

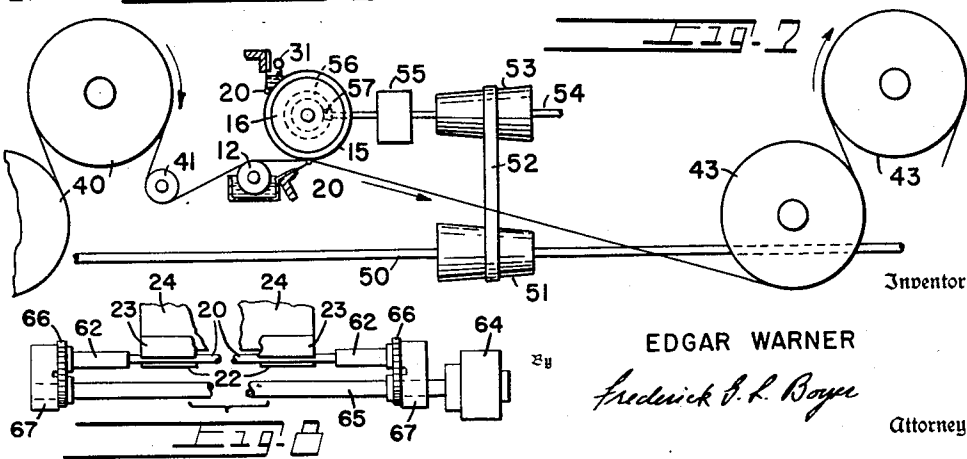
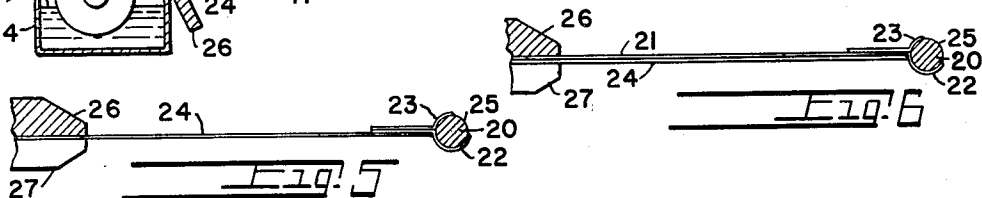
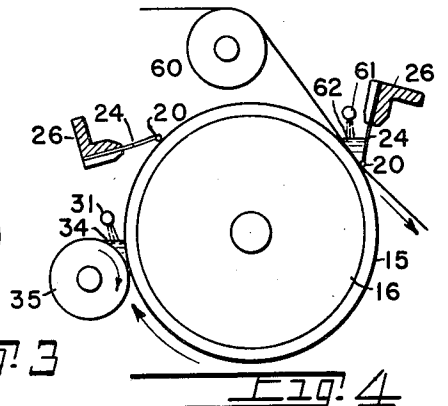
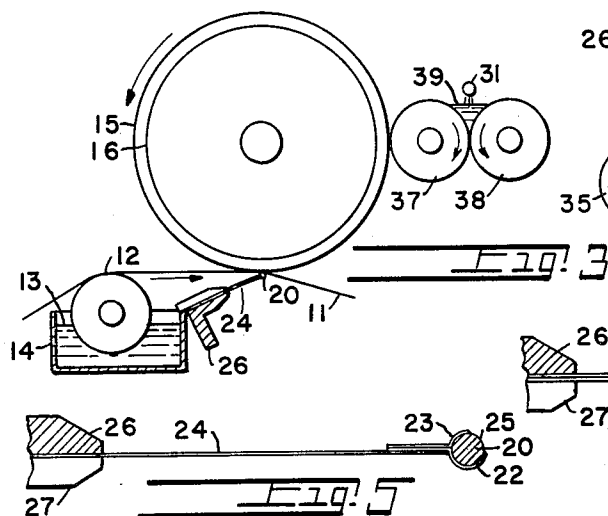
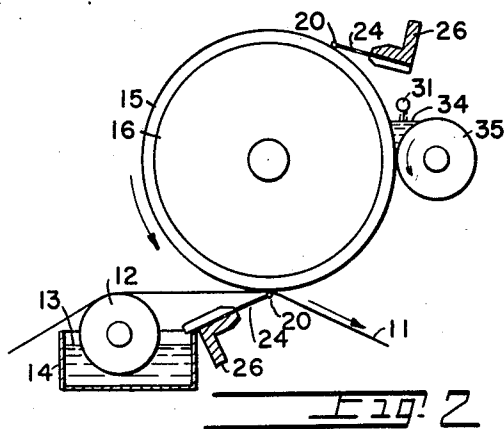
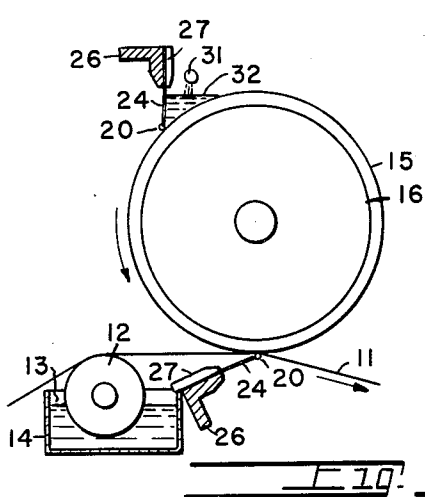
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APPARATUS FOR COATING PAPER

