July 1, 1969 J. E. PENKALA ETAL 3,453,137

PAPER MACHINERY

Filed Oct. 5, 1965 Sheet 1 of 2

FIG-1

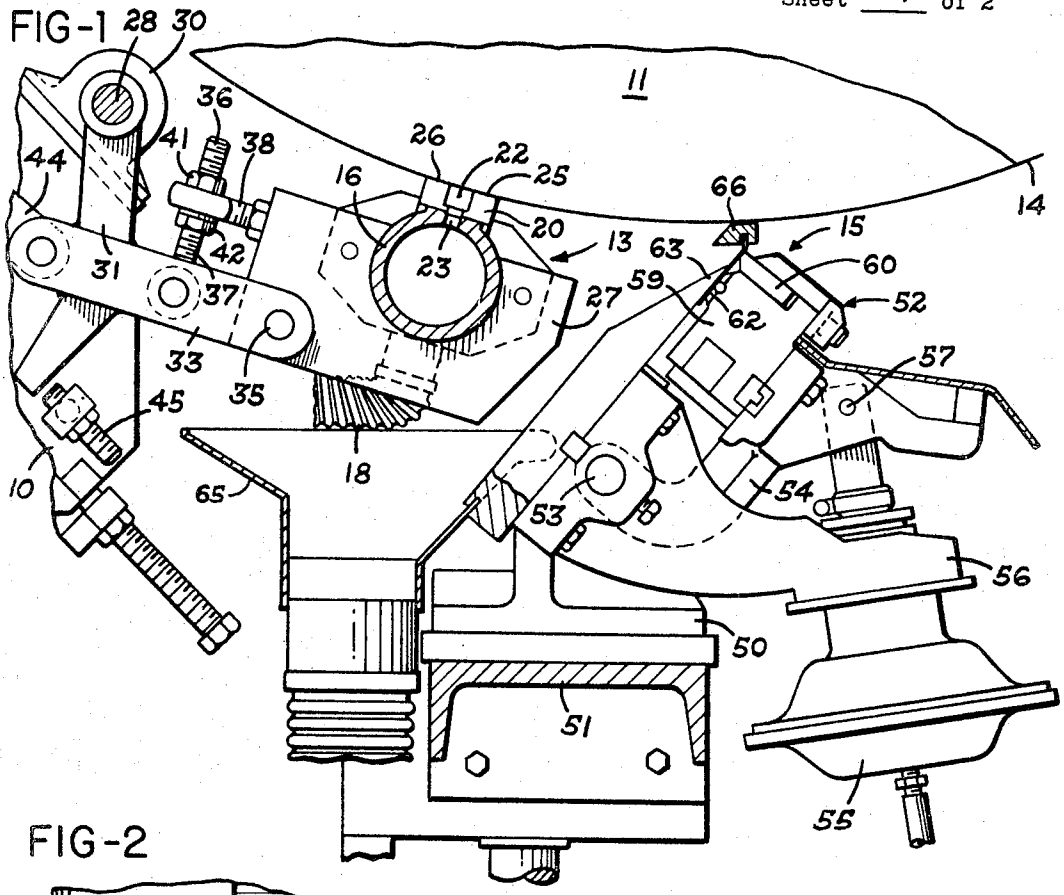
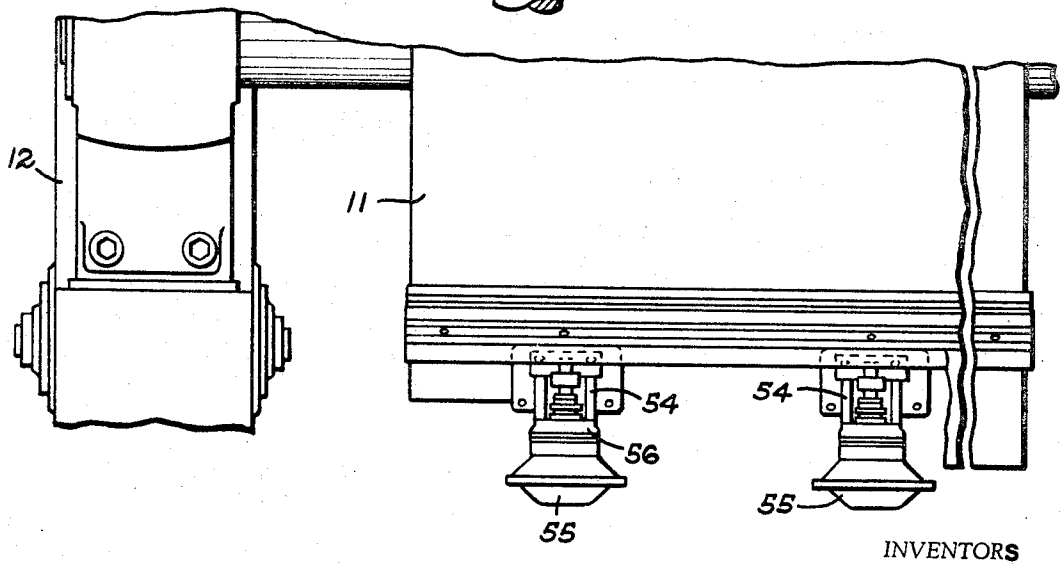


