

Dec. 8, 1970

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3,546,065

CORONA DISCHARGE APPLIED DIRECTLY TO CREPING SURFACE
TO INCREASE ADHESION OF WEB TO SURFACE

Filed Dec. 29, 1967

3 Sheets-Sheet 2

EFFECT OF CORONA TREATMENT ON DRIER SURFACE WETTING AND ON SHEET ADHESION

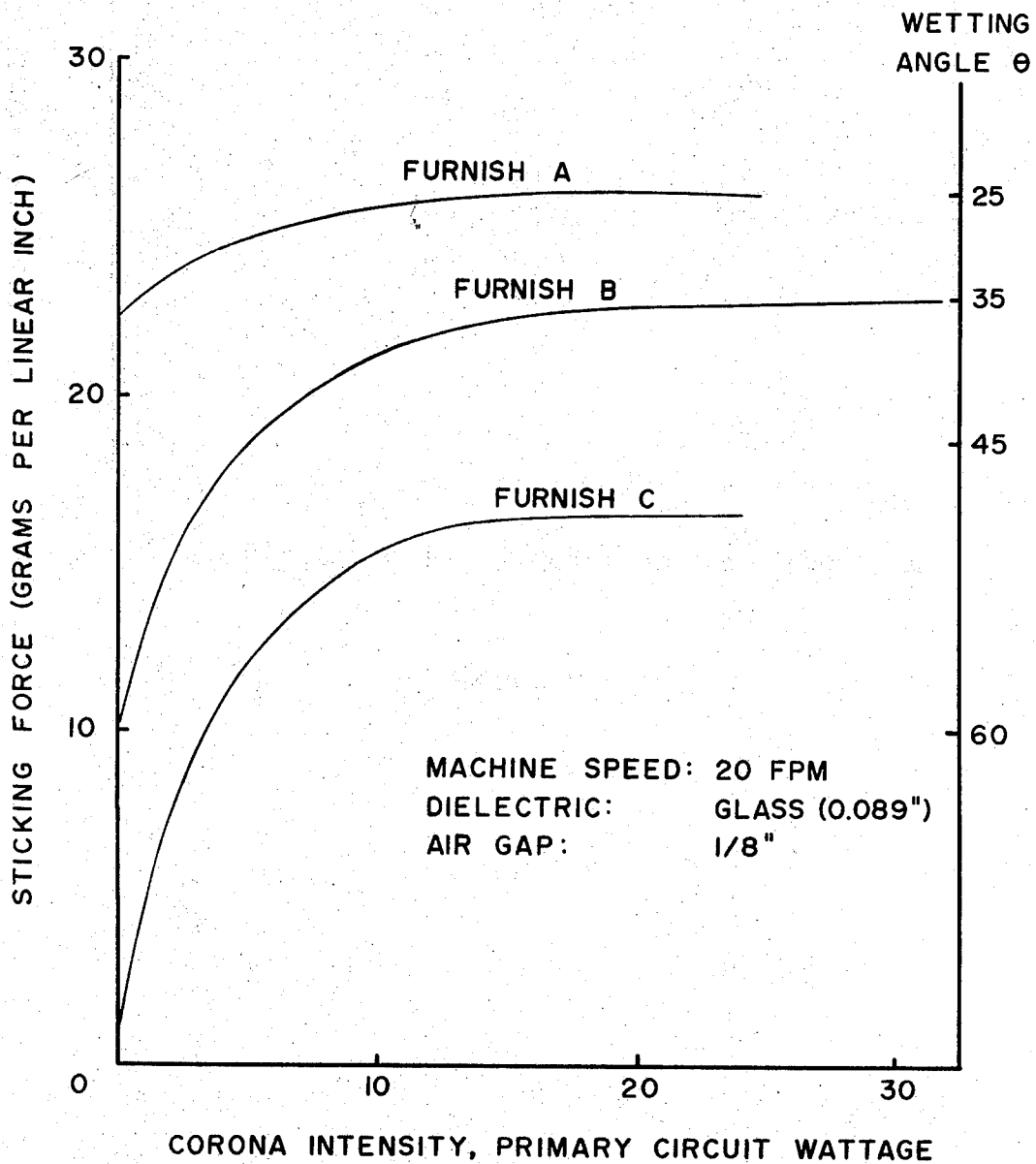


FIG. 3

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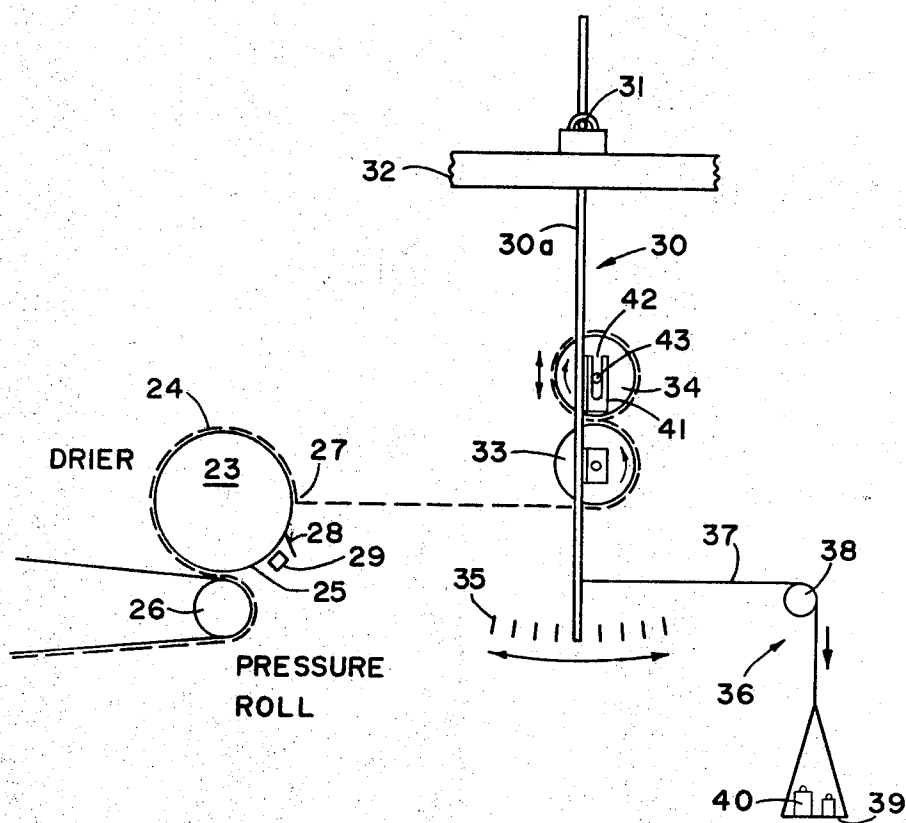


FIG. 4

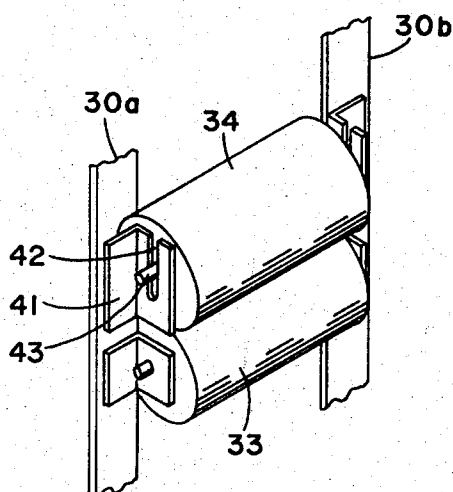


FIG. 5

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CORONA DISCHARGE APPLIED DIRECTLY TO CREPING SURFACE TO INCREASE ADHESION OF WEB TO SURFACE

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Filed Dec. 29, 1967, Ser. No. 694,681

Int. Cl. B31f 1/12

U.S. Cl. 162-111

7 Claims

ABSTRACT OF THE DISCLOSURE

A method and apparatus for the production of creped tissue paper. The normal adhesion of paper which is dried on the surface of a crepe wadding dryer is increased, and controllably so, by applying a corona discharge to the dryer surface in advance of the application of the wet web. As is customary in such operations, the dryer is most suitably a rotating cylinder and the wet web is fed continuously to and creped from the cylinder. The adhesion of the web may be increased or decreased in the course of a creping operation to control the crepe structure of the paper product. The extent of the effect of the corona treatment on adhesion is related to the degree of adhesion which would normally occur in the drying of the sheet on the dryer surface.

This present invention relates to the manufacture of paper and is concerned with the production of creped tissue or creped wadding by the dry-creping process.

In the dry creping of paper the paper web, when quite wet, is pressed onto a drying cylinder and dried to a moisture content usually of about 5-10% based on the bone dry weight of the web. The paper adheres more or less firmly to the drying cylinder and is removed from the cylinder by the action of a doctor blade which is urged against the cylinder and serves, in effect, to scrape the paper from the rotating drying cylinder. As an incident of the removal action of the blade, the paper is creped or crinkled.

