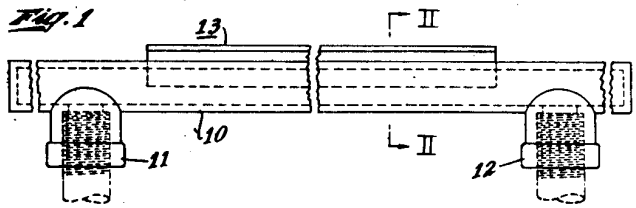
March 10, 1936. R. L. JENKINS ET AL 2,033,379

DOCTOR OR SMOOTHING BLADE FOR TREATING COATED SHEETS

Filed Feb. 18, 1933

Fig. 1



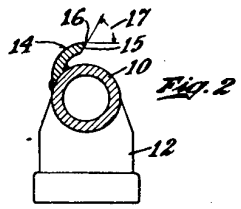


Fig. 2

Fig. 4

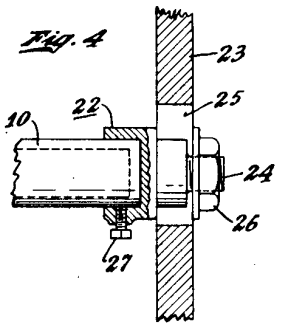
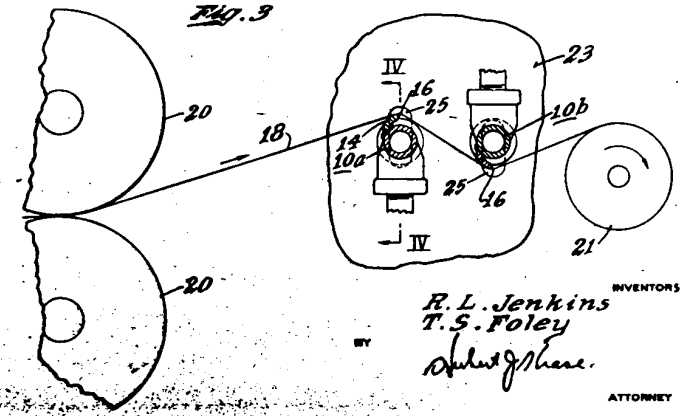


Fig. 3



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DOCTOR OR SMOOTHING BLADE FOR TREATING COATED SHEETS

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Application February 18, 1933, Serial No. 657,226

1 Claim. (Cl. 91—53)

The object of this invention is to provide a new and improved doctor or smoothing blade, particularly adapted for use in connection with sheet or paper coating or impregnating machines. A further object is to provide a heated doctor which may be used for smoothing paper or other sheet material which has been previously coated with resins, waxes or mixtures of the same, and which will cause a smooth, glossy surface to be formed thereon, thereby giving maximum transparency to the coated paper.

The coating of paper, either of the glassine or tissue type, with resins, waxes or mixtures thereof, or of other transparent sheets therewith, is usually carried out by passing a continuous web or sheet of the paper through a saturating bath of the coating composition, then through squeeze rolls which may remove some material from the sheet, and then over doctors or scrapers which remove a further excess of the composition from the sheet.

For most paper coating purposes a molten mixture of resins and waxes is employed for saturating the sheet; however, in certain cases it may be desirable to lower the temperature of application of such composition by the addition of a solvent thereto. Such solvent may be removed from the surface of the coated paper by passing the sheet through a heated chamber or by blowing air over same. The use of our improved heated doctor herein disclosed will, in such cases, assist in the evaporation of any residual solvent and leave the surface of the paper in a particularly smooth condition.

We have found that the ordinary flat surfaced or cylindrical doctors when used with resinous coating compositions, especially those containing waxes, leave the surface covered with minute projections or irregularities. Such surface irregularities tend to cause dispersion of light falling on the surface and thereby decrease the transparency of the sheet. We have now found that if a doctor blade be equipped with a curved or cylindrical surface terminating in a straight sharp edge, the coated paper, after having been drawn under tension over such surface and edge, possesses a remarkably smooth surface—the sheet having a high degree of transparency.

The construction and use of our improved doctor will be apparent by reference to the accompanying drawing in which

Figure 1 is a plan view;

Figure 2 is a section along the line II—II of Figure 1;

Figure 3 is another sectional view showing how the coated sheet is passed over the doctor when in use.

Figure 4 is a sectional view taken along the line IV—IV of Figure 3.