FIG-2



INVENTORS
JOSEPH E. PENKALA &
JEAN-PIERRE ESCARFAIL

BY Marechal, Biebel, French & Bugg

ATTORNEYS

July 1, 1969 J. E. PENKALA ET AL 3,453,137

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Filed Oct. 5, 1965 Sheet 2 of 2

FIG-3

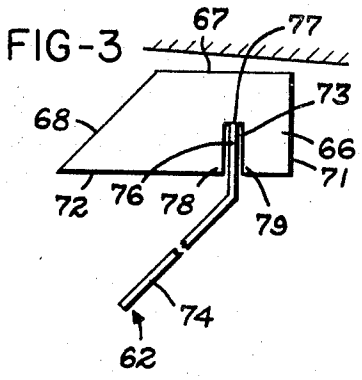


FIG-4

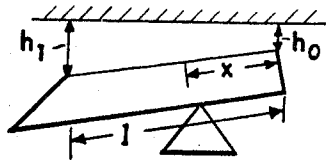


FIG-5

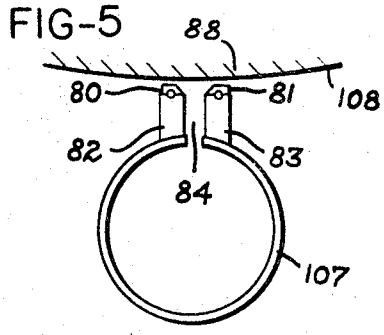


FIG-6

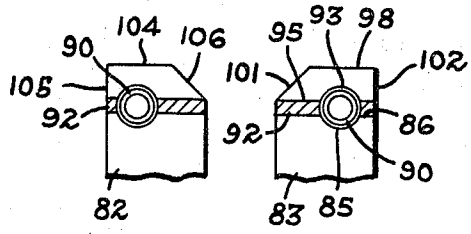


FIG-7

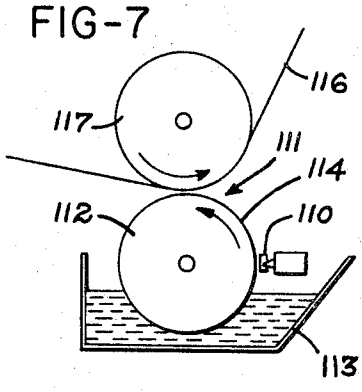


FIG-8

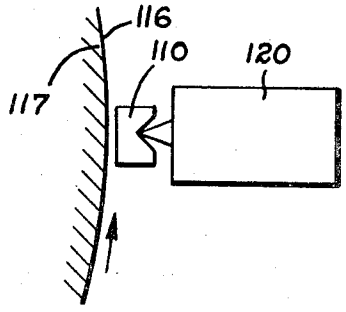
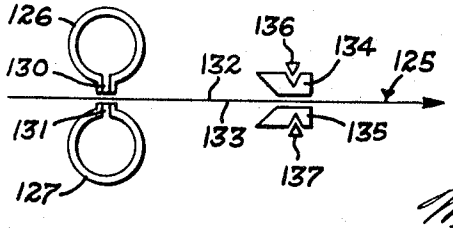


FIG-9



INVENTORS
JOSEPH E. PENKALA &
BY JEAN-PIERRE ESCARFAIL

Marechal, Biebel, French & Bugg
ATTORNEYS

United States Patent Office

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3,453,137

PAPER MACHINERY

Joseph E. Penkala, Fulton, N.Y., and Jean-Pierre Escarfail, Pontcharra, France, assignors to The Black Clawson Company, Hamilton, Ohio, a corporation of Ohio

Filed Oct. 5, 1965, Ser. No. 493,027
Int. Cl. B05c *11/02*
U.S. Cl. 117—102 13 Claims

ABSTRACT OF THE DISCLOSURE

A doctoring apparatus for smoothing a coating on a paper web supported on a roll including an elongated doctor bar which is mounted on a pivot for free movement with respect to the roll. The doctoring bar has a flat surface adapted to cooperate with the paper web being coated, and this doctoring bar moves automatically to a doctoring position wherein the pressure of the coating liquid in the space between the paper web and the flat space is uniform to create a smooth contact on the surfaces.

This invention relates to the art of applying a coating to a smooth surface, and particularly to a process and apparatus for applying a coating to a traveling web.

