March 3, 1942. R. L. MELTON 2,274,726

MANUFACTURE OF ABRASIVE COATED WEBS

Filed April 13, 1940

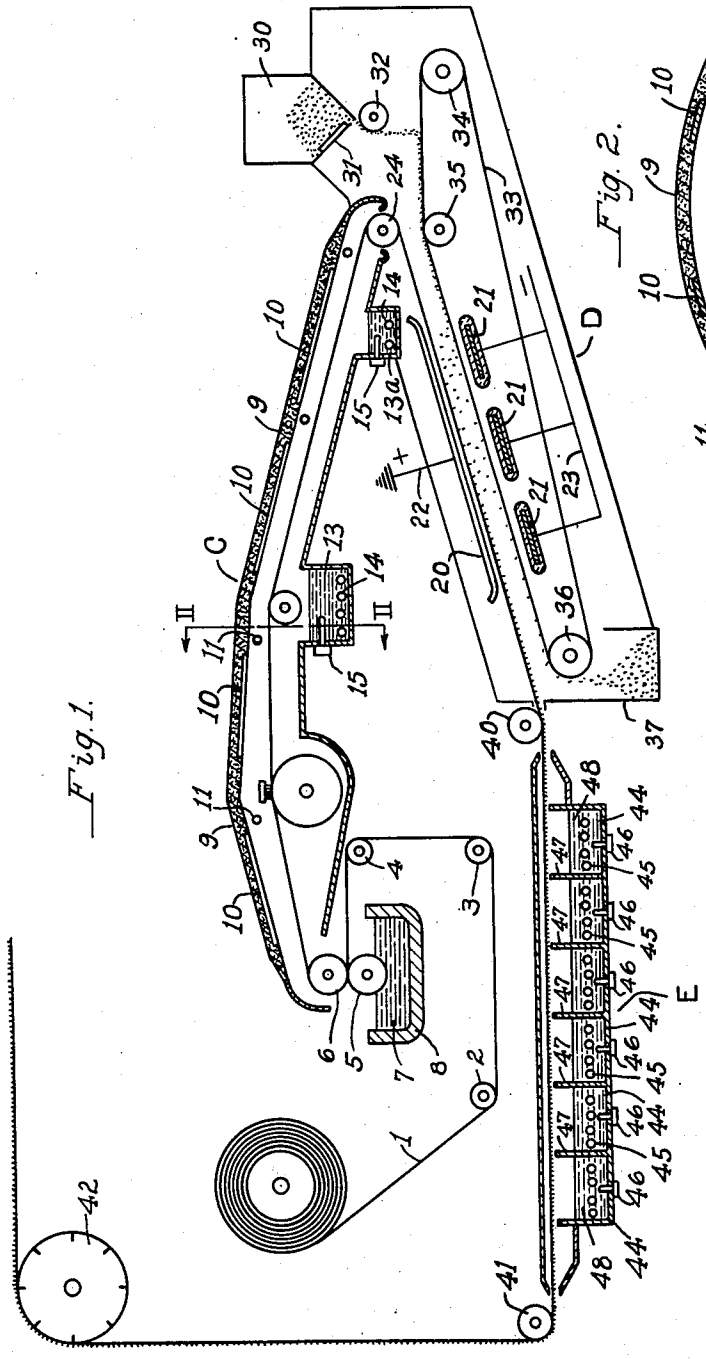


Fig. 1.

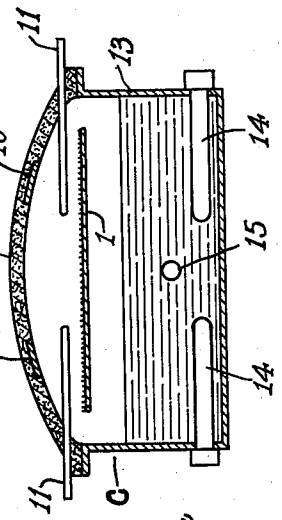


Fig. 2.

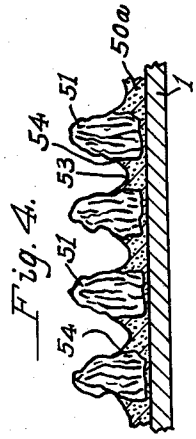


Fig. 4.

