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[54] **MACHINES FOR COATING SHEET MATERIAL**

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[73] Assignee: **USM Corporation,** Boston, Mass.

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[52] **U.S. Cl.** **118/630,** 118/631, 118/641, 156/289

[51] **Int. Cl.**.....**B05b 5/02,** G03g 13/06

[58] **Field of Search**.....118/627, 629, 630, 118/631, 632, 633, 637, 641, DIG. 5; 117/17, 17.5; 156/247, 249, 289, 344

[56] **References Cited**

UNITED STATES PATENTS

3,374,769	3/1968	Carlson	118/637
3,128,378	4/1964	Cisek et al.	250/65
3,273,496	9/1966	Melmon	118/637
3,605,690	9/1971	Staller	118/637
3,248,253	4/1966	Barford et al.	117/17
2,815,734	12/1957	Carlson	118/630
2,813,052	11/1957	Lancaster	154/95
2,841,461	7/1958	Gleason	118/637
3,288,605	11/1966	Macklem	96/1
3,013,878	12/1961	Dessauer	96/1

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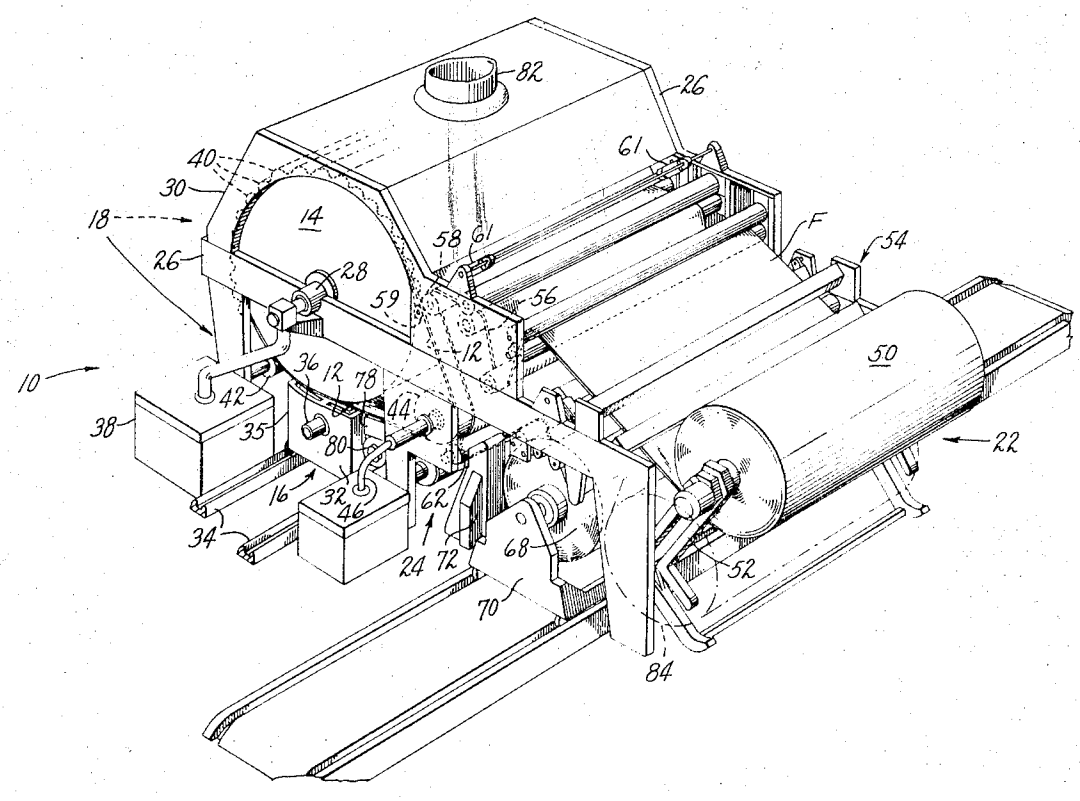
[57] **ABSTRACT**

A continuously operative coating machine electrostatically deposits heat activatable powdered polymers, for example polyurethane, on a release carrier which progressively passes through a heating zone. The powder is applied from an electrostatic fluidized bed employing a microporous wire cloth as both bed and charging grid. Deposited powder is transformed to a film which is brought into adhering relation to flexible sheet material such as a fabric to be coated. The carrier and the sheet material then pass over a cooling means where the film is solidified and bonded to the material and the unloaded carrier is returned for receiving further powder deposits. The powder bed may include compartments for successive application of different types of powder particles. An ionized zone preferably insures that the recirculated carrier is free from any residual positive or negative charge which might affect the charged powder particles to be deposited by the electrostatic fluidized bed. An alternative arrangement employs a reuseable release paper backed by a metallic flexible strip for transfer of the film to the sheet material. When either arrangement is operated without supplying sheet material, it may with slight modification be used to produce plastic sheeting per se.