At the present time the speed of machinery for applying a coating to a web of paper impervious film is limited by the coater or fluid applicator, rather than the drives, driers, and unwind and rewind equipment. One possible exception is the blade coater which uses a flexible blade pressed against the traveling web. However, this type of machinery cannot produce a "wet film" wherein a portion of the coating remains above the surface of the web since the flexible blade actually contacts the web. Consequently, the machinery cannot be used to apply a coating to an impervious web, e.g., plastic material.

It is difficult to obtain a speed above 1000 feet per minute with existing "wet film" coaters due primarily to the use of a diverging nip area in most of these coaters. Diverging nips allow rapid release of internal pressure in the coating that eventually breaks the wet film or produces a pattern even before a reasonably high speed can be developed. While the air doctor type of wet coater may not suffer from the problems of a diverging nip, it does experience "coating aspiration" which becomes acute at pressures over 3 p.s.i. It is therefore impossible to obtain a high quality coating at high speeds and during long runs with the air doctor.

Although reverse roll coaters can be operated at high speed, high quality results thereon require high tolerances of the rolls. Thus the rolls have as much as one-tenth mil variation between the cooperating rolls, the coating thickness can vary one-half to three-quarter pound in a coat weight of five–ten pounds.

Accordingly, an important object of this invention is to provide a process and apparatus for applying a wet coating to a web of paper or other material at high speed and with high quality results.

Another object of this invention is to provide a process and apparatus for doctoring the coating on a web which permits a wide range of coating thicknesses without creating undesirable patterns in the coating, and particularly to provide such doctor apparatus which can be used with substantially any type of apparatus for applying the coating to the web.

A further object of this invention is to provide apparatus for doctoring the coating on a web moving at high speed wherein the coating itself cooperates with the doctor apparatus to smooth and even the coating and to remove a portion thereof to achieve a coating of desired thickness, and further to provide a doctor apparatus which

operates equally as well over a wide range of web speeds and wherein the pressures generated in the coating are not sufficient to cause detrimental flow into the substrate of the web being coated.

Another object of this invention is to provide apparatus for doctoring a coating which is simple in design and is self-tilting to accommodate automatically the speed of the web and the viscosity of the coating to produce a coating of uniform thickness and free of patterns, and particularly to provide a doctor apparatus of the aforesaid type which can be used with a fountain type coater or a reverse roll coater, as well as to coat simultaneously both sides of a moving web.

Other objects and advantages of the invention will be apparent from the following description, the accompanying drawings and the appended claims.

In the drawings:

FIG. 1 is a side elevation, partially in section, of the coating apparatus in accordance with the invention;

FIG. 2 is a plan view of the coating apparatus shown in FIG. 1;

FIG. 3 is an enlarged side elevation showing the doctor bar and its supporting structure;

FIG. 4 is a schematic illustration which demonstrates the dimensional consideration in the doctor bar;

FIG. 5 is a side elevation view of another form of the invention;

FIG. 6 is an enlarged side elevation view of the fountain coater embodiment shown in FIG. 5;

FIG. 7 is a side elevation view of a reverse roll coater embodiment of the invention;

FIG. 8 is an enlarged side view of the embodiments shown in FIG. 7; and

FIG. 9 is a schematic side elevation view of another embodiment of the invention wherein both sides of the web are coated simultaneously.

Referring to the drawings, which illustrate preferred embodiments of the invention, FIGS. 1 and 2 show a portion of the frame **10** of a coater which includes a pair of spaced end stands **12** supporting a backing roll **11**. Suitable frame and end stand structure for this purpose are shown in the United States patent of Jacobs et al. No. 3,079,889, issued Mar. 5, 1963, and assigned to the assignee of this application.

FIG. 1 further illustrates the coater apparatus including a fountain coater assembly **13** which applies the coating to one surface of a web **14**, and a doctor assembly **15** for smoothing and removing any excess coating applied by the fountain. It is this latter assembly to which this invention is primarily directed, and the fountain coater assembly which is shown for purposes of illustration is described and claimed in the copending United States application of Richard W. Phelps et al., Ser. No. 408,163, filed Nov. 2, 1964, and assigned to the assignee of this application.

The fountain assembly **13** includes a conduit or tube **16** which extends the width of the roll **11**. The tube **16** is closed or blocked at the ends thereof and a coating liquid is supplied to the interior of the tube through the flexible inlet conduit **18**, which connects centrally to the tube **16**.

The fountain assembly **13** further includes a fountain bar **20** mounted on an upper surface of the tube **16** and also extends the width of the roll **11**. The bar **20** is formed with a longitudinal groove **22** which may be rectangular in section, and this groove **22** opens into the interior of the fountain tube **16** through a series of longitudinally spaced openings **23** in the bottom of the bar **20** and the top of the tube **16**. The bar **20** and the tube **16** may be held together as a unitary assembly by welding to the tube **16** or any other conventional manner. The fountain

bar **20** is formed with the upstream and downstream longitudinal lips **25** and **26**, each of which has a flat surface adjacent the roll **11** and extends uniformly from either side of the groove **22**.