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APPARATUS FOR COATING PAPER

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This invention relates to the manufacture of coated paper for high grade printing and other purposes. It has particular reference to methods and apparatus for applying coating compositions, especially those of adhesive and pigment in aqueous dispersion, to both sides of a travelling paper web in one operation. It is particularly useful for producing two-side-coated paper directly on the paper making machine.

In my co-pending application Serial No. 328,840, now Patent 2,729,192, of which the present application is a continuation-in-part, I have disclosed a method and apparatus for coating paper on only one side at a time, either on or apart from the paper making machine. In that process, coating composition is applied in excess to one side of a paper web supported on the surface of a rubber covered carrier roll. The surplus coating composition is then removed and that remaining on the web is smoothed into a uniform film by a rotating small-diameter doctor rod carried by a spring mounting which presses it with uniform pressure against the coated surface of the paper web while it is supported on the surface of said carrier roll.

I have now found it possible to modify the said process and apparatus and thereby make it possible to coat both sides of the paper web in a single operation, in a novel manner. To this end, an excess of coating composition is applied to one surface of the paper web and the surplus is removed, as in my aforesaid prior process, by a small diameter rotating doctor rod carried by a spring mounting which presses it with uniform pressure against the freshly coated surface of the paper web while the web is backed up by a rubber-covered roll. Instead of passing the paper web around the roll, as in my prior process, I pass it around the small diameter doctor rod so that the opposite side of the web only contacts the rubber-covered roll momentarily, as it passes between the doctor rod and the roll. The excess of coating composition is, therefore, applied to the paper web before the other side of the web contacts the backing roll. In order to apply coating to the other side of the web, I first apply a thin, substantially uniform film of the coating composition to the surface of the rubber-covered roll. This is then transferred to the surface of the paper web as the web passes between the doctor rod and the coated surface of the roll. If the roll is rotated at paper speed, the transfer takes place directly. I have discovered, however, that this is not necessary. Instead, the roll may be rotated at speeds considerably faster, or considerably slower, than the speed of the paper. This gives a wiping action, in connection with the transfer, which appears to be of advantage in many cases and results in a coating layer on the paper which is either correspondingly thicker or correspondingly thinner than the film on the rubber-surfaced roll before transfer to the paper. For best results, I find, the speed of the roll should either be equal to paper speed or differ therefrom by as much as about five percent or more. Any suitable means, such, for example, as known roll type spreading and distributing devices,

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may be used for applying and uniformly spreading the film of coating composition on the surface of the rubber-covered roll. In general, however, I prefer to use a small diameter, rotating, spring mounted doctor rod similar to that used for smoothing and limiting the weight of the coating on the other side of the paper. In spite of the fact that the process, as described, uses widely different methods of coating the opposite sides of the web, I find it possible, when desired, to secure coatings on the opposite sides of the web, which are practically indistinguishable, one from the other. I have now found it possible for the opposite sides of paper coated in this manner to made to differ as little as do the opposite sides of the same paper when coated in the same manner on both sides.

The invention will be further described with reference to the accompanying drawing, in which:

Fig. 1 is a diagrammatic view showing the mechanisms for applying and smoothing the coating on both sides of the paper.

Fig. 2 is a similar diagrammatic view showing a different device for applying an excess of coating to the surface of the roll.

Fig. 3 is a similar diagrammatic view showing a different device for forming the film of coating on the surface of the roll.

Fig. 4 is a similar diagrammatic view showing an alternative arrangement of the parts.

