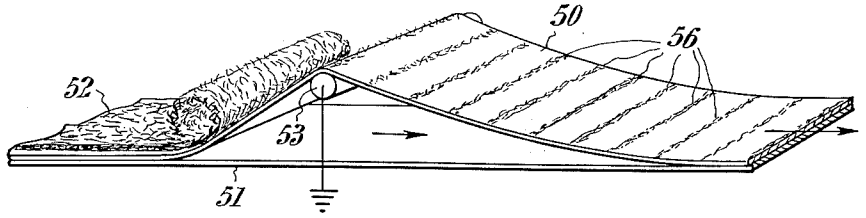
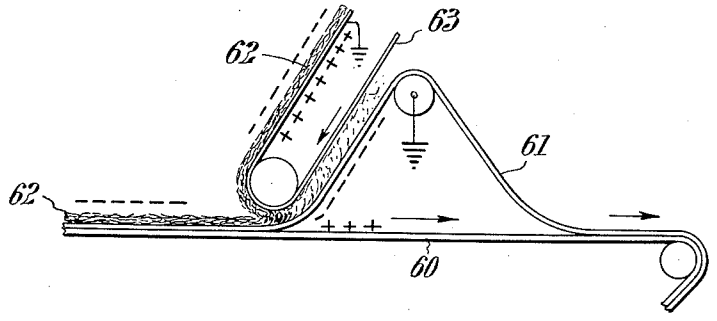


FIG. 8



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METHOD AND APPARATUS FOR HANDLING CHARGED PARTICLES

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16 Claims. (Cl. 198—1)

This invention relates to a method and apparatus for handling small particles and particularly particles of a substantially dielectric material capable of carrying an electrostatic charge. More specifically, the invention relates to a method and apparatus for handling relatively large quantities of glass fibers as an incident to the formation of mats and shaped articles of resin bonded Fiberglas.

In my co-pending patent applications, Serial No. 648,336, filed March 25, 1957; Serial No. 559,221, filed January 16, 1956 and Serial No. 476,733, filed December 21, 1954, I have described methods and apparatus for forming Fiberglas mats and shaped articles. In each case the glass fibers have been given an electrostatic charge by means of corona discharge and the further handling of the particles has been accomplished by means of electrostatic attraction. One of the principal problems arising in the handling of electrostatic charged particles on a moving belt or the like arises from any attempt to transfer the particles in mass from one moving surface to another. This invention is directed primarily to a method and apparatus for controlling the transfer of charged particles from one surface to another and for controlling charged particles on moving belts or the like.

The handling of small particles by acting upon electrostatic charges which they carry is known in the art. By way of example, electrostatic precipitation has been used to control particles dispersed in air. However, the control of particles for the purpose of forming a mat or shaped object requires a measure of particle control which has heretofore not been achieved. In my co-pending applications I have described means for transferring charged particles from one surface to another by means of gravity and the use of an attracting electrode. I have now found that charged particles may be moved and handled by means of the controlled withdrawal of an attracting force.

It is a principal object of this invention to provide a method and apparatus for controlling the movements of a mass of electrostatically charged particles in a moving system.

It is also an object of this invention to provide a method and apparatus for transferring charged particles in a moving system.

It is a further object of this invention to transfer a mass of charged particles from one moving surface to another.

It is a still further object of this invention to provide an economical and efficient apparatus for handling electrically charged glass fibers in the formation of resin bonded glass fiber mats and shaped articles.

These objects and others are achieved by the invention set forth in the following description and drawings of which:

FIG. 1 is a diagrammatic elevation showing charged particles carried on a moving belt being controlled in accordance with one embodiment of the invention.

FIG. 2 is a diagrammatic side elevation illustrating another embodiment of the invention wherein the charged particles are transferred from a moving belt to a stationary electrode.

FIG. 3 is a diagrammatic side elevation further illustrating the embodiment of FIG. 2 wherein the electrode is withdrawn from the surface of the moving belt.

FIG. 4 is a diagrammatic side elevation illustrating a still further specific embodiment of the invention wherein

the charge is withdrawn without physically withdrawing the electrode.

FIG. 5 is a diagrammatic side elevation illustrating another embodiment of the invention wherein the charge buildup on the particles is removed by means of alternating current.

FIG. 6 is a diagrammatic side elevation illustrating a still further embodiment of the invention employing a split moving belt.

FIG. 7 is a diagrammatic perspective view similar to FIG. 6.

FIG. 8 is a diagrammatic side elevation illustrating the transfer of charged particles from one moving surface to another in accordance with the invention.

In FIG. 1 a mass of negatively charged electrostatic particles 10 is shown being carried on a moving belt 11 in the direction of the arrow 12. Beneath the belt 11 is positioned electrode 13 which is grounded. By virtue of the negatively charged particles 10 a positive charge is induced on the back of electrode 13, resulting in a force acting on fibers 10 in the direction indicated by arrow 14. As the fibers 10 pass over electrode 13 on belt 11 they are retained against the belt 11 by this force. However, electrode 13 has fixed dimensions and where it ends along the path of travel along the belt 11 the particles 10, as indicated in FIG. 1 tend to be propelled back along the surface belt 11 and to move against the direction of travel of the belt 11. This result is obtained because of the forces acting on the particle 10. Taking a specific particle 15 at the position indicated, the net attracting force of grounded electrode 13 is indicated by arrow 16. This force 16 has a component 17 directed oppositely to the direction of travel of the belt 11 and causes the particles 15 to move in the direction of force 17.