The fountain assembly **13** is supported for application of coating material to the web **14** and includes the support plates **27** adjacent the ends of the tube **16**. The support plates **27** are suitably cut out at the top to receive the tube **16** in supporting cradled relation therein. The fountain assembly is mounted for movement about the pivot shaft **28** which extends through suitable bearings **30** mounted on the frame **10**. The bracket members **31** are pivotally supported by the bearing **30** and each include an elongated support bar **33** which is rigidly secured to the bracket member **31** and is pivotally secured to the support plates **27** by the pins **35**.

The fountain assembly is adjusted with respect to these support bars **33** by adjusting the relative position of the threaded extension **36** of the I-bolt **37** on the bars **33** with respect to the I-bolt **38** secured to the end plates **27**. Thus by loosening each of the nuts **41** and **42**, the relative position of the bolts **37** and **38** can be varied thereby to change the angular relationship between the fountain assembly **13** and the support bars **33**. It should be understood that only one side of the coating apparatus is shown and that the opposite is substantially a mirror image of that shown and described.

An actuator **44** (shown partially in FIG. 1) is used to pivot the bracket **31** about the shaft **30** to move the entire fountain assembly **13** to a position remote from the roll **11** for cleaning and maintenance. The adjustable stop **45** may be provided on the frame **10** to limit the extent that the bracket **31** will move in a counterclockwise direction, as viewed in FIG. 1.

The doctor assembly **15** is an important part of this invention and includes a support assembly which is preferably constructed according to the teachings of the copending United States application of James T. Coghill, Ser. No. 350,910, filed Mar. 10, 1964, now Patent No. 3,301,214, and assigned to the same assignee as this application. That is, the support assembly preferably includes a supporting frame **50** which is rigidly mounted on a cross channel **51** forming a part of the frame **10** of the coating apparatus.

The clamping assembly **52** is mounted for pivotal movement on a shaft **53** by a plurality of arms **54** and is movable with the arms **54** between an advanced or operating position (FIG. 1) and a retracted position (not shown) wherein the clamping assembly **52** is retracted to a position spaced clockwise from the position shown in FIG. 1. The clamping assembly **52** also includes a series of actuators in the form of air motors **55** which are fixedly mounted on support arms **56** and which are connected to the arms **54** by a pin **57** for effecting movement of the assembly **52** between the operating and retracted positions.

The clamping assembly **52** also includes the clamp and pressure bars **59** and **60** which extend transversely at least the width of the web **14** to clamp the support blade **62** in the position shown in FIG. 1, between the pressure bars **59** and **60** and the forward lip **63** extending upwardly from the frame **50**. The bar **60** is adjustable along its length as described in the aforesaid Coghill application to vary the force extend along the length of the support blade **62**. The entire frame **50** and doctor assembly **15** may be retracted for the purpose of cleaning, maintenance, replacement, and the like, by use of conventional actuators and related equipment, not shown. The overflow trough **65** is provided on the frame **50** below the fountain **13** to collect any coating color which may overflow the fountain during start-up.

FIG. 3 illustrates the self-adjusting doctor assembly **15** including the elongated doctor bar **66** which extends coextensively with the roll **11**, and is pivotally supported on the support blade **62**. The doctor bar **66** has a flat face **67** with a sloping front wall **68** on the leading portion thereof, while the trailing wall **71** is perpendicular to the flat face **67**. The bottom side **72** is also flat and parallel to the face **67**, and has a mounting slot **73** therein perpendicular to the flat face **67**.

The support blade **62** is coextensive with the doctor bar **66** and has a mounting portion **74** which is rigidly held in position by the clamping assembly **52** between the lip **63** and the pressure bars **59** and **60**. The adjustable pressure bar **60** may apply forces to the mounting portion **74** to deform the same along its length for limited adjustment thereof, but this invention may be used without this adjustable feature.

The support blade **62** also includes a pivot portion **76** formed integrally with the mounting portion **74** and disposed at an angle thereto so that this portion is substantially perpendicular to a plane tangent to the adjacent portion of the backing roll **11**. The pivot portion **76** is received within the slot **73** in the doctor bar **66**, and since the slot has a width substantially wider than the thickness of the pivot portion **76**, the doctor bar is free to tilt within limits about the upper edge **77** of the support blade **62**. The extent of tilting is limited by the contact between the corners **78** and **79** on the bar **66** at the entrance to the slot **73** so that the bar **66** is free to tilt within limits but cannot be disengaged from the support blade **62** during operation.

