

Sept. 16, 1952

W. W. ROWE

2,610,935

CREPED PAPER PRODUCT AND PROCESS

Filed Feb. 24, 1949

2 SHEETS—SHEET 1

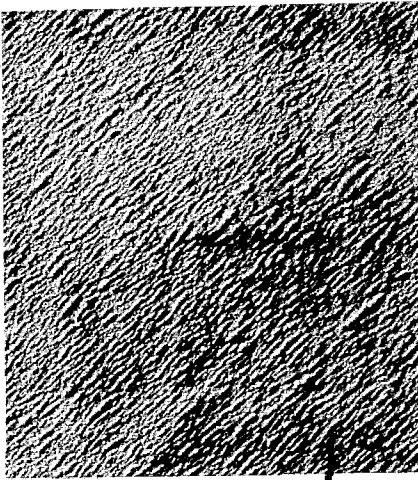


FIG. 1.

12

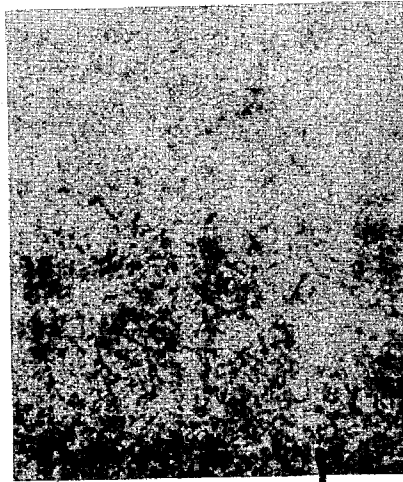


FIG. 2.

13

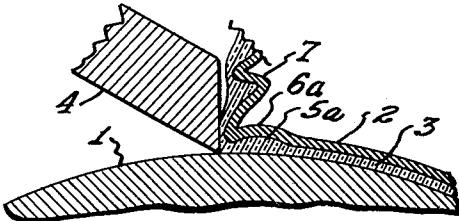


FIG. 3.

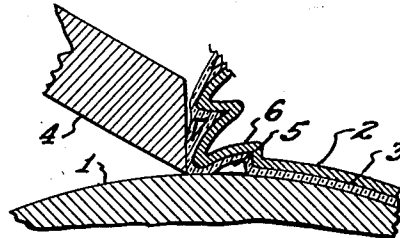


FIG. 4.

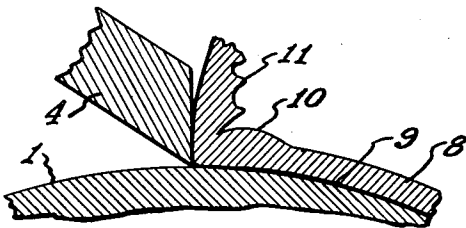


FIG. 5.

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2 SHEETS—SHEET 2

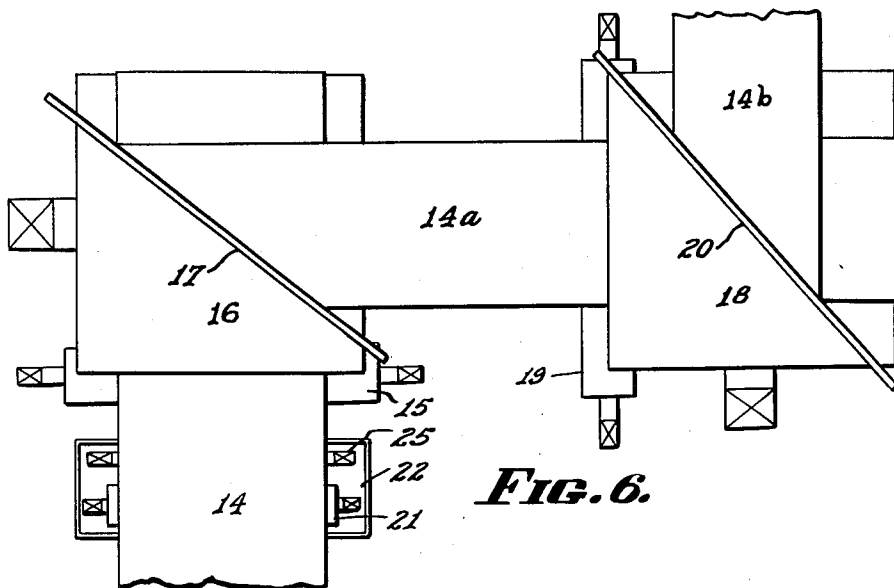


FIG. 6.

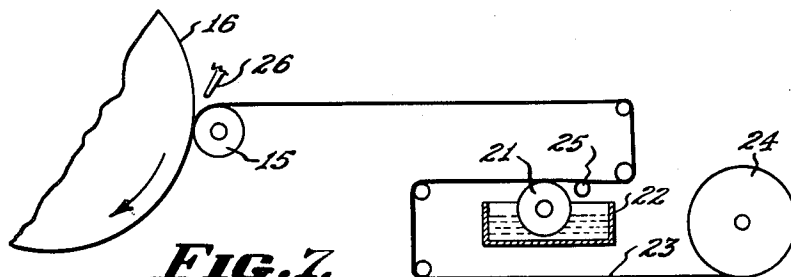


FIG. 7.

