

[54] **METHOD FOR ELECTROSTATICALLY HOLDING PARTICLES ALONG A MOLD SURFACE**

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[56] **References Cited**

UNITED STATES PATENTS

3,301,925	1/1967	Engel.....	264/37
3,491,170	1/1970	Roe, Jr.	264/26

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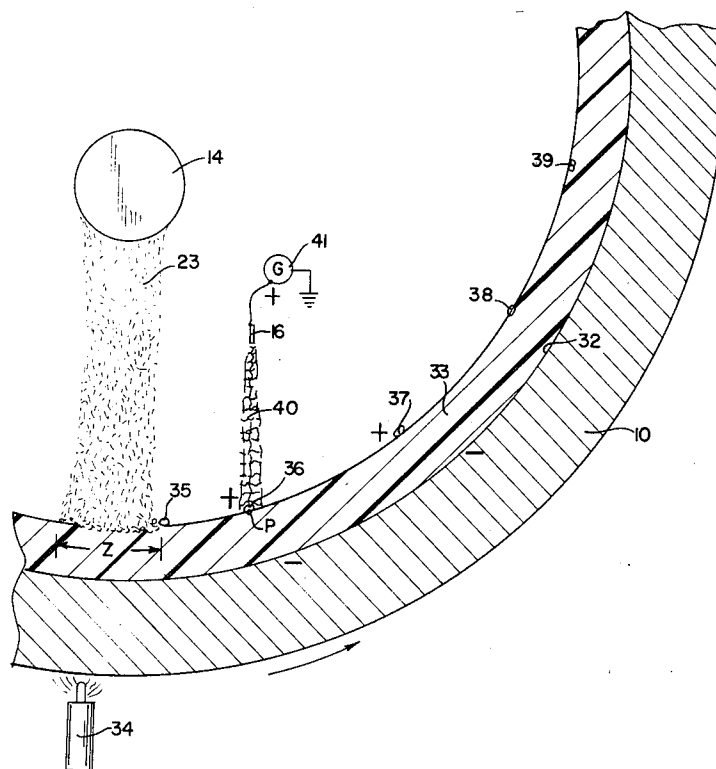
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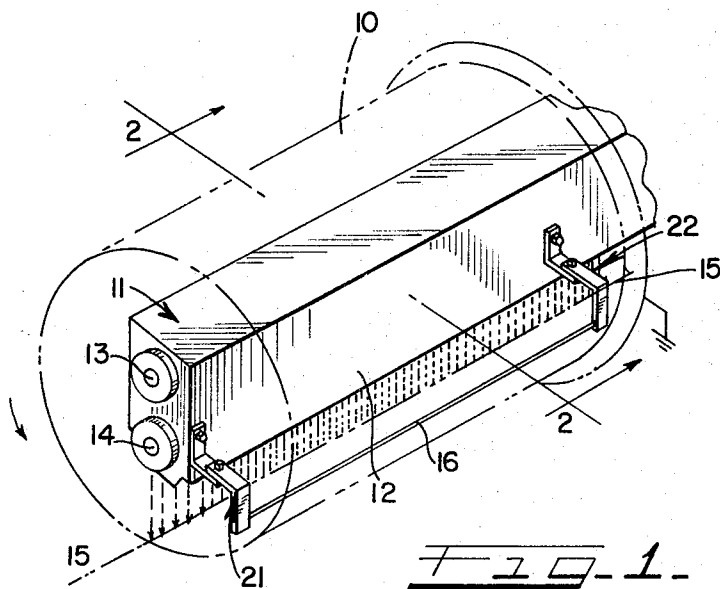
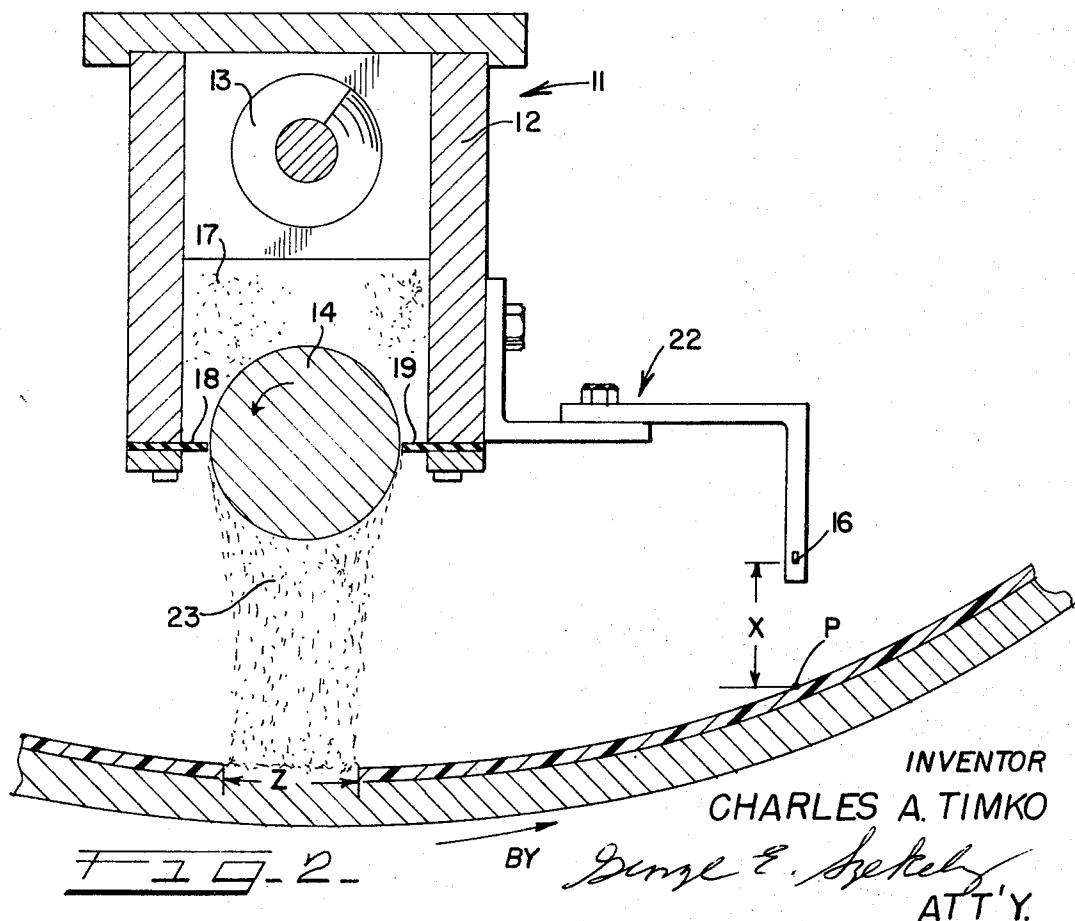
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ABSTRACT