In operation, the fountain coater **13** is moved to its operative position with respect to the backing roll **11** and coating is forced from the tube **16** upwardly between the lips **25** and **26** to apply a coating of excess thickness to the web **14** as it moves on the roll **11** past the lips in the manner described in the aforesaid Phelps et al. application. As the web **14** moves with the backing roll **11** past the doctor bar **66**, the coating is smoothed and evened to a precise thickness and uniformity. Because of the capability of the doctor bar **66** to pivot about the edge **77** of the support blade **62**, the pressure of the wedge of coating liquid between the web **14** and the flat surface **67** automatically evens itself throughout the wedge thereby preventing the occurrence of high pressures which would undesirably force the coating into the substrate of the web **14**.

The excess coating on the web **14** is removed as the coating contacts the leading surface **68** of the doctor bar **66**, and only the preset thickness is allowed to pass through the tapered wedge which is formed between the flat surface **67** and the roll **11**. The excess coating flows downwardly along the surface **68** and then eventually flows into the overflow trough **65** and is reprocessed or discarded. The thickness of the coating is dependent upon the space between the surface **67** and the web **14**, and this can be readily varied by changing the position of the doctor bar **66** with respect to the web **14** so that the desired thickness of coating is achieved. It will be seen that the thickness of the coating cannot abruptly change across the width due to irregularity in the surface of the backing roll **11**, since the pressure within the coating wedge is also uniform in a direction transversely of the roll.

In order to prohibit excessive pressures between the surface **67** and the web and to obtain an effective doctoring action, it is necessary that the pivot point be precisely located to provide for an even distribution of pressure on the flat surface **67** of the doctor bar **66**. The pressure distribution on the flat surface is given by the following equation:

$$P=\frac{6uVl}{h_0^2}K_p \qquad (1)$$

u is the viscosity of the liquid between the web and the flat surface,

V is the velocity of the web,

l is the length of the bearing surface,

h_0 is the distance between the trailing edge and the web or the thickness of the coating, and

K_p is a function of the point of application of the pressure on the surface:

$$K_p=\frac{1}{m'}\left(\frac{2m'+2}{-2(2+m')\left(1+m'\frac{x}{l}\right)^2}+\frac{1}{1+m'\frac{x}{l}}-\frac{1}{2+m'}\right) \quad (2)$$

where x is the distance between the trailing edge of the surface and the center of the pressure application,

$$m'=\frac{h_1-h_0}{h_0} \quad (3)$$

h_1 and h_0 are the clearances between the flat surface and the traveling web at the leading and at the trailing edge of the surface, respectively. As can be seen, K_p depends also upon the inclination of the bearing.

The center of pressure of the surface under hydrodynamic pressure is then as follows:

$$l_G=\frac{\int_0^l Pxdx}{\int_0^l Pdx} \quad (4)$$

or

$$\frac{lG}{l}=\frac{\int_0^1 K_p\left(\frac{x}{l}\right)d\left(\frac{x}{l}\right)}{\int_0^1 K_p d\left(\frac{x}{l}\right)} \quad (5)$$

The average pressure P and the friction F on the surface of the doctor bar are important since they affect the penetration of the coating color into the web **14**. They can be calculated by integration or from the following formulas:

$$P=0.174\frac{uVl}{h_0^2}K_p \quad (6)$$

$$F=2.9\times10^{-5}u\frac{V}{h_0}K_F \quad (7)$$

where:

K_p and K_F are tabulated functions of the inclination of the surface **67**. These values are fairly constant so that the values of $K_p=0.0267$ and $K_F=0.614$ were chosen, assuming $m'=1$.

Coating colors are non-Newtonian fluids. They are often considered exhibiting pseudoplastic behavior:

$$u=u_0S^{n-1} \quad (8)$$

where:

u_0 is the viscosity at the point where the rate of shear S equals 1. However, the plasticity exponent n is not constant when considering broad ranges of rate of shear. When plotting the exponent n as a function of the logarithm of the viscosity, a nearly straight line is obtained:

$$n=l-a\log u \quad (9)$$

This linear approximation is coarse but sufficient when considering the many different rheological behaviors of coating color. This will permit a good extrapolation of the viscosity at very high shear rates:

$$u=u_0^{S-\frac{a}{M}} \quad (10)$$

A statistical analysis of a wide range of viscosities of coating colors gives a value for a between 0.15 and 0.25 when plotting the decimal logarithm of the viscosity. The value of $a=0.20$ was used into the calculations, together with the factor $M=2.303$ to convert decimal into natural logarithms.

The rate of shear S under the bearing and, therefore the viscosity u, are not uniform but the differences are small and the rate of shear at the trailing edge is used in the calculations:

$$S=200\frac{V}{h_o} \quad (11)$$

When the center of the pressure is calculated in accordance with Equations 2 and 5 for a plurality of inclinations of the surface **67**, it is found the center of pressure is placed at 40 to 44 percent of the surface width as measured from the trailing edge. To assure the best tiltability, the pivot point must be then placed at this center of pressure, i.e., between about 13/32–7/16 of the surface from the trailing edge.