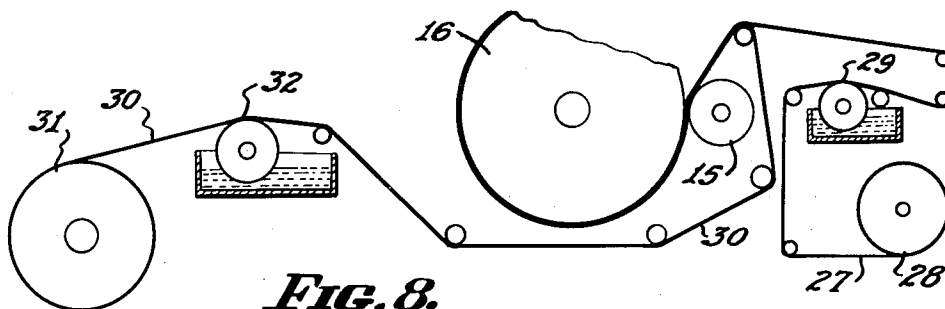


FIG. 8.

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UNITED STATES PATENT OFFICE

2,610,935

CREPED PAPER PRODUCT AND PROCESS

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Application February 24, 1949, Serial No. 78,197

18 Claims. (Cl. 154—33.05)

1

The principal objects of my invention are the provision of improved creped paper materials and methods of making them.

In this connection an object of the invention is the provision of a mode of operation whereby the absorptivity of paper materials may be greatly and usefully increased. This increase appears to be due to an opening up of the interior structure of the paper webs referred to hereinafter for convenience as "interfacial disruption."

Another object of the invention is the provision of creped paper products having the novel characteristic of exhibiting creping crinkles on one side only, such products being hereinafter referred to for convenience as "two-sided creped products."

These and other objects of my invention, which will be set forth hereinafter or will be apparent to one skilled in the art upon reading these specifications, I accomplish in those products and procedures of which I shall now set forth exemplary embodiments. Reference is made to the accompanying drawings in which:

Figure 1 is a photographic reproduction of a creped paper product in accordance with my invention, showing the side thereof which was located away from the creping cylinder.

Figure 2 is a similar reproduction of a crepe paper product showing the side thereof which lay against the creping cylinders during the creping operation.

Figure 3 is a diagrammatic representation on an exaggerated scale of one type of creping action which normally occurs when webs are creped by means of a positive adhesive.

Figure 4 is a similar diagrammatic representation of another type of creping action which normally occurs when webs are creped by means of a positive adhesive.

Figure 5 is a similar diagrammatic representation of an action believed to occur in the practice of the present invention.

Figure 6 is a diagrammatic plan view of a double creping apparatus with which my invention may be carried on.

Figure 7 is a diagrammatic elevational view of a creping cylinder and means for coating and treating the web to be creped.

Figure 8 is a diagrammatic elevational representation of a creping cylinder with means for coating and combining webs.

My invention relates to creping processes in which a web of paper is caused to adhere to the creping surface by means of a positive adhesive substance. Preferably, the substance is thermo-

2

plastic in character and hence subject to control at the creping point through temperature. Creping by means of positive adhesives is taught in my reissue patent No. Re. 17,633. The teachings of the present invention are particularly valuable in the manufacture of paper webs which are stretchable in all directions. Such webs may be those made by the general process and on the apparatus of the Kemp Patents 2,071,347, 2,008,182 and 2,008,181, or may be those made by the procedure and apparatus of the copending application of Paul W. Dorst, Serial No. 686,899, filed July 29, 1946, now Patent No. 2,494,334, issued January 10, 1950. For the purpose of setting forth an exemplary embodiment, I shall describe my invention in connection with the procedure and apparatus of the Kemp patents.

In this procedure and apparatus, the paper web is caused to adhere to the surface of a first creping cylinder from which it is removed and contracted by the action of a knife or doctor disposed substantially helically on the surface of said cylinder and at a substantial angle to the longitudinal axis of the uncreped web. As it leaves the knife, the paper is reversed, i. e. turned upside down, and is carried away from the creping cylinder generally in the direction of the axis of that cylinder, to a second creping cylinder oriented usually at right angles to the first. It is caused to adhere to the second creping cylinder, usually by the same coating of adhesive, and is removed from its surface and further gathered by another substantially helical knife, disposed in such a way as to produce creping crinkles oppositely disposed to the first creping crinkles. Both sets of creping crinkles are disposed aslant to the longitudinal axis of the gathered web, and since the sets of creping crinkles cross each other, the web is so gathered as to be universally stretchable.

