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3,551,178

METHOD AND APPARATUS FOR ELECTROSTATIC FLOCKING

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2 Sheets-Sheet 1

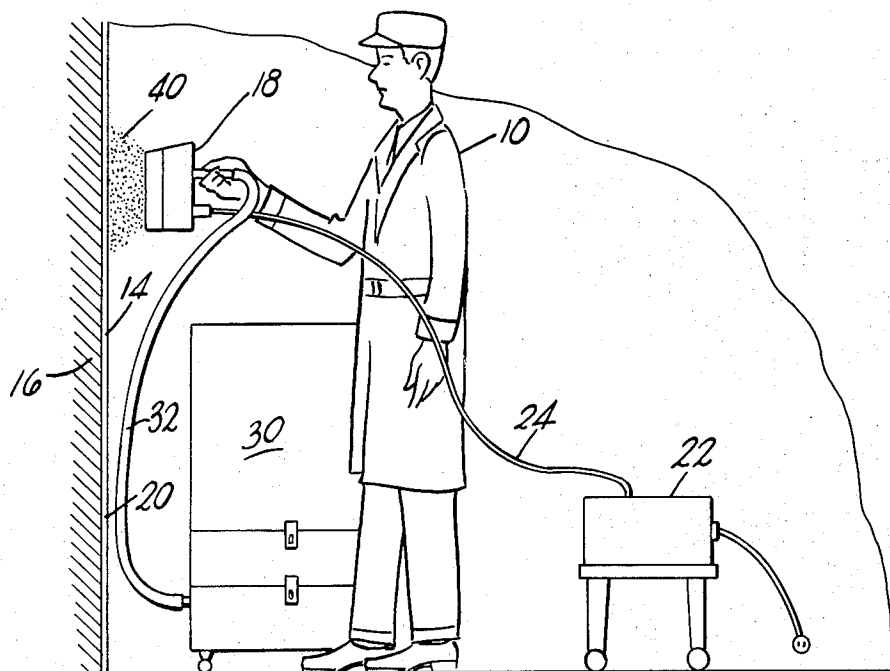


FIG. 1

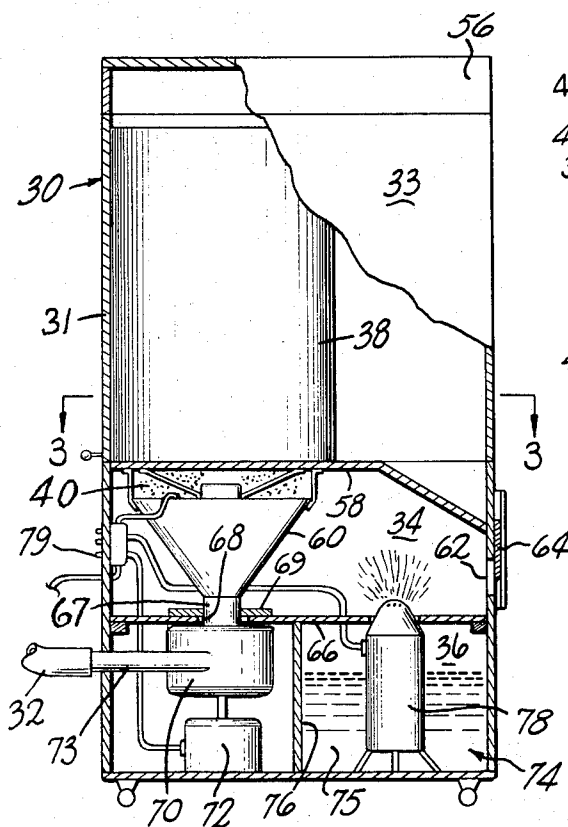


FIG. 2

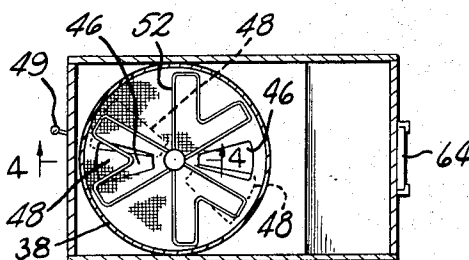


FIG. 3

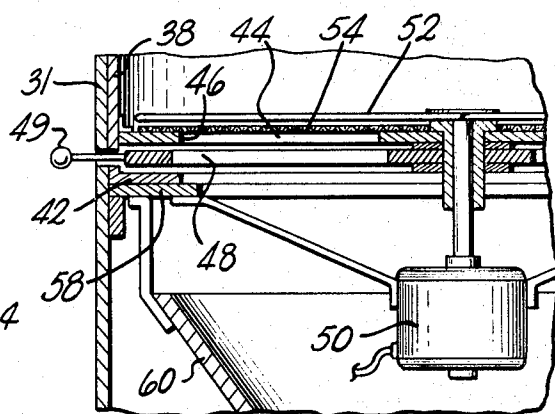


FIG. 4

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2 Sheets-Sheet 2

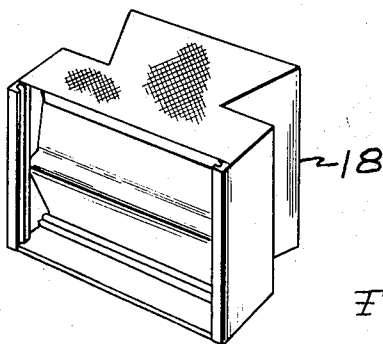


FIG. 5

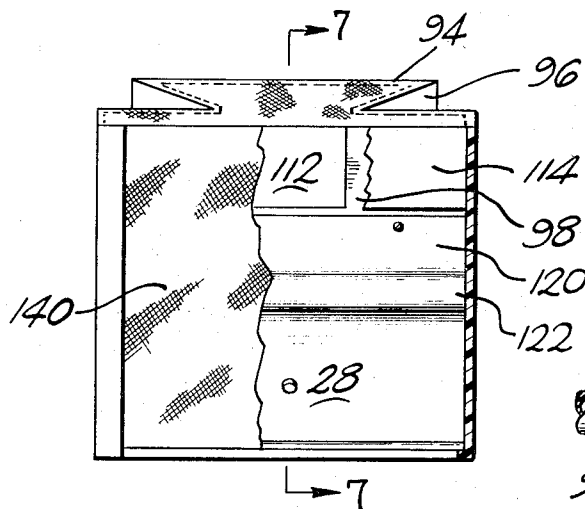


FIG. 6

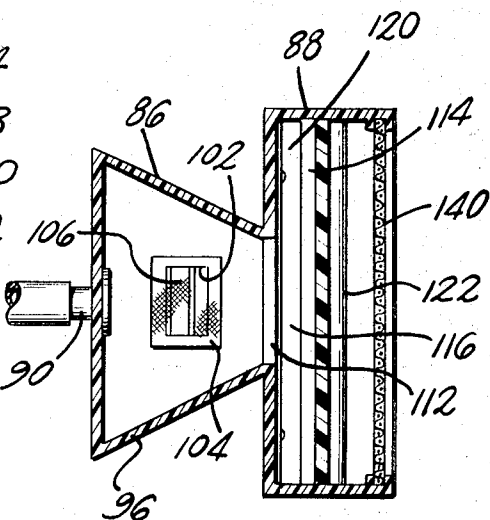


FIG. 8

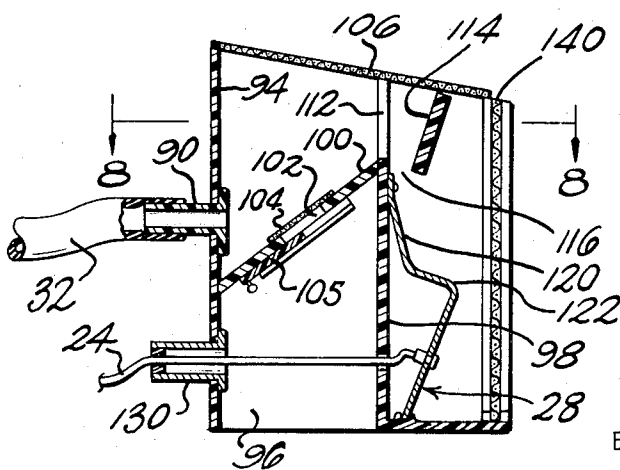


FIG. 7

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3,551,178

## METHOD AND APPARATUS FOR ELECTROSTATIC FLOCKING

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11 Claims

### ABSTRACT OF THE DISCLOSURE

Method and apparatus for electrostatic application of flock coating are disclosed. An electrostatic flocking machine includes a portable hand-held applicator having an electrode therein which is energized to establish an electrostatic field between the electrode and a wall that is to be flocked with fibers. There is a bulk fiber storage receptacle separate and remote from the applicator. Loose fibers are blown from the receptacle through a duct to the applicator. The air which transports the fibers from the receptacle to the applicator is preferably humidified to enhance the electrostatic deposition of the fibers onto the wall. The applicator includes a baffle and screen arrangement