Jan. 18, 1966 L. S. SHELTON 3,229,661

PNEUMATICALLY BIASED, MUTUALLY OPPOSED, PIVOTAL DOCTOR MEANS

Filed April 18, 1962 2 Sheets-Sheet 1

Fig. 1.

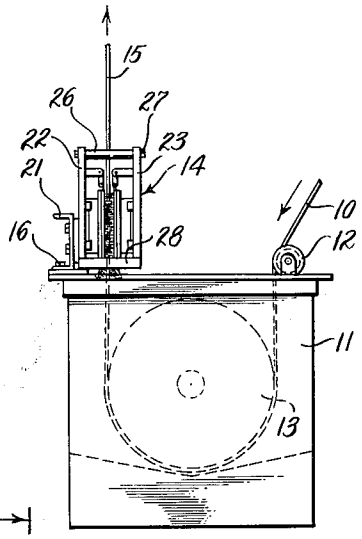


Fig. 2.

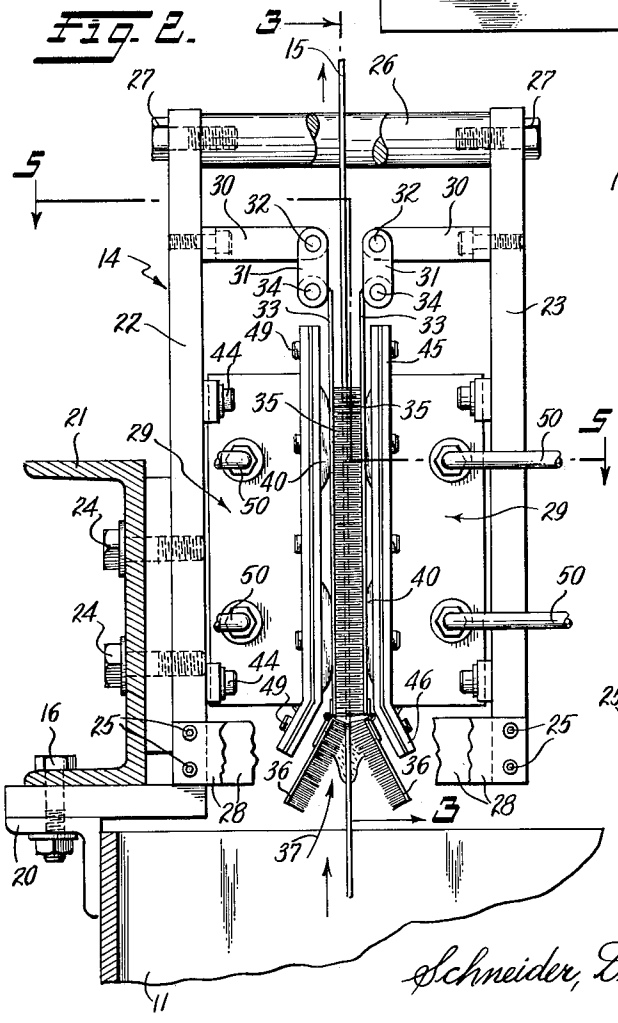
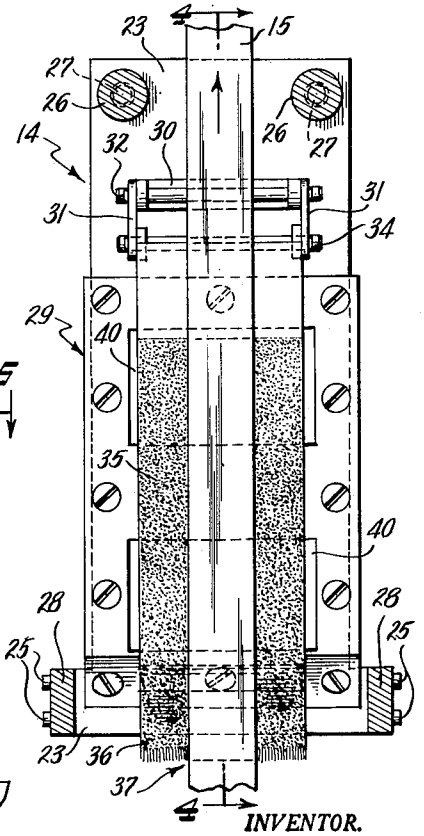


Fig. 3.



