United States Patent [19]

Fowble

[11] B **3,916,043**

[45] **Oct. 28, 1975**

[54] **METHOD OF COATING A SPLICED WEB**

[75] Inventor: **William F. Fowble,** Rochester, N.Y.

[73] Assignee: **Eastman Kodak Company,** Rochester, N.Y.

[22] Filed: **Nov. 15, 1971**

[21] Appl. No.: **198,810**

[44] Published under the Trial Voluntary Protest Program on January 28, 1975 as document no. B 198,810.

[52] **U.S. Cl.** ..... **427/294;** 96/85; 96/87 R; 96/94 R; 118/50; 118/63; 118/410; 427/296; 427/350

[51] **Int. Cl.²** **B05C 3/12;** B05D 1/26; G03C 1/74

[58] **Field of Search** ..... 117/34, 47 A, 61, 119; 118/63, 50, 410; 427/294, 296, 350

[56] **References Cited**

UNITED STATES PATENTS

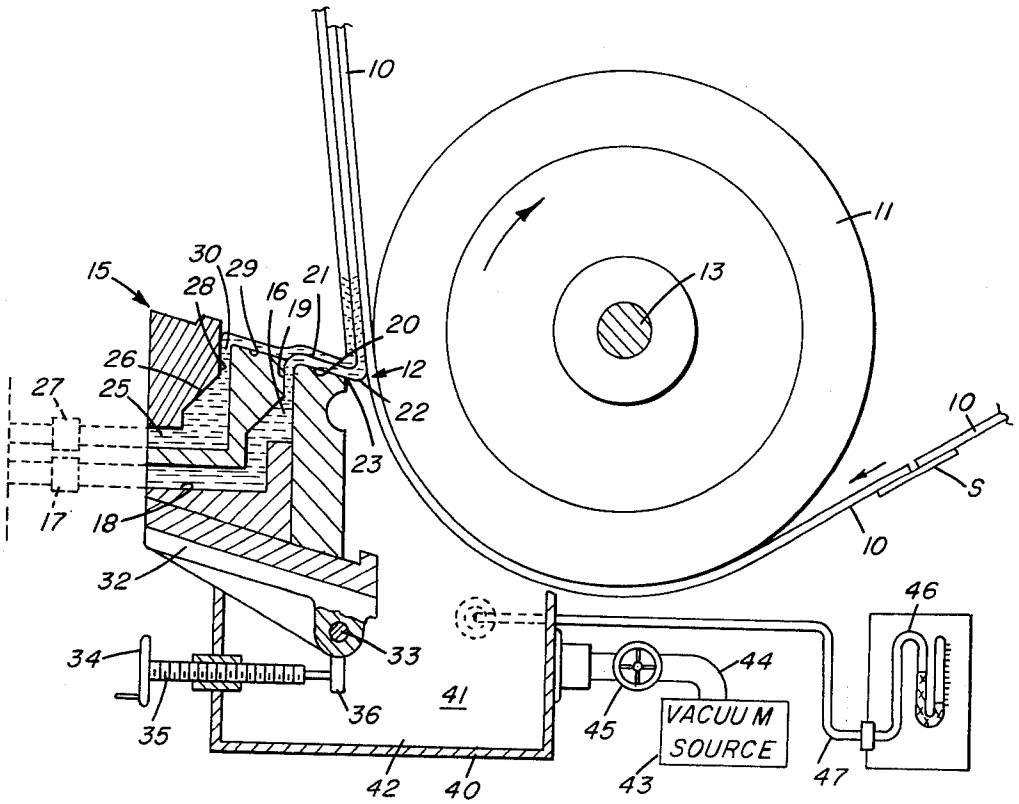
2,681,294	6/1954	Beguin	117/34
2,761,418	9/1956	Russell	118/410
2,761,791	9/1956	Russell	118/410
2,952,559	9/1960	Nadeau	117/34
3,206,323	9/1965	Miller	117/34
3,227,136	1/1966	Bartlett	118/63
3,348,964	10/1967	Good	118/50
3,502,494	3/1970	Ishiwata	118/50
3,503,370	3/1970	Ishiwata	117/34
3,518,141	6/1970	Boarns et al.	117/34
3,640,752	2/1972	Ishiwata	117/34
3,645,773	2/1972	Herzhoff et al.	117/34
3,663,292	5/1972	Herzhoff et al.	117/34