which separates the moving fibers from the moving air and directs the fibers downwardly in front of the electrode and into the field. The baffles are constructed so that the fibers fall downwardly toward the electrode primarily due to gravity. The screens allow moving air to escape from the applicator and substantially eliminate or, at the least, greatly reduce the effect of the moving air on the motion of the fibers just before the fibers are introduced into the electrostatic field.

This invention relates to electrostatic application of fiber-coatings and more particularly to a method and apparatus for continuously feeding loose fibers into an electrostatic field during an electrostatic flocking operation. The present invention is particularly useful with electrostatic methods and apparatus wherein a hand-held applicator is used to apply fiber-coatings to a wall and the like such as disclosed in my copending application entitled "Electrostatic Flocking," Ser. No. 382,501, filed July 14, 1964 now abandoned and in U.S. Pat. No. 2,706,963, entitled "Device for Fiber-Coating Materials and Objects" and granted to Rudolf Hug on Apr. 26, 1955. In one embodiment of the invention of my aforementioned application and also in the aforementioned Hug patent (FIG. 4), a portable hand-held applicator is used in fiber-coating or flocking a wall. The applicator carries one electrode and also serves as a fiber container. Fibers are disposed in the container so that they can be introduced, as by shaking the applicator, into an electrostatic field created by the electrode. However, the applicator has only limited fiber storage capacity compatible with manual manipulation of the applicator and thus when flocking walls or other large areas, the flocking process must be interrupted from time to time to refill the applicator with fibers. This decreases the efficiency of the flocking operation and thus increases the cost thereof. Small size and lightweight construction of the applicator are limited to some extent by the electrode configuration. Thus, if an applicator is constructed to have greater fiber capacity it will be larger, heavier and bulkier, making the applicator difficult to manipulate and the work load greater.

The present invention contemplates a method and an apparatus of electrostatic flocking, particularly of the type referred to hereinabove wherein the flocking fibers are stored in a receptacle separate and remote from the portable applicator. During a flocking operation, the fibers

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are blown from the receptacle through a flexible hose to the applicator to continuously supply fibers as required by the flocking operation. By this arrangement, the size and weight of the applicator can be reduced and effective flocking is achieved more efficiently, with less work and greater ease in handling of the applicator by comparison to the aforementioned prior art techniques. Humidity control and a particular construction of the applicator are also contemplated by the present invention to further improve the flocking operation.