Fig. 5 is an enlarged detail view of the doctor rod and its spring mount.

Fig. 6 is a similar view showing a modified construction for use where one side of the mount is submerged.

Fig. 7 is a diagrammatic view illustrating the invention in use on a paper making machine.

Fig. 8 is a similarly diagrammatic fragmentary transverse view illustrating the length of the doctor rod, and its holder and showing means for applying power to both ends of the doctor rod simultaneously, to cause its rotation.

Referring first to Fig. 1, a paper web 11 is shown moving in the direction indicated by the arrow. It passes over a roll 12 which dips into a pool 13 of fluid coating composition maintained at suitable level in pan 14 by a known type of supply mechanism, not shown. The roll 12 is rotated by conventional means, not shown, either in or opposite to, the paper direction, at a speed such that it will carry coating from the pool 13 and deposit it on the lower surface of paper web 11 in substantial excess over the amount required on that surface of the finished paper. From the roll 12, the web 11 passes substantially tangent to the surface of a natural or synthetic rubber cover 15 on a roll 16. At substantially the point of tangency the paper web 11 is pressed against the rubber cover 15 by a small diameter rotating doctor rod 20, which is shown in more detail in Fig. 5. The rod 20 is advantageously made of steel heavily plated with chromium to render it rust proof and enhance its wearing properties. It is grasped around more than half of its circumference by a flexible holder composed of two suitably formed parts 22 and 23, between which a portion 25 of the surface is exposed to form the working edge of the doctor, all as more fully described in my aforesaid co-pending application. This holder (see also Fig. 8) is continuous throughout the working length of the doctor rod 20, and is fixedly attached along one edge of a spring mount 24, the other edge of which is firmly mounted on a rigid support 26 by any suitable means such, for example, as a clamp plate 27. These parts are so positioned that the doctor rod 20 is pressed firmly against the coated paper web 11, pressing it against the surface of the rubber cover 15 on roll 16 under yielding pressure from spring mount

24. The doctor rod 20 is slowly rotated, advantageously opposite to the direction of paper travel, by any suitable means, such as an auxiliary electric motor 64, with suitable advantageously built-in, speed reduction gearing. This doctor then serves to remove surplus coating composition from the surface of paper web 11 and to smooth the coating layer remaining on the surface of the paper in the manner described in my aforesaid co-pending application.

For coating the other side of the paper web 11, I provide means for forming, on the surface of the rubber cover 15 on roll 16, a substantially uniform film coating composition which is then transferred to the surface of the paper where it is pressed against the coated surface of roll 16 by the doctor rod 20, as hereinafter more particularly described. This film may be formed on the surface of roll 16 by any suitable means. In Fig. 1, I have illustrated the formation of the film by use of a spring mounted small diameter rotating doctor rod which may be substantially identical with that already described as being used for removing surplus coating composition from, and smoothing the remaining coating layer on, the lower surface of the paper web. An excess of coating composition which may conveniently be supplied through a shower pipe 31 forms a pool 32 where it is retained against the surface of rubber cover 15 on roll 16 by the doctor rod 20 and its associated parts. As the roll rotates, it carries with it, under the doctor rod 20, a film of coating composition, the thickness of which depends on a variety of factors such as the character, solids content, and viscosity of the coating composition, the speed of the roll, the diameter and speed of rotation of the doctor rod and the character of its surface, etc. Since the surface of the rubber cover 15 on roll 16 is impervious, it can not absorb the vehicle from the coating composition to form a filter cake on the surface as in the case of paper. Consequently, the line of demarcation between the coating composition to remain on the surface and the surplus to be removed, which forms automatically when an excess of a suitable coating is applied to the surface of a suitably absorbent paper web, can not be formed on the surface of the rubber cover 15. The coating which is to remain on the rubber surface thus has the same fluidity as that which is to be removed by the doctor rod 20. Consequently, the thickness of the film must be regulated by the other factors noted. Normally, if the coating compositions and the doctor rods are identical, a substantially heavier layer of coating will be left on the surface of the paper by the doctor than will be left on the rubber roll surface. To increase the weight of the film on the rubber surface, I find that, in general, the most ready solution is to increase the solids content and/or viscosity of the coating. Some increase may be secured by increasing the diameter of the doctor rod. However, I find, if this is increased to much over an inch, increasingly troublesome ridges are formed in the coating on the roll surface which, with many of the types of coating used on paper, will not flow out but leave corresponding irregularities on the coated surface of the paper. Another method which can be used to increase the weight of the coating layer left on the surface 15, is to provide a wire wound doctor rod, or a rod provided with fine, closely spaced, thread-like grooves, which provide a fixed area for the passage of coating and yet are close enough together that no appreciable ridges are left in the coating on the roll surface.