Referring now to the drawing, numeral 10 designates a supporting bar which, if desired, may also serve as a source of heat for the doctor blade. For this purpose, if steam is available, the supporting bar 10 is a hollow tube with appropriate connections 11 and 12 to serve as inlet and outlet, respectively, for the steam. To bar 10 the curved arcuate doctor blade 13 is affixed by any suitable means, such as welding or soldering. The essentials of doctor blade 13 are the curved surface 14, preferably highly polished, and the cut-back face 15 forming, at the juncture with the curved surface, a sharp edge 16. For most satisfactory results the angle 17 between face 15 and a tangent to curve 14 at the edge 16 should be somewhat less than 90°. We have found that if angle 17 is made approximately 60°, satisfactory results may be obtained.

Referring to Fig. 3 of the drawing, we show a preferred arrangement of a pair of our improved doctors for smoothing a coating on both sides of a sheet of paper so as to develop smoothness and a maximum transparency of surface. A sheet of paper 18, which has previously been passed through a coating bath (not shown) is passed through a pair of squeeze rolls 20 and is then passed over one of our improved doctors 10a disposed to smooth the lower surface of the paper. From thence the paper passes under a second doctor 10b, disposed to smooth the upper surface of the paper. The two doctors, 10a and 10b, are so disposed with relation to each other, and the curved blade 13 of the doctor 10a is so disposed, that the sheet of paper 18 passes first upwardly over the curved surface 14 and is then drawn downwardly, as seen in the drawing, at an angle to bring it sharply across the sharp edge 16 of the blade.

For most of the hard varieties of coating compositions, the doctor blade 13 is so disposed that a considerable portion of the curved surface 14 is in contact with the sheet 18 as it passes thereover, and a maximum degree of smoothing of the coating is had. This is ordinarily referred to in the art as the "wrap". The amount of wrap, however, is variable, which is inter-related with other factors to be explained more in detail hereafter.

From the doctor 10a, the sheet 18 passes downwardly under the doctor 10b, and the blade 13 of the latter doctor is also so disposed that the

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upper surface of the sheet receives a treatment similar to that already described for the lower surface. The blade 18 is also so disposed that it serves to draw the sheet 18 downwardly to bring the lower surface sharply over the sharp edge 16 of the doctor 18a. After passing the doctor 18b, another roll 21 is employed to direct the sheet 18 upwardly and thus bring the upper surface of the sheet 18 sharply over the edge 16 of the doctor 18b, thus providing a treatment similar to that given the lower surface, as heretofore described.

The doctors 18a and 18b are adjustable angularly and vertically with respect to each other in any suitable manner, an example of which is shown in Fig. 4 of the drawing. Each of the doctors is mounted at the ends in a cup bracket 22 secured to the frame 23 of the machine by a threaded shank 24 passing through a slot 25 in the frame of the machine and provided with a nut 26. The doctor is angularly adjustable in the cup bracket and fixed in its adjusted position by means of a set screw 27. It will be apparent that the angle of approach of the paper to the curved surface as well as its leaving angle with respect to the edge of the blade may be varied within any desired limits by the adjustments described.

Having described the general features of construction of our improved doctor blade, it remains to describe the several features peculiar to its operation, since its adjustment is somewhat critical.

The factors which we have found to be of importance in the operation of our improved apparatus are as follows:—

(a) Tension of the sheet passing over the blades.

(b) Temperature of the blades.

(c) Amount of wrap.

(d) Speed of the sheet over the blades.

(e) Properties of the hot coating composition, such as viscosity or softening point.

Referring to (a) above, in operating a coating machine employing our improved doctor blades, it is first desirable to adjust the tension of the sheet to the point where the blade tends to smooth out lines or other irregularities on the coated sheet but which tension is still insufficient to cut off wax from the sheet. It should be borne in mind in this connection that when the coated or saturated sheet arrives at the point in the machine where our doctor blades are to function, it is presumed that the amount of coating material remaining on the sheet is the amount finally desired on such sheet, any excess thereof having been removed by squeeze rolls or scraping blades of the ordinary type. If the tension on the moving sheet is too great, wax will accumulate on the blade at the point where sheet 18 comes into contact with surface 14 of the blade. By descreasing the tension on the sheet, this effect can be prevented. However, if the tension is insufficient, the maximum degree of smoothing will not be attained.