5 Claims, 5 Drawing Figures



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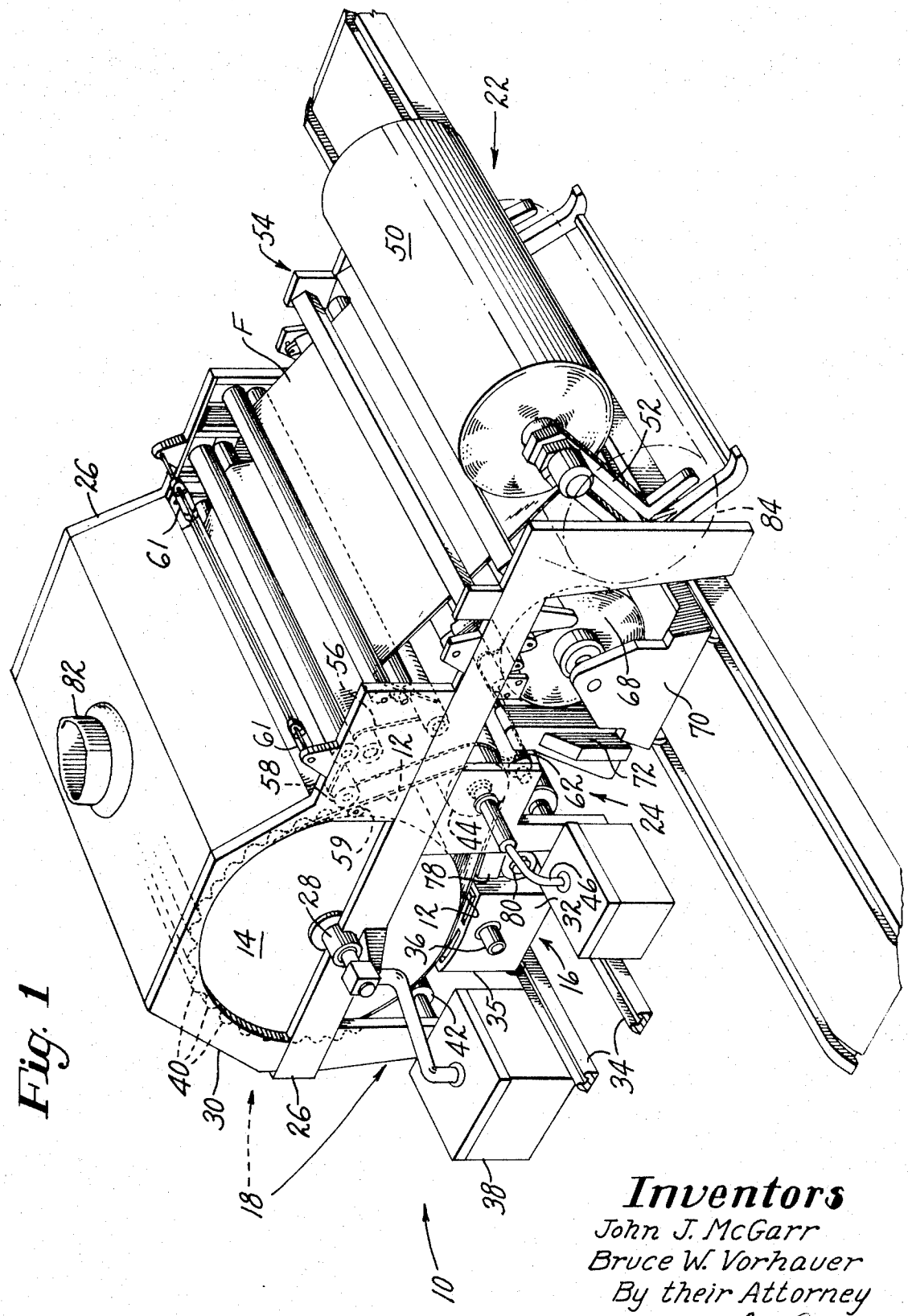

Fig. 1

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Bruce W. Vorhauer
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Carl E. Johnson.