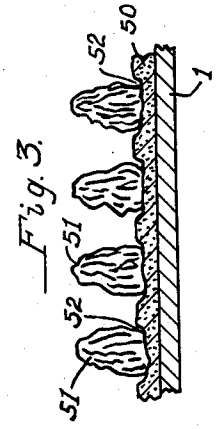


Fig. 3.

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MANUFACTURE OF ABRASIVE COATED WEBS

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5 Claims. (Cl. 91—55)

This invention relates to an improvement in the manufacture of coated webs such as granular or abrasive coated products and the like. More specifically, the invention is concerned with an improvement in that part of the apparatus and process wherein a layer of adhesive is applied to a web backing material and maintained in a substantially unchanged condition until the subsequent coating of granular or abrasive material is applied thereto.

The present invention relates primarily to an improvement in apparatus for maintaining a layer of adhesive in a suitably tacky condition from the time said adhesive is applied to a continuously moving web until granular particles are deposited thereon.

In the manufacture of abrasive and similar coated webs, a layer of adhesive is applied to one side of the web by some suitable means, such as by means of a fountain roll immersed in the liquid adhesive. The abrasive material is then applied to the adhesive coated side of the web, following which the adhesive is hardened, as for example, by cooling and drying, where a glue is used, or by evaporating the solvent where the adhesive is in the form of a solution of the adhesive in a relatively volatile solvent. Certain difficulties have been experienced in various modifications of the above process because of the fact that most adhesives used in the abrasive industry tend to "set" or harden before the abrasive grains can be applied. This difficulty is particularly pronounced in certain types of apparatus in which there is a considerable distance between the adhesive-applying rolls and the point of grain application. This difficulty was recognized and specific apparatus developed to eliminate such difficulties, this apparatus being described in a Patent No. 2,049,535, issued August 4, 1936, to R. C. Benner, H. P. Kirchner and R. L. Melton. This patent covers in general the method and apparatus for passing an adhesively coated web through a zone of controlled atmosphere whereby the liquid adhesive is maintained in a suitably fluid condition for the retention of abrasive particles applied thereto. The apparatus disclosed is that of a conditioning zone or passageway through which the adhesively coated web is moved, and means for circulating and maintaining an atmosphere of desired temperature and moisture or solvent content.

Certain difficulties developed in the commercial use of the method and apparatus described in the above patent due principally to the condensation of moisture on the roof and side walls of the tunnel or passageway, causing droplets of such condensed water or other solvent to fall onto the adhesively coated sheet causing undesirable marks or damaged spots. Furthermore, it was found that circulation of conditioned air over the surface of the adhesively coated web caused undesirable air currents to be set up which were found to be detrimental and caused erratic results in the surface condition of the adhesive film.

I have found that the above and other difficulties can be eliminated by the apparatus described herein in which the adhesively coated web is passed through a zone of controlled but calm or quiescent atmosphere. Furthermore, the roof of the chamber is maintained at a temperature above the point at which condensation of moisture will occur thereon and also curved so as to prevent any tendency of droplets of solvent to form and then fall onto the surface of the adhesively coated sheet.

A better understanding of my improved apparatus may be obtained by reference to the accompanying drawing in which:

Figure 1 is a diagrammatic side elevation of one type of coating apparatus embodying the invention;

Figure 2 is a cross section of the enclosed chamber along the line II—II;

Figure 3 is an enlarged cross section of an abrasive coated web during one stage of its manufacture; and

Figure 4 is an enlarged cross section of an abrasive coated web produced in accordance with the present invention.

In Figure 1, the web 1 passes around the idler rolls 2, 3 and 4 and between the adhesive roll 5 and the pressure roll 6 whereupon a layer of adhesive is applied from the adhesive or fountain roll 5, which is partially immersed in the liquid adhesive 7 contained in the pan 8. Upon passing from the adhesive applying rolls 5 and 6, the adhesively coated web 1 immediately enters the enclosed and controlled chamber C in which the atmosphere is maintained in such condition of temperature and humidity (where glue is the adhesive employed) that the adhesive remains in substantially an unchanged condition during passage through the entire length of said chamber. Thus the adhesively coated web 1 passes out of the opposite end of said chamber C with the adhesive in a suitably fluid or tacky condition for the most effective adhesion and retention of abrasive particles applied thereto. The temperature of the atmosphere within the chamber C (shown