The use of a positive creping adhesive generally results in the formation of very fine creping crinkles even in heavy webs by reason of the comparatively great force required to remove the paper from the creping cylinder and the uniformity of its adhesion thereto, as compared with water creped products which are characterized by relatively very coarse crinkles and frequent "skips" where the paper appears to have broken away from the cylinder for substantial distances in advancing of the knife.

In creping with positive adhesive substances existing as coatings of substantial thickness on the surface of a web, it has been noted that the coating substance must be sufficiently viscous and

have sufficient body to transmit the creping force to the web. Otherwise the web may simply slide off over the knife without creping. With thinner coatings of adhesive, the requirements for viscosity and body become less. In creping, the knife crowds the web back upon itself and forms creping crinkles which are in the nature of minute folds in the paper web as such.

This action, and hitherto the only action obtained by the art in the creping operations employing positive adhesive substances, is believed to be that illustrated diagrammatically in Figures 3 and 4, where 1 represents a creping surface, such as the surface of a creping cylinder, to which a web of paper 2 is caused to adhere by means of a layer 3 of positive adhesive substance. The thickness of this layer has been exaggerated for clarity. The paper web is removed from the creping surface 1 by a doctor or knife 4, the leading edge of which forms with the surface of the cylinder a creping V of desired angularity.

The knife 4, being stationary in space while the cylinder 1 in Figure 3 turns in a counter-clockwise direction, serves as an abutment in the path of both the layer of adhesive and the paper web, exerting force on them in a direction opposite the travel of the web as produced by the cylinder. In a water-creping operation, where the web clings to the surface of the cylinder because of atmospheric pressure and due to the water seal, it is believed that the web breaks away from the surface of the cylinder in areas ahead of the knife, thus starting folds which are completed by the movement of the paper against the knife. Where the paper is bound to the surface of the cylinder by a thermoplastic, positive adhesive, a somewhat similar action may occur, depending upon the condition and thickness of the adhesive which may come away from the surface of the cylinder as at 5 in Figure 4, or from the paper, or may part within itself in any case starting a fold 6 in the paper ahead of the knife, which fold collapses against the knife to form a crinkle. If the adhesive is plastic in nature while adherent to the paper and cylinder, the knife 4, as illustrated in Figure 3, produces a displacement of the adhesive in the nature of a thickening thereof as indicated at 5a. This in turn permits the paper layer to move upwardly as at 6a slightly ahead of the knife, thus starting a fold which is completed as the paper moves against the knife. The adhesive, somewhat thickened in the valleys of the crinkles as viewed from the adhesive coated side of the web, leaves the surface of the cylinder with the web excepting for a thin resident film. The paper web 2, however, is bodily folded into creping crinkles diagrammatically indicated at 7. In all of these instances, crinkles of substantially the same depth and appearance are visible on both sides of the web if the adhesive is removed, as by extraction with a solvent.

The teachings of this application are essentially directed to a different type of action obtained as hereinafter more fully taught in detail. I have discovered that it is possible to contract a web with the same apparatus, specifically or generally, but with an entirely new type of contracting action which is diagrammatically illustrated in Figure 5. The creping cylinder is again indicated at 1 and the knife or doctor at 4. For clarity the paper web 8 has been illustrated as a thick web, bound to the surface of the cylinder by a very thin layer 9 of positive adhesive substance. In the diagrammatic illustration, this layer is of such character that it does not become

distorted as at 5a in Figure 3 so as to acquire surface rugosities sufficiently large to be followed by the paper web, i. e. to permit the paper web bodily to buckle just ahead of the knife to form an incipient fold. On the other hand, the adhesive has sufficient strength and cohesion that it will neither separate from the paper or the cylinder, nor split within itself as in Figure 4. The adhesive 9 binds the paper web 8 to the surface of the cylinder 1 so strongly that the strength of the bond is inherently greater than the resistance of the paper to internal disruption.

Under these circumstances, as the paper web 8 is moved against the knife 4, several actions appear to occur. First, the adhesive layer 9 (excepting for a thin film normally resident on the cylinder) is substantially smoothly, uniformly and continuously removed from the cylinder by the knife, and greatly retards, and may entirely prevent the formation of crinkles on the under side of the paper. Second, the upper surface of the paper tends to form into creping crinkles. These actions are mutually inconsistent, as will be evident. Hence a third action occurs to make the other two possible. This is an actual disruption of the interior structure of the paper. The surface of the web which lies away from the cylinder is displaced upwardly as at 10 in the formation of an incipient fold or creping crinkle. But since the lower surface of the web is bound to the surface of the cylinder 1 so strongly that it cannot move away from the creping surface until actually scraped therefrom by the knife 4, the formation of the displacement of the upper surface of the paper, indicated at 10, implies and produces an actual thickening of the paper web, and hence an internal or interfacial disruption thereof. Both sides of the web are of course contracted. The contraction of the upper portion resides in creping crinkles of normal form and appearance. The under surface of the paper web is scraped from the surface of the cylinder 1 with a crowding together of its fibers, but with a complete or substantial absence of creping crinkles. The result is a web creped or crinkled as to its upper surface layers, but smooth, substantially smooth, or exhibiting creping crinkles to a very much less extent on its under surface, accompanied by an interfacial disruption or rearrangement of the fibers making up the web in order to permit this differential activity to go on. The internal or interfacial disruption of the paper web can easily be seen in section under the microscope at 50x or greater, for ordinary kraft wrapping papers, and is further evidenced by the marked increase in absorptivity of the product, as hereinafter set forth.