Primary Examiner—William R. Trenor
Attorney, Agent, or Firm—A. P. Lorenzo

[57] **ABSTRACT**

In coating by discharging a ribbon of coating material onto a moving web to form a coating bead while applying suction to the side of the bead or ribbon which the web approaches, defects caused by a web splice are reduced by momentarily increasing the suction.

12 Claims, 2 Drawing Figures



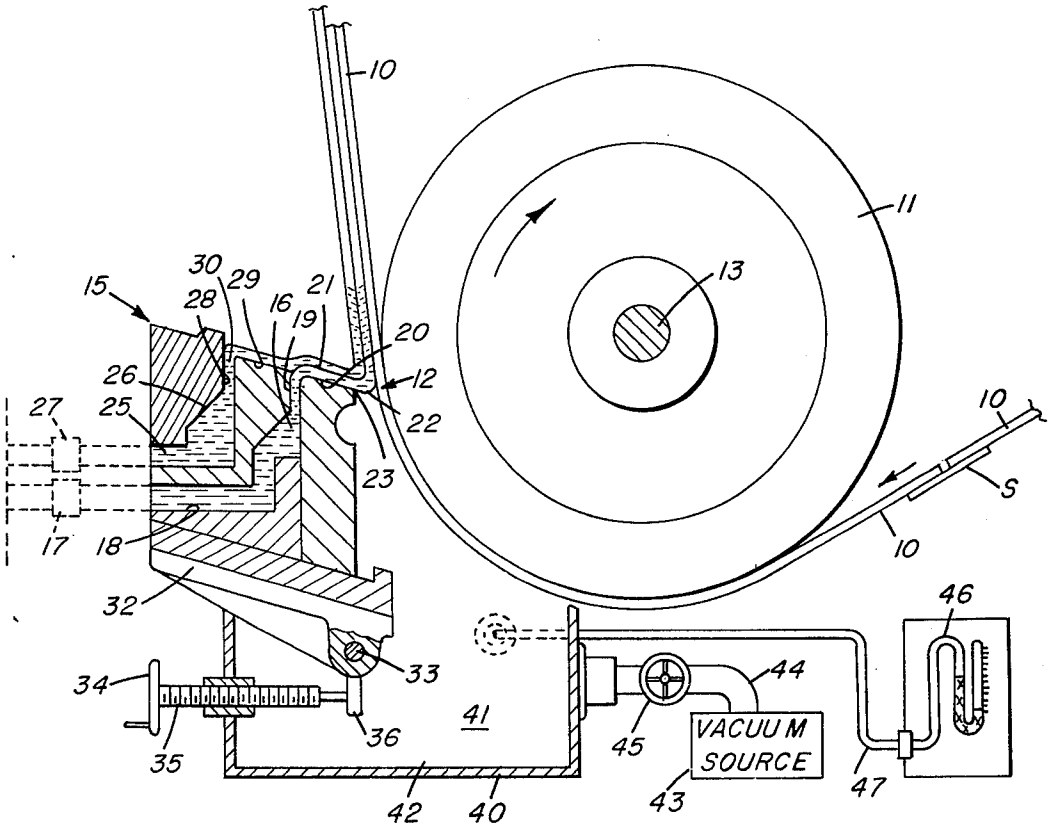


FIG. 1

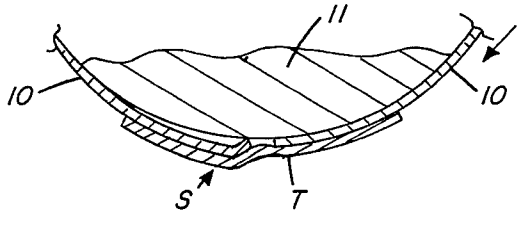


FIG. 2

WILLIAM F. FOWBLE
INVENTOR.