Particles of plastic material are attracted to a mold surface by impressing an electrostatic charge on the particles subsequent to their deposit, minimizing disturbance of the deposition stream and sticking of powder in the deposition apparatus. A roll deposition unit and corona bar are employed in association with a rotating mold to form a cylindrical member from powdered plastic material. The unit deposits powder in a strip zone lengthwise of the mold. The corona bar is positioned externally of the roll case, parallel to and coextensive with the roll and closest to the cylindrical mold wall in a plane outside the stream of powder flowing from the roll to the mold wall. When the bar is charged and the mold is grounded, the resultant discharge is largely concentrated outside the stream, minimizing electrostatic effect on particles in the stream.

5 Claims, 4 Drawing Figures





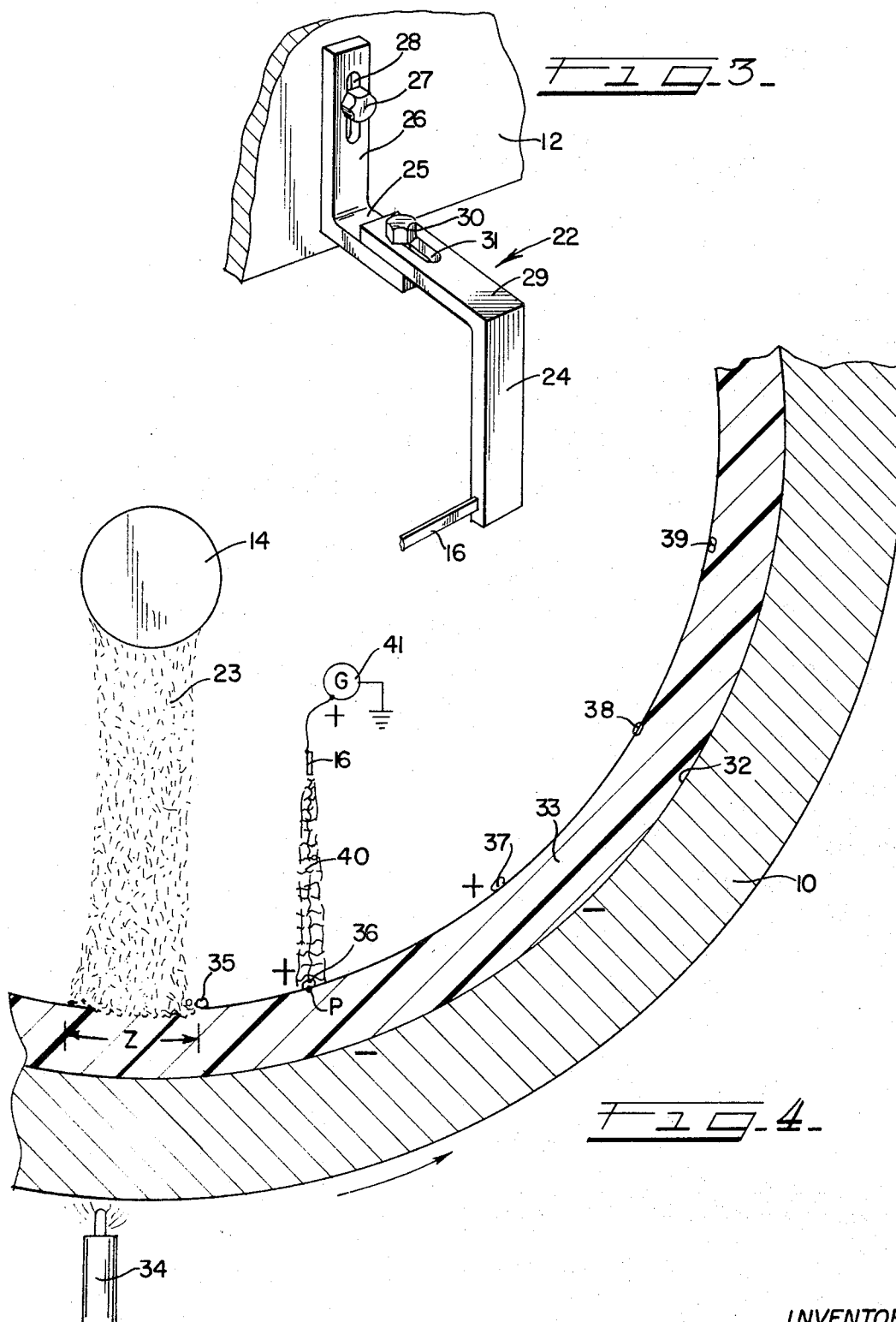


Fig. 4.

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METHOD FOR ELECTROSTATICALLY HOLDING PARTICLES ALONG A MOLD SURFACE

BACKGROUND OF THE INVENTION

1. Field of Invention

This invention relates to a method of sinter molding, and more particularly the employment therein of electrostatic means to aid retention of comminuted material on the mold surface.

2. The Prior Art

Electrostatic deposition methods and means are well known for use in coating surfaces of metal, paper and other materials. Usually such coatings are relatively thin, on the order of a few mils. Electrostatic deposition has been found satisfactory for such applications.