By carrying on the type of creping operation illustrated in Figure 5 with very thick and heavy papers, the internal disruption of the web becomes clearly apparent to the naked eye at cut edges thereof. The upper surface of the web is formed into relatively heavy and coarse creping crinkles, while the under side of the web is smooth or substantially so. The interfacial disruption in such thick and heavy webs is sometimes so great that the treated web may readily be separated into two layers, one a thin layer of smooth character which was the side of the web lying next the creping cylinder, and the other a heavier layer having the creping crinkles on its upper surface and presenting the appearance at its lower or disrupted surface of a very substantial opening up of the fibrous structure. With thinner webs, such as those ordinarily em-

played in the manufacture of creped products, the same sort of condition prevails, although with such thinner webs the interfacial disruption is not apparent to the eye, and such products present the novel appearance of being creped normally upon one side and uncreped upon the other.

The new products have a number of novel and valuable characteristics. For example it has hitherto been known that ordinary creping will increase the absorptivity of a paper to a slight degree, since the bare act of folding the paper into creping crinkles opens it up slightly and disturbs to some extent the relationship of any sizing in the paper to the fibers which make up the web. My new products, however, exhibit an astonishing increase in absorptivity, which is due to the interfacial disruption I have described:

By way of example, a hard sized, sixty-pound kraft paper, creped by means of asphalt as the positive creping adhesive after the manner illustrated diagrammatically in Figure 3, and being a "one-sided" product in that the creping crinkles are substantially the same on both sides of the web, has by reason of its lack of interfacial disruption, a relatively low absorptivity. When such a paper, after extraction of the asphalt, is treated with a dispersion of a synthetic rubber such as neoprene containing 36% solids, it will absorb only about 20% of the rubber solids, based on the weight of the web. The same paper creped as diagrammatically illustrated in Figure 5, so as to be "two-sided" in that it has creping crinkles upon one face and an absence or substantially absence of them on the other, when treated with the same rubbery dispersion will absorb about 35% of the rubber solids based on its weight. This surprising increase in absorptivity holds good for all other substances capable of being absorbed into a fibrous web, such as solutions of saturants, normally liquid saturating media, and thermoplastic substances which can be brought to saturating consistencies under heat. Valuable products may be made from my treated papers which were hitherto not possible in the art. The resilience and tear strengths of papers may thus be very greatly increased by saturating them with latex and dispersions of rubbers, both natural and artificial, and rubbery and resinous substances derived from solutions.

In my U. S. Patent No. 2,343,930 I have taught the manufacture of molded products from laminated mold charges of universally stretchable papers saturated with or otherwise associated with incompletely polymerized synthetic resins, or thermoplastic synthetic resins, such mold charges having the property of flowing in a closed mold under heat and pressure without losing their laminated character. By contracting the paper webs in accordance with the teachings of this invention, their absorptivity may be very greatly increased, so that larger quantities of resinous substances may be associated with them by saturation. It will be evident also that since the process of this invention very greatly increases the absorptivity of hard sized, dense and strong papers, these papers which are ordinarily much less expensive, may be substituted for the more expensive, special, "open," unsized webs hitherto employed in resin molding operations, and in rubber saturating operations.

Yet again, the practice of my invention enables me to produce creped paper products which are highly contracted and have high degrees of

stretchability, especially universally stretchable webs as hereinafter set forth, which are crinkled on one side only and hence are especially valuable in the production of embossed products like artificial leathers, in uses where coating substances must be uniformly and economically applied to one side of the creped paper webs, and in uses where contracted paper webs must be uniformly cemented against other surfaces, with a minimum of adhesive coating.

In Figure 1, I have shown a photographic representation at 12 of a universally stretchable creped paper product made in accordance with my invention, the view being of that side of the product which lay away from the creping drums during the creping operation.

Figure 2 shows at 13 the opposite face of the same product. It will thus be seen that this product is characterized by creping crinkles on one surface, and on the other by a complete visual absence of creping crinkles.

I shall now describe a preferred mode of manufacture of my novel creped paper products.