The film of coating thus formed on the surface of the rubber cover 15 of roll 16 is transferred to the upper surface of the paper web as it passes between the roll and the doctor rod 20, under pressure exerted by the spring mount 24. If the surface speed of the roll is equal to paper speed, the film is transferred directly to the surface of the paper. As already stated, however, I have found that it is not necessary to rotate the roll 16 at paper speed, but that large differences in speed are often found

useful. In the first place, they give a wiping action which is apparently advantageous and, if adjustable, they further afford an opportunity of adjusting the thickness of the coating on the paper without changing the thickness of the film formed on the roll surface 15. If the roll speed is slower than paper speed, the thickness of coating applied to the paper is correspondingly less than that on the roll surface. If, on the other hand, the roll speed is higher than the paper speed, the thickness of coating on the paper is correspondingly greater than that on the roll surface. Adjustment of the speed of the roll 16, therefore, provides a ready method of regulating the thickness of coating applied to the upper side of the web to equal, or bear other desired relationship to, the thickness of coating applied to the other side of the web. Theoretically, it should be possible to utilize small as well as large speed differences. I have found, however, particularly where positively geared speed differences are not provided, that roll speeds which differ by only a small amount from paper speed, often give unsatisfactory results due, it is thought, at least in part to the effort of the moving web to hold the roll surface to the same speed. I, therefore, find that speed differences—whether plus or minus—should advantageously be at least as much as about 5% of paper speed, though, when desired, they can be much larger.

As the paper web, now coated on both sides, emerges from between the roll and the doctor rod, it is withdrawn downwardly and away from the roll in a direction such that it follows the surface of doctor rod 20 away from the surface of the roll. The paper is thus forced to part much more abruptly from roll surface 15 than if pulled away on a tangent. By this means I find I can secure a decidedly smoother coating surface on the upper side of the paper web than is attainable when the coated paper is pulled away from the applicator roll in the usual manner.

When the coating mechanisms described are incorporated in the paper making machine, the drying of the coated web is normally accomplished on the rotating drying cylinders regularly used for the drying of the paper in the machine. Such location of the coating devices is illustrated in Fig. 7. From one of the dryers 40 the paper web 11 passes around a guide roll 41, then over the coating applying roll 12 and then passes between the rubber covering 15 on roll 16 and the rotating doctor rod 20 which limits and smooths the coating on that side of the web while pressing the paper web into contact with the surface of the rubber cover 15 on roll 16 on which a layer of coating composition has been applied as already described. The web of paper 11, now freshly coated on both sides, then passes through the air for a distance sufficient for the coating to become sufficiently solidified to safely contact the heated drying cylinders 43 in the ensuing dryer section of the paper machine. This section of dryers is driven in the conventional manner at a speed which is adjusted to pull the paper web 11 away from the coating apparatus with the requisite tension.

The method in which the roll 16 is driven and its speed is adjusted is advantageously suited to the type of drive used on the paper machine itself. In Fig. 7 this is illustrated as a line shaft 50, only a fragmentary portion of which is shown in the drawing. A conventional cone pulley 51 is mounted on shaft 50 and by means of a belt 52 drives cone pulley 53 mounted on shaft 54 which drives roll 16. Small adjustments in roll speed relative to paper speed may be made by shifting belt 52 on the cone pulleys 51, 53. Larger changes can be made by means of a gear box 55, or other conventional speed changing mechanism which may, if desired, be interposed between pulley 53 and the bevel gears 56, 57 by which the roll 16 is driven from shaft 54. In the case of paper machines with electrical drive, the roll drive is advantageously of the same type, with speed controls analogous to those used on the other sections of the paper machine.

Fig. 2 illustrates an alternative method of forming the uniform film of coating on the surface of rubber cover 15 on roll 16. The doctor rod 20 with its spring mount 24 and rigid support 26 is placed on the upwardly moving side of roll 16. The coating composition is supplied in excess by the shower pipe 31 forming a pool 34 in the nip between roll 16 and a coating roll 35. The surplus coating is removed from the surface of the cover 15 by the spring held doctor rod 20, as in the device illustrated in Fig. 1. Otherwise, the operation is the same as described.