more clearly in Figure 2) is controlled and maintained at a desired value by means of heating elements 10, which may be electrical resistance elements or steam pipes as desired, and suitable cooperating temperature regulating means such as bimetallic temperature control elements 11. The moisture content or partial pressure of the atmosphere within the chamber C may be controlled by regulating the temperature and hence the evaporation of a solvent from the reservoirs 13 and 13a. Heating elements 14 are immersed in the liquid in said reservoirs and temperature control elements 15 are provided to maintain the solvent at a predetermined temperature. By regulating the temperature of the atmosphere within the said chamber C by means of the control elements 11 and heating elements 10, and by regulating the temperature of the liquid in the reservoirs 13 and 13a by means of the control 15 and heating elements 14, any desired humidity or partial pressure of the atmosphere may be maintained.

The roof portion of the chamber C is preferably arched (as shown) so as to eliminate any tendency of droplets of moisture to condense thereon and fall onto the adhesively coated web 1. In addition, the location of the heating elements 10 and the heat insulating layer 9 maintain the roof portion of the said chamber at a temperature above that of the enclosed atmosphere. This prevents any possibility of moisture condensing on the roof portion of the chamber, dripping onto the adhesive surface and spoiling the coated web.

Immediately after leaving the controlled chamber C, the adhesively coated web 1 is inverted by passing over idler roll 24 so that the adhesive surface faces downwardly, and passes into an electrostatic field set up between the upper electrode 20 and the high tension electrodes 21. Such electrodes 20 and 21 are connected, by cables 22 and 23, to a source of high potential difference not shown in the drawing but indicated by the characters + and —.

Abrasive grains are fed from the hopper 30 through an adjustable feed gate 31 and over a distributing feed roll 32 onto a conveyor belt 33. The grain feed belt 33 is supported by the rollers 34, 35 and 36 and driven by suitable means not shown in the drawing. The feed belt 33 carries the abrasive granules into the electrostatic field produced between the electrodes 20 and 21 where the said abrasive grains are electrically charged and projected upwardly against the downwardly facing adhesively coated surface of the web 1. Any abrasive granules not deposited onto the adhesively coated sheet 1 are carried to the container 37 located at the far end of the feed belt 33. For a more detailed description of suitable electrostatic apparatus for orientation and projection of the abrasive granules onto the downwardly facing adhesively coated web, reference is made to Patent No. 2,187,624, issued January 14, 1940, to R. L. Melton, R. C. Benner and H. P. Kirchner.

For most efficient results I have found it preferable to enclose the above electrostatic grain coating unit in a substantially air-tight compartment, indicated by the reference character D and to maintain the atmosphere within said enclosed unit at a relative humidity within the range of 45% to 60% at a temperature of 70° to 80° F.

The abrasive coated web is carried through and out of the electrostatic grain projecting zone and around idler rolls 40, 41 and suction drum 42 and then to suitable drying racks not shown.

The present invention has been found to be particularly advantageous in connection with apparatus for applying abrasive material wherein the abrasive particles are projected upwardly onto the underside of a downwardly facing adhesively coated surface. Such coating apparatus have been found to produce improved products by reason of the fact that irregularly shaped abrasive grains, particularly elongated grains, are thereby projected onto a web backing material and oriented in such a manner as to present an unusually sharp surface which has been described as "oriented abrasive coated material."

In designing machinery suitable for the electrical projection of abrasive grains upwardly onto a downwardly facing adhesively coated surface, it is difficult to position the adhesive-applying means in close proximity to the grain-projecting means. As will be seen by reference by Figure 1, an adhesively coated web must be passed over a series of rollers and its direction of movement reversed in order to bring the adhesively coated web into a position with the adhesive surface facing downwardly. For this reason the present apparatus for maintaining the layer of adhesive in a substantially unchanged condition from that at which it was applied by the rolls 5 and 6 has been an exceedingly valuable, if not indispensable, aid to the efficient functioning of grain coating apparatus of the upwardly projecting type.