Referring to Figure 6, I have shown diagrammatically a double creping machine of the Kemp type. A web of paper 14, which is coated on its under surface with adhesive, is pressed by means of a pressure roll 15 against the surface of a first creping drum 16, provided with a diagonal knife 17. Through the operation of this apparatus, the paper is contracted both widthwise and lengthwise by the formation therein of diagonal creping crinkles or gatherings. The paper so treated, as at 14a is conducted to a second creping cylinder 18 and pressed against its surface by a pressure roll 19. A diagonal knife or doctor 20 removes the paper from this cylinder, imparting to it diagonal creping crinkles extending oppositely to those imparted by the first knife. The doubly contracted and universally stretchable web is indicated in Figure 6 at 14b.

In accordance with this invention the creping adhesive employed may be applied to the web 14 or to the creping surface in any suitable way as by spraying, doctoring or the like. I prefer to employ an applicator roll 21 turning in the pan 22 of the adhesive substance. I may employ a doctor or metering device to gauge the film of dispersions picked up by the roll 21. A smoothing element 25, such as a small diameter roll turning oppositely to the travel of the paper web may be employed if desired.

In the light of the discussion above of the action illustrated in Figure 5, it will be evident that various factors have a bearing upon the obtaining of the effects inherent in my novel products. The resistance of the web to interfacial disruption is one of these, inasmuch as it is easier to obtain a two-sided product with a web which is more readily disruptable, and in general with thicker webs as compared with thinner webs. As to the ease with which the fibrous structure of a web may be disturbed, various factors are also involved. The nature of the fibers in the sheet is one. The degree of "openness" of the sheet, its density, whether or not it has been calendered, are others. The amount of internal sizing may be important, and borderline conditions can be found which will produce a two-sided effect with a slack sized paper but will produce a one-sided creping effect with a hard sized paper, otherwise the same. However the teachings of this invention are applicable to paper webs in general, and

two-sided creping may be practiced with most types of paper webs.

Irrespective, however, of the initial character of the paper chosen, the operator has substantial control over its resistance to disruption, since it is readily possible for him to soften the paper temporarily as by wetting. The amount of water introduced into the paper and resident in it at the creping point ordinarily controls, though in some instances the softening effect will be progressive, so that wetting the paper for a greater or less time prior to creping will affect the strength of the paper. The use of wetting agents in the water will frequently assist in the softening of papers.

As has been indicated, the nature and disposition of the creping adhesive is of importance. The adhesive must be employed in a layer such that the creping knife or doctor cannot displace it as illustrated in Figure 3 to the extent of permitting the paper web to form, bodily, an incipient fold or creping crinkle ahead of the knife.

Putting this another way, the adhesive must not tend to be displaced ahead of the knife in such fashion that its upper surface will form into corrugations or ridges large enough to be followed bodily by the paper. With usual adhesives this implies either a thin layer, or a discontinuous layer, or both. The conditions of creping can be widely varied, as will presently be seen, and extreme thinness and discontinuity are not necessary limitations. Nevertheless, it will not be found possible to accomplish "one-sided" creping with so heavy a layer of plastic adhesive that the action of the creping knife on the adhesive alone would be to form crinkles or corrugations in its upper surface suitable for imparting similar configurations to the paper web.

Again, the adhesive must not be such as will permit the under surface of the web to become free of the surface of the cylinder sufficiently ahead of the knife to permit the knife to form crinkles or folds in the under side of the web as the web is contracted. Thus an adhesive in a hard or brittle condition such that it tends to split away from the cylinder or split within its body well in advance of the knife is not suitable. It goes without saying that an adhesive which has so little cohesion and adhesion that the creping doctor or knife can scrape the paper from the surface of the cylinder without contracting it at all, cannot be used.

The adhesive in the thickness and condition employed must be so strong and cohesive under the circumstances of creping as to bind the paper to the creping surface with a force greater than the resistance of the paper web to internal disruption. The web must be equally contracted as to both of its faces, and while the upper surface of the paper will form into creping crinkles accompanied by internal disruption of the web, the inner or lower surface of the paper must remain firmly bound to the surface of the cylinder without moving away from that surface, to the very point where it is contacted and gathered by the creping knife by crowding its fibers together, and without the production of the rugosities ordinarily recognized as creping crinkles.

Thus the nature and disposition of the adhesive should be such that the paper is prevented from bodily separating from the cylinder either through release of the adhesive bond or through displacement of the adhesive ahead of the knife, and beyond this the requirement for the adhesive is that its bond and cohesiveness should be great-

er than the resistance of the particular paper web to internal disruption.

The cohesion and consistency of most adhesives can be controlled in various ways as by solvents or by the use of heat or temperature control if the adhesives are thermoplastic. I have indicated above that the resistance of the paper web to internal disruption can also be widely controlled. Thus the invention may be practiced with a great variety of adhesives.

