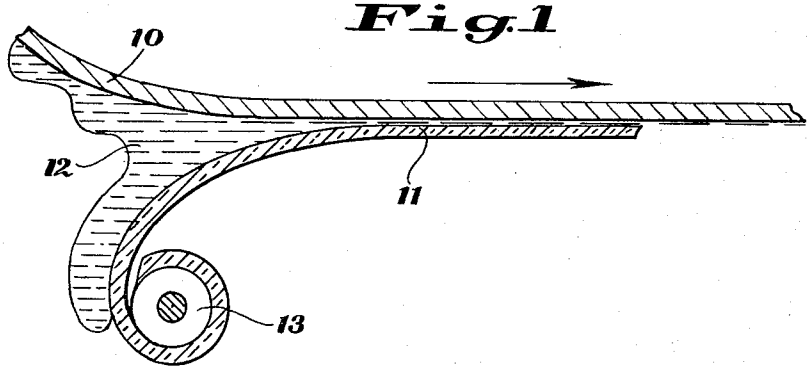
Nov. 14, 1967 J. S. ALKOFER 3,352,706

METHOD FOR SMOOTHING A COATED WEB

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Fig. 1



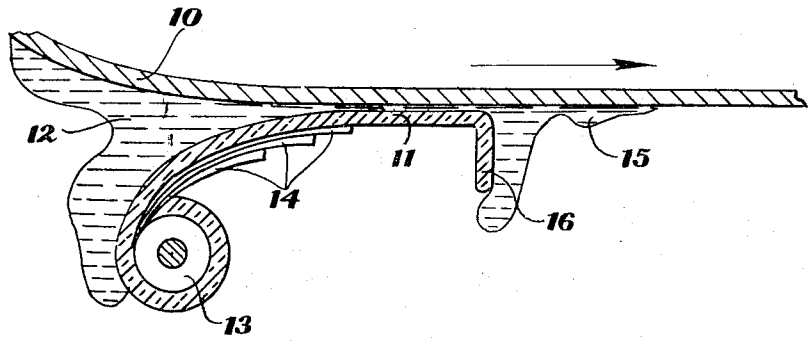


Fig. 2

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METHOD FOR SMOOTHING A COATED WEB

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This invention involves a squeegee, and more particularly, a squeegee and squeegee method for removing fluid from a surface of a moving web.

Squeegees previously employed for removing fluid from moving webs have used wiper blades, rollers, and streams of air. Some of the shortcomings of such devices are: tendencies to trap foreign material at the squeegee point and thus mar the passing web; inability to prevent contamination of a supply of fluid being applied to a web by another subsequently applied fluid running back down the web; confinement of the web to a fixed path of travel past the squeegee; tension and friction forces imposed upon the passing web creating power losses, limiting web speeds, and tending to tear, or injure the web; and expense of manufacture, repair, and adjustment.

In part to overcome such deficiencies, the objects of this invention include removing fluid from a surface of a web traveling at high speed by an economical squeegee which will tend to not trap foreign matter at the squeegee point, or subject the passing web to injurious forces or tensions, and which will allow the passing web some latitude as to a path of travel.

Another object of this invention is to prevent contamination of a supply of fluid being applied to a passing web by a subsequently applied fluid running back along the moving web against the direction of the web's travel.

In general, the objects of this invention are accomplished by a fluid-removing member or squeegee sheet in contact with fluid on a moving web, the squeegee sheet having a surface substantially planar at the locus of contact with the fluid.

The invention will be more clearly understood by reference to the drawings, wherein:

FIG. 1 shows a cross section of a squeegee according to this invention in contact with fluid on the surface of a web; and

FIG. 2 shows a cross section of another embodiment of a squeegee according to this invention in contact with the fluid on a web.