Thus, the objects of the present invention include providing methods and apparatus of electrostatic flocking that overcome the aforementioned disadvantages; that provide uniform and controllable introduction of fibers into the electrostatic field; that provide a simple arrangement for moistening fibers when required and thus further improve the electrostatic flocking operation; that are easier to employ, require less work and are more efficient and more economical by comparison to prior art techniques.

Other objects, features and advantages of the present invention will become apparent in connection with the following description, the appended claims and the accompanying drawings in which:

FIG. 1 diagrammatically illustrates an operator using a portable applicator to apply flocking material to a wall according to the present invention;

FIG. 2 is a view, partly broken away and in section, of apparatus for storing bulk fibers and blowing the fibers to the hand-held applicator;

FIG. 3 is a fragmentary horizontal section taken on line 3—3 of FIG. 2 to illustrate a sifter outlet construction of a fiber storage bin;

FIG. 4 is a horizontal section taken on lines 4—4 of FIG. 3;

FIG. 5 is a perspective view of the portable applicator;

FIG. 6 is a front view, partly broken away and in section, of the applicator;

FIG. 7 is a vertical section taken on line 7—7 of FIG. 6; and

FIG. 8 is a horizontal section taken on line 8—8 of FIG. 7.

FIG. 1 illustrates an operator 10 applying flocking fibers to the exposed surface 14 of a solid wall 16 with a hand-held applicator 18. Surface 14 is coated with a layer of conductive adhesive 20 which in the preferred embodiment is treated by adding finely divided metallic particles thereto to increase the conductivity of the adhesive. A portable direct-current power supply has one of its output terminals (not shown) connected via a shielded lead 24 to an electrode 28 in applicator 18. In the illustrated and preferred embodiment of the present invention, the other output terminal of the power supply 22 need not be connected to either wall 16 or adhesive 20 for performing the flocking operation as set forth in greater detail in my aforementioned prior application. However, the present invention also contemplates a two-lead system such as disclosed in the aforementioned Hug patent wherein the other output terminal from power supply 22 is electrically connected to the adhesive coated wall 16 so that wall 16 serves as a second activated electrode. Reference may be had to either my prior application or to the aforementioned Hug patent for further details of the system thus far described and the operation thereof by which fibers can be electrostatically deposited on wall 16.

In accordance with one important aspect of the present invention, there is a fiber storage and blowing unit 30 which is connected to applicator 18 by a flexible hose 32 to continuously supply fibers to the applicator 18 during a flocking operation. Referring to FIGS. 2—4, the unit 30 generally comprises a housing 31 divided generally into an upper section 33, a middle section 34 and a bottom section 36. Mounted in the top section 33 of housing 31

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is a cylindrical receptacle or bin 38 containing bulk flocking fibers generally indicated at 40. The bottom of bin 38 is formed with a radially inwardly projecting, annular flange 42. A circular bottom plate 44 is mounted in the lower portion of bin 38 spaced just above flange 42. Plate 44 has a pair of openings 46 which serve as an outlet for the bin. The effective size of the outlet openings 46 is controlled by an adjustable gate plate 48 rotatably mounted in the space between plate 44 and flange 42. Plate 48 has a handle 49 which extends radially outwardly therefrom through suitable openings in the bin 38 and housing 31 so that an operator can adjust the fiber flow rate through outlet openings 46. A motor 50 is suitably mounted on housing 31 below and centrally of bin 38. Motor 50 drives a sifter blade 52 disposed above plate 44 to agitate fibers 40 and thus facilitate flow thereof through the outlet openings 46. A screen 54 is mounted on top of plate 44 below blade 52 to block passage of agglomerated fibers. The upper section 33 also has a removable cover 56 for access thereto as when filling bin 38. The upper section 33 is preferably hinged to the middle section 34 to provide easy access to the middle section 34.