The choice of adhesives is wide, for most strong adhesives in thin layers will have or can be made to have a sufficient internal strength and such adhesives include in general bitumens, resins, natural and artificial, glues and rubbery substances, and mixtures of them. Since the adhesives are employed in thin layers, it is desirable that the same adhesive be used for affixing the web to the second creping cylinder as was used in affixing it to the first, and without the addition of a further adhesive increment. Thus the adhesive is preferably one which can be reactivated at the second creping cylinder, and since this is most readily done by controlling the temperature of the second cylinder, my preference is for a thermoplastic adhesive. Rubber as such is not classed by me as a thermoplastic or thermosensitive adhesive. It is principally, if not entirely, pressure sensitive only to itself for creping purposes when dry, and this is true whether the rubber be derived from latex or other dispersion, or from a solution. Consequently, while pure rubber may be employed to adhere a web to a first creping cylinder, it will not adequately cause it to adhere to a second creping cylinder unless additional dissolved or dispersed rubber be employed.

Many adhesives in which rubber is combined with resinous or bituminous substances are, however, suitable for my purpose.

In general, the coatings of adhesive employed by me are thin, and this may present a problem of application. Because a small quantity of the adhesive is employed, it must be kept as a superficial coating on the web, since to the extent that it is drawn into the web by capillarity it will be ineffective in affixing the web to the creping cylinder and will strengthen the web against interfacial disruption. It is quite possible to bring a thermoplastic adhesive by heat or by dispersion to a consistency at which it may be sprayed in a thin enough layer on the surface of a web of paper, and discontinuities in a coating thus produced are not disadvantageous providing they are fine and uniform. However, spraying equipment is costly and liable to sporadic variations in use. If the viscosity for application is attained through the use of organic solvents, there is an added factor of expense, and of equipment if solvent recovery is attempted. An attempt to cut back an adhesive with solvent to a low enough viscosity to permit roller coating in a thin layer as required by my invention may result in the solution attaining a saturating viscosity which will leave the adhesive within the web rather than on its surface.

In the practice of my invention, the easiest way to obtain a coating of suitable adhesive of sufficient thinness and evenness of distribution is to employ water dispersions or artificial latices of the desired adhesives. There are a large number of such dispersions which may be employed. In general, they comprise dispersions of any of the natural or synthetic resins which either are continuously thermoplastic, or if

thermosetting are thermoplastic in the particular stage of polymerization in which they are used, or dispersions of bituminous materials, or dispersions of resins with natural or artificial rubbers, or mixtures of any of these substances. Excellent results, by way of a non-limitative example, are obtained by me when using a dispersion of a polymerized wood rosin.

Such substances or mixtures of substances may be dispersed in water in ways known in the art. I have found that such dispersions have a number of important advantages in creping. The quantity of solids in the dispersion as compared with the quantity of the water vehicle can be very carefully controlled, as by simple dilution, so that the film of solids applied to the web can be controlled with great uniformity and accuracy. The dispersions are of relatively low viscosity, in relation to the quantity of solids they contain, so that they are very easily handled in coating apparatus such as has been described above.

Although the dispersions are non-tacky in the dispersed form, when they are applied to the webs of paper, the aqueous vehicle is rapidly absorbed by the webs, breaking the emulsion and depositing the adhesive solids on the surface of the web. The nature of the dispersions is such that the particles of adhesive they contain tend to filter out upon the surface of a web as the aqueous vehicle is absorbed therein, so as to form an almost entirely superficial film or coating of the solids on the web. Once the emulsion is broken, it does not tend to reform, and the presence of water in the web does not prevent the activation of the adhesive solids by temperature control. The aqueous vehicle of the dispersions is useful in wetting and hence softening the web and in interfacially weakening the web, particularly on that side to which the adhesive is applied. If the quantity of water in the aqueous vehicle is not sufficient to strike through the web and moisten all parts of it, additional wetting can be accomplished easily from the opposite side of the web to bring about a thorough softening.

The use of dispersions enables me to form exceedingly thin coatings of adhesive substances of great strength, which coatings are wholly superficial. It can be demonstrated with dispersions that when all other conditions remain the same the difference between one-sided and two-sided creping can be merely a matter of the quantity of solids applied per unit of area of the web. Thus if one-sided creping is accomplished with a dispersion containing a high quantity of solids and hence forming a comparatively thick layer of adhesive on the surface of the web, two-sided creping may be obtained under identical conditions by simply sufficiently diluting the same dispersion as applied. The specific thinness of the coating which will produce two-sided creping or a substantial interfacial disruption of the web will vary to a substantial extent with the thickness of the web, the degree of softening thereof as by water, and the natural resistance of the web to internal disruption.