Fig. 3 shows another alternative method of securing the film of coating composition on the surface of rubber cover 15 on roll 16, in this case without use of the spring mounted doctor. This method makes use of a two roll fountain 37, 38 between which a pool 39 of coating composition is maintained by supply from the shower pipe 31. By suitable adjustment of the spacing and relative speeds of the rolls, coating carried from pool 39 on the surface of roll 37 is deposited on the surface of rubber cover 15 and carried through in suitable amount between rolls 16 and 37 to leave a film of the desired thickness on the surface of the rubber covering 15. Otherwise, the operation is the same as hereinabove described. Although the film can be secured in this manner without use of the doctor rod, I find it, in general, both simpler and more satisfactory to use the doctor rod with its spring mounting as described.

Fig. 4 shows a modified arrangement of the parts without any change in the principle of operation. The film of coating is applied on the upwardly moving side of the roll as described in connection with Fig. 2. The paper web 11 is, however, led over a guide roll 60 and contacts the downwardly moving side of the cover 15 on roll 16, passing between it and the doctor rod 20 while moving in a downward direction. This arrangement differs from that already described in that the excess of coating is applied to the web 11 by the shower pipe 61 which maintains a pool 62 between the doctor rod 20 and associated parts and the paper web itself, the excess being held back as before by the rotating doctor rod 20. The paper web is led out from under doctor rod 20, as before, in a direction to wrap the doctor rod and part abruptly from the roll.

In those cases, such as illustrated in Figs. 1 and 4, in which a pool of coating composition is held back by the doctor structure, it is necessary to prevent coating from leaking around the doctor holder 22, 23 and being deposited on the already smoothed coating layer. For this purpose, the joint between the holder 22, 23 and the spring mount 24 must be made leak proof. In order to simplify this requirement and at the same time prevent contact of the aqueous coating liquid from rusting the steel spring 24 and then carrying rust stains onto the paper, it is frequently desirable to use the doctor structure illustrated in Fig. 6 in which the holder 22 is formed on the edge of a flat plate 21 of stainless steel or other rust resisting metal which prevents access of the liquid to the steel spring 24 and to the joint between it and holder 22, 23. This feature of the improvement, though illustrated and described in the present application is not claimed herein, but is claimed in my co-pending, concurrently filed application Serial No. 554,970 wherein it is also illustrated and described.

The doctor rod, indicated throughout by the numeral 20, is defined as being of small diameter by which is usually meant between $\frac{1}{16}$ inch and one inch, though doctors somewhat beyond those limits can be used on occasion. The preferred range is from $\frac{1}{4}$ inch to $\frac{3}{8}$ inch in diameter, with preference in general for the smaller sizes, particularly for the doctors operating on the paper rather than on the rubber-covered roll. Longer doctor rods for use on wider machines are desirably made of larger size than shorter rods for narrower machines because of their

greater resistance to torsional strains and torsional vibration. Also, doctor rods which are excessively long in relation to their diameter are advantageously driven from both ends, as illustrated in Fig. 8 and as set forth in my aforesaid co-pending application, in order to reduce the tendency to torsional vibration and any resulting deleterious effects on the smoothness of the coated surface. The speed at which the doctor rod 20 is rotated, is not critical. Ordinarily a surface speed of about one foot per minute is adequate to accomplish the desired results. Somewhat slower as well as faster speeds may be used though, in general, higher speeds only result in increasing the wear and are accordingly not desirable. The means for driving doctor rod 20 from both ends simultaneously is best seen in Fig. 8, where motor 64, with built-in gear reducer, drives shaft 65 which extends across the machine and is relatively stiff in comparison with the doctor rod 20. At each side of the machine is a chain or gear drive 66 which transmits power from shaft 65 to stub shafts, 20 mounted in bearing blocks 67, from which power is transmitted through flexible shafts 62 to both ends of the doctor rod 20, at the same time. If desired, the cross shaft 65 can be eliminated and a separate motor reducer, similar to that designated 64, can be used to apply torque to the other end of doctor rod 20.

The spring mount 24 should be stiff enough to exert a pressure of from 1 to 10 pounds per linear inch between the surface of the roll, depending on the hardness of the rubber cover 15, the diameter of the doctor rod 20, the nature of the paper and coating material, the weight of coating desired, etc. Usually, the most advantageous pressures are found between 2 and 8 pounds per linear inch. The working pressure should flex the spring mount 24, an amount substantially greater than any changes of flexure such as occur during normal operation due to eccentricity or out-of-roundness of the roll 16, or other cause, in order that the pressure may be maintained substantially constant in use.