The tenacity with which the web adheres to the drying cylinder at the blade is an important factor in attaining the proper degree of crepe in a product. If the paper releases from the drying cylinder too readily, the paper tends to flare from the dryer and does not crepe well; if the paper holds to the dryer too well, it tends to pass the creping blade and may be torn.

The tendency of various types of webs to be retained on the dryer surface varies with the specific nature of the web. Some types of webs adhere to the dryer well and requires that a release agent be provided to attain the proper degree of adhesion at the blade. Other types of webs are benefited by the provision of an agent which assists in attaining adhesion of the web to the dryer surface.

The dry creping process may be effected in either an on-the-machine operation or an off-the-machine operation. In the former instance the paper is formed, dried, creped, and usually reeled in a continuous run. In the latter case formed paper is rewetted, creped and reeled. In either instance the efficiency of the creping operation as to the attainment of the desired crepe and sheet properties may be evaluated as creping proceeds. Such checking of the crepe structure by machine operators may be by visual inspection of the sheet, by testing the hardness of the wound paper on the reel during winding or by power consumption measurement, for example, the power consumed by the motor which drives the drying cylinder against the creping blade action. Generally, however, the

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control of the degree of adhesion of the sheet to the dryer is slow and it is difficult to alter the creping significantly during a run while maintaining control of the traveling sheet itself.

I have found that the drying cylinder surface is itself changed in operation by the application of the web or sheet of cellulosic material to it. The drying cylinder commonly, for operating reasons, is of cast iron, mild steel or steel coated with another metal, for example, chromium; such cylinders must be ground true to a high degree of smoothness for successful dry creping at the high speeds usual to modern dry tissue papermaking operations. When ground, such cylinders tend to develop an oxide film. In addition, in use the cylinders apparently also develop a film which is related to the type of paper web applied to it; the film developed by a given web appears to be of relatively constant nature since the adhesion between a given sheet and the dryer will be relatively constant, high in some instances but low in others. Herein I term for convenience the dryer surface to which the webs are presented as the "creping surface."

The dryer creping surface usually demonstrates both hydrophilic and hydrophobic properties. An important phase of this invention involves changing the wettability with water of such creping surface and thus changing the receptivity of the creping surface to a wet sheet or web on the creping surface. I have found that by successively applying a corona discharge and a wet web to the creping surface the adhesion or binding of the web to the creping surface, as the web dries, may be significantly increased over that degree of adhesion which the same web would normally display. Further, the extent of the adhesion is dependent upon the intensity of the corona discharge applied at the creping surface as well as the nature of the web; for a specific web the adhesion is not only increased but is controllably increased. Importantly also, I have found that the binding or adhesion may, within limits, be decreased, that is, regulated from a higher degree of bonding to a lower degree though not below that adhesion which would occur between the creping surface and the web in the absence of the corona treatment.

The ability of the corona discharge to increase the adhesion of a web to a creping surface apparently results from the considerable effect in wetting angle change occasioned by the corona treatment. This effect varies, I have found, and tends to level off at a wetting angle which is constant over a considerable range of corona intensity for a given web. Further, the effect is greater for webs which commonly have low adherence to the creping surface. By reason of this ability of the treatment described, the range of webs which may be usefully creped is increased and better crepe uniformity is attained.

The invention will be more fully understood by reference to the following detailed description and accompanying drawings wherein:

FIG. 1 schematically illustrates an apparatus arrangement useful in a preferred embodiment of the invention;

FIG. 2 is an enlarged fragmentary and schematic view further illustrating the corona discharge equipment and its relation to the drying equipment;

FIG. 3 is a graph illustrating the effect of a corona discharge at various intensity levels on the sticking force of a plurality of webs of different characteristics, the effect of the corona on wetting angle of the drying being also indicated;

FIG. 4 is a schematic view of an apparatus arrangement for determining adhesion or sticking force; and

FIG. 5 is a fragmentary view illustrating in more detail a portion of the structure of FIG. 4.

Referring now to FIG. 1 of the accompanying drawings, a wet tissue web 1, after being couched in customary

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manner from a paper machine wire (not shown) and carried to a top felt 2 (illustrated in dash lines) in any suitable known manner, is directed in a substantially continuous manner over guide roll 3 with the top felt into a pressure nip 4. Nip 4 is formed by press roll 5 and the Yankee drying cylinder 6. The web commonly has been partially dewatered prior to passage over roll 3 by various felts (not shown) and by the operation in the nip 4 such that it has a water content of about 60-65% by weight immediately after passage of the nip. The wet web adheres to the circumferential creping surface 7 of drying cylinder 6 and is removed from the felt 2 in conventional manner. No release agent need be applied to web 1 as it approaches nip 4 but, if a release agent is present, the effect of the corona still is to increase adhesion of the web.