Because of the interplay of the factors described above, it is not possible to give specific directions for all papers and for all adhesives. By way of a single, non-limitative example, I consistently obtain two-sided creping with ordinary 30-pound kraft wrapping paper, using a dispersion of polymerized wood rosin, and applying it in such fashion as to produce a coating of about one and one-half pounds of solids per

thousand square feet of the web surface. Since the desired thickness of coating will vary with the nature of the adhesive, the nature of the web being treated, and the degree of softening to which it has been subjected, specific ranges of thickness of the adhesive are not controlling. I have secured one-sided creping with layers of adhesive ranging from approximately one-tenth to three or more pounds per thousand square feet of the web surface, the general operating range preferred by me lying between approximately one-half and two pounds per thousand square feet for most webs and most adhesives. Given an adhesive which can act to prevent the web from separating from the cylinder ahead of the creping knife, so as to hump up bodily into incipient creping crinkles, the question then becomes one of attaining a bond which is stronger than the resistance of the paper web to internal disruption. This may be accomplished either by increasing the internal cohesion of a particular adhesive as by temperature control and the like discussed above, by selecting an adhesive having greater internal cohesion, by weakening the web to a greater extent as discussed above, or by selecting a web having less resistance to internal disruption.

Referring to Figure 7, I have shown a web 23 being withdrawn from a supply roll 24 and, by means of suitable idler rolls carried across a coating roll 21 turning in the pan 22 of dispersion, and being treated by the smoothing bar or roll 25. As already indicated, as soon as the aqueous vehicle of the dispersion strikes into the web, the emulsion breaks and the solids are deposited upon the web surface, the aqueous vehicle serving to soften the web. The web is then pressed against the surface of the creping drum 16 by the pressure roll 15. If additional wetting of the web is desired, this may be accomplished as at 26 by flowing water into the pinch between the pressure roll 15 and the creping roll 16. The temperature of the creping roll 16 will be controlled to activate the adhesive solids and produce a strong adhesion of the web 23 to the surface of the cylinder.

If the web is carried to a second creping cylinder, a reactivation of the adhesive is similarly accomplished on the second cylinder.

Aqueous dispersions are also highly useful in plying materials together either before or after creping. In Figure 8 I have shown a web 27 being withdrawn from a supply roll 28, coated as at 29 with an aqueous dispersion of suitable adhesive, and pressed by the pressure roll 15 against the surface of the creping cylinder 16. A second web 30, withdrawn from a supply roll 31 is coated as at 32 with an aqueous dispersion and, carried beneath the creping cylinder 16 on a plurality of idler rolls, is combined with the web 27 against the surface of the cylinder 16 by the pressure roll 15. It will be noted that here both webs are softened by the aqueous vehicle of the dispersions employed; the webs will be solidly combined and cemented together by the adhesive applied to the second web.

By methods hereinabove set forth, I have succeeded in producing single and double creped papers bearing upon that surface which lay against the creping cylinder or cylinders a thin coating of adhesive substance which is preferably completely nontacky at normal or room temperatures, which is preferably light in color, and which is so thin as to give the appearance of a product which lacks any coating of adhesive

substance, while the fineness and evenness of the creping crinkles or gatherings is such as can only be produced with a positive creping adhesive, and with such an adhesive, only in the event the web or webs were thoroughly softened by wetting at the time of creping.

My novel products have a wide range of utility. In general they are of high value whenever a universally stretchable web is desired without the appearance at one external surface of the roughness characteristic of creping crinkles. Hitherto, in the making of artificial leathers by way of example, from coated, double-diagonally crepe papers it has been desirable to emboss the product so perfectly that any appearance of creping crinkles (as distinguished from the embossed design) is destroyed by pressure. This meant the taking of tedious and expensive precautions in the manufacture of the embossing dies, which, with allowance for the thickness of the paper web had to be made to mate exactly so as to subject all parts of the web to the same heavy pressure. With my new products this precaution is no longer necessary. The products, when coated on the smooth side, have no visual appearance of creping crinkles to begin with nor do creping crinkles become apparent when the product is stretched. Hence the provision of an embossed product in which the embossed design appears free from the extraneous design of creping crinkles is not dependent upon the exertion of high and uniform pressure on all parts of the web. The embossing dies do not have to be made so as to be capable of exerting such pressure. A light impression or a heavy impression may be made, depending upon the effect desired; and in no instance will there be apparent upon the surface anything but the embossed design. Herein and in the claims which follow the terms "emulsion" and "dispersion" are used interchangeably and without distinction to indicate a suspension of one normally incompatible substance in another.

Modifications may be made in my product and procedure without departing from the spirit of the invention. Having described my invention in certain exemplary embodiments what I claim as new and desire to secure by Letters Patent is:

1. A process of creping paper which comprises treating a paper web with a water dispersion of thermoplastic adhesive, causing the adhesive to come out of the dispersed phase and activating the said adhesive for creping purposes by applying heat and pressure thereto to develop sufficient tackiness to bind the web to a creping surface, the said dispersion being applied to the paper web while the web is in a substantially dry and absorptive condition, in which process the breaking of the dispersion is produced by the absorption of the water vehicle thereof by the paper web and in which the said water vehicle serves to soften the paper web, at least at that surface against which the said adhesive is applied.

2. The process claimed in claim 1 wherein the paper web is additionally softened prior to creping by the application thereto of water on the opposite side.