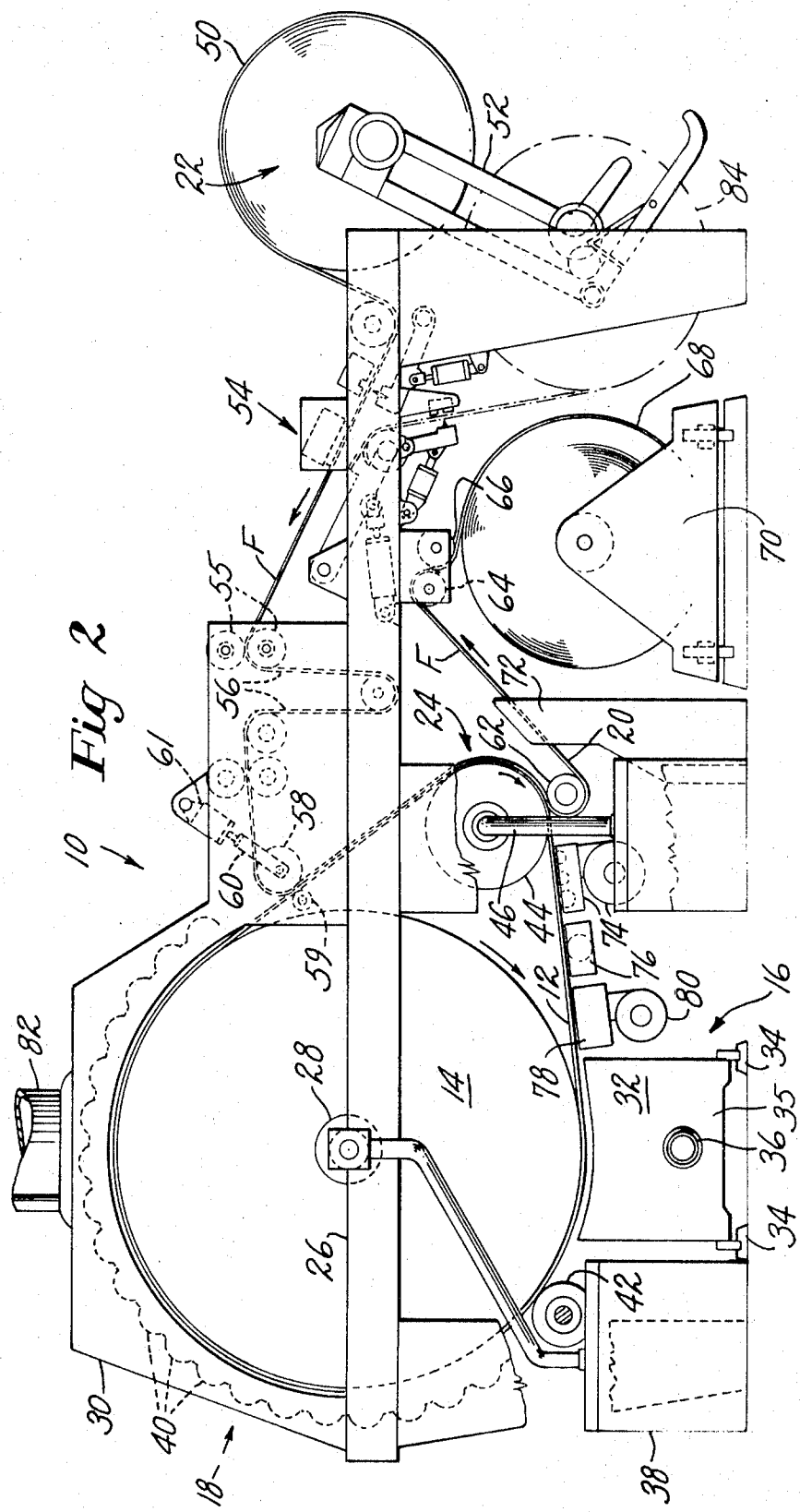
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Fig 2