BY

ATTORNEY

METHOD OF COATING A SPLICED WEB

This invention relates to improvements in the method of applying a layer of liquid coating composition to the surface of a moving web of material, and particularly to a spliced web.

U.S. Pat. Nos. 2,681,294 and 2,761,791 disclose methods of coating which include flowing a stream or layer of liquid coating composition from a coating device toward the surface of a web to be coated to maintain a ribbon or bead of coating solution in bridging relation between the coating device and the web surface during the coating operation. In order to stabilize the ribbon or bead of coating, and/or prevent it from longitudinally stretching in the direction of the web movement, a greater pneumatic or other gaseous pressure is maintained on that side of the ribbon or bead of coating solution from which the coated web moves away than on that side toward which the web to be coated approaches. The use of this differential gaseous pressure on the opposite sides of the ribbon or bead of coating composition overcomes many disadvantages of earlier methods of coating, as well as permitting the coating speed to be greatly increased. However, the increase in speed presents certain difficulties in the coating of spliced webs which results in a considerable loss of coated material as the result of a splice passing through the ribbon or bead of coating composition. One of the primary advantages claimed for this method of coating is that the coating device can be spaced from the web to be coated by an amount sufficient to permit a splice in the web to pass the coating station without having to move the coating device away from the surface being coated. It has been found, however, that as a splice in the web moves across the coating station longitudinal streaks may develop in the coating, and persist for some time, at all coating speeds, and that "blow-up" or rupture of the ribbon or bead occurs at high coating speeds, which results in a defective coating until the bead is reformed and becomes stabilized again. It will be appreciated that these imperfections in the coating resulting from the passage of a splice past the coating station, even though they might only persist for a short time, will result in the waste of a considerable length of web, particularly when the coating operation is being carried out at high speeds, e.g. greater than 200 feet per minute.

It has been discovered that if the differential pressure on the opposite sides of the ribbon or bead of coating composition is increased just before a splice in a web enters the coating station and is maintained during the time the splice is passing the coating station and for a short time thereafter, before it is reduced to the level used for normal coating, then these coating problems caused by the passage of a splice past the coating station can be greatly decreased or completely eliminated.

The primary object of the present invention is, therefore, to provide a method of coating over splices in a web material to be coated which is less wasteful of material than with prior methods.

A further object is to provide a method of coating a spliced web material which permits the use of high coating speeds without danger of the ribbon or bead of coating composition bridging the space between the coating device and the web surface being ruptured or suffering a "blow-up" as it is known in the art.

The novel features that I consider characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its methods of operation, together with additional objects and advantages thereof, will best be understood from the following description when read in connection with the accompanying drawings in which:

FIG. **1** is a diagrammatic side elevation, partly in section, of a form of apparatus by which the improved method can be carried out; and

FIG. **2** is an exaggerated fragmentary sectional view showing how the spliced ends of two webs form a hump as they move onto the surface of the coating roll by reason of their inherent curl.

With reference to FIG. **1**, the web material **10**, such as film or paper, is drawn from a source of supply, not shown, and partially wrapped around the roll **11** for movement past the coating station **12**, the roll **11** being keyed to shaft **13** which is continuously rotated at a desired rate (feet per minute) in accordance with the liquid coating composition to be applied to the web. Thus, as the uncoated web **10** is moved into the coating station, the liquid coating composition is applied to the surface thereof and then passes away from the roll for the necessary drying operations.