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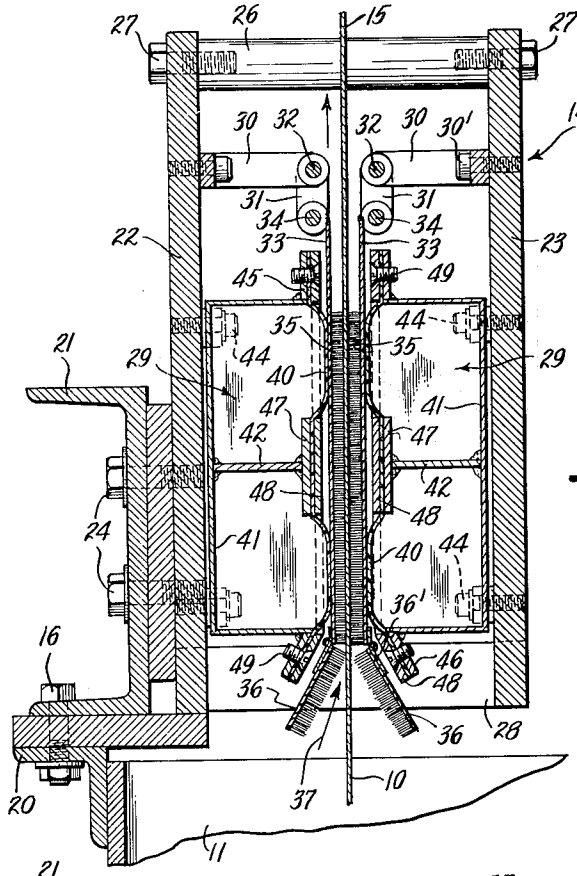


Fig. 4.

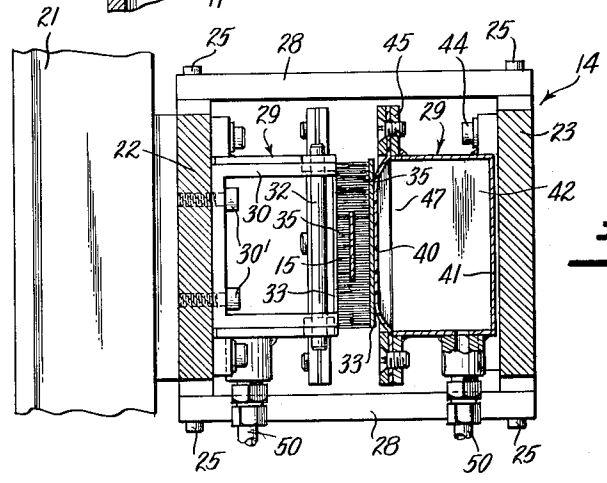


Fig. 5.

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PNEUMATICALLY BIASED, MUTUALLY OPPOSED, PIVOTAL DOCTOR MEANS

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Filed Apr. 18, 1962, Ser. No. 188,302
4 Claims. (Cl. 118—122)

The present invention is directed to apparatus for coating strip material to apply a uniform controlled amount of liquid coating material to all of the surfaces of the strip, especially when the strip is moving through the coating apparatus at high speed as, for example, at a speed within the range of 100–800 feet per minute. It is particularly desired to provide apparatus for the uniform coating of strip material in which the thickness of the coating is uniform along the length of the strip and in which variation in the thickness of the coating from one side of the strip to the other side of the strip is retained at a minimum. The invention is particularly directed to the application of coatings in thin layers having a controlled thickness in the range of from 0.0001 to 0.001 inch on each side of the strip and to the coating of strips of rectangular cross-section in which the coating covers the edges of the strip as well as the sides thereof.

Although high speed coating presents an obvious advantage to the art, various difficulties have been encountered and high speed coating has met with little success in commerce to the present time. More specifically, it is quite difficult to apply a uniform and continuous layer of coating material to a very rapidly moving strip and it is also quite difficult to rapidly and controllably heat-cure the wet coating on the strip within an oven of feasible size and length. The high speed curing of the wet coating is described in a copending application filed jointly by me and Glennard R. Lucas, this application being Serial No. 188,498, filed April 18, 1962. The present application directed to improved apparatus for applying uniform wet coatings to the rapidly moving strip of material which, although they may be cured in any desired manner are preferably cured as taught in said copending application.