It has been proposed to adapt electrostatic deposition of comminuted material for sinter molding to form such articles as plastic receptacles. It has also been proposed in certain such applications to use roll deposition apparatus, which is found advantageous for depositing large quantities of material in a short time. However, prior proposed methods and apparatus for electrostatically charging powder streaming from a roll deposition unit have proved unsatisfactory, particularly with high-capacity units. Furthermore, a strong electrostatic field in the vicinity of the roll causes material to stick or clump in the unit. Various schemes for grounding, shielding or countercharging of the roll, case and other parts have proved to be complex, costly and generally unsatisfactory.

In the case of a high deposition rate, as required for good production economy, fusion alone often will not effect sufficiently complete particle adherence or coherence on impingement to preclude dislodgement of some particles from their points of deposit on the mold, or form. Such dislodgement, by falloff, windage, vibration or other operating conditions, results in erratic distribution and assimilation of the material, precluding consistent uniform molding to the desired configuration. Irregular distribution of the material exhibits itself in rough surfaces, thin spots and porosity of the article.

SUMMARY OF THE INVENTION

It is an object of this invention to provide a method for fostering adherence and uniform build-up of plastic powder progressively deposited on a substrate, such as a mold surface or the like.

It is a further object of this invention to provide a method for effecting retention of comminuted material upon a form or mold surface by electrostatically charging the material immediately subsequent to deposition on the substrate, outside the particle stream and deposition zone.

It is a still further object of this invention to provide in association with a method for sinter molding hollow articles in a cylindrical mold, a method for applying an electrostatic charge to freshly deposited powder so as to attract unassimilated particles to the mold and thus retain such particles at their respective points of deposition, notwithstanding effects of gravity, windage and vibration, at least until such particles fully assimilate with the other material along the mold surface.

The foregoing and other objects and advantages are achieved by a novel method wherein particles carried on a form or mold are passed through an electrostatic field immediately subsequent to deposition of the particles on the form. The field is maintained at a potential different from that of the form or mold.

The invention is exemplified in a preferred embodiment as an arrangement for sinter molding a plastic drum liner, wherein a heated, open cylindrical mold is rotated with its axis horizontal and a stream of powder is directed downwardly on the mold surface in a strip zone along the bottom of the mold. A corona bar is positioned outside the case of the deposition unit, parallel to and coextensive with the effective length of the deposition roll, and thus coextensive and parallel to the strip deposition zone. The corona bar is positioned so as to oppose the wall of the mold most closely just beyond the deposi-

tion zone. The mold is grounded. An electrostatic charge on the bar sets up a field having an ionizing envelope of highest intensity generally parallel to and outside the deposition stream, between the bar and the mold. The freshly deposited powder carried on the mold surface passes through the high-intensity ionizing envelope, whereby unassimilated particles are charged and are attracted to the mold wall with sufficient force to counteract the forces of gravity, windage and vibration tending to dislodge such particles. Therefore, such relatively free particles do not fall back along the mold wall toward the deposition zone, where they would otherwise collect and tumble randomly until fused.

The charging potential difference is such that the uncoalesced particles remain charged and adherent where deposited, until they are permanently assimilated by fusion and coalescence. The charges then dissipate through the grounded mold so that substantially the full potential difference is effective on the next pass to maintain the field between the corona bar and the mold with material fused along the mold surface. In this manner substantially all particles are retained at their respective points of deposit along the mold wall, according to the pattern predetermined by the deposition unit, which pattern is relatively unaffected by electrostatic disturbance. A homogeneous article of predetermined thickness or wall section is thus obtained with an arrangement which is readily adaptable to automatic production.