The coating device **15** can be of the type disclosed in U.S. Pat. Nos. 2,761,419 and 2,681,294 in which a fluid composition **16** is continuously pumped by a constant discharge pump **17** into a cavity **18** at a given rate, the composition being forced through a layer distributing slot **19** in the form of a ribbon and out onto a downwardly inclined slide surface **20.** The ribbon flows by gravity in the form of a layer **21** to a point where it forms a coating bead or ribbon **22** between the lip **23** of surface **20** and the surface of the moving web **10.** A second fluid composition **25** is pumped into cavity **26** by another constant discharge pump **27** and is forced through the distributing slot **28** in the form of a ribbon and out onto the downwardly inclined slide surface **29.** As the layer **30** reaches layer **21** it flows onto the top thereof and the two layers **30** and **21** flow down slide surface **20** and into the coating bead **22.**

The coating device **15** extends axially with respect to the roll **11** and is mounted on a plate **32** which, in turn, is pivotally mounted on cross shaft **33.** By means of hand wheel **34** and lead screw **35,** which is pivotally connected to extension **36** on plate **32,** the coating device **15** can be moved toward and away from the surface of the web **10** on the roll **11** to vary the depth of the coating bead (determined by the spacing between the coating device and the web surface which the bead must bridge) and/or to permit threading up of the coating apparatus.

A casting **40** having end walls **41** together with coating device **15** and a portion of roll **11** form a chamber **42.** A vacuum pump **43** is connected to chamber **42** by a pipe **44** which is provided with a regulating valve **45.** The pressure within the chamber can be indicated by means of a manometer **46** which is connected to chamber **42** by means of line **47.**

When starting a coating operation the coating device **15** is moved or tilted away from the coating roll **11** to permit threading of the web **10** about roll **11.** Then

after the pumps **17** and **27** are started to form the layers **21** and **30** flowing toward the lip **23** of the coating device, the coating device is moved toward the roll **11** until the layers **21** and **30** contact the surface of the web to form the coating bead **22.** After the bead **22** has been formed transversely of web **10,** and the layers **21** and **30** are being applied uniformly to the surface of the web, the coating device is moved away from the web **10** into the coat position. The position of lip **23** relative to the web for forming the desired coating bead and for maintaining a uniform coating application will be dependent upon the fluid composition, the material of the web to be coated and the rate of movement of the web across the bead. In accordance with the method of coating taught by U.S. Pat. No. 2,681,294, during coating the pressure within chamber **42** is reduced so that it is subatmospheric with a pressure differential of the order of 0.1 inch to 5.0 inch of water depending upon the fluid composition, the material to be coated and the rate of coating. This differential pressure is selected to retain the ribbon or bead of coating in coating position and to maintain a uniform coating on the web material, and as noted will vary with the coating composition, the surface characteristics of the web being coated and the rate of coating.

While this differential pressure maintained on opposite sides of the coating bead tends to stabilize the bead and permit the lip of the coating device to be spaced far enough from the web to be coated to allow the passage of a splice S in the web without having to back off the coating device from the coating roll, it has been found that the passage of a splice in the web through the coating bead produces coating defects which result in considerable waste of product. These coating defects which are most prevalent occur at high speeds of coating, e.g. greater than 200 feet per minute, and result from bead "blow-up" which is a complete or partial rupture of a coating bead **22.** When this occurs, the coating is interrupted and does not again become uniform and satisfactory until the bead reforms itself and becomes restabilized. Even if this ruptured bead reforms itself without intervention by the operator it will be appreciated that considerable material is wasted before a uniform coating is reestablished.

Even at the slower coating speeds the passage of a splice through the coating bead has been found to produce coating defects in the form of longitudinal lines, generally referred to as splice oriented defects, which persist for varying lengths of time after a splice has passed through the coating bead. In the latter instance it has been determined that these coating lines have been caused by the stability of the coating bead being upset by the passage of a splice and/or by bubbles of air which are trapped in the coating bead as a result of the splice passing through.