Fig. 3

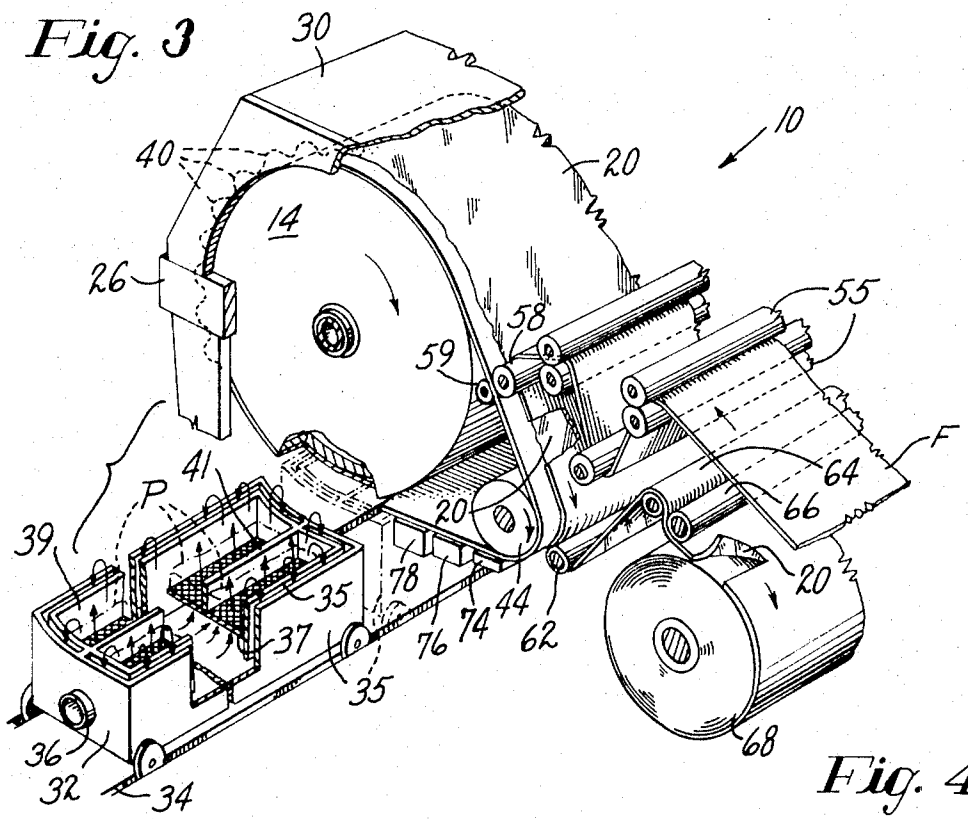


Fig. 4

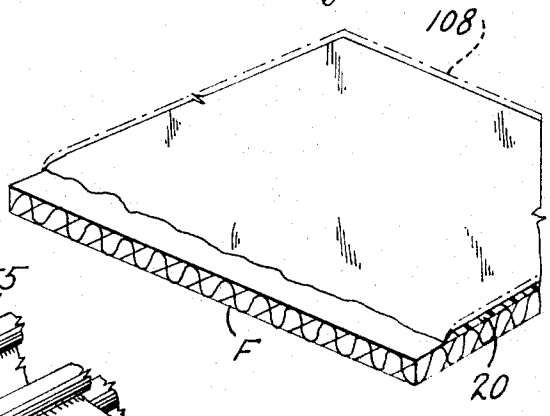
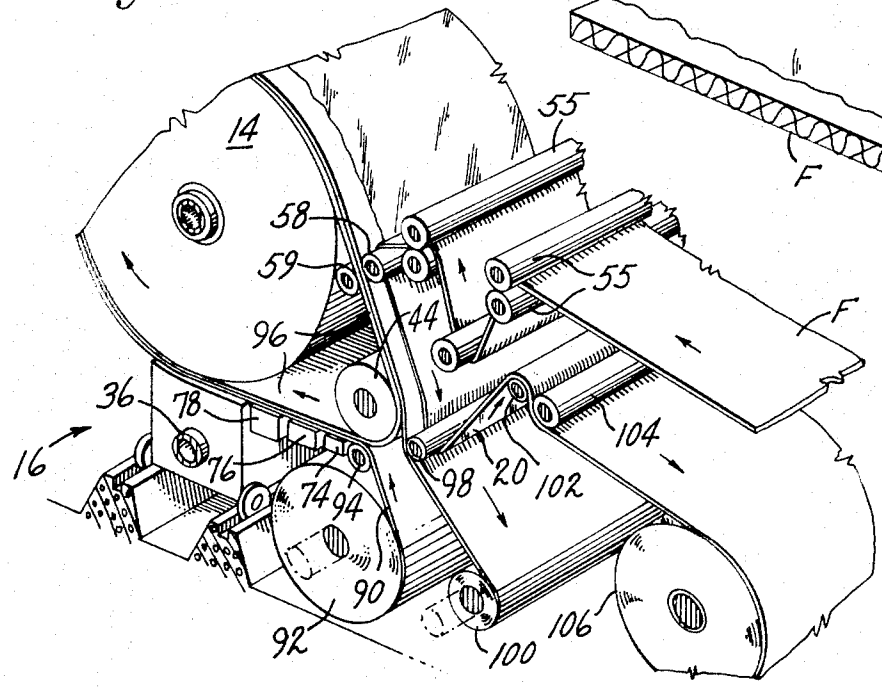


Fig. 5



MACHINES FOR COATING SHEET MATERIAL

CROSS REFERENCE TO RELATED APPLICATION

The process of coating sheet material practiced by the machine herein disclosed is fully described and claimed in a co-pending application Ser. No. 58,006, filed July 24, 1970 in the name of John J. McGarr.

BACKGROUND OF THE INVENTION

The invention relates to a machine using heat activatable powder for continuously coating flexible sheet material.