The phenomenon illustrated in FIG. 1 is utilized as shown in FIGS. 2–4. In FIG. 2 the particles 20 are carried on a moving belt 21 in the direction of arrow 22. In this case the electrode beneath belt 21 is in two separate parts, 23 and 24, connected by wire 25. Opposite electrode section 24 and above particles 20 is another grounded electrode 26. As shown in FIG. 2, the particles 20 passing thraugh the electrodes 23, 24, and 26 adhere to belt 21. However, if electrode section 24 is suddenly withdrawn from belt 21 as illustrated in FIG. 3 the particles 20 positioned under electrode 26 will be propelled upward against that electrode. By this means the particles have been transferred from a moving to a non-moving surface without the use of an electrode charged other than by the charge on the particles themselves. In FIG. 4 particles 30 are carried on belt 31 in the direction of arrow 32. Grounded electrode 33, with its induced positive charge, acts to retain particles 30 on belt 31. Transfer electrode 34 is provided with a switch enabling it to be grounded or to carry a negative charge. Electrodes 33 and 34 are separated by insulated electrodes 38 and 39. These electrodes are not grounded and are provided to prevent arcing between electrodes 33 and 34. When it is grounded, as indicated by the solid arrow, 35, the particles 30 are carried on belt 31. When the electrode 30 is in the negative position indicated by broken arrow 36 the particles 30 will be propelled upward from the belt 30 to grounded electrode 37.

FIG. 5 illustrates a specific embodiment of the invention wherein fibers 40 carried on belt 41 in the direction indicated by arrow 42. Rotating drum 44 is a grounded electrode and carries an induced positive charge as a result of the negative charge on the particles 40 carried on belt 41. In accordance with the method of FIG. 1, the fibers 40 which have passed over electrode 44 will tend to follow the direction of arrow 45. However, alternating current discharge electrode 46 is positioned above belt 41 discharging in the direction of the particles 40

and electrode 44. Electrode 46, by its alternating current discharge, removes the negative charges from particles 40 enabling them to continue to travel along belt 41 in the direction of arrow 42. Thus the alternating current from electrode 46 serves to prevent the uncontrolled movement of particles 40 on belt 41.

In FIG. 6 a split belt is employed having upper layer 50 and lower layer 51, carrying negative charged particles 52. The particles 52 are carried by the layer 50 as shown over grounded roller 53. Layer 51 is directed over roller 54. At the point of separation of the layers 50 and 51 the particles 52 follow the direction indicated by arrow 55. The layers 50 and 51 must be selected to produce the necessary electrostatic effect at the point of separation. It has been found that if the layers 50 and 51 are carried in close proximity as illustrated in FIG. 6, when they are separated, depending upon the particular quality of the material used, they will acquire charges of opposite polarity. Of a number of materials tested, results were obtained as indicated in the following table.

Layer 51	Polarity	Layer 50	Polarity
Polyethylene	+	Saran	−
KL-F	+	Polyethylene	−
Mylar	+	Saran	−
Mylar	+	KL-F	−

(KL-F is a film of a polymer of trifluorochloroethylene; Mylar is a film of a polester made from polyethylene terephthalate; Saran is a film of vinylidene chloride.)

Thus by employing the material indicated in the table for layers 51 and 50 the results illustrated in FIG. 6 will be obtained. If particles 52 are negatively charged, materials should be used to produce a negative charge on layer 50. These materials utilize high surface charges developed by intimate contact followed by separation of the two materials whereby layer 50 acquires a high negative charge which repulses the particles 52. By adjusting the angle of separation of the two layers the effect of the separation of the particles may be varied. Thus if the angle is steep none of the articles will pass beyond the point of separation. If the angle of separation is made less steep, as shown in FIG. 7, the fibers, upon reaching the point of separation, will roll back from it in a continuously rolling mass which builds up to a point at which a number of particles in a defined line 56 passes beyond the separation point and is carried forward by the belt 50. In this case it has been found that the fibers tend to align themselves with the axis of the roller 53. It will then be seen that, without the use of any additional electrostatic charges, an economical and efficient method of aligning and quantisizing particles is provided.

The method illustrated in FIGS. 6 and 7 may be further employed as shown in FIG. 8. There the fibers 62 are carried on layer 61 which is in intimate contact with layer 60 to the point of separation. Moving belt 63 is positioned above layer 61 beyond the separation point. This belt may be grounded or charged opposite the charge on the fibers. It has been found that by merely passing the grounded belt 63 over the particles 62 at the point of separation, the particles are propelled from layer 61 to belt 63 to which they adhere. It will again be apparent that a simple and economical method has been provided for transferring small particles from one moving surface to another without employing any electrostatic forces other than those carried by the particles themselves.