I have found that if the differential pressure on the coating bead is increased just before a splice in the web reaches the coating bead and this increased differential pressure is maintained until the splice has passed through the coating bead, and is then reduced to the normal coating differential pressure, then the splice oriented coating defects and/or the defects caused by bead blow-up are greatly reduced or eliminated. Debead "blow-up" are greatly reduced or eliminated. Depending upon the coating composition, the speed of coating and the surface characteristics of the web being coated, as well as the surface characteristics of the splice material used, the differential pressure may have to be increased from 0.2 inch of water up to 1.2 inches of water above the differential pressure used during normal coating.

The reason for bead "blow-up" or rupture when a splice passes the coating station, particularly at high speeds, is quite understandable. The splice in a web to be coated generally consists in joining the butted relation, the end of an expiring web and the end of a new web by a strip of adhesive tape placed over the butted ends of the webs and extending transversely of the surface to be coated, see S in FIG. **1.** While a splicing tape generally used which is as thin as the required strength allows, the thickness of the tape adds significantly to the overall thickness of the web, particularly as concerns the spacing between the coating device and the web surface being coated, or the depth of the coating bead. Also, it is not uncommon when splices are made to have bubbles of air formed under the splice material which form humps in the splice which increases the thickness of the web at the splice to an even greater value. The passage of the splice through the coating bead can readily rupture the bead or upset its stability to the extent that the uniformity of the applied coating is destroyed until the bead is reformed and/or restabilized. Since the leading edge of the splicing tape is generally perpendicular to the web surface it subjects the coating bead to a sudden change in depth which, by itself, is sometimes sufficient to rupture the bead. In addition, at high speed the trailing edge of the splice tape disturbs the boundary layer of air surrounding the web. At high coating speeds, all of this turbulent air following the trailing edge of the splice does not have a chance to exhaust at the edges of the web but must exhaust through the bead. As a result, there is a build up of compressed air behind the splice which aids in the rupture or "blow-up" of the coating bead as the splice passes through the same. Feathering of the edges of the splicing tape to lessen this turbulence has been tried but is not the complete answer to the problem of splice oriented coating defects.

Another condition which can upset the coating bead when a splice in the web passes therethrough is known as "splice humping". This occurs primarily in webs of plastic, e.g. acetate, polyester, etc, used as photographic film support as will now be explained. These supports usually have a thickness in the order of 4 to 11 mils and are usually stored in rolls for some time before they are coated. As a result, the ends of the supports which are spliced just before coating have an inherent curl which is generally sharper than the arcuate surface of the coating roll **11.** Although the webs are said to be butt spliced, actually the ends of the spliced webs are generally separated by as much as 1/32 inch, either because the operator has not made the cut off accurately on the splice board, or if the splice is automatically made by a machine, to insure that the web ends won't overlap. As shown in FIG. **2** on an exaggerated scale, the result of this is that the thin splicing tape T is not strong enough, or the tension in the web going onto the coating roll **11** is not great enough, to straighten the inherent curl out of the spliced ends of the web to make them conform to the circumference

of the coating roll. Consequently, a hump in the web appears at the splice, and the effective thickness of this hump may approach the width of the space between the web and the coating device so that as it passes the coating position it can readily upset the stability of, or rupture, depending upon the speed the web is moving at, the coating bead. Likewise, if this splice is made on the backside of the film, (the surface not coated) as it sometimes is, or in the instance where both sides are to be coated alternately, then the coating bead will drop down into the space between the separated ends of the spliced webs and have its stability upset as the splice passes through the coating bead.

Increasing the differential pressure on the opposite sides of the coating bead before the splice reaches the bead, and maintaining this increased differential pressure until the splice passes through the coating bead has been found to prevent the bead from rupturing and quickly overcomes any instability the bead might suffer by reason of the passage of the splice. It will be appreciated that the differential pressure required will vary with the coating composition, the rate of coating and the wetting characteristics of the web surface being coated. However, the pressure differential used must not be so great that it will itself cause rupture of the bead, particularly under normal coating conditions, e.g. those encountered before and after the splice enters, or has passed through, the coating bead.