The operational viscosity, the pressure and the friction are calculated according to the Equations 10, 6 and 7, for a plurality of different film thicknesses. These calculations are repeated for a plurality of different speeds and again repeated for a plurality of different viscosities. The conclusion reached is that this coater will operate in a medium pressure range. A high solids coating of 10 to 20 pounds corresponds to a film thickness of 1 to 2 mils at a viscosity of 10,000 cps., and a low solid coating of 2 to 4 pounds corresponds to a film thickness of 0.5 to 1 mil at a viscosity of 100 cps. In both cases, the hydrodynamic pressure is calculated to be between 20 and 60 p.s.i.

FIGS. 5 and 6 illustrate another embodiment of the invention wherein a pair of tilting doctor bars **80** and **81** are mounted on the lips **82** and **83** of a fountain coater similar to that shown in FIG. 1. Thus the lips **82** and **83** on the opposite sides of the flow channel **84** have the annular depressions **85** formed in the top surfaces **86** thereof. These lips and depressions extend coextensively with the backing roll **88** and an elongated inflatable tube **90** is disposed in each of the depressions **85**. A strip **92** of resilient material, for example, polyurethane foam, is secured in place on the surfaces **86** on the opposite sides of the tubes **90**.

The tilting doctor bars **80** and **81** having the curved depressions **93** in the bottom surfaces **95** thereof complementary to the depressions **85** are then placed on top of the tubes **90** and resilient strips **92** so that the top portions of the tubes **90** are received within the depressions **93**. The bars **80** and **81** are otherwise very similar to that shown in FIG. 3 except for the manner in which they are mounted for pivotal movement, as explained above. Accordingly, the flat top surface **98**, and rear and leading sides **101** and **102**, of the downstream bar **81** are substantially identical to those described in connection with the embodiment of FIGS. 1–4. The upstream bar **80** is also similar with the flat top surface **104** having a square side wall **105** on the upstream side and the tapered side wall **106** at the downstream side thereof.

The doctor bars **80** and **81** pivot about the axis of the tube **90** in response to the pressures created on the surfaces **98** and **104** thereof during the coating operation. Since the pivot axis of these tubes is disposed in accordance with the calculations set forth above, the bar **80** or **81** is tilted until the pressure within the coating wedge is uniform. The tilting movement of the bars **80** and **81** causes one of the resilient pads **92** to be compressed without any substantial resistance to the tilting movement of the bars, and when this tilting force is removed the resilient pads return the bars to their horizontal position.

In operation of this embodiment, the coating fluid under pressure is forced through the tube **107** and upwardly into the channel **84** formed between the vertical lips **82** and **83**. Excessive coating is applied under pressure to the moving web **108** by the flow between the tilting doctor bars **80** and **81** and, as the web moves over one of the doctor bars **80** or **81**, a smoothing operation substantially identical to that described above occurs. That is, the pressures created between the web **108** and the smooth flat surface **98** or **104** of the doctor bar **80** or **81** causes the doctor bar to tilt to a position wherein the

coating is evenly smoothed without patterns and of uniform thickness.

If the web is moving to the right, as viewed in FIG. 5, the upstream doctor bar **80** on the left lip **82** merely serves to limit or confine the flow of liquid between this doctor bar **80** and the backing roll **88**. With this arrangement, however, the direction of the roll **88** and web **108** can be reversed without any adjustment of the doctor bar **80** or **81** since the bar **80** then operates in the same manner as the bar **81**, while the bar **81** then operates as bar **80**.

FIGS. 7 and 8 disclose a further embodiment of this invention wherein the tilting doctor bar **110** is used in a reverse roll coater **111**. In this arrangement, the lower roll **112** rotates through a reservoir **113** of coating liquid which thus causes an excessive amount to adhere temporarily to the outer surfaces **114** thereof during rotation. The web **116** to be coated moves with the backing roll **117** in a direction opposite to the adjacent portion of the lower roll **112** which is spaced from the web a slight distance so that the coating on the roll **112** is applied to the web **116** in a known manner.

The tilting doctor bar **110** is used to even the coating on the lower roll **112** prior to the transfer of this coating to the web **116**. The tilting doctor bar **110** is pivotally supported on a pivot member **120** for cooperation with the surface **114** of the lower roll **112** to provide a smooth pattern free coating thereon of preset thickness in the manner similar to that described hereinbefore in connection with FIGS. 1–4.

A further embodiment of the invention is illustrated schematically in FIG. 9 wherein both sides of a moving web **125** are coated and thus no backing surfaces per se are used. Specifically, a pair of fountain coaters **126** and **127** apply an excessive coating to the opposite sides **132** and **133** of the moving web **125**. Downstream from these fountain coaters is a pair of tilting doctor bars **134** and **135** pivotally supported on the pivot members **136** and **137** and disposed on opposite sides of the moving web to remove the excess liquid and to smooth this coating in the manner described above. In this embodiment, the doctor bars **134** and **135** also work together forming backing surface for the opposite doctor bar, and the coating operation is otherwise substantially identical to that described above. Moreover, the pivot axes of the doctor bars **110**, **134**, and **135** are selected in accordance with the calculations set forth in connection with FIGS. 1–4.