The foregoing features, objects and advantages of the invention will be more fully understood from the ensuing detailed description read with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic perspective view of novel apparatus in accordance with this invention, for practicing the novel method in association with formation of a receptacle in an open, hollow mold;

FIG. 2 is a section on line 2—2 of FIG. 1;

FIG. 3 is a fragmentary perspective view along one side of the deposition case, showing one of the adjustable brackets for supporting the corona bar; and

FIG. 4 is a schematic, partial cross-section of the apparatus on an exaggerated scale, showing the effect of electrostatic charges on the progress of assimilating comminuted plastic material in the mold shown in FIG. 1.

DESCRIPTION OF PREFERRED EMBODIMENT

The invention is herein described in association with sinter molding to form the cylindrical wall of a drum liner from comminuted electrically non-conductive plastic material, such as polyethylene. A representative liner is about 2 ½ feet in diameter × 3 ½ feet long, with a wall thickness of about 1/32nd to 1/16th of an inch.

As seen in FIG. 1, cylindrical mold 10 is positioned with its axis horizontal, for rotation about its axis in a counter-clockwise direction as viewed from the forward end of the mold. A roll deposition unit 11 is positioned axially of the mold. The deposition unit consists of a case 12, housing an auger 13 for feeding powder lengthwise of the case, and deposition roll 14 parallel to and immediately beneath the auger, for streaming powder downwardly onto the wall of mold 10 throughout substantially the full mold length along line 15—15 at the bottom of the rotational path.

The mold is heated in any suitable manner, by burners, or by jacket heating with steam or hot water, for the purpose of rapidly fusing powder deposited in the mold. Particular heating means is not part of this invention. The mold temperature is maintained at a value sufficient to effect fusion of powder particles on their near approach to the mold surface, so that the material incipiently fuses and assimilates substantially as rapidly as deposited. Because of aeration and unavoidable variation in the distribution of particles within the stream falling upon the mold, there will usually be some variation in

the fusion rate among the particles, particularly after some thickness has been built up in the course of repeated mold rotation and associated progressive deposition. Accordingly, some particles do not fully adhere or cohere by immediate fusion and assimilation. These relatively free particles generally are dislodged from the place of deposit by falling or rolling back as the mold carries the material away and upward from the deposition zone. However, such dislodgement is negligible in the path just beyond the deposition zone, where the mold wall provides substantial upward support.

With usually suitable plastic materials, it is not feasible to solve the problem of particle fallout by increasing the mold temperature, as an unduly high temperature may result in overly rapid degradation, "burning" or other deleterious effect on the material, and consequent defects in the article. An acceptable fusion rate can be established which is sufficient to preclude significant particle dislodgement for a short distance from a line of deposit along the bottom of the mold path, but fallout usually becomes excessive as the freshly deposited material approaches and crosses the horizontal plane, where there is no direct support. Dislodgement or fallout is usually irregular, resulting in an irregularity of the material distribution along the mold wall, with corresponding pebbling, thick and thin spots, pin-holing, voids and similar defects in the resultant article.

As previously observed, the expedient of charging the stream does not prove efficacious in a sinter molding operation such as that herein involved. Good production economy requires deposition at an exceptionally high rate, with a correspondingly dense, large stream of powder at relatively low particle velocity. Charging the particles in the deposition stream by means of a practicable electrostatic charging apparatus does not produce a consistent charge throughout the stream. Particle flow is correspondingly erratic, especially at the low velocities involved in roll deposition. In the case of a molding operation as illustrated in FIG. 1, a fairly high effective potential difference is required to insure retention of particles travelling upward. A corresponding charge imposed on particles in the deposition stream not only gives rise to the erratic flow conditions described, but is wasteful of energy, since much or most of the material will satisfactorily adhere along the mold without the electrostatic assist.

FIGS. 1 and 2 show the arrangement according to this invention, whereby to charge material subsequent to deposition, with an electrostatic field in an ionizing envelope beyond the deposition zone. Corona bar 16 is provided for this purpose, mold 10 being grounded as shown. Powder falls from roll 14 at a predetermined rate, according to the speed of roll 14 and the setting of blades 18 and 19, forming a stream 23, which impinges on mold 10 along the line 15—15 (FIG. 1), within a zone of arcuate extent Z.