The sheet or web as it rotates with the dryer adheres thereto to a greater or lesser degree as it dries and loses moisture to the extent that the web as it approaches the doctor blade 8 contains 2 to 10% of moisture by weight. Suitably, the dryer surface has a temperature of between about 85° C. and 130° C. The blade scrapes the substantially dry web from the creping surface producing the creped or crinkled effect as indicated at 9. The creped web is then passed over guide roll 10 to a conventional winding mechanism 11 and is reeled at 12.

The drying and creping procedure thus generally described is known and the application to either the dryer or the web itself of either release or adhesion producing agents is also known. A difficulty with these known systems is that of adequate control of the adhesion at the blade to produce the desired degree of crepe consistently while, of course, attaining sheet release by the blade action without excessive blade pressure against the drying cylinder.

Between blade 8 and nip 4 I provide an electrode structure generally indicated at 13 for a corona discharge in the air gap illustrated at 14. The structure 13 extends across the dryer surface (FIG. 2) parallel to the dryer axis and is closely positioned to the dryer surface, usually spaced about $\frac{1}{8}$ " to $\frac{1}{4}$ ".

This structure 13 (FIG. 2) includes a longitudinally extending generally rectangular block 15 of resin serving as a casing and retainer for a metallic electrode 16. Electrode 16 is suitably of aluminum, steel or brass and is contoured to conform with the dryer surface. Block 15 is suitably of a methyl methacrylate resin. A dielectric material in the form of sheet D, preferably in contact with the electrode casing block 15 and spaced from the creping surface 7 of the cylinder, is provided to completely shield the electrode from the cylinder and to inhibit disruptive discharges between the electrode and cylinder. A film of silicone rubber or a sheet of glass serves the purpose as the dielectric material.

A heavy threaded rod engages in the aluminum electrode and extends outwardly of the plastic casing 15 to provide an electrical terminal 17. Cable 18 connects terminal 17 to any suitable high potential source 19; such source may include, for example, a high frequency generator supplied at an adjustable input power. In the present instance on equipment illustrating the practice of the invention, an input variable between 0 and 10 watts per lineal inch of sheet width at a sheet speed of 20 ft./minute has been found satisfactory to produce the required corona at a $\frac{1}{16}$ " to $\frac{1}{8}$ " electrode spacing. Potential source 19 is grounded at 20 (FIG. 2) and the dryer is suitably grounded at 21 through a sliding contact.

FIG. 3 illustrates my findings with respect to the capacity of a corona discharge to increase the ability of a creping cylinder dryer surface to retain webs of various characteristics. The sticking force data for curves A, B and C was obtained by running a sheet of specific character on a slowly moving (20 f.p.m.) dryer surface and withdrawing a determined width of web from the dryer surface just prior to the blade. The withdrawal point was at about

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the horizontal diameter of the dryer cylinder. Equipment employed is illustrated generally in FIG. 4.

In FIG. 4 the arrangement for determination of sticking force is illustrated schematically. A dryer designated at 23 carries a cellulose pulp web 24 which is directed to the creping or dryer surface 25 by pressure roll 26. The web is dried to a moisture content of about 5% as it moves toward a takeoff point 27 which is just short of creping blade position 28. In this measurement the doctor or creping blade serves only as a cleaning device and is not contacted by the sheet. The corona discharge source means is indicated generally at 29 and is effective to provide an adjustable power input in a manner known to the art. The web 24, as noted, is not creped in this measurement operation but is directed to a winder frame 30. The winder frame is pivoted at 31 to a fixed support 32 which is suitably a part of the general frame of the equipment. Guide roll 33 is held fixed against linear movement relative to the frame 30 and is driven in rotation by suitable means not shown. Such means may include a motor mounted on the frame above the pivot 31 and a chain and sprocket system. The sheet is wound by directing it over guide roll 33 to windup roll 34 which is itself driven by friction with roll 33 on which it rests. The roll 34 is journaled in the frame for movement vertically as indicated by (FIG. 4) the double headed arrow to accommodate the wound sheet as the wound roll increases in diameter. The frame 30 is adapted to traverse a scale 35 and the lower extremity of the frame has secured thereto a balance 36 comprised of a flexible cord 37, a guide pulley 38 and pan 39. In the embodiment shown frame element 30a carries an angle iron 41 which is notched at 42 to receive one end of the shaft 43 of roll 34. The second end of roll 34 is similarly mounted providing for free upward roll movement.