While each of the embodiments of the invention describes the surface adjacent the moving web or backing surface as a flat face or smooth surface, these terms are intended to include surfaces which are rounded either in a concave or convex manner, or which have grooves disposed therein either longitudinally of the face or transversely thereof to facilitate the application of the coating. The important feature of the invention is that the surface is free to tilt about an axis in accordance with the pressures developed within the wedge coating material formed between the surface being coated and the face so that this pressure is uniform throughout the wedge thereby facilitating high speed coating application without touching the surface being coated. The uniform pressures are less than those that would otherwise normally be present, and therefore the coating fluid is not forced into the substrate of the web, or through the web itself as would occur if higher pressures were utilized.

What is claimed is:

1. Apparatus for doctoring a coating liquid which has been applied to a smooth surface or the like, comprising an elongated doctor bar, support means tiltably supporting said doctor bar in a preset position for pivotal movement about an axis parallel to the smooth surface, means for effecting relative movement between said smooth surface and said doctor bar, said doctor bar having a flat face adjacent the smooth surface with leading and trailing edges thereon, a pivot connection between said doctor bar and said support means, said connection being parallel to said flat face and located a distance which equals about 40 to 44% of the width of said flat face measured from said trailing edge, and means for moving said smooth surface with respect to said doctor bar to enable said doctor bar to be pivoted automatically to a doctoring position wherein the pressure of the coating liquid in the space between said smooth surface and said flat face is uniform and a smooth coating of precise thickness is created on the smooth surface.

2. Apparatus for applying a wet coating to a web or the like supported by a backing surface, comprising means for applying excessive coating liquid to the web, means for doctoring said excessive coating including an elongated doctor bar, support means tiltably supporting said doctor bar in a preset position with respect to said backing surface for pivotal movement about an axis parallel to the web, means for effecting movement of said web with respect to said smooth surface on said doctor bar, said doctor bar having a smooth face adjacent the web surface with leading and trailing edges thereon, and a pivot connection between said doctor bar and said support means located a distance which equals about 40 to 44% of the width of said flat face measured from said trailing edge, said doctor bar being adapted to pivot automatically to a position wherein the pressure of the coating liquid in the space between said smooth surface and said web is uniform throughout said space to produce a smooth pattern-free coating of precise thickness on the web.

3. Apparatus for coating a smooth surface or the like, comprising means for applying excessive coating liquid to the smooth surface, means for doctoring said excessive coating including an elongated doctor bar, said doctor bar having a flat face adjacent the smooth surface with leading and trailing edges thereon, means defining a slot in a surface of said doctor bar parallel to and opposite said flat face, support blade means coextensive with said doctor bar and having a thickness less than the width of said slot so that a portion of said support blade means is received in said slot to support said doctor bar for pivotal movement about an axis parallel to the smooh surface, said slot being located a distance measured from said trailing edge which equals about 40 to 44% of the width of said flat face, and means for effecting relative movement between said smooth surface and said doctor bar, said doctor bar being adapted to be tilted automatically to a position wherein the pressure of the coating liquid in the space between said smooth surface and said flat face is uniform and a smooth coating of precise thickness is created on the smooth surface.

4. Apparatus for coating a smooth surface or the like, comprising means for applying excessive coating liquid to the smooth surface including a pair of parallel lips defining therebetween a flow path, means for forcing coating liquid through said flow path to apply the excessive coating to the smooth surface, one of said lips having an elongated doctor bar pivotally supported for movement of said doctor bar about an axis parallel to the smooth surface, said doctor bar having a flat face adjacent the smooth surface, and means for effecting relative movement between said smooth surface and said doctor bar, said doctor bar being adapted to pivot automatically to a position wherein the pressure of the coating fluid in the space between said smooth surface and said flat face is uniform and a smooth coating of precise thickness is created on the smooth surface.

5. Apparatus for coating a smooth surface or the like, comprising means for applying excessive coating liquid to the smooth surface including a pair of parallel lips defining therebetween a flow path, means for forcing coating liquid through said flow path to apply the excessive coating to the smooth surface, each of said lips having an elongated doctor bar pivotally supported thereon for pivotal movement of said doctor bar about an axis parallel to the smooth surface, said doctor bars having a flat face adjacent the smooth surface, and means for

effecting relative movement between said smooth surface and said doctor bars, said doctor bars being adapted to pivot automatically to a position wherein the pressure of the coating liquid in the space between said smooth surface and said flat face is uniform and a smooth coating of precise thickness is created on the smooth surface.