Bar 16 is supported on a pair of brackets, 21, 22 which in turn are affixed to the deposition roll case 12. A length of band saw blade is a suitable bar, with the edge most closely opposing the wall of mold 10 immediately below bar 16, providing a directional emission of peak intensity along a line of the mold outside the deposition zone and parallel thereto.

Corona bar 16 is so positioned that the closest communication to ground is through the grounded mold 10 along its element most closely opposite the bar 16. An electrostatic charge on bar 16 establishes a field having a peak intensity envelope between bar 16 and mold 10, through which envelope material is carried on mold 10 in its path away from deposition zone Z. Unassimilated particles accept charges from the field, setting up attractive forces between such particles and the mold, to resist dislodgement by gravitational, windage and other forces acting on the particles. In the case of the operating conditions here described a charge of 20 kv on bar 16 and a gap X of about 1-1/4 inches establish a suitable field. A gap at least about twice the distance X is maintained between bar 16 and powder 17 in case 12, assuring against stray discharge tending to cause powder to stick on roll 14. Bar 16 is also sufficiently remote from any part of mold 10 on a line across

stream 23 to insure that the field is of substantial intensity primarily outside the stream, minimizing electrostatic disturbance of the stream and the pattern of distribution on mold 10 along arc Z. The electrostatic discharge thus focuses along a line of peak intensity through point P, parallel to the axis of mold 10, but remote from the deposition zone along arc Z.

In order to assure an optimum combination of electrostatic field strength and focus of peak intensity for given operating conditions, the position of bar 16 is adjustable on two axes relative to unit 11. Operating variables contemplated include the distance of roll 14 from the mold 10, the rate of deposition, the rotative speed of mold 10, and use of the deposition unit with other mold sizes. Corresponding adjustments of bar 16 are provided by adjustability of the brackets 21, 22 laterally and vertically.

The construction of bracket 22 is shown in FIG. 3, bracket 21 being similarly constructed. Bracket 22 comprises two angles 24 and 25. The upright leg 26 is fastened to case 12 by means of cap screw 27, extending through slot 28. The horizontal leg of angle 24 is clamped to angle 25 by cap screw 30 passing through slot 31. Thus, slot 28 provides for vertical adjustment of bracket 22 and bar 26, while slot 31 provides lateral adjustment. Brackets 21 and 22 are rubber-coated or insulated in any suitable manner, to obviate shorting or arcing.

Operation can best be understood by reference to FIG. 4, representing a stage at which a substantial deposit has been built up along mold surface 32 in the form of a blanket 33 of sintered material, brought to and maintained in sintering state by heating mold 10, as indicated schematically by the burner 34. Mold 10 rotates counterclockwise, as viewed in FIG. 4. While mold 10 rotates, with blanket 33 maintained at sintering temperature, the stream of material 23 is projected downward from roll 14 onto the blanket 33. Most of the particles deposited from stream 23 assimilate virtually instantaneously with the previous deposit, at least to such degree as to become substantially inseparable. However, due to unavoidable variations in distribution of particles in stream 23 and associated non-uniformity of particle heating and fusion rate, random particles do not instantaneously assimilate with blanket 33, but only lightly adhere on the surface, as represented by particle 35, here enlarged for illustrative purposes. Under conditions of high speed production and correspondingly high deposition rate, the proportion of such unassimilated particles 35 usually is fairly substantial. Particles thus lightly adhered are generally so delayed in fusion and assimilation that they tend to separate from blanket 33 and roll back along mold 10, due to the forces of gravity, windage and vibration, as the point of deposit on surface 32 moves along the upward arc of rotation, absent an auxiliary attracting force. Such dislodgement or fallout is random, resulting in irregular formation of the article. This objectionable condition tends to become even more aggravated as the operation proceeds, with free particles in increasing number tumbling at the bottom of the mold and disrupting assimilation of fresh material from stream 23.