The coating defects encountered at slow coating speeds, or when no bead "blow-up" occurs, are not quite so obvious. In this case it is believed that coating bead instability results not only from the sudden change in thickness of the web at a splice, but, in addition, due to the volume of air moved into the bead by the leading edge of the splicing tape. While in this instance the coating bead is not ruptured it is believed that the volume of air moved into the bead by the leading edge of the splicing tape forms a cushion of air which lifts or stretches the coating bead, or shifts the wetting line thereof, longitudinally of the web. As a result, instead of the coating composition being deposited on the web surface right up to the leading edge of the splicing tape T, it is lifted by the cushion of air at the leading edge of the splice and is in fact momentarily unsupported except for this cushion of air. The same effect occurs at the trailing edge of the splice so that the layer(s) of coating instead of flowing sharply down the rear edge of the splicing tape, leave the tape on an incline.

Another factor which might enter into the instability of the coating bead is that the wetting characteristics of the splicing tape T are usually different than those of the web to be coated. If the surface of the tape has a different wetting characteristic for the coating composition than the web itself, this will tend to cause a shift in the wetting line of the coating bead as the splice passes therethrough, and a sudden shift in the wetting line will produce an instability in the bead. Increasing the differential pressure during the time a splice is passing through the coating bead in accordance with the present invention is believed to hold the bead down so that it squeezes air out from under the coating and holds the wetting line of the bead constant, rather than the increase in vacuum on the underside of the bead acting to pull air out from under the bead.

In order to more clearly illustrate the applicability of the invention with respect to particular coating applications, several specific examples are described hereinafter. It is to be understood, of course, that the invention is not limited to the materials nor the various features set forth in these examples.

Example 1

An aqueous solution of gelatin and silver halide having a viscosity of approximately 4.5 centipoise at 95°F was applied to a web with a wet lay down thickness of approximately 3 mils. This coating composition was coated on a dry 5 mil or 8 mil acetate support. The normal coating suction was 0.5 inch of water and the high vacuum used at splices was 1.0 inch of water. The coating speed was 110 feet per minute.

Example 2

An aqueous solution of gelatin and silver halide having a viscosity of 8.5 centipoise at 95°F was coated at 300 feet per minute with a wet lay down thickness of approximately 2 mils. This material was coated on a polyethylene terephthalate support. The normal coating suction was 0.6 inch of water and the high vacuum at splices was 1.0 inch of water.

Example 3

The same materials as used in Example 2 were coated at 400 feet per minute with a normal coating suction of 0.2 inch of water and a high vacuum at splices of 0.7 inch of water.

Example 4

An aqueous solution of gelatin, silver halide and latex polymer having a viscosity of 9 centipoise at 95°F was coated on a 4 mil polyethylene terephthalate support with a wet lay down thickness of approximately 3 mils. The normal coating suction was 0.6 inch of water and the high vacuum at splices was 0.9 inch of water. The coating speed used was 300 fpm.

In the first three examples the coating and high suction were applied to the face of a splice, that is, that side of the support on which the splicing tape is applied. In the last example the coating was applied to the back of the support, and the high suction was used on the back of the splice to prevent bead disturbance resulting from the gap between the two butted ends of the support.

In addition to the above examples, reference can also be had to the examples set forth in U.S. Pat. No. 2,681,294 wherein various initial air pressure differentials are disclosed for coating other materials with different fluid compositions. The increased air pressure differential to be used in these examples will again be dependent upon the web material, the fluid coating composition used and the rate of coating.