A large market exists for plastic-coated flexible sheet material. Fabric coated with vinyl, for instance, is extensively used for upholstery and apparel. Apparatus hitherto employed for coating sheet material has taken many forms, often being quite large, complex and costly and employing, for example, calendering, extruding, plastisol or solution coating equipment. Such apparatus, as pointed out in the application above cited, frequently has been attended with problems relating to toxicity, stop-start, thermal degradation, fire hazard, etc. By means of the novel machine herein to be described, an efficient and relatively compact arrangement is provided whereby items such as solvents, ovens, release papers, calenders and extruders are or may be advantageously eliminated.

SUMMARY OF THE INVENTION

A main object of this invention in view of the foregoing is to provide a versatile machine for continuously coating flexible sheet material with a thermally activatable, i. e. thermoplastic or thermosetting, polymer supplied in powder form.

Another object of the invention is to provide an improved machine for progressively applying thermoplastic material in an economical, safe manner to uniformly coat a flexible substrate.

A further and more specific object of this invention is to provide a high output machine for making urethane-coated fabric at low cost. An additional object of this invention is to provide a versatile machine for continuously coating sheet material and alternatively useful with or without reuseable release paper.

To these ends, and in accordance with a feature of the invention, a machine for coating flexible sheet material comprises in novel combination a movable release carrier, mechanism for advancing the carrier over a closed path, means for distributing heat activatable powder onto a portion of the carrier as it passes through a loading zone, heating mechanism for transforming the deposited powder to a film on the carrier, mechanism for feeding sheet material to be coated along a path partly juxtaposed in contiguous transfer relation with the film on the carrier, and cooling means operative on the carrier in the zone of the juxtaposed paths whereby the film is progressively transferred by adherance to the sheet material and the now unloaded portion of the carrier is returned to its loading zone.

As herein disclosed in one compact embodiment the release carrier is in the form of an endless belt which may suitably be of "Teflon" (polytetrafluoroethylene) or silicone rubber treated sheet material. This belt is continuously driven by a rotary drum disposed adjacent to a novel electrostatic fluidized bed of thermoplastic

or thermosetting powder, a vacuum means being provided for recovering any of the powder not electrostatically deposited on the belt in the course of transfer. The drum is desirably preheated ahead of the powder loading zone, and the belt is thereafter heated together with the powder deposited thereon, for instance by an infrared lamp, to melt and fuse the powder into a film. Optionally an air or otherwise cooled pressure roll may cooperate with the drum ahead of the heating zone to insure that the deposited powder is compressed on the release carrier belt to provide pinhole-free films and more efficient heat transfer to the powder.

In the preferred illustrative arrangement the powder depositing mechanism is mounted beneath the drum, and the flexible sheet material to be coated is progressively brought by a combining roll into adhering contact with the heated and fused plastic backed by its carrier belt and an idler roll. Means preferably are provided for adjusting working pressure of the combining roll thereby achieving different finishes. At a chilling means, such as a roll spaced from the drum and over which the release belt and sheet material pass, the cured film is peeled from the belt, having been bonded to the material, and is then entirely transferred along with the material. The unloaded portion of the belt thereupon returns to the fluidized bed for reloading.

A further feature found advantageous when certain combinations of heat-activatable plastic powder and sheet material are to be united resides in the provision of ionized air flow directed to the returning unloaded belt (and/or the drum) whereby it is freed of any electrostatic charge and/or charged, excess powder particles. It is to be recognized that though the illustrative machine is herein described as adapted for applying urethane powder to coat fabric, the invention is not thus limited, but has use in coating such flexible materials as non-wovens, knits, foams, leathers, metal foils, or other films with, for instance, vinyl, nylon, polyamide, or acrylic and combinations thereof. Versatility of the machine for suitably combining these materials and plastics is enhanced by the inclusion of mechanism for changing the speed of rotation of the drum, varying the intensity of the heating and cooling elements, and modifying the effective voltage of the electrostatic powder applying bed.

BRIEF DESCRIPTION OF DRAWINGS

The foregoing and other features of the invention, together with various novel details in construction and arrangements of parts, will now be more particularly described in connection with an illustrative embodiment, in which:

FIG. 1 is a perspective view of a machine for coating flexible sheet material with a heat activatable plastic supplied in powdered form, the drive mechanism and controls therefor being omitted.

FIG. 2 is a view in side elevation, with portions broken away, of the machine shown in FIG. 1;

FIG. 3 is a perspective view of a portion of the machine, the fluidized bed being sectioned to reveal construction details;

FIG. 4 is a fragmentary view of a substrate and its coating produced by the machine; and

FIG. 5 shows in perspective a modified form of the machine as adapted to employ reuseable release paper as a carrier.

DESCRIPTION OF PREFERRED EMBODIMENT

The illustrative machine will be described with reference to coating one side or surface of sheet material such as a fabric F with heat curable plastic P, it being appreciated that the material may be of paper, foam sheet, knit goods, leather, metal foil, or other flexible laminate, and may be coated by the machine with either a thermoplastic and/or thermosetting polymer. While a machine for continous, single coating is first described herein, the machine may be adapted for interrupted or pattern coating and for consecutively applying more than a single coat as later explained.