3. In a process of creping paper in accordance with the process of claim 1 the steps of treating a pair of paper webs with dispersions of thermoplastic adhesive applied to one side of each web under conditions in which such webs can absorb the water vehicles of such dispersions and become softened thereby, leading such webs to-

gether so that one such coating of thermoplastic adhesive will serve to laminate them, leading the webs together against a creping surface with the other of said adhesive applications between said surfaces and the webs, and creping the webs together while said webs are so softened.

4. The process of claim 1 wherein the adhesive is applied in a layer containing no more than about 2 pounds solids per 1,000 square feet.

5. The process of claim 1 wherein the adhesive is applied in a layer containing no more than about 2 pounds solids per 1,000 square feet, and wherein the creping operation results in interfacial disruption of the web by forming unequal gatherings in opposite sides thereof.

6. The process claimed in claim 3 including the step of applying additional water to said webs on the sides opposite the application of said dispersions.

7. A process for the purpose described comprising applying a water emulsion of a thermoplastic adhesive to a web under conditions in which said web absorbs the water vehicle of said emulsion and breaks said emulsion, using the coating of thermoplastic solid on the surface of said web to bind it to a creping surface and creping said web while it is still wet with said vehicle, afterward reactivating said thermoplastic solid by heat and causing it to adhere said web to another surface.

8. A universally stretchable, double-diagonally creped paper product comprising a single thickness sheet having on one side rugosities characteristic of creping crinkles, the opposite side being devoid of such rugosities to the extent of having the general appearance of plain, uncreped paper.

9. A universally stretchable creped paper product comprising a single thickness sheet having one side smooth and free of the appearance of creping crinkles.

10. A universally stretchable creped paper product comprising a single thickness sheet having one side smooth and free of the appearance of creping crinkles, said smooth side having the property of being stretchable to the extent of the resilient stretchability in the product, without loss of its said smoothness.

11. A universally stretchable creped paper product comprising a single thickness sheet having one side smooth and free of the appearance of creping crinkles, said smooth side having the property of being stretchable to the extent of the resilient stretchability of the product, without loss of its said smoothness, and bearing a surface coating of creping adhesive, which coating contains no more than substantially one to two pounds solids per thousand square feet.

12. A process of creping webs with the interposition of adhesive material between the web to be creped and the creping surface, which comprises binding paper to a creping surface by means of a positive adhesive substance and removing it therefrom with a creping knife, employing for the purpose a layer of adhesive such as will not permit separation of the web bodily from the cylinder ahead of the creping knife so as to form incipient crinkles therein, and proportioning the cohesive strength of the adhesive to the resistance of the paper to internal disruption, so as to provide a bond which is greater than the said resistance.

13. A single thickness web of paper contracted in area by creping, characterized by creping rugosities on one surface which are not matched by conjoint rugosities on the opposing surface

and further characterized by voids in the internal structure of the web.

14. A single thickness creped paper web characterized by localized inequalities in the cross sectional thickness of the creped web, said inequalities resulting from interfacial disruption of the web, said web having creping rugosities on one surface only.

15. A process of producing a single thickness, universally stretchable creped paper product having a substantially smooth side, which comprises binding a paper web to a creping cylinder by means of a positive adhesive and removing it therefrom with a creping knife, including the steps of treating the web with a water dispersion of thermoplastic adhesive, causing the adhesive to come out of the dispersed phase and activating the adhesive for creping purposes by applying heat and pressure thereto to bind the web to the creping surface, and proportioning the cohesive strength of the adhesive to the resistance of the paper web to interfacial disruption so as to provide a bond between the web and the creping cylinder which is greater than the resistance of the web to interfacial disruption, the cohesive strength of the adhesive also being such as will not permit separation of the web bodily from the cylinder ahead of the creping knife so as to form incipient crinkles in the adhesively coated surface of the web.

16. A stretchable creped paper product comprising a single thickness paper sheet opposite sides of which are equally contracted areawise, one of said sides being characterized by readily visible and substantially uniform creping rugosities throughout, and the other of said sides being relatively smooth and relatively free of the same rugosities, the different physical characteristics of the contraction of the opposite sides of said

sheet of paper resulting in a disruption of the internal structure thereof and the opening up of the sheet whereby it is made more absorptive.

17. A process of producing a single thickness, universally stretchable creped paper product having a crinkled side and a substantially smooth side, which comprises binding a paper web to a creping cylinder by means of a thin layer of positive adhesive and removing it therefrom with a creping knife, while proportioning the cohesive strength of the thin layer of adhesive to the resistance of the paper web to interfacial disruption so as to provide a bond between the web and the creping cylinder which is greater than the resistance of the web to interfacial disruption, the cohesive strength of the adhesive being such as will inhibit separation of the web bodily from the cylinder ahead of the creping knife whereby to inhibit the formation of visible creping crinkles in the adhesive surface of the web.

18. The process of claim 17 in which the creping adhesive is a substance derived from a water dispersion of rubbery and resinous materials and in which the water vehicle is absorbed by the paper web to soften it during creping.

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