Assimilation of such lightly adhered material at the place of deposit along surface 32 is fostered by charging the particles while still substantially supported by the mold, thereby effecting a retentive attraction between unassimilated particles and mold 10. Generator 41 impresses an electrostatic charge on corona bar 16, establishing the field having peak intensity in ionizing envelope 40, here shown as positive in sign, with the grounded mold 10 negative. As particle 36 passes through ionizing envelope 40, the particle is charged and strongly attracted toward grounded surface 32, thus adhering particle 36 in its position of rest on blanket 33 causing such particle to adhere to the deposit blanket 33 by virtue of attractive force between the particle and the mold 10.

The nature of the electrostatic effects is illustrated by the schematic representation of a series of particles, such as particle 35, in progress around the path of rotation of mold 10. Particle 36 is passing through ionizing envelope 40 and is there charged. Charged particle 37 remains adhered to the

blanket 33, as assimilation sets in. Particle 38 is partially assimilated and particle 39 has been fully assimilated. As assimilation proceeds, with accompanying electrical conductivity between the blanket 33 and mold 10, particle charges are dissipated at a rate generally corresponding to the rate of particle assimilation. Observations indicate that in the example here described the charges are substantially dissipated within one revolution, particles becoming fully fusion-adherent within a fraction of revolution. With the blanket 33 at all times grounded through the mold 10, requisite electrostatic field strength for effectively charging free, unassimilated particles as described can be maintained with a relatively low demand on the generator 41.

That portion of the material which is fully assimilated is substantially at ground potential on approach to the electrostatic field. By virtue of good electrical communication between the mass of the deposit and the mold wall, the coalesced material is substantially fully de-ionized when passing through the deposition zone and approaching the field. This condition minimizes any repellent effect between the general mass of the plastic material and unassimilated or imperfectly coalesced particles along the surface. Because of substantial electrical discontinuity, the free particles accept the electrostatic charge and are attracted to the mold wall and to the other material with sufficient force to preclude dislodgement, until fully assimilated as described.

The practice of the invention is not limited to the preferred embodiment above described. The invention is also useful in association with deposition on mandrels, male molds, webs, and other forms. Those skilled in the art will perceive other uses, variations, and modifications within the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. In a method of molding an article from comminuted particles of an electrically non-conductive material upon a mold surface to which said particles are fixed in place during said molding, including the steps of depositing a layer of said comminuted particles along successive portions of said mold surface, and fusing said particles to each other for forming a blan-

ket of said material upon said mold surface; the improvement comprising:

imposing an electrostatic charge to said layer of particles only subsequent to performing said step of depositing said particles for causing said particles to be electrostatically fixed in place relative to said mold surface until said particles have assimilated in said blanket.

2. A method as defined in claim 1 wherein said particles are assimilated into a blanket by the step of heating said mold to a temperature at least as high as the melting temperature of said particles prior to the step of depositing said particles.

3. A method as defined in claim 1 wherein the step of depositing said particles is accomplished with the aid of gravity, and includes the step of rotating said mold about said particles which are being deposited for carrying deposited particles past a source of electrostatic charges located remote from the point at which said particles are being deposited.

4. In a method of forming a hollow cylindrical plastic member, including providing a mold having a cylindrical cavity, heating said mold, rotating said mold about the axis of said cavity, and directing a stream of comminuted plastic material against the wall of said cavity in a deposition zone so as to effect assimilation of said material along said wall, the improvement comprising positioning a corona bar in said cavity with said bar extending lengthwise of said wall coextensively with said zone and said bar closest to said wall along a line thereof outside said zone, and creating an electrostatic discharge between said bar and said wall so as to concentrate charging effect of said discharge on said material largely along said line, thereby charging particles of said material carried on said wall upon crossing said line and effecting attraction of said particles to said wall free of significant electrostatic effect in said zone.

5. The method as defined in claim 4, said bar being elongated parallel to said axis and outside said stream and positioned closest to said wall in a plane common to a line of said wall immediately beyond said zone in the direction of mold rotation, including grounding said mold, and impressing an electrostatic charge on said bar.

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