Feb. 25, 1969 J. J. MORIARTY 3,429,741

METHOD OF COATING USING A BEAD COATER

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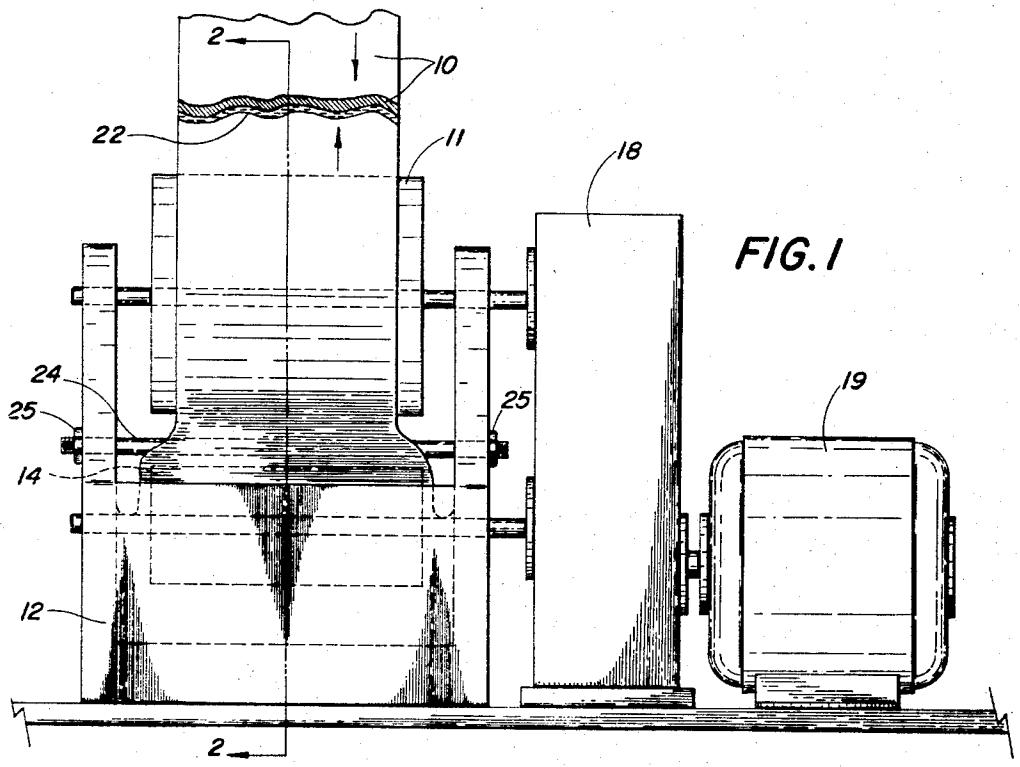

FIG. 1

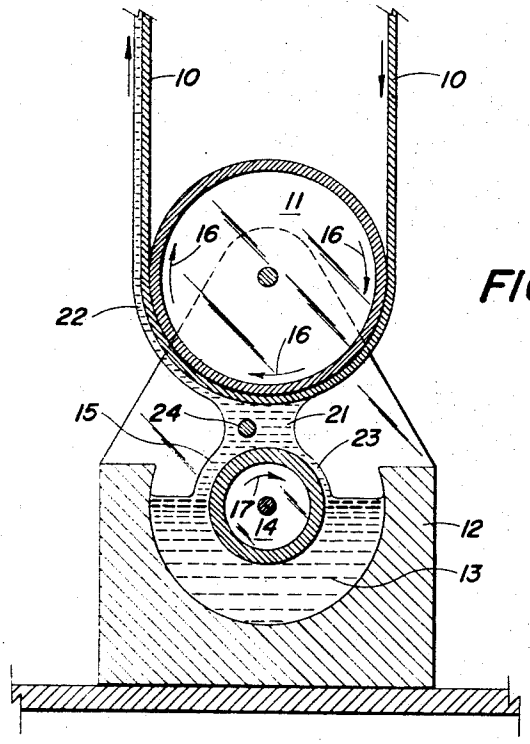

FIG. 2

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METHOD OF COATING USING A BEAD COATER

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Int. Cl. B05c 5/02, 3/18, 1/12

ABSTRACT OF THE DISCLOSURE

A method and apparatus for continuously applying a layer of coating liquid to the surface of a web by moving the web across and in contact with a bead of the liquid maintained between the surface of the web and a lifter roller which rotates in a supply of said liquid and feeds liquid to said bead in excess of that coated out on said web. To improve the uniformity of the coating at high coating rates the bead is internally stabilized by a taut wire extending the full length of said bead and completely immersed therein.

The present invention relates to a continuous coating mechanism and more particularly to a single side coating mechanism for transferring a liquid layer to a continuous web.

In the art of continuous coating, several mechanisms are known, with one being termed a bead coater. In a bead coating mechanism, a continuous web is passed over a coating tank having therein a driven lift roller spaced a few thousandths of an inch below the web and which raises the liquid to contact the moving web, with the contacting liquid being referred to as a bead. The lift roller has a surface veocity opposed to that of the web. Thus the liquid bead is sheared during the coating process. As the speed of these bead coaters is increased, it sometimes occurs that the bead tends to be shifted laterally or otherwise deformed because of the various stresses in the liquid. At certain speeds this shifting tends to make the bead unstable or vibratory or to capture bubbles so that the coating has varying thicknesses throughout the length of the web. Probably this shifting causing such variations is what might be termed a harmonic vibration of the liquid bead. Such variations in the coating, particularly in the art of manufacture of photosensitive films, often cause the finished product to be unacceptable for marketing.