Referring to FIG. **1**, a plastic coating machine generally designated **10** comprises, in combination, a release carrier in the form of an endless belt **12** which may, for instance, be of silicone rubber, mechanism including an at least partly heated rotary, hollow metal drum **14** for advancing the carrier belt **12** continuously, means generally designated **16** for distributing heat activatable plastic powder P (FIG. **3**) to a surface of the belt **12** as it passes through a loading zone, mechanism **18** for transforming the deposited powder to a film **20** (FIG. **3**) on the carrier belt, mechanism **22** for feeding the sheet material F to be coated in contiguous transfer relation with the film on the carrier belt, and a cooling-stripping means **24** operative on the belt at a transfer zone adjacent to the material F whereby the latter by adherance continuously receives the film **20**, and the unloaded portion of the carrier belt **12** is returned to its powder loading means **16**.

As herein shown the machine **10** more particularly includes a pair of parallel main frame side supports **26**, **26**, an axle **28** journalled thereon for rotatably supporting the drum **14** horizontally, and an exhaust hood **30** largely surrounding the drum for a purpose later described. The arrangement preferably is such that the drum **14** has the lower portion of its external circumferance supported at a height sufficient to accomodate thereunder the plastic powder loading or distributing means **16**. The latter is desirably in the form of an electrostatic fluidized bed device **32** mounted for movement widthwise of the machine from an inoperative powder-receiving position to an operative position directly under the drum **14** and the carrier belt **12**. To this end the device **32** is shiftable widthwise on tracks **34** and includes, as hereinafter further described with reference to FIG. **5**, at least one interior chamber **35** containing, for instance, particles of powdered plastic such as polyurethane P, a suitable agitating mechanism therefor (not shown), an air inlet **36** coupling a blower (not shown) to space beneath a porous bed-grid **37** which supports a supply of the powder, and electrical mechanism (not shown) for effecting a voltage differential between the electrically grounded drum **14** on one hand and the bed-grid **37** and powder particles on the other hand whereby the latter are attracted for electrodeposition on the release carrier belt **12** as its successive portions overlie the chamber **35**. Suitable rectifier, transformer and other operating controls are provided in an adjacent console (not shown).

It will be understood that the device **32** extends widthwise substantially to the same extent as the axial dimension of the drum **14**, and that the open upper ends of the exterior housing of the device as well as of the chamber **35** are contoured to fit closely to the adjacent locus of the belt **12** as it passes beneath the drum. As illustrated in FIG. **3**, the device **32** may optionally house one or more additional powder-containing compartments **39** and a widthwise divider(s) **41** accordingly extends above the bed-grid **37** in the event a second (or more) powder of different color and/or composition or particle size is to be fluidized and electrostatically charged for application in like manner but in overlying relation to the powder of chamber **35**. This feature enables various attractive combinations of physical characteristics in material and color to be attained in the coated product. The chamber **35** and the compartment **39** if used are spaced from the interior walls of the device **32** to provide therebetween exhaust passages for air flow and entrained powder particles not attracted to the belt **12** or otherwise exhausted. While it has hitherto been common in electrostatic bed devices to employ both a bed member (usually ceramic) and an overlying charging metal grid member, in the novel device **32** the bed and grid functions are preferably performed by the single bed-grid **37** consisting of a microporous woven wire cloth sheet. It gives a more uniform charge distribution on the fluidized powders, not only agitating the negatively charged particles blown upwardly by air passing therethrough, but also repelling them since the wire cloth sheet is itself negatively charged. It will be understood that the screen hole size of the bed-grid **37** is selected to be smaller than the smallest particles of the powder P to be applied from the particular chamber **35** or compartment **39**.

The mechanism **18** for transforming the deposited powder P (which may, for example, be a vinyl and/or urethane) to the film **20** comprises, as herein shown, a circulating means **38** (FIGS. **1**, **2**) for supplying heated fluid such as an oil to the bottom interior of the drum **14** the ends of which are closed to provide a sump. For coating with a thermoplastic polyurethane powder, for example, the fluid is desirably maintained at a sump temperature slightly above the melting point of the powder, e. g. at about 380° F. Additionally, the mechanism **18** includes one or more heaters desirably in the form of infrared quartz lamps **40** disposed under the hood **30** for heating on the order of about 180° of the periphery of the drum **14** backing the powder-loaded carrier belt **12**. A rotary compactor roll **42** (FIGS. **1**, **2**) having its axis parallel to that of the drum is usually advantageously mounted in the frame ahead of the lamps **40** for uniformly coalescing the deposited powder particles, as heated by the sump fluid, and pressing the film **20** thus formed into intimate contact with the belt **12**. The lamp heaters **40** then cause the film as it travels with the belt to be raised to a temperature suitable for bonding to the sheet material F. For free-flowing polymer melts the roll **42** may not be required, though it is desirable for use on melts of greater viscosity.