As employed herein in connection with FIG. 3 measurements and data, the web 24 was withdrawn from dryer 23 at an angle of 100° or slightly above the horizontal diameter of the dryer; the sheet was wound at 20 f.p.m. creating a pull on the winder and necessitating the use of weights 40 to counter balance the sticking force of the web and maintain the frame 30 vertical. The weight in grams necessary to pull the winder frame just off the balance mark is defined as the sticking force. A sound indicator may suitably be employed to provide the indication quite accurately. The data of FIG. 3 is obtained by measuring the sticking force as thus defined at various power inputs of the corona discharge source 29.

As a corollary to sticking force measurements, the wetting angle of the dryer surface was measured by a method based on Langmuir and Schaefer as described in the Journal of the American Chemical Society, vol. 59, page 2405, 1937. Such wetting angle data is incorporated in FIG. 3 also.

Referring specifically to FIG. 3, the curve A illustrates the effect of the corona discharge at varying intensity on a web of a pulp furnish of 100% long fibered kraft. Webs of 100% kraft commonly adhere well and crepe well. Nevertheless, the adherence is increased significantly from about 22 grams per lineal inch to about 26 grams per lineal inch, or about 18%, by the corona usage.

A furnish having about 60% kraft, 20% sulfite, and 20% groundwood by weight provided the web for the data of curve B. As will be readily noted, the sticking force in this instance increased by well over 200%, indicating the greater effect on the more poorly adhering webs. This is further borne out by curve C wherein the furnish for the web is about 20% kraft, 60% sulfite and 20% groundwood. The increase in this instance is very considerable percentage-wise. It is thus apparent that the simple use of a corona has a decided beneficial effect on adherence over the whole furnish range. Importantly, such corona usage permits the selection of pulp furnishes and creping techniques which otherwise would not be employed for the purpose.

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FIG. 3 correlates the change in wetting angle of the cylinder dryer surface with the sticking force. It is thus clear that it is the wettability which is altered, and altered without the addition to the surface of chemical agents.

Importantly, by simply reducing the intensity of the discharge from the higher values, the sticking force may be reduced from the plateau zones of the curves to lesser values of sticking force. Apparently, this occurs because in operation a new surface is constantly presented for treatment by the corona. In any event control is readily attained so that the creping may be regulated readily.

The practice of the process provides that in the creping action the sheet absorbency, softness, bulk and similar properties may be materially improved beyond the conditions obtained when adherence to the creping cylinder is dependent upon drying alone. Additionally, to secure the very high degree of adhesion to the creping cylinder, no creping additives such as adhesives are necessary.

As many apparently widely different embodiments of this invention may be made without departing from the spirit and scope thereof, it is to be understood that I do not limit myself to the specific embodiments thereof except as defined in the appended claims.

I claim:

1. A process of producing a creped web which comprises binding a wet traveling web while drying the web to a creping surface moving in a complete circumferential path by directly applying a corona discharge to the creping surface and then applying the wet web to the creping surface, heating the web on the surface to dry the web to 2 to 10% moisture, and creping the bound web from the corona treated surface.

2. The process according to claim 1 in which the intensity of the corona discharge is raised to provide an

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increased binding of the web to the creping surface in amounts as set forth in the curves of FIG. 3.

3. The process according to claim 1 in which the creping surface is cylindrical, the wet web is pressed to the creping surface at a circumferential zone of the surface remote from the position of creping of the bound web, and the corona discharge is applied to the creping surface between the said circumferential zone and the creping position.

4. The process according to claim 1 in which the web by weight on a dry basis is at least 50% by weight of cellulosic sulfite pulp.

5. The process according to claim 1 in which the web by weight on a dry basis is at least 50% by weight of cellulosic kraft pulp.

6. The process according to claim 1 in which the web by weight on a dry basis is at least 20% by weight of ground-wood pulp.

7. The process according to claim 3 in which the wet traveling web wraps the cylindrical creping surface to the extent of greater than 180° and the corona discharge is applied to the extent of between about 5° and 35° of cylinder arc.

References Cited

UNITED STATES PATENTS

2,910,723 11/1959 Traver ----- 204—168

S. LEON BASHORE, Primary Examiner

R. H. ANDERSON, Assistant Examiner

U.S. Cl. X.R.

204—168. 264—283