In accordance with the present invention, liquid coating material in excess of that desired is applied to the moving strip of material in any convenient manner and the excess coating material is wiped from the coated strip as the strip is moved vertically between two oppositely facing resilient elements providing resilient wiping surfaces such as dense cut pile carpets which are vertically positioned and biased toward one another with a pressure insufficient to eliminate the resilient surface of the wiping elements, e.g., to crush the fibers of the pile. The resilient elements, referred to for convenience as carpets, are supported at the rear thereof by opposed floating back-up plates which are mounted for lateral movement in unison, the back-up plates serving to maintain the carpets in flat condition. The back-up plates are resiliently biased toward one another, the pressure being transmitted to the rear of the respective carpets. To minimize variation in the thickness of the applied coating along the length of the strip, the resilient pressure applied to the plates to urge the carpets against one another is supplied by pairs of opposed resilient pressure members which are vertically spaced apart, e.g., along the length of the strip. Most preferably, the carpet biasing pressure is supplied by inflated members to enable very accurate adjustment of coating thickness by regulation of the inflating pressure.

Desirably, the strip is immersed in liquid coating composition to apply the desired excess coating to all of the peripheral surfaces thereof and the coated strip is moved upwardly into the space between the carpets with the excess coating applied to the strip being wiped back by the carpets and desirably returned to the body of liquid coating composition in which the strip is immersed to be reused. Most preferably, the lower end of the carpets flare downwardly and outwardly at an angle of about 30° to the vertical to maintain a pool or well of liquid coating material at the lower end of the entrance to the opposed carpets.

It is desired to point out that carpet coating devices are known in the art, but these have not been well adapted for the efficient and uniform application of liquid coating material to all sides of a rapidly moving strip.

The invention will be more fully described in conjunction with the accompanying drawings in which:

FIG. 1 is a side elevation of a preferred coating unit constructed in accordance with the invention, FIG. 1 illustrating the overall positioning of parts which are employed in accordance with the invention;

FIG. 2 is an enlarged side elevational view, partly in section and with certain parts cut away for purposes of clarity, and showing the overall construction of the wiping device and its securement to the coater tank;

FIG. 3 is a vertical cross-sectional view taken substantially on the line 3—3 of FIG. 2;

FIG. 4 is a vertical cross-sectional view similar to FIG. 2, taken substantially on the line 4—4 of FIG. 3; and

FIG. 5 is a staggered horizontal cross-sectional view taken substantially on the line 5—5 of FIG. 2.

Referring more particularly to FIG. 1, the numeral **10** identifies a strip of material to be coated. The strip **10** is desirably a steel strap supplied from any convenient source, not shown, and advanced in the direction indicated by arrows. These arrows diagrammatically identify means for guiding the strip **10** and for moving the same, the specific details of which form no portion of the present invention. The advancing strip **10** is immersed in a liquid coating composition stored within a coater tank **11**, the entering strip being positioned by a guide roller **12** and being drawn through the liquid coating composition around a roller **13** and then upwardly through a device for wiping excess coating material from the strip, this device being broadly identified at **14**. The wet coated strip emerging from the wiping device **14** is identified by the numeral **15**. As will be apparent from the positioning of parts shown in FIG. 1, the excess liquid coating composition is wiped from the strip as it enters the wiping device **14** and returns to the coater tank **11** for reuse. It is convenient, as shown in FIG. 1, to secure the wiping device **14** at the exit end of the coater tank **11** as broadly indicated by the bolt **16**.

The construction of the wiping device **14** will be more fully apparent from FIGS. 2–5.

Referring more particularly to FIG. 2, the wiping device **14** is shown mounted on an upper edge of the coater tank **11**. As will be evident, any structural support arrangement may be employed, FIG. 2 illustrating a suitable construction in which an angle iron **20** is welded to the side of the coater tank **11** and a girder **21** is secured by bolts **16** to the angle iron **20**, the girder **21** carrying the wiping device **14**. More specifically, the wiping device **14** comprises opposed side plates **22** and **23**, the side plate **22** being bolted to the girder **21** by means of bolts **24**. The side plates **22** and **23** are vertically disposed in spaced apart parallel planes. The upper ends of side plates **22** and **23** are separated by rods **26**, the plates being secured to the rods **26** by threaded bolts **27**. At the lower end, the side plates **22** and **23** are fixed in spaced apart position by means of bottom plates **28** secured by screws **25**.

The side plates **22** and **23** each carry a carpet support bracket and a pressure applying unit. Since the strip **10** is preferably moved upwardly, the pressure applying unit is conveniently positioned at the lower end of the side

plates where it is generically identified by numeral 29. The carpet support brackets 30 are positioned at the upper end of the side plates, the carpets being hung from the brackets 30 for lateral movement in unison between the side plates. More particularly, the carpet brackets 30 are pivotally joined to the upper end of links 31 by means of pivots 32 and the lower ends of the links 31 pivotally carry carpet back-up plates 33, the back-up plates being pivotally secured to the links 31 by means of pivots 34. Thus, the back-up plates 33 hang downwardly through the space defined between the opposed pressure applying units 29 and the opposed carpets 35 are fastened to the back-up plates in any suitable manner as by the use of clips, adhesive or any other desired securing device. As will be evident, the use of links 31 and the pivotal connections 32 and 34 permits the back-up plates 33 to move toward and away from one another and it also permits these members to move laterally in unison as may be dictated by the forces imposed upon the carpets 35 by the rapidly moving strip 10. Of course, the lateral movement is actually a swinging movement, but both plates 33 swing together and the lateral movement predominates. The carpets 35 move with the back-up plates 33 and, hence, the carpets 35 move laterally in unison with the back-up plates 33.