It will be understood that, in an alternate construction not herein shown, it is possible to chill another peripheral portion of the drum itself preparatory to causing the carrier belt **12** to release its plastic film. As shown herein, however, a separate rotary chilling drum **44** (FIGS. **1–3**, **5**) preferably is provided about which the release belt **12** passes prior to its return to the powder loading means **16**. The drum **44** is suitably journalled in the opposite sides of the machine frame, ex-

tends parallel to the drum **14**, and is cooled as by water circulated via an inlet **46** to enable the plastic film **20** to be peeled from the belt **12** as will hereinafter be explained.

It will be understood that sheet material to be coated may be continuously and progressively supplied by a variety of control means. As herein illustrated, for example, a supply roll **50** (FIGS. **1**, **2**) of the fabric F is rotatably supported on a mount **52**, and the fabric is advanced over a path which may include an end sensing and splicing mechanism generally designated **54**, through driven feed rolls **55**, **55** and a variable feed signal loop designated **56** for controlling feed speed, and then over a combining roll **58** journalled in the machine frame and extending parallel to the drum **14**. The rate of linear travel of the fabric F is at all times maintained equal to that of the release carrier belt **12**. The combining roll **58** is arranged to feed the surface of the fabric F to be coated in contiguous relation with the plastic film **20** as it passes over a cooperating idler roll **59** journalled in the frame. A hold-down piston **60** (FIG. **2**) actuated by an air cylinder **61** bracketed on the frame, or other substantially equivalent mechanism, is provided for causing the combining roll **58** to bear with a selected degree of uniform pressure across the roll width on the heated plastic film **20**, backed by the belt **12**, as it emerges from beneath the heaters **40** and separates from the drum **14**. It is found that usually the more open type mesh of a fabric will require little pressure to be exerted by the roll **58**, and that greater pressure is sometimes desirable, particularly on finer mesh goods, in that different surface textures and characteristics can be obtained in the film coating.

During cooling the film **20** is progressing in adhering relation to the fabric F and they travel jointly over a portion of the roll **44**, perhaps on the order of up to about 120° of its periphery. A take-off or stripping roll **62** parallel to and immediately beneath the chilling drum **44** is journalled in the machine frame and serves to guide the fabric F as it continuously peels off the film **20** from the belt **12**. The thus coated fabric with its transferred film now progresses between idler rolls **64**, **66** onto a laterally movable dolly **70**. The coated fabric may optionally, prior to reaching the roll **68**, be guided through a conventional margin trimming mechanism generally designated **72** (FIGS. **1** and **2**) for insuring that longitudinal edges are straight and any unwanted marginal portions are eliminated.

Upon leaving the chilling drum **44**, the unloaded portions of the belt **12** preferably are automatically processed in preparation for reloading. To this end, as illustrated, the belt preferably successively passes over a vacuum cleaning device **74**, an applicator roll **76** for treating the outer surface of the belt **12** with a release agent, if needed, and an ionizing unit **78** whereat, for example by means of ionized air directed from an impeller **80**, any superfluous remaining positive or negative charge on the belt is eliminated. The belt **12** may then be recycled through the fluidized powder bed **35**. An exhaust duct **82** on the hood **30** withdraws therefrom any fumes, loose dust or free powder particles not electro-deposited by the means **16** on the belt **12** or which may become dissociated therefrom subsequent to film peeling at the chilling drum **44**. When the supply roll **50** is depleted, or nearly so, a reserve roll **84** (FIGS. **1** and **2**) of fabric F next to be coated may have its leading end spliced by the mechanism **54** to the trailing portion of the fabric from the roll **50**.

Referring now more especially to FIG. **5**, with minor alterations the machine of FIGS. **1–3**, which employs no release paper as such, may be converted as next explained when desirable for obtaining novel finish effects or for other purposes to the usage, especially repeat usage, of a release paper **90** as the transfer medium in lieu of the endless belt **12**. The release paper is supplied from a roll **92** journalled in the frame, passes over an idler roll **94** and into tangential relation with the external surface of an endless, metal backing material preferably in the form of a flexible stainless steel belt **96** which replaces the belt **12**. The belt **96** accordingly travels about the drum **14** and the cooling roll **44**. The paper **90** receiving the electro-deposited powder P for heating and pressure processing as above described then advances between the combining roll **58** and the idler **59**, the fabric F being pressed into adhering relation with the heated plastic film **20** in the way previously explained. In the FIG. **5** arrangement the belt **96** and hence the paper **90** is cooled by the roll **44**, and the paper **90** is now conducted about a stripping roll **98** for take-up on a roll **100**. The fabric F proceeding under the stripping roll **98** peels off the coating film **20** from the paper **90** and progresses between a pair of rolls **102**, **104** for accumulation on a take-up roll **106**. The release paper **90**, being employed in a solvent free process, may be expected to serve for recycling for twelve or more times thereby probably making the FIG. **5** arrangement economically competitive as well as productive of attractive coatings.