One of the principal values of the invention lies in the provision of a method and apparatus for controlling the movement of small particles carrying an electrostatic charge in which the controlled movement of the particles is achieved by means of the charges on the particles themselves. It is thus unnecessary to provide oppositely charged electrodes at every point at which it is desired to move or transfer the particles. By employing the method and apparatus of the invention, the charged particles can be aligned, quantisized, transferred in bulk or transferred continuously without additional external high voltage equipment.

It will be apparent that the invention is directed to a very basic method of handling particles and that many variations in the method and apparatus may be employed without departing from the spirit of the invention as defined by the following claims:

Having thus described my invention I claim:

1. A method of handling charged particles of a substantially non-conductive material comprising moving said particles on a substantially non-conductive moving belt in a predetermined direction, placing an electrostatic charge of opposite polarity to the charge on said particles on the side of said belt opposite said particles and suddenly removing said last mentioned charge thereby causing said particles to be propelled away from the surface of said belt.

2. A method of handling charged particles of a substantially non-conductive material, comprising carrying said charged particles on a moving belt of a substantially non-conductive material between two grounded electrodes, one of said electrodes being disposed on the side of said belt opposite said particles and having an induced charge of opposite polarity to the charge on said particles, and suddenly removing at least a portion of said last mentioned electrode, thereby causing said particles to be propelled toward said other electrode.

3. A method of handling charged particles of a substantially non-conductive material, comprising moving said charged particles on a moving belt over a plurality of grounded electrodes, thereby causing said particles to adhere to said belt, passing said belt and said particles between two grounded electrodes and placing a charge on the electrode beneath said belt, said charge being of opposite polarity to the charge on said particles to be propelled toward the other of said two electrodes.

4. A method of handling charged particles of a substantially dielectric material, comprising depositing said charged particles on a moving belt of a substantially dielectric material, placing a grounded electrode on the side of said belt opposite said particles and directing an alternating current electrical discharge toward said fibers and the line of separation between said belt and said grounded electrode whereby the electrostatic charge on said particles is discharged so that the particles will remain on said belt in the direction of travel of said belt.

5. A method of handling charged particles of a substantially dielectric material, comprising moving said particles on a two-layer moving belt of a substantially dielectric material and separating the layers of said belt at a predetermined point thereby causing the layer of said belt adjacent the particles to acquire the same charge as said particles propelling said particles from the surface of said belt.

6. The method of claim 5 wherein the angle of separation between the layers of said belt is maintained at a predetermined size whereby a portion of said particles at relatively evenly spaced intervals adhere to said belt and are carried thereby beyond said separation point.

7. A method of transferring charged particles of a substantially dielectric material from one moving belt to a second moving belt, comprising moving said particles on a two-layer belt of a substantially dielectric material, and transferring said particles to a second moving belt by separating the layers of said first mentioned belt and causing the layer of said belt adjacent the particles to acquire the same charge as the particles.

8. Apparatus for handling charged particles of a substantially dielectric material comprising a moving belt of a substantially dielectric material for carrying said particles, a two-part electrically connected grounded electrode disposed beneath said belt, and a second grounded electrode disposed above said particles and said belt and substantially over one of the parts of said two-part elec-

trode, said last mentioned part of said two-part electrode being adapted to be removed from beneath said belt whereby the portion of said particles disposed beneath said second grounded electrode are transferred to said second grounded electrode.

9. Apparatus for handling charged particles of a substantially dielectric material comprising a pair of spaced, grounded electrodes, means for conveying said particles between said electrodes and means for placing a charge on one of said electrodes of the same polarity as the charge on said particles, whereby the portion of said particles between said electrodes is transferred from said conveying means to the remaining grounded electrode.

10. Apparatus for handling charged particles of a substantially dielectric material comprising continuously moving means for carrying said particles, a grounded electrode disposed on the side of said moving means opposite said particles and means for directing an alternating current electrical discharge toward said particles on said moving means and the line of separation between said moving means and said grounded electrode.

11. Apparatus for handling charged particles comprising a two-layer continuously moving belt wherein the layers are composed of materials which enable the layers to acquire substantial electrostatic charges of opposite polarity when the layers are separated and in which the layer of said belt adjacent the particles acquires a charge of the same polarity as the charge on the particles, means for continuously separating said layers and grounded conveying means disposed adjacent one of said layers along a portion of said layer which is separated from the other layer of said belt.

12. Apparatus for handling charged particles comprising a two-layer belt wherein one layer is polyethylene and the other layer is Saran.

13. Apparatus for handling charged particles comprising a two-layer belt wherein one layer is KL–F and the other layer is polyethylene.

14. Apparatus for handling charged particles comprising a two-layer belt wherein one layer is Mylar and the other layer is Saran.

15. Apparatus for handling charged particles comprising a two-layer belt wherein one layer is Mylar and the other layer is KL–F.

16. A method of handling charged particles of a substantially non-conductive material comprising moving said particles on a substantially non-conductive moving belt in a pre-determined direction over and past a grounded electrode of fixed dimensions and propelling said particles away from said belt at a point immediately past said electrode in the travel of said particles on said belt.

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