Referring to the drawings, web **10**, the undersurface of which is wet with a fluid **12**, is moved in the direction of the arrow past a fluid-removing member or squeegee sheet **11** which is mounted upon a bar **13**. The fluid **12** and the squeegee sheet **11** are brought into contact with each other by positioning the web and/or squeegee sheet. While the squeegee sheet **11** is in contact with the fluid **12** and the web **10** is moving, or there is relative motion between the web **10** and the squeegee sheet **11**, the physical forces acting upon fluids including Bernoulli forces, surface tension, capillarity, adhesion, cohesion, and gravity cooperate to hold the squeegee sheet **11** in contact with the fluid **12**, and to remove the fluid **12** from the undersurface of the web **10**, allowing the fluid to run off in a downwardly-directed, run-off path.

Part of the explanation for the squeegee sheet's removal of excess fluid from the web **10** is that a substantial surface area of the squeegee sheet **11** disrupts the surface continuity of the fluid **12** on the under side of the web **10**, and the squeegee sheet **11** forms a boundary of fluid **12**. The fluid **12** is then situated between two principal boundary areas—the boundary formed by the web **10** and the boundary formed by the squeegee sheet **11**. Relative movement between the web boundary and squeegee sheet

boundary helps overcome the forces causing the fluid **12** to adhere to the web **10**, and the speed of this relative movement affects the amount of fluid released from the web—higher speeds tending to leave the web more nearly dry than lower speeds. The fluid thus released from adherence to the web is guided away from the web along a run-off path. The run-off path illustrated in the drawings is the downwardly curved portion of the surface of squeegee sheet **11**, and this curved portion communicates with the fluid boundary portion of the squeegee sheet's surface so that the fluid is led away from the web **10**.

The squeegee sheet **11** removes a gross excess of fluid from the web **10** even if the web forms a loop or dips below the squeegee sheet **11** after passing beyond the sheet's trailing edge. The squeegee sheet **11** may also be disposed for removing fluid from the upper side of web **10** so long as suitable fluid run-off paths are provided.

The shape of the upper surface of squeegee sheet **11** as illustrated in the drawings can be defined in the language of descriptive geometry as a ruled or cylindrical surface of single curvature having a plane director and a curved directrix. The plane director, with respect to which a line generating the surface remains parallel, is a plane tangent to the web **10** at the locus of contact between squeegee sheet **11** and fluid **12**. The curved directrix, which the generating line touches, lies in the plane of a cross-section perpendicular to the tangent plane and parallel to a longitudinal edge of the web, and the directrix asymptotically approaches the tangent plane in the direction of travel of the web. The fluid boundary surface of squeegee sheet **11** may also be described as a surface formed by a straight-line generatrix remaining parallel to the plane tangent to the web, normal to the cross-sectional plane, and constantly touching the curved directrix in the cross-sectional plane.

As shown in the drawings, the form of the fluid-contacting or fluid-boundary surface of squeegee sheet **11** is such that a substantial area of the squeegee (as compared to a wiper blade, for example) is in contact with the fluid and substantially parallel to the web **10** at the locus of contact between the squeegee sheet **11** and the fluid **12**.

If the squeegee sheet is resilient or movably mounted, it remains in contact with the fluid **12** on the web **10** throughout a considerable vertical latitude in the path of travel of the web **10**. The web need not be threaded through guides or rollers to engage the squeegee sheet **11** at a fluid-removing station, and the squeegee may be engaged by casting a loop of the web **10** until contact is made between the squeegee sheet **11** and the fluid **12**. Once contact is made, a resilient squeegee sheet rises and falls with the travel variations of web **10**. If the squeegee is formed of light-weight material, it remains in contact with the fluid **12** on web **10** even when the web is stopped.

Although a gross excess of fluid is removed by the squeegee sheet **11**, small particles of foreign matter are allowed to pass without being stopped at the fluid removing location where they might scratch or injure the passing web **10**. The squeegee sheet **11** surpasses wiper blade or pinch-roll type squeegees in this ability to allow small particles of foreign matter to pass the fluid-removing location without being trapped.