The upper section 33 is separated from the middle section 34 by a generally horizontal partition 58 removably mounted on housing 31 and having an opening therein aligned with the outlet of bin 38. A conical hopper 60 is mounted in the middle section 34 of housing 31 as by rigid suspension on partition 58. Hopper 60 is disposed directly below bin 38 to receive fibers 40 passing through the outlet openings 46. The top of hopper 60 is spaced below partition 58 to provide a vent through which air is drawn into the hopper. At one side of housing 31 is an outside vent 62 communicating with the middle section 34. The effective size of vent 62 can be varied by an adjustable gate 64. Preferably, housing 31 is reasonably airtight except for vent 62 so that all the air flow through the unit 30 can be effectively controlled. However, special precautions are not necessary since generally the air flow does not require narrow tolerance control.

The middle section 34 is separated from the lower section 36 by a partition 66 removably mounted on the lower section. Hopper 60 has a tubular outlet portion 67 which passes downwardly through a suitable opening 68 in partition 66. A flat rigid gasket 69 is mounted on the hopper portion 67 to seal the opening 68. The hopper outlet portion communicates with the inlet of a centrifugal blower 70 mounted in the lower section. Blower 70 is driven by a motor 72 and has an outlet 73 which passes outwardly through housing 31 and is connected to hose 32. The lower section 36 also houses a humidifier indicated generally at 74 for adding moisture to the air being drawn through the middle section 34. Various types of humidifiers may be used but for purposes of illustration, humidifier 74 is shown as comprising a water tank 75 formed by a transverse wall 76 in the lower section 36. An atomizer 78 is mounted in tank 75 with its outlet communicating upwardly through partition 66 and into housing section 34 so that atomized water particles are directed into the air drawn through port 62.

Also in the preferred embodiment, the middle section 34 is hinged or otherwise removably secured to the lower section 36 to provide access to blower 70 and humidifier 74. It is also desirable but not essential that partitions 58, 66 are constructed so that excessive moisture and condensation in the middle section 34 cannot readily pass into either the upper section 33 or the lower section 36. Suitable electrical connections are made to sifter motor 50, blower motor 72 and atomizer 78. The speed of blower 70 can be varied by means of suitable electrical controls 79 for motor 72. The atomization rate of the atomizer 78 may also be made variable by suitable controls, although an On-Off atomizer can provide satisfactory humidity control for most applications.

Referring more particularly to FIG. 5-8, the applicator 18 is formed with a rear inlet section 86 and a front outlet section 88. In general, the inlet section 86 receives the

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air and entrained fibers 40 from hose 32, separates the moving fibers 40 from the moving air and delivers the fibers to the front section 88 where they are directed downwardly into the electrostatic field primarily under the influence of gravity. More particularly, the applicator end of hose 32 is fastened on a supporting sleeve 90 which passes through and is fastened on a rear wall 94 to serve as a handle and an inlet for applicator 18. The rear section 86 has side walls 96 which converge forwardly and laterally inwardly from the rear wall 94 to a back wall 98 of the front section 88. The side walls 96 extend the full height of the applicator. An inclined partition 100, trapezoidal in shape, is fastened at its lower rear end to wall 94 below the sleeve 90. Partition 100 extends transversely between the side walls 96 and is inclined forwardly and upwardly with its forward edge joined to wall 98 just below the top of the applicator at the bottom of a rectangular cutout 112 in the wall 98.

Partition 100 has a rectangular opening 102 therethrough disposed directly in front of sleeve 90 and covered by a fine mesh silk screen 104. A flat stop or plate 105 is slidably mounted on the underneath side of partition 100 to adjust the effective size of the opening 102. Air entering the rear section 86 can pass freely through screen 104 whereas the fibers 40 cannot and thus partition 100 and screen 104 deflect the fibers upwardly and forwardly in section 86 while permitting some of the moving air to pass through the screen and out of the lower open end of section 86. The entire top of the applicator 18 is also open and is covered by a second fine mesh silk screen 106 to permit moving air to pass freely therethrough while containing fibers 40 within the applicator.