In using the arrangement of FIGS. **1–3** or of FIG. **5** if the second compartment **39** in the powder loading means **16** is employed for depositing a second film on the belt **12** or the release paper **90**, the second film created from the powder in the compartment **39** and designated **108** in FIG. **4** will overlay the film **20** on the fabric F. Other conditions being equal the thickness of the film **108** will normally be thicker or thinner than the film **20** according to whether the dimension in the direction of belt travel across the compartment **39** is more or less than the corresponding dimension for the chamber **35**.

When either of the above described arrangements of the illustrative machine is employed without operating the sheet feeding mechanism, the film **20** may still be peeled off the belt **12** or the belt **96** and progressively accumulated by itself on a roll. Thus the invention further provides a machine for making, from a powder, a self-supporting film which advantageously has no locked-in residual stresses. Such film finds many uses in addition to that of serving as a protective wrapping.

Referring to FIG. **2**, for instance, the film **20** may progress about the roll **62**, then pass between the rolls **64**, **66** for accumulation in a roll on the dolly **70**. As above explained, moreover, the film may be produced in overlaying, bonded plies of the same plastic and color or of different plastic and color.

It will be appreciated from the foregoing that the invention affords an efficient, compact and versatile machine for coating flexible sheet material with a heat activatable plastic supplied in powdered form.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. In a machine for coating a surface of flexible sheet material, means for feeding the material at a predetermined speed between a pair of cooperating pressure rolls, a supply chamber for heat activatable powder, a release carrier belt continuously operable over the chamber and about a heated drum and a cooling roll and guided thereby at said predetermined speed for passage between said pair of rolls into superposed tangential relation to the sheet material so that molten film formed from the powder adheres thereto, mechanism for uniformly charging and distributing particles of the heat activatable polymer powder to the carrier belt as it progresses between the chamber and a portion of the drum, and stripping mechanism operable adjacent to the cooling roll for progressively transferring the sheet material with its film coating from the carrier belt.

2. A machine as set forth in claim 1 wherein the carrier belt comprises an endless metallic conveyor backing a length of reuseable release paper.

3. A machine as defined in claim 1 wherein the powder distributing mechanism comprises an electrostatic fluidized bed device including at least one compartment for the powder adapted to fit closely adjacent to lower circumferential portion of the drum, the device including a microporous bed-grid of wire negatively or positively chargeable relative to the drum, and means for agitating a supply of the powder on the bed-grid while air flow is directed upwardly therethrough.

4. A machine for producing a continuous flexible, plastic self-supporting film from heat activatable polymer powder, comprising a movable release carrier, mechanism including an electrostatic fluidized bed for receiving a supply of the powder and having a grid through which air is blown to direct particles of the powder toward an overlying portion of the carrier, mechanism including a drum for advancing and heating successive portions of the release carrier as they pass in close proximity over the bed, said drum being charged with a voltage potential opposite to that of the grid for causing the powder particles to be uniformly distributed on the carrier, pressure means cooperative with the drum for coalescing the deposited powder to a film on the carrier, a heating means for activating the film to a temperature substantially suitable for bonding, and a stripper-cooling device for progressively peeling the cooled film from the carrier.

5. A machine for continuously coating flexible sheet material with a heat activatable polymer supplied in powdered form comprising, in combination, a movable release carrier, mechanism including a rotary, electrically-grounded drum for advancing the carrier over a path at predetermined speed, means adjacent to the path for distributing the powdered polymer directly on a portion of the carrier as it passes through a loading zone, said drum having a substantially horizontal axis and adapted to provide a sump for hot fluid adapted to heat the carrier portion in said loading zone and the powdered polymer deposited thereon, heating and coalescing mechanism disposed for transforming the deposited powder to a molten film on the moving carrier, mechanism for feeding the sheet material to be coated into contiguous, superposed relation to the molten film on the moving carrier and at substantially the same speed, chilling means adjacent to the carrier for chilling its film in adhering relation to the sheet material, said chilling means comprising a fluid-cooled rotary drum parallel and adjacent to said heated sump drum, the cooled drum progressively receiving the sheet material and carrier in superposed relation while cooling the film on the carrier, and stripper mechanism including a stripping roll parallel and adjacent to the fluid-cooled drum for progressively peeling off the material with the film transferred thereon.

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