The condition of the atmosphere in the zone C should be varied with the different types of adhesive employed and also with the viscosity of the particular adhesive. For example, a layer of adhesive suitable for retaining very small or fine abrasive grains may comprise 20% glue solids and 80% water to form a liquid of such viscosity as to be applied in a suitably thin film to the web backing material. With such an adhesive a higher humidity must be maintained in the controlled atmosphere within the chamber C in order to prevent undesirable evaporation of the water from such a thin solution of glue. In contrast to this, a more viscous layer of adhesive, which may comprise 75% glue solids and 25% water, is used with very coarse grit materials. Such an adhesive would require an atmosphere of somewhat lower humidity or moisture content in order to prevent any change in concentration or viscosity of the adhesive film as it passes through the controlled chamber C. Generally speaking, the atmosphere within the chamber C should be maintained at a temperature of approximately 150–160° F. and the relative humidity should be maintained at a point just below that of saturation, the exact value depending of course upon the concentration and viscosity of the particular adhesive employed. By proper control of the moisture content within the chamber C the adhesive film is neither dried nor wetted by the controlled atmosphere. Instead it is maintained at substantially the same condition of concentration and viscosity as that at which it was applied by the rolls 5 and 6.

By the present method and apparatus it is possible to make up a glue solution of proper concentration, apply said adhesive to a moving web and then maintain the film of adhesive at the optimum condition for retaining abrasive granules until such grains are projected onto said adhesive film. This process is in sharp

contrast to the previous practice of attempting to compensate for the evaporation of solvent and thickening or chilling of the glue, during the interval of passage from the glue rolls to the grain projecting means, by dilution of the glue at the point of application. Obviously such methods of compensation for uncontrollable variations were subject to variation from time to time, depending upon the normal room temperature and circulation of air.

In certain instances it has been found particularly desirable to provide a second conditioned chamber E through which the abrasive coated web is passed immediately after deposition of the abrasive particles thereon. In this conditioned zone or chamber E the atmosphere is maintained at a proper temperature and moisture content so that the surface tension of the adhesive coating is adjusted to such a value that the freshly deposited abrasive granules will be wetted and the grains drawn into the adhesive layer and firmly embedded therein. When the surface tension of the adhesive film is properly controlled the abrasive grains are actually pulled or drawn toward the web backing 1 and caused to penetrate the layer of adhesive to such an extent that the base of each individual granule is substantially in contact with the web backing 1. This is more clearly shown in Figures 3 and 4 of which Figure 3 shows an enlarged section of an abrasive coated web as it passes out of the electrostatic grain coating unit and Figure 4 shows a similar cross-section of the abrasive coated web as it passes out of the atmospheric conditioned chamber E.

Referring to Figure 3, the web backing 1 is coated with a layer of adhesive 50 and abrasive grains 51 are adhesively attached but rather insecurely anchored thereto. The abrasive granules 51 were propelled forcibly into engagement with the adhesively coated web 1, but, as will be seen from the drawing, did not fully penetrate the layer of adhesive 50 and consequently are not securely held thereby. In fact, the slight penetration of the abrasive granules 51 produced undesirable depressions 52 in the adhesive film 50 which further reduced the contact area of the grain-adhesive surface.

By passing the abrasive coated web of Figure 3 through a suitably conditioned zone E, I have been able to bring about a greater penetration of the abrasive particles into the layer of adhesive and thus eliminate the additional sizing coating of adhesive heretofore required in the manufacture of abrasive coated material. Referring to Figure 4, it will be seen that the abrasive particles 51 have penetrated the layer of adhesive 50a so that the base of each individual abrasive particle is substantially in contact with the web backing material 1 and the adhesive has wetted the sides of the upstanding abrasive particles. Furthermore, the adhesive film is depressed at the mid-point 53 between the abrasive grains and extends up the sides 54 of each grain to form a mound around the base of each granule and firmly anchor the individual grains in position.

In practicing the present invention of embedding or anchoring abrasive grains in an adhesive surface, it is necessary to maintain the atmosphere within the chamber E at such a temperature and humidity that the surface tension of the adhesive film will be substantially reduced and caused to wet the sides of the grains. With abrasive coated webs employing hide glue the atmosphere is maintained at a temperature of approximately 140–180° F. and the moisture or solvent content of the atmosphere is maintained at or slightly above saturation point at that particular temperature. Consequently, there will be a controlled rate of deposition of moisture onto the abrasive coated surface and over the surface of the adhesive film between the upstanding grains. This alters the surface tension of the adhesive films to such an extent that the grains are drawn into the adhesive film. The moisture content or partial pressure of the atmosphere within the chamber E may be controlled by any suitable means, such as by regulating the temperature and hence the evaporation of a solvent from the reservoirs 44. Heating elements 45 are immersed in the liquid 48 in said reservoirs and temperature control elements 46 are provided to maintain the solvent at a predetermined temperature.