The lower ends of the floating back-up plates 33 are bent outwardly as indicated at 36 at an angle of approximately 30° to the vertical and the carpets extend downwardly across the bent back portion to provide an inverted V-shaped entranceway identified by arrow 37. Excess liquid coating material wiped from the strip 10 is deposited in the V-shaped entranceway 37 where it forms a pool into which the entering strip 10 is immersed as it enters the nip between the carpets 35, such immersion insuring the presence of excess liquid coating material upon the strip at the time of initial contact between the strip and the facing cut pile surfaces of the carpets 35. The shape of the bent portion 36 may be retained through the use of stiffening element 36'. Thus, the back-up plates 33 hang from support brackets 30 which are mounted by threaded bolts 30', and the linkage arrangement 31, 32, 34 permits the back-up plates 33 to remain vertical at all times and despite any lateral movement of which they may partake. Since the strip being coated does not remain in a fixed position, the opposed carpets 35 seek the position of the strip and follow this position as the strip moves.

The pressure applying units 29 which are used in the invention are more clearly shown in FIGS. 4 and 5, although the action of the pressure applying diaphragm 40 can be seen in FIG. 2, and FIG. 3 provides an elevational showing which may facilitate understanding.

As can best be seen in FIG. 4, each of the pressure applying units 29 comprises a flexible diaphragm 40 carried at the forward end of a housing 41 which is partitioned to provide an upper and lower air space by means of partition 42. The housings 41 are secured to the respective side plates 22 and 23 by means of threaded bolts 44. At the forward end of each of the housings 41 is a marginal flange 45, the lower portion of which is inclined rearwardly as indicated at 46. The marginal flange 45 is continued across the center of the housing 41 where it is carried by the partition 42 and identified at 47. Mating with the marginal flange 45 including the inclined portion 46 and the central portion 47, is a cover plate 48 which is held in place by screws 49, the screws 49 clamping the diahphragm 40 between the flanges 45, 46 and 47 on the one hand, and the cover plate 48, on the other hand. The flexible diahphragm 40 completes the upper and lower air chambers which are supplied with gas under pressure through the lines 50 in order to cause the flexible diaphragms 40 to be inflated and to apply a resilient pressure to the back-up plates 33, this resilient pressure forcing the carpets 35 into engagement with one another. Means for precisely regualting the diaphragm inflating pressure are desirably employed, but these means are conventional and are not shown.

As will be evident from FIG. 4, opposed biasing forces are developed at vertically spaced apart zones by the flexible diaphragms 40 and this is important to the achievement of uniform coatings.

As will be evident, the greater the biasing force, the stronger will be wiping action, and it has been found that operating pressures of 1–6 p.s.i.g. in the unit 29 are illustrative of preferred operating conditions for the application of uniform paint films at wet film thicknesses of 0.3–1.0 mil. For the application of very thin and uniform wax emulsions, such as a 10% emulsion of wax in water, operating pressures of 10–30 p.s.i.g.. are preferred. While the flexible diaphragms 40 do not apply pressure at a single point, it may be assumed that the effective force which is developed is centralized at the center of the region of contact between the diaphragms 40 and the back-up plates 33, thus providing upper and lower contact zones which are vertically spaced apart in the invention for a distance of from 1½ to 5 inches, preferably from 2–4 inches.

It will be appreciated that the upper and lower air chambers which are provided in the illustrative form of the invention by a single partitioned housing and a single flexible diaphragm may be provided with equal facility by two separate air tight units, each faced with its own flexible diaphragm.

When the vertical distance between the points of effective pressure application is unduly short, the rapidly moving strip which passes between the carpets 35 tends to flutter and the thickness of coating varies excessively along the length of the strip. In other words, if sufficient vertical spacing between the pressure applying zones is not employed, or if pressure is applied using only a single zone of application, strip vibration leads to uneven coatings. On the other hand, if the effective zones of pressure application are too far apart, the capacity to adjust the coating thickness which is appleid is hampered and this is of considerable importance to the production of thin coatings. Stated briefly, when the zones of pressure application are spaced over too great a distance, one tends to obtain either too thick a coating or to employ excessive wiping pressure which wipes the coating from the edges of the strip.