The hardness or "density" of the rubber cover 15 of roll 16 may be selected within rather wide limits. I have successfully used rolls as hard as 60 density as measured by the Pusey & Jones Densometer and as soft as 250 measured by the same device, without apparently having reached the limit in either direction. If the rubber cover 15 is sufficiently soft, it may compensate for lack of flexibility in the doctor rod mounting. If soft enough that the small changes in indentation occurring in service do not cause significant changes in pressure, the doctor mounting may be made rigid and still accomplish the result above described if the doctor is set to indent the roll to the extent required to give the desired doctor pressure.

The following example will serve to illustrate the use of the present invention. The paper coming to the device had already had two coats of approximately 5 pounds per ream (500 sheets 25 x 38 inches) applied thereto in the paper making machine. As brought to the coating device of the present invention, it carried a coating of approximately 10 pounds per ream on each side and was traveling at a speed of approximately 600 feet per minute. The coating device used in this case was constructed as illustrated in Fig. 3. The roll 16 had a rubber covering 15 of approximately 20 inches diameter and a Pusey & Jones hardness of 150. The fountain rolls 37, 38 were made of metal and were 10 inches in diameter. The doctor rod 20 was $\frac{1}{4}$ inch in diameter tool steel heavily plated with chromium. It was carried, as illustrated in Fig. 5, in a holder 22, 23 made of 0.025 inch thick stainless steel and mounted on a spring steel mount 24 which was .031 inch thick and projected 3 inches from holder 26, 27 in which it was firmly clamped. It was rotated at a speed of 10 revolutions per minute by an independent motor with suitable speed reducer. The roll 16 was rotated at a surface speed of approximately 630 feet per minute by an electric motor so connected with the ma-

chine drive as to maintain an adjusted speed ratio with the adjacent dryer section of the machine. The coating supplied was the same for both sides and consisted essentially of clay and casein in aqueous dispersion with a total solids content of about 50 percent. In this manner, about 6 pounds additional coating was applied on each side to give a finished paper weighing about 80 pounds per ream. After being dried on conventional drying cylinders and supercalendered in a usual manner, the resulting paper was a high grade coated two side printing paper.

I claim:

1. A coating apparatus for applying a mineral pigment-adhesive coating composition to both sides of a traveling paper web comprising a large diameter resilient surfaced roll and a substantially smaller diameter flexible rotatable doctor rod yieldingly bearing against said resilient surfaced roll across its entire width and defining therewith a narrow zone of contact through which the paper web passes, means for rotating said large diameter roll in a direction corresponding to the movement of said traveling web, means for rotating said flexible doctor rod, means for applying a uniform layer of coating composition on the surface of said large diameter roll, means for applying an excess of coating composition to that side of the traveling web opposite to that contacted by said large diameter roll, means for passing said web between the surface of the large diameter roll and said doctor rod, and means for drawing said web around said doctor rod and away from said large diameter roll such that the area of contact of the traveling web with said resilient surfaced large diameter roll is limited to the narrow zone of contact defined between said resilient surfaced roll and said doctor rod, whereby the uniform layer of coating composition applied to said resilient surfaced roll will be wiped on one surface of the traveling web and the excess of coating composition applied to the opposite surface of the web will be doctored there-

from, while the coating composition remaining thereon is smoothed by said rotatable flexible doctor rod.

2. A coating apparatus as defined in claim 1, wherein the rate of rotation of said large diameter roll is such that a speed differential of at least 5% is created between the traveling paper web and the resilient surface of the roll.

3. A coating apparatus as defined in claim 1, wherein said flexible doctor rod includes a holder in engagement with said doctor rod throughout its length, said holder being resiliently flexible wherein said doctor rod is resiliently and flexibly in contact with the surface of the resilient surfaced large diameter roll.

4. A coating apparatus as defined in claim 3, wherein said doctor rod bears against the large diameter resilient surfaced roll at a value of from 2 to 8 pounds per lineal inch.

5. A device as defined in claim 1, wherein means is provided for driving the doctor rod in a direction reverse to the direction of paper travel, at a surface speed of between 3 inches and 30 inches per minute.

6. A device as defined in claim 1, wherein the diameter of the doctor rod is between $\frac{3}{16}$ inch and $\frac{1}{2}$ inch.

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