Therefore, an object of the present invention is to provide an improved continuous bead coating mechanism.

In accordance with one embodiment of my invention, a web is passed over a coating liquid tank with the liquid being raised at a constant rate from the tank by a liquid lift roller having a surface velocity opposite that of the web. The bead of liquid formed between the lift roller and the web has immersed therein a tensioned wire which dampens any tendency of the bead to become unstable.

The subject matter which is regarded as my invention is particularly pointed out and distinctly claimed in the concluding portion of this specification. The invention, however, as to its organization and operation, together with further objects and advantages thereof will best be understood by reference to the following description taken in connection with the accompanying drawing, in which:

FIG. 1 is an elevation view illustrating the general layout of a bead coater; and

FIG. 2 is a cross-section view taken along the line 2—2 of FIG. 1 and illustrating one embodiment of my invention.

Referring now to the drawing, wherein like numbers indicate similar parts, a web **10** such as a cellulosic film

base material is passed over a support and transport roller **11** to come close to a tank **12** having therein a coating liquid **13**. Partially submerged in the coating liquid **13** is a lift roller **14** which raises continuousy the liquid in a "stream" **15** from the tank **12**. As indicated by the arrows **16**, the web transport roll **11** passes the web **10** toward the left over the tank **12** (FIG. 2). As indicated by the arrow **17**, the lift roller **14** causes the liquid to move in the opposite direction at the surface closest to the web **10**. This relative rotation of the rollers **11** and **14** is developed by gearing in a gear box **18** and driven at controllable speeds by a motor **19** shown in FIG. 1.

The continuous lift of the liquid **13** causes a bead **21** of liquid to be formed in the nip between the lift roller **14** and the web **10**. A portion of liquid stream **15** flowing to the bead **21** is transferred to the web **10** as a coating layer **22**. The excess liquid of the bead **21** returns to the tank **12** as indicated at **23**. Since the liquid viscosity, relative velocities (**16** and **17**), and nip spacing of the system may be varied considerably, accurate and uniform coatings **22** may be developed by this type of coating system. Also, these system parameters may be adjusted to provide maximum practical flow of liquid **15** into the bead **21** while maintaining a stable condition to operate at relatively high coating speeds. For practical purposes the minimum nip clearance is usually about 10 mils. Maximum clearance, depending on adhesive and cohesive properties of the liquid **13**, is reached when the bead **21** breaks or becomes unstable.

However, at certain higher speeds of operation of this coating process and depending on the properties of the liquid **13**, the bead **21** tends to exhibit instability characteristics. This instability causes nonuniformities in the coating layer **22**. Since the layer must attack and swell the cellulosic base web **10**, any nonuniformities cause differential attack and swell of the web. Such differentials result in physical and/or optical defects after the coating layer has dried. Reducing the nip clearance toward minimum tends to maintain a stable bead **21** but once minimum clearance is reached, attempts to increase the bead coating process velocity have been thwarted in prior art devices using certain coating liquids.

In accordance with my invention, this instability is overcome by placing within the bead **21** a taut rod or wire **24**. The wire **24** may be tightened in place as by lock nuts **25**. Apparently the wire **24** dampens any tendencies of the bead **21** to vibrate laterally or to develop bubbles because of the high speed shear action resulting from the relative velocities of the web **10** and the liquid being lifted.

In one example of the operation of my invention, a 42" wide transparent cellulose acetate web **10** was transported over the tank **12** at seven feet per minute to be coated with a liquid composition including dispersed gelatin in organic solvents and having a viscosity of 1 centipoise. The lift roller **14** was operated at surface speeds of about two to twelve feet per minute with a nip clearance of 0.020". Without the wire **24**, bubbles were present in the bead at nodal points, and the resulting coating had nonuniformities. Normal adjustments of nip spacing, temperature regulation etc. did not correct the situation. When the taut wire **24** of about 9 or 12 mils 316 stainless steel was introduced into the bead **21**, all nodes in the bead disappeared. Thus, I have found that a coating having reduced stability characteristics may now be applied at higher speeds by the bead coating process because of the stabilization afforded by the taut wire **24**.

Empirical data indicates that the taut wire **24** is most effective if placed nearest the up-stream **15** and spaced from the web **10** a distance greater than the desired thick-

ness of the layer **22**. When so placed, no nonuniformities in the coating layer **22** were noted even at web speeds up to forty-five feet per minute and surface speeds of the lift roller **14** of between five and thirty feet per minute. However, the overall shape of the bead is changed slightly by the taut wire **24**. Apparently, this change is caused by its interruption of the up-stream **15**. Also it should be noted that except for possible abrasive properties in the fluid **13**, there is no wearing of the wire **24** so that even a small diameter wire will not cause appreciable maintenance problems.

I claim:

1. The bead coating method of applying a smooth layer of a coating liquid onto a web surface at high speeds and using a lift roller spaced from said web surface by a distance greater than the thickness of the layer applied to said web to maintain the bead, comprising the steps of:

moving the web surface to be coated in transfer relation with said lift roller;

raising a layer of liquid from a liquid supply on the surface of said lift roller to form and thereafter maintain a continuous bead of liquid in the space between the web surface and the lift roller, said raising step providing a liquid flow generally opposite to the motion of the web; and

internally stabilizing said bead to provide a uniformly thick layer of coating on the web.

2. The method of bead coating according to claim **1**, characterized in that the internally stabilizing step is accomplished by a thin, rigid obstruction extending the full length of said bead in spaced relation to the web and said lift roller and entirely immersed in the bead.

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