The cutout 112 at the top of wall 98 extends transversely between the side walls 96. Fibers directed upwardly by partition 100 pass from the rear section 86 through cutout 112 into the front section 88. Directly in front of cutout 112 is a baffle 114 which extends the full width of the front section and is inclined downwardly and rearwardly from the top screen 106 toward wall 98 with the lower edge of the baffle generally horizontally in line with the bottom of cutout 112. Baffle 114 catches the fibers 40 entering the front section 88 through the cutout 112 and causes the fibers to fall downwardly from the baffle. Any air moving through the cutout 112 is directed upwardly by baffle 114 through the top screen 106. The lower edge of baffle 114 is spaced forwardly of wall 98 to form a slot-like aperture 116 across the full width of section 88 through which fibers can fall toward electrode 28.

Electrode 28 is contoured sheet metal which extends substantially the full width of the front section 88. The top edge of electrode 28 is fastened to wall 98 slightly below the bottom of cutout 112. A flat top portion 120 of electrode 28 inclines forwardly and downwardly to a forwardly projecting ridge portion 122. The top surface of the ridge 122 is generally horizontal. The electrostatic field will be strongest in the vicinity of the ridge portion 122 since it is closest to the wall 16 being coated. Some of the fibers falling through aperture 116 will enter the field in front of the inclined electrode portion 120 and be propelled to the wall 16. However, most of the fibers, or at least a substantial portion thereof, will strike the inclined electrode portion 120 and fall downwardly onto the top of ridge portion 122 where they are subjected to the strongest field and rapidly propelled to wall 16. The flat horizontal top of ridge portion 122 assists in aligning the fibers horizontally as they are propelled by the field to wall 16. The contour of electrode 28 returns from the ridge portion 122 downwardly and slightly rearwardly to the bottom of the front section 88.

The front of the applicator 18 is closed by a removable screen 140 spaced forwardly of electrode 28. Screen 140 is slideable in a guide formed in the side walls of section 88. The mesh size of screen 140 is substantially greater than the mesh of the screens 104, 106 so that individual fibers can pass freely through the mesh of the screen

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140. The mesh size of screen 140 can be substantially less than the length of the individual fibers 40 since it has been found that the fibers tend to align with the field in a direction between electrode 28 and the object or wall 16. However, the mesh size is chosen small enough to prevent fibers from falling out of the applicator 18 unless they are aligned generally perpendicular to the screen.

The shielded lead 24 is connected to the lower portion of the electrode plate 28 and extends rearwardly therefrom through a second supporting sleeve 130 mounted on wall 94. Sleeve 90 is intended to serve as the main handle for applicator 18 whereas sleeve 130 serves as an auxiliary handle when the operator desires to use both hands. With the exception of electrode 28 and the electrical connections to lead 24, all of the remaining parts of the applicator 18 described hereinabove are formed of suitable insulating material.

To summarize the electrostatic flocking described hereinabove, the operator turns on power supply 22, sifter motor 50, blower 70 and atomizer 78. The sifter blade 52 agitates fibers 40 in bin 38 and causes them to fall downwardly through the outlet openings 46 and into the hopper 60 in a free-falling loose condition. Blower 70 draws air into the middle section 34 through vent 62 and over the top of the hopper where it picks up the fibers. The air entering vent 62 also picks up moisture in passing through section 34 and above atomizer 78. Loose fibers entrained in the air are drawn into blower 70 and then blown through hose 32 to applicator 18. By adjusting the speed of motor 72 and adjusting the stops 48, 64, the quantity of fibers 40 supplied to applicator 18 and the quantity of air necessary to transport the fibers can be selected as required.