Referring to (b), the temperature at which the blades are operated is of importance. A relatively high temperature of the blades will increase the tendency of the blades to cut wax, while a lower temperature will decrease such tendency. The optimum temperature for any given coating composition is that at which effective smoothing of the coating is obtained without removing any substantial amounts of the composition from the sheet.

Referring to (c), the amount of wrap of the sheet on the blades determines the velocity at which the sheet may be drawn over the blades and also the self-cleaning tendency. Since the function of the blade is to smooth a thermoplastic material by means of heat and pressure, sufficient wrap is desired so that a softening of the coating on the sheet is obtained in the time interval during which such sheet is in contact with the blade surface 14.

By self-cleaning tendency is meant the ability of the blade to pass particles of dirt or foreign matter which inevitably lodge in the coating bath or on the paper, and which, unless removed, cause lines or streaks on the sheet which seriously detract from the appearance of the finished sheet. By a proper choice of wrap and tension the blade can be caused to freely pass such foreign particles; in other words, the blade becomes self cleaning.

Referring to (d), the speed of the coated sheet over the blades is, as has already been said, a factor dependent upon the amount of wrap, the properties of the coating composition and the temperature of the blades. The rate of travel of the sheet should be sufficient to allow the softening of the coating to take place, so that the smoothing of the surface is complete before the sheet leaves the trailing edge 16 of the blade.

Referring to (e), as has already been mentioned, the coating composition to be applied to paper or other sheet material usually consists of a thermoplastic mixture of resins, waxes and plasticizers, the viscosity of which varies with the properties of the material entering into the composition. In general it may be said that the higher the viscosity of the coating composition, the higher must the temperature of the doctor blade be, in order to obtain effective smoothing of the coating and the greater must the tension be.

From the above description of the operation of our improved apparatus, it will be seen that as the coated sheet comes into initial contact tangentially with the curved surface 14 of the blade, and passes over the blade surface to the trailing edge 16, an increasingly greater pressure is exerted by the blade on the sheet. Such increasing pressure permits the surface of the thermoplastic coating composition to gradually attain the temperature of the blade, causing a gradual softening and flowing of the coating, due to the temperature and pressure to which it is subjected. At the edge 16 just before the sheet leaves the blade, the unit pressure of the blade on the coating is a maximum. After the sheet has passed over edge 16, all pressure on the sheet has been released. The important point in regard to the successful operation of our improved blade on coated sheets, particularly those coated with resins and waxes, is the combined effect of the sliding motion of such coated sheets over the curved surface, the gradually increasing pressure exerted thereby, which pressure rises to a maximum at the trailing edge 16, after which all pressure is suddenly released. In order that the pressure be a maximum at the edge 16, it is necessary that the "take off" angle of the sheet at the edge 16 be of substantial size.

By "take off angle" is meant the angle between a tangent to surface 14 at the edge 16 and sheet 18 when the intersection between the direction line of the paper and the line of the tangent is at the edge 16. If the "take off angle" is small, i. e., zero or approximately zero, the beneficial

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effect of the edge of the blade is likewise small. As the angle increases, the beneficial effect increases altho probably not in direct proportion to the angular increase. The adjustment of the blade to give the proper "take off angle" is a simple matter of varying the inclination of the blade until maximum smoothing is obtained.

In this connection it should be noted that if the imaginary tangent line to the curved surface 14 at edge 18 and the direction line of the sheet 18 do not intersect at edge 18, then the take off from the blade will be tangential to curve 14, at a point other than 18. When operating in this manner, the blade causes ripple-marks on the coated surface, which decrease the transparency of the sheet. The regular orientation and structure of these ripple-marks also causes a noticeable astigmatism of objects viewed through the sheet. Such defects in the coated sheet are readily overcome by the use of our improved doctor blade in the manner set forth.

While we have described our invention in but one form, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various changes and modifications without departing from the spirit thereof; and we desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art, or as are specifically set forth in the appended claim.

What is claimed is,

A doctor for smoothing coating material on a tensioned moving web comprising a heated tubular support and a parallel edged smoothing blade tangentially attached thereto, said smoothing blade having a curved section of uniform thickness terminating in a sharp straight edge, said curved section being adapted for tangential contact with said web at a point spaced from said edge, a transverse section taken at said edge exhibiting an angle of substantially 60°, said blade being adapted to maintain continuous contact with said tensioned moving web from the point of tangential contact of said web on said curved section to the point of edge contact.

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