The squeegee sheet **11** illustrated in FIG. 2 is formed of a thin, resilient material such as a light-weight, flexible sheet of plastic or rubber, and is backed up by resilient members **14** formed of stiffer sheeets of resilient materials such as rubber, plastic or metal, all of which are fastened to a bar **13**. The resilient members **14** urge the squeegee sheet **11** upward toward contact with the passing web **10**, and thus facilitate contact between the squeegee sheet **11** and the fluid **12**.

Success has been had with a squeeege of the type shown in FIG. 2 in which the squeegee sheet **11** is formed of polyethylene and is 10 mils thick. The resilient members **14** backing up such a squeegee sheet are formed of stainless steel, and the over-all length of squeegee sheet **11** varies between 2 and 3 inches. Although width of material is not a significant factor, such a squeegee has been used on paper from 3½ inches to 10 inches wide.

The embodiment illustrated in FIG. 2 has a drip tab **16** formed on squeegee sheet **11**. The drip tab **16** comprises a surface forming a dihedral angle with the surface of squeegee sheet **11** along the squeegee sheet's trailing edge, or edge last to contact the moving web **10**. A satisfactory drip tab may be fashioned by bending the squeegee sheet to form an abrupt, dihedral angle in the trailing edge portion. The function of drip tab **16** is to divert a fluid **15** which is applied to web **10** at a point beyond the squeegee point and which is running back along the undersurface of web **10** against the direction of the web's travel. Deflection of fluid **15** by drip tab **16** prevents fluid **15** from contaminating the fluid supply from which fluid **12** was applied to web **10**.

Viscous drag and shear stress forces between the squeegeee sheet **11** and the web **10** may be kept within suitable limits by adjusting the length of squeegee sheet **11**. The web speed available is a function of the strength and surface texture of the web, the viscosity of the fluid being removed, and the length of the squeegee sheet. Proper balancing of these parameters allows very high web speeds, and speeds up to 200 feet per minute have already been obtained during squeegeeing of processing solutions from photographic paper.

At very high web speeds, a squeegee sheeet which is long enough will remove nearly all the fluid from the surface of the passing web, but will create a severe drag force capable of damaging the web. At very high web speeds, the length of squeegee sheet **11** is reduced to overcome this tendency. The drag force of squeegee sheet ll and its fluid-removing capacity appear to be best balanced when a very thin layer of fluid is permitted to pass the trailing edge of the squeegee sheet. Such a condition will vary with materials, fluids, etc., but can easily be determined by varying web speeds for each case.

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 as described hereinabove and as defined in the appended claims.

I claim:

1. The method of smoothing a fluid coating on a web which includes continuously moving a web having a fluid coating thereon over a path, thereafter at a position spaced from the position where the fluid coating was applied to the web engaging an unsupported end of a sheet of thin flexible material with the still fluid coating over a substantial area in the direction of travel of the web, said material being wet by the fluid coating and held thereagainst substantially by the wetting action alone, holding the other end of the sheet of material against movement, and continuously moving the web and fluid coating past the material to smooth the coating on the web.

2. The method of smoothing a coating of a fluid carried on a moving web comprising the steps of contacting the fluid coating with an unsupported end of a thin flexible sheet, extending the contacted portion of said sheet over a substantial area of said coating in the direction of web travel, holding said sheet against said fluid coating substantially only by the wetting action of the fluid on said sheet, and restraining the opposite end of the sheet against movement while maintaining movement of the web and fluid coating relative to the sheet.

3. The method of smoothing a coating of a fluid carried on a web according to claim **2** including the step of regulating the speed of said web past the material to control the thickness of said coating.

4. The method of smoothing a coating of fluid carried on a web according to claim **2** including the step of guiding the fluid released from adherence to said web by contact with the sheet from the vicinity of said web along a downwardly-directed, fluid-run-off path away from said web.

5. The method of smoothing a coating of a fluid carried on a web according to claim **2** including the step of diverting away from said web, along a downwardly-directed fluid diverting path, any fluid moving along said web toward the downstream end of said material from a subsequent fluid coating station.

6. The method of smoothing a coating of a fluid carried on a web according to claim **2** wherein said thin flexible sheet is polyethylene substantially 10 mils thick.

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