As the fibers entrained in the air enter the applicator 18 through sleeve 90, they are deflected upwardly and forwardly by partition 100 and screen 104 toward cutout 112. Some of the air will pass through screen 104 and out of the lower open end of the applicator. The effective size of opening 102 is set by stop 105 so that the air remaining is sufficient to carry all of the fibers upwardly to cutout 112. As the fibers pass through cutout 112, they will either drop directly through aperture 116 or they will impinge upon baffle 114 and then fall downward through the aperture 116. Substantially all of the moving air remaining will pass upwardly through screen 106 at the top of the applicator. Thus, the motion of the fibers as they pass through aperture 116 is due almost entirely to gravity and to some extent to the electrostatic field. Stated differently, the motion of these fibers as they drop downwardly onto electrode 28 is substantially free from the effect of the moving air which brought them to the applicator. This relatively inert motion of the fibers as they drop downwardly into the electrostatic field permits the electrostatic field to effectively align the fibers and propel them to the object being coated. As a practical matter, some excess air passing through cutout 112 may pass downwardly through aperture 116. Such excess air will be deflected horizontally toward wall 16 by the inclined electrode portion 120 and the top of ridge portion 122. The cubic feet per minute of air and fibers entering applicator 18 and the effective size of opening 102 will be adjusted such that an optimum quantity of fibers are delivered to electrode 28 while maintaining the amount of excess air passing through aperture 116 to an insignificant amount so as not to interfere with the action of the electrostatic field on the fibers.

It was found that without the converging side walls 96, the fibers would tend to flare laterally outwardly as they enter the field and fibers would accumulate at the sides of the front section. However, with the converging side walls 96 and the narrow width cutout 112 the tendency of the fibers to spread laterally is reduced. The slope of the side walls 96 and the width of cutout 112 are chosen

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so that the fibers spread sufficiently to optimize the effective width of electrode 28 without accumulating fibers at the sides of the electrode. Other techniques could be used either in connection with the converging side walls or in place thereof. For example, the rear side of baffle 114 could be either scalloped or serrated to interfere with lateral motion of the fibers or the baffle could be concave forwardly with either a smooth or a stepped horizontal cross section. Various shapes are also contemplated for electrode 28. For example, very satisfactory results were obtained with an electrode having a lower portion extending vertically downwardly from the front of the ridge portion 122 rather than being inclined slightly rearwardly as described hereinabove.

It is to be understood that the dimensions of the applicator as shown in FIGS. 5-7 are not intended to be to scale. By way of example and not limitation, in one particular applicator the width of the front section 88 was 12", the width of the rear wall of the rear section 86 was 8", the height was approximately 11" and the depth of the applicator from front to back was 6½". Electrode 28 was 9½" high and slightly more than 11" wide. The opening 102 was 3" by 4", cutout 112 was 1½" by 6" and the aperture 116 was 1" by 11". By way of further example, the inner diameter of the inlet sleeve 90 and of hose 32 was 2" and blower 70 had a maximum capacity of 140 c.f.m. Blowers having substantially higher capacities of say 240 c.f.m. may also be used to increase the quantity of fibers delivered to the applicator.

The method and the apparatus for electrostatic flocking have been described hereinabove for purposes of illustration and are not intended to define limits of the present invention the scope of which is defined by the following claims:

I claim:

1. The method of applying fibers to an object such as a wall or the like wherein an electrode is carried by a portable hand-held applicator and electrical energy is operatively applied to said electrode to establish an electrostatic field in a first direction between said electrode and said object when said applicator is in proximity to said object comprising the steps of storing fibers in bulk at a location remote from said applicator, establishing a confined current of air moving from said remote location to said applicator, introducing loose fibers from said bulk stored fibers into said moving air to thereby transport fibers from said remote location to said applicator, separating fibers received at said applicator from said moving air, introducing the fibers so separated into said electrostatic field in a direction generally perpendicular to said first direction, causing said fibers to be propelled to and deposited on said object under the influence of said electrostatic field, and directing said moving air after said fibers have been separated therefrom in a direction away from said first direction so that said moving air does not substantially interfere with the propelling action of said electrostatic field on said fibers.