The effective length of the conditioned zone may be varied to suit the particular material being coated by applying heat to the elements 45 of one, two, three or more of the reservoir compartments 44. Isolation of the atmosphere in each compartment is obtained by means of separators 47 which extend well above the level of the liquid 48 and to a point near the path of the moving web.

The surface tension of adhesives, such as hide glue, which is the adhesive most commonly employed in the abrasive industry, is sufficient to draw the abrasive particles upwardly into the layer of adhesive even though the abrasive coated surface is facing downwardly and the embedding force produced by the surface tension of the adhesive must act against and overcome the normal gravitational force acting on the downwardly hanging abrasive particles.

While the present invention has been described with particular reference to glue as the adhesive most commonly employed in the abrasive industry, it is to be understood that other adhesives, such as, synthetic resins of the phenol formaldehyde and vinyl types as well as silicates, varnishes and the like, may be employed. In such cases the atmosphere within the controlled chambers C and E is partially saturated with a solvent of the particular adhesive employed and the temperature is maintained at a suitable temperature for that particular adhesive.

It is not intended that the invention should be limited to the examples given herein, which are for illustrative purposes only, but rather that the scope of the invention should be defined only by the appended claims, as obviously such improvements are adaptable to other than abrasive coated processes wherein an adhesive is applied to a moving web material as a preliminary step to the coating of the said backing.

I claim:

1. Apparatus for the manufacture of granular coated webs comprising means for applying a layer of liquid adhesive to a web, a chamber through which said adhesively coated web is passed, means within said chamber for controlling the atmosphere of said chamber to prevent drying of said liquid adhesive, means for heating the upper surface of the chamber walls to a temperature above that of the enclosed atmosphere whereby condensation of vapors thereon is prevented, and means for applying granular particles to the adhesively coated web.

2. Apparatus for the manufacture of granular coated webs comprising means for applying a layer of liquid adhesive to a web, a chamber ad-

jacent said adhesive-applying means through which said adhesively coated web is passed, said chamber having an arched roof adapted to prevent the accumulation of any condensed vapors on said roof, means within said chamber for controlling the atmosphere of said chamber to prevent drying of said liquid adhesive, means for heating the said arched roof to a temperature above that of the enclosed atmosphere to prevent condensation of vapors upon said chamber walls above the surface of said adhesively coated web, and means adjacent to said chamber for applying granular particles to the adhesively coated web.

3. Apparatus for the manufacture of granular coated webs comprising means for applying a layer of liquid adhesive to a web, a chamber through which said adhesively coated web is passed, said chamber containing a quiescent controlled atmosphere having a high solvent vapor content which maintains the adhesive in a substantially unchanged condition, heating means to maintain the roof of said chamber at a temperature above the condensation point for said solvent vapors, and means adjacent to said chamber for applying granular particles to the adhesively coated web.

4. Apparatus for the manufacture of granular coated webs comprising means for applying a layer of liquid adhesive to a moving web, a chamber containing a quiescent atmosphere and through which the adhesively coated web is passed, means for controlling the temperature and vapor pressure of the quiescent atmosphere within said chamber to prevent drying of said liquid adhesive, means for heating the upper surface of the chamber walls to a temperature above that of the enclosed quiescent atmosphere whereby condensation of vapors thereon is prevented, means for applying granular particles to the adhesively coated web, a second chamber through which the granular coated web is passed, and means for maintaining the atmosphere in said second chamber at such a temperature and vapor pressure that the adhesive-granular coating is rewetted and the granules more firmly embedded in said adhesive.

5. Apparatus for the manufacture of granular coated webs comprising means for applying a layer of adhesive to a moving web, means for supporting the web with the adhesively coated surface facing downwardly, means for maintaining the temperature and vapor pressure of the atmosphere surrounding said web to prevent drying of said adhesive, means for projecting granular particles upwardly against the adhesively coated web, a chamber through which the granular coated web is passed and means for maintaining the atmosphere within said chamber at a predetermined value of temperature and vapor pressure sufficient to rewet the coating of adhesive and granular particles so that the granules are drawn upwardly into the adhesive layer and become more firmly embedded therein.

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