6. Apparatus for coating a smooth surface or the like, comprising means for applying excessive coating liquid to the smooth surface including a pair of parallel lips defining therebetween a flow path, means for forcing coating liquid through said flow path to apply the excessive coating to the smooth surface, one of said lips having a flat outer surface having an elongated groove therein, a pivot tube having a portion which extends into said groove, an elongated doctor bar having a groove in the back portion thereof for receiving a portion of said pivot tube for pivotal movement of said doctor bar about the axis of said tube, said doctor bar having a flat face adjacent the smooth surface, and means for effecting relative movement between said smooth surface and said doctor bar, said doctor bar being adapted to be moved automatically to a position wherein the pressure of the coating liquid in the space between said smooth surface and said flat face is uniform and a smooth coating of precise thickness is created on the smooth surface.

7. Apparatus as defined in claim 6 wherein resilient means are provided on opposite sides of said pivot tube between said outer surface and said doctor bar for urging said doctor bar to a central position.

8. In a reverse roll coater for applying a liquid coating to a moving web, the improvement of apparatus for doctoring the excessive liquid coating applied to the coating roll as it rotates with its lower portion submerged in liquid coating, said improvement comprising an elongated doctor bar at least equal to the width of the web, support means tiltably supporting said doctor bar in a preset spaced relation with respect to the coating roll for pivotal movement about an axis parallel to the axis of the coating roll, said doctor bar having a smooth face adjacent and spaced from the coating roll, and said doctor bar being adapted to pivot to a position wherein the pressure of the coating liquid in the space between the roll and said flat surface is uniform and creates a smooth coating of precise thickness on the web at high speed.

9. Apparatus for coating a web of paper or the like, comprising means for applying excessive coating liquid to the opposite sides of the web, a pair of elongated doctor bars disposed on opposite sides of the web to provide a backing support for each other, support means tiltably mounting said doctor bars in a preset position for pivotal movement about an axis parallel to the plane of the web, each said doctor bar having a smooth face adjacent the web, and means for effecting relative movement between the web and said doctor bars, said doctor bars being adapted to pivot to a position wherein the pressure of the coating liquid in each of the spaces between the web and said smooth faces is uniform and creates a smooth coating of precise thickness on the web at high speed.

10. Apparatus for coating a web, comprising means for applying a coating liquid to the opposite sides of the web moving at high speed, a pair of elongated doctor bars disposed on opposite sides of the web to provide a backing support for each other, support means tiltably mounting said doctor bars in a preset position for pivotal movement about an axis parallel to the plane of the web, and each said doctor bar having a smooth face adjacent the web, said doctor bars being adapted to pivot automatically to a position wherein the pressure of the coating liquid in each of the spaces between the web and smooth faces is uniform and creates a smooth coating of precise thickness on the web at high speed.

11. A high speed process of doctoring an excessive coating on a web moving at high speed, comprising the steps of positioning a free tilting doctor bar having a smooth face adjacent but spaced from the web, effecting relative movement between said web and said smooth face, supporting said web on the side opposite said doctor bar and directly opposite said smooth face so that the coating forms an elongated tapered wedge in the space between said smooth face and the web, and automatically tilting said doctor bar to a position wherein the pressure of said coating within said wedge is constant and uniform throughout thereby enabling lower pressures within said wedge, said smooth face cooperating with the coating and web to even the coating and to remove excess coating so that a coating of precise depth is created.

12. A high speed process of coating on a smooth surface with a liquid coating, comprising the steps of forcing the coating liquid upward between the two lips which are closely spaced from said smooth surface to apply excessive coating liquid to said smooth surface, effecting relative movement between said lips and said smooth surface, said lip on the downstream side of said passage having a free tilting doctor bar including a flat face disposed adjacent but spaced slightly from the smooth surface, said relative movement forming an elongated tapered wedge in the space betwen said flat face and the smooth surface, and automatically tilting said doctor bar to a position wherein the pressure of said coating within said wedge is constant and uniform throughout, said flat face cooperating with the coating and smooth surface to even the coating and to remove excess coating so that a coating of precise thickness is provided on said smooth surface.

13. A high speed process of simultaneously doctoring a coating on the opposite side of a web moving at high speed, comprising the step of positioning a free tilting doctor bar having a smooth face adjacent but spaced slightly from the opposite sides of the web, effecting relative movement between said web and said smooth faces, supporting said web between said smooth faces so that the coating forms a pair of elongated tapered wedges in the spaces between said smooth faces and the web, and automatically tilting said doctor bars to a position wherein the pressures of said coating within said wedges are constant and uniform throughout thereby enabling lower pressures within said wedges, said smooth faces cooperating with the coating and the web to even the coating and provide a coating of precise depth.

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ALFRED L. LEAVITT, *Primary Examiner.*

J. A. BELL, *Assistant Examiner.*

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