2. The method set forth in claim 1 wherein said fibers are separated from said moving air at least in part at a location above said electrode while simultaneously minimizing motion components of said fibers along said first direction and wherein said fibers are introduced into said field primarily due to gravity.

3. The method set forth in claim 1 further comprising introducing moisture into said moving current of air at a location upstream of said applicator whereby said fibers are moistened prior to introduction into said field.

4. The method set forth in claim 3 wherein the introduction of moisture into said moving air occurs at said remote location prior to introduction of said loose fibers into said moving air.

5. An apparatus for depositing fibers as a coating on an object such as on a wall or the like comprising a portable hand-held applicator having an electrode mounted thereon, an electrical power supply operatively coupled

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to said electrode so as to establish an electrostatic field between said electrode and said object when said electrode is in proximity to said object and means for introducing fibers into said field comprising fiber storage means for storing fibers in bulk, said storage means being located remote from said applicator, conduit means operatively communicating with said storage means and with said applicator to form a passageway therebetween, fan means operatively coupled with said conduit means to establish a current of air therein moving in a direction from said storage means to said applicator, and means for transferring fibers from said storage means into said moving air so that said fibers are transported by the moving air to said applicator to thereby provide a substantially continuous supply of fibers at said applicator for introduction into said field during a coating operation, and wherein said applicator comprises a housing having an inlet therein communicating with said conduit means, deflector means mounted in said applicator housing and disposed between said inlet and said electrode so as to direct fibers from said inlet in a direction along a path in said applicator toward said electrode, said deflector means being perforated to allow moving air to pass therethrough and out of said housing while preventing the passage of fibers therethrough.

6. The apparatus set forth in claim 5 wherein said applicator further comprises baffle means mounted in said housing downstream of said deflector means to effect a final separation of fibers from moving air and introduce said finally separated fibers into said electrostatic field.

7. The apparatus set forth in claim 6 wherein said inlet is arranged to direct fibers from said conduit means into said applicator in a generally horizontal direction, said deflector means comprises a partition in said housing inclined upwardly and forwardly from below said inlet and extending in front of said inlet toward the top of said applicator, said partition having an opening therethrough covered with a fine mesh screen so that fibers striking said screen and said partition are deflected upwardly and forwardly from said inlet while some of the moving air passes through said screen, said baffle means being mounted in said housing generally above and forwardly of said partition so that at least some of the deflected fibers strike said baffle means, said baffle means being inclined downwardly and rearwardly so that air impinging on said baffle means is deflected upwardly, the top of said applicator being open and covered with a fine mesh screen to allow air deflected from said partition and said baffle means to pass out of said applicator housing while re-

taining fibers therein, the slope of said baffle means being such that as the air deflected therefrom passes out of said housing the fibers striking said baffle means fall downwardly therefrom due to gravity, and wherein said electrode is mounted below said baffle means so that fibers falling from said baffle means drop into said field.

8. The apparatus set forth in claim 7 wherein said applicator has vertical side walls converging laterally inwardly from said inlet toward said baffle means.

9. The apparatus set forth in claim 6 wherein said electrode is mounted on said applicator below said baffle means, said electrode has a transverse ridge thereon extending laterally of said applicator and projecting forwardly thereof, said ridge having a generally flat horizontal top face, and means on said applicator to receive fibers from said baffle means and direct the fibers downwardly toward said top face.

10. The apparatus set forth in claim 5 wherein said deflector means comprises a baffle portion and a perforated portion, said baffle portion being positioned so as to deflect said moving air through said perforated portion, and wherein said perforated portion has perforations therein dimensioned to prevent fibers from passing therethrough while said fibers are directed in a direction along said path toward said electrode.

11. The apparatus set forth in claim 5 further comprising means for introducing moisture into said current of air at a location remote from said applicator so that said fibers are subjected to said moisture prior to introduction of said fibers into said applicator.

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U.S. Cl. X.R.

117—33; 118—629, 640; 239—3, 15