While the valve **45** can be manually adjusted to obtain the desired air pressure differential at the proper time, it is preferred to perform this task automatically and with precision. To this end, the valve **45** could be a two position valve, one of its positions producing the desired initial or normal pressure differential for coating, and the other position producing the desired increased pressure differential for the passage of a splice in the web. In order to obtain a quick and automatic re-

sponse this valve could be operated by an electrical solenoid. Then an electrical signal from a splice detector could shift the valve to its other position as a splice approached the coating station and an electrical timer or footage indicator, could automatically shift it to its first position a given time after the splice has passed the coating position for the normal coating condition. It has been found preferable in the coating examples noted above to apply the increased pressure differential at the time a splice is two feet ahead of the coating bead and to maintain this increased pressure differential until the splice is two feet beyond the coating bead. It will be appreciated that the time that this increased pressure differential is applied and the length of time it is maintained may vary with the speed of coating, the type of coating composition used, the material of the web to be coated, and/or the type of splice used to join the web ends. In order to make the differential pressure control system more versatile, so far as its applicability to different coating compositions is concerned, it might be desirable to use two valves in the suction line instead of one, one to produce the desired initial pressure differential for coating and the other to produce the increased pressure differential for the passage of splices, and make each of these valves adjustable for different coating conditions. These two valves could be connected in the suction line in parallel and the selective use of one or the other could be controlled by a splice detector and a timer as mentioned above.

While for purposes of disclosure the present method of coating has been shown in connection with a coating device adapted to apply two coatings to a web simultaneously, it will be appreciated that the coating method could just as well be used in applying a single layer of coating composition, or three or more layers simultaneously of the same or different coating composition, to a moving web.

The invention has been described in detail with particular reference to preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention.

I claim:

1. A method of coating a spliced strip material from a coating device which comprises

moving the strip material adjacent and relative to the coating device;

discharging a ribbon of liquid coating composition from the coating device toward said strip of material to form and maintain a bead of liquid composition transversely of an area of the moving strip across which the web moves and picks up a layer of said liquid composition;

subjecting the bead of liquid coating composition to an initial differential air pressure to hold the bead of coating composition from movement in the direction of travel of the strip material, the pressures being selected to retain the bead of coating composition in a coating position and to maintain a uniform coating on the strip material, the lesser air pressure being on the side of the bead toward which the web approaches;

increasing the initial differential air pressure just before a splice in the strip material reaches said bead;

maintaining the increased differential air pressure until the splice in the strip material has passed through said bead; and

decreasing the differential air pressure to the initial differential air pressure after the splice in the strip material has passed through said bead.

2. The method of coating a strip of spliced strip material as defined in claim **1**, wherein the increase in the initial differential takes place a predetermined interval before a splice in the strip material reaches said bead, and the decrease in the differential pressure to the initial differential air pressure takes place a predetermined interval after the splice has passed through said bead of liquid composition.

3. The method of coating a strip of spliced strip material as defined in claim **1**, wherein the initial differential air pressure is in the order of 0.1 inch to 5.00 inch of water.

4. The method of coating a strip of spliced strip material as defined in claim **1**, wherein the increased differential air pressure is 2 to 12 times that of the initial differential air pressure.

5. A method of coating a thin layer of liquid coating material from a coating device onto a web having at least one transverse splice, comprising:

moving the web adjacent and relative to the coating device;

discharging a ribbon of the liquid coating material from the coating device onto said moving web in bridging relation between the coating device and the moving web;

subjecting the surface of the ribbon advancing into contact with the web to an initial predetermined subatmospheric gaseous pressure while maintaining atmospheric pressure on the opposite surface of the ribbon;

reducing said subatmospheric pressure by a predetermined increment a predetermined interval before the splice in the web reaches the ribbon of coating material;

maintaining the reduced subatmospheric pressure for a predetermined interval after the splice in the web reaches the ribbon coating material; and

increasing said subatmospheric pressure to said initial predetermined subatmospheric pressure after said second interval.