The coating apparatus of the invention is especially adapted to the coating of strips of relatively small cross-section as, for example, strap having a width of ⅜ inch and a thickness of 0.010 inch to wider and heavier strap having a width of ¾ inch and a thickness of 0.035 inch. In the coating of strap, it is desired to apply coatings in which the variation in thickness along the length of the strap varies not more than about 5% from the desired thickness and in which the minimum thickness on either side of the strap is within about 10% of the greatest thickness on the other side of the strap. Moreover, it is also desired that the edges of the strap be coated and this is well achieved using the wiping device presented by the invention.

In actual operation, a variety of clear and pigmented solutions of thermosetting resins dissolved in organic solvents have been applied to provide smooth and uniform coatings which are essentially free of dips and valleys and in which the edges of the straps are remarkably well coated despite the difficulty inherent in uniformly wiping the sides of the strap to provide uniformly thin coatings thereupon without, at the same time, scraping the coating from the edges of the strap. The coating material may also be in emulsion form and the invention is well adapted to the uniform application of very thin coatings of wax from aqueous emulsion.

While the invention has been illustrated by the use of dense cut pile carpet to provide the desired resilient wiping surface, it will be understood that this merely represents preferred practice for the application of syn-

thetic resinous coatings from organic solvent solutions thereof. Thus, other resilient wiping elements such as sponge or felt can be used. Indeed, felt is preferred for the application of very thin and uniform wax films from aqueous emulsion.

The primary regulation of coating thickness is simply achieved by varying the air pressure which is employed to inflate the diaphragm **40**, although the viscosity of the coating solution is also of significance. To illustrate the invention, and using a system in which the vertical spacing of effective pressure is 2.0 inches, the application of a coating having a thickness of 0.001 inch using a solution coating having a viscosity of 30 seconds measured at 25° C. in a #1 Zahn Cup requires a pressure application of 3.0 p.s.i.g. With a more viscous coating material having a #1 Zahn Cup viscosity of 37 seconds, a coating having a thickness of 0.0002 inch is produced using an air pressure of 2.7 p.s.i.g. Using a still more viscous coating solution having a #1 Zahn Cup viscosity of 142 seconds, a coating having a thickness of 0.0004 inch is produced using a pressure of 1.7 p.s.i.g., and a coating having a thickness of 0.002 inch is produced using a pressure of 3.9 p.s.i.g.

For the application of very thin films of wax from aqueous emulsions, it is preferred to use a concentrated emulsion containing about 10% by weight of dispersed wax. With such an emulsion coated upon ⅝" x 0.023" strapping precoated with synthetic resin and moving at 750 feet per minute, it has been found that a ¼" felt wiper provides an excellent resilient wiping surface which provides very thin and uniform coatings using air pressures of 10–30 p.s.i.g., preferably 20 p.s.i.g. To picture this variation in structure, the opposed carpets **35** in the drawing diagrammatically identify the felt wipers which are contemplated.

The invention is defined in the claims which follow.

I claim:

1. Apparatus for wiping excess liquid coating material from a wet-coated strip of material to thereby apply a uniform controlled amount of coating material to all of the surfaces of the strip comprising, a pair of vertically disposed resilient wiping elements providing oppositely facing resilient wiping surfaces in contact wth one another, a pair of substantially vertical back-up plates, one of said back-up plates being positioned against the rear surface of one of said resilient wiping elements and the other of said back-up plates being positioned against the rear surface of the other of said resilient wiping elements,

said back-up plates being suspended for lateral swinging movement in unison while retaining their vertical position, said wiping elements being carried by said back-up plates for movement therewith, two vertically spaced apart pairs of opposed inflatable pressure applying devices for resiliently biasing said back-up plates toward one another to force said resilient wiping surfaces together and means to guide said wet-coated strip in an approximately vertical upward path between said resilient wiping elements.

2. Apparatus as recited in claim **1** in which said resilient wiping surfaces are provided by oppositely facing dense cut pile carpets having their pile surfaces in contact with one another.

3. Apparatus as recited in claim **1** in which said resilient wiping surfaces are provided by a pair of felt layers.

4. Apparatus as recited in claim **1** in which said back-up plates are bent outwardly at the entrance end thereof and said resilient wiping elements extend over said outwardly bent portion to form an inverted V-shaped entranceway for the collection of excess liquid coating material.

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