6. The method of coating a strip of spliced strip material as defined in claim **5**, wherein the initial subatmospheric pressure is 0.5 inch to 0.7 inch of water less than atmospheric pressure and the reduced subatmospheric pressure is 0.9 inch to 1.0 inch of water less than atmospheric pressure.

7. The method of coating a strip of spliced material as defined in claim **5**, wherein the strip of material is butt spliced by a strip of splicing tape extending transversely of and overlying the butted ends of the strip and the splicing tape is on the surface of the web to be coated, the initial subatmospheric pressure is 0.2 inch to 0.7 inch of water less than atmospheric pressure and the reduced subatmospheric pressure is 0.7 inch to 1.0 inch of water less than atmospheric pressure.

8. A method of coating a strip of spliced material as defined in claim **5**, wherein the splicing tape is on the uncoated side of the strip of material and the initial subatmospheric pressure is 0.6 inch of water less than atmospheric pressure and the reduced subatmospheric pressure is 0.9 inch of water less than atmospheric pressure.

9. In a method of coating a moving web of substantially nonporous flexible material containing at least

one splice whose thickness is substantially greater than the thickness of the web of material with a liquid coating composition having viscosities of between 3 and 35 centipoises, comprising flowing a thin layer of said composition from a coating device to the web of nonporous material to form a bead of composition therebetween extending transversely of the web, said bead having a depth several times the thickness of said web while passing from the coating device to the web and while the web moves toward the coating device and away from the coating device, maintaining the bead of coating composition in a coating condition by applying an initial predetermined differential in gaseous pressures on the two sides of the bead of coating composition, the pressure on that side of the bead from which the web approaches the coating device being less than the pressure on that side of the bead from which the web moves away from the coating device, the improvement which comprises,

increasing the initial pressure differential a predetermined increment a predetermined time interval before a splice in the web reaches the bead of coating composition;

maintaining the increased pressure differential until the splice in the web has passed through said bead of coating composition; and

decreasing the pressure differential to the initial pressure differential after the splice in the web has passed through said bead of coating composition.

10. A method of coating a strip of spliced material as defined in claim **9,** wherein the increased pressure differential is applied when the splice is approximately 2 feet ahead of the coating bead and is decreased to the initial differential pressure after the splice is approximately 2 feet beyond the coating bead.

11. A method of coating a thin layer of liquid coating material from a coating device onto a web having at least one transverse splice, comprising:

moving the web adjacent and relative to the coating device;

discharging a ribbon of the liquid coating material from the coating device onto said moving web in bridging relation between the coating device and the moving web;

establishiing an initial predetermined gaseous pressure differential across the opposite surfaces of the ribbon, such that the pressure on the surface of the ribbon advancing into contact with the web is lower than the pressure on the opposite surface of the ribbon;

increasing the differential pressure by a predetermined increment a predetermined interval before the splice in the web reaches the ribbon of coating material;

maintaining the increased differential pressure for a predetermined interval after the splice in the web reaches the ribbon coating material; and

decreasing the differential pressure to the initial predetermined pressure after said second interval.

12. A method of coating a thin layer of liquid coating material from a coating device onto a web having at least one transverse splice, comprising:

moving the web adjacent and relative to the coating device;

discharging a ribbon of the liquid coating material from the coating device onto said moving web in bridging relation between the coating device and the moving web;

subjecting the surface of the ribbon advancing into contact with the web to an initial predetermined subatmospheric gaseous pressure in the range of 0.2 to 0.6 inches of water less than atmospheric pressure, while maintaining atmospheric pressure on the opposite surface of the ribbon;

reducing said subatmospheric pressure by a predetermined increment to a pressure in the range of 0.7 to 1.0 inches of water less than atmospheric pressure a predetermined interval before the splice in the web reaches the ribbon of coating material;

maintaining the reduced subatmospheric pressure for a predetermined interval after the splice in the web reaches the ribbon coating material; and

increasing said subatmospheric pressure to said initial predetermined subatmospheric pressure after said second interval.

* * * * *