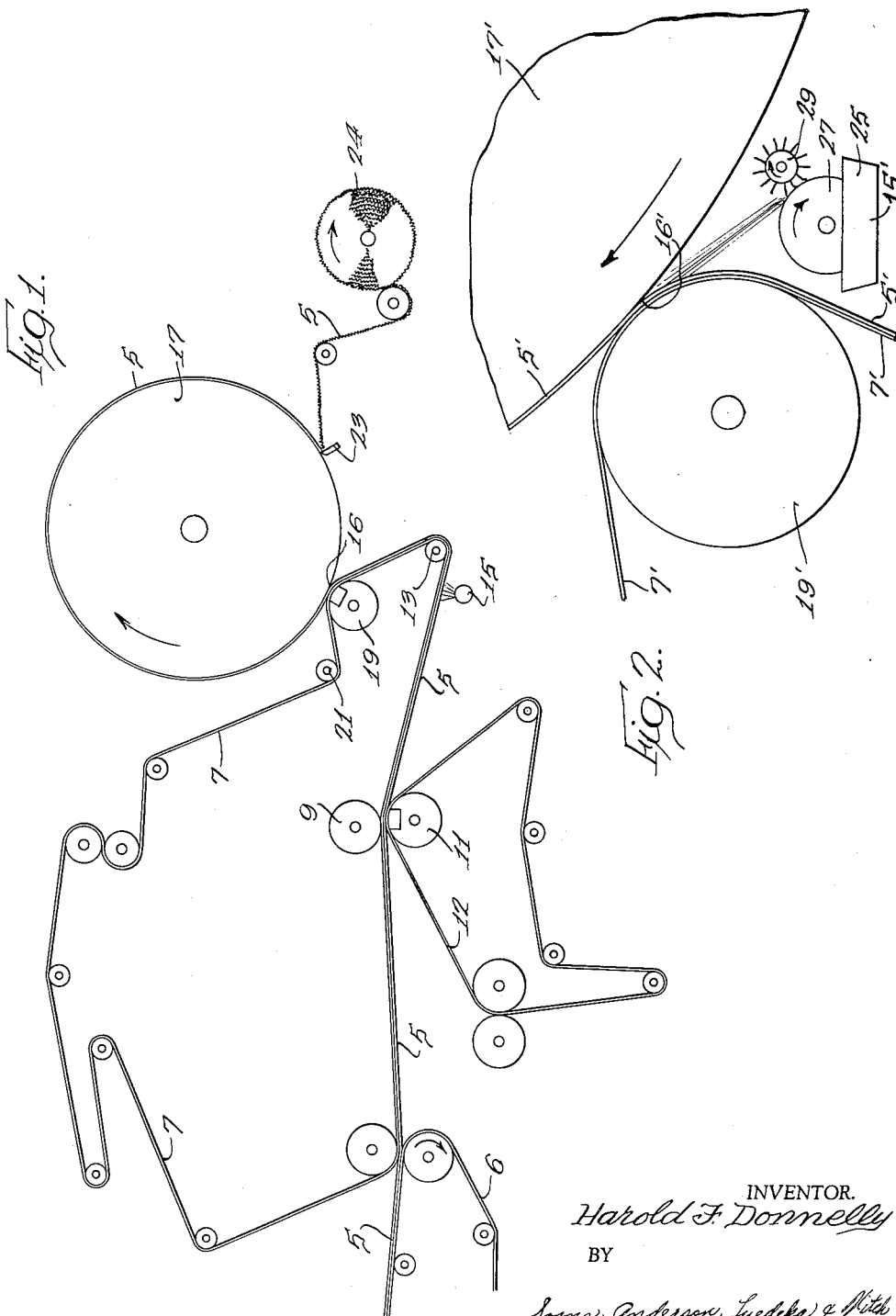


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METHOD OF FABRICATING TISSUE

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METHOD OF FABRICATING TISSUE

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This invention generally relates to a method of fabricating improved tissue. The invention more particularly relates to a method of manufacturing dry creped cellulosic tissue webs having improved characteristics and physical properties.

In the manufacture of dry creped tissue webs by conventional procedures, the webs are usually water-laid upon a suitable web-forming wire. In each case the formed web is then passed onto the surface of a heated rotating drum or series of drums, where it is dried to a suitable moisture content. The dried web is creped from the surface of the drum by means of suitable creping equipment, usually a creping doctor blade. The dried creped tissue is wound on a suitable drum or reel which stretches the tissue web as an incident to the winding operation. The web is then ready for assembly into finished tissue products. However, in such manufacture of dry creped cellulosic tissue webs certain difficulties have been encountered, particularly with respect to adequate release of the webs from the drier section of the tissue-making apparatus during creping.

In the manufacture of dry creped tissue it is important to obtain a proper amount of adhesion between the web and the drier so that the desired type of creping results. When there is too little adhesion of the web to the drier surface, the web will flare off the drier without being creped, or will be creped with a coarser type of crepe than desired, since resistance of the web to removal from the drier surface by the creping mechanism is in large part responsible for the type of creping effected.

Conversely, if the web adheres too tenaciously to the drier surface during creping, the web may be partially or wholly fractured as an incident to its removal, thereby resulting in a low strength web and requiring costly slowing down or stoppage of the conventional high-speed tissue-making process. Moreover, it has been found that tightly adhering webs are often creped more finely than desired, resulting in other undesirable physical properties.

It is also desirable to have the creping as uniform as possible across the web, and to avoid various degrees of web adhesion to the drier surface for a particular section of tissue web with consequent uneven creping of the web and web areas of differing web strength.

Certain factors have been found to influence the degree of drier adhesion. It has been found, for example, that cellulosic pulps vary considerably in their natural adhesivity to drier surfaces when made into creped tissue webs. This is due in part to considerable variations in the concentrations of non-cellulosic constituents. For example, some of these constituents such as pitch aid release, while others such as carbohydrates increase adhesion.

Sulfate wood pulps and western sulfite wood pulps are particularly prone to cling or stick too firmly to the drier surface to allow easy release therefrom. In fact, certain of these pulps have been found to be almost impossible to utilize commercially in the fabrication of dry creped tissue webs, without admixture with less strongly adhering pulps.

It has further been discovered that the more highly refined the wood pulp, whatever its origin, the stronger will be the adhesion to drier surfaces of webs fabricated therefrom. Thus, in the manufacture of tissue wadding where the furnish is highly refined, increased drier adhesion normally occurs.

An added difficulty lies in the effect that the water

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utilized in making up the stock suspension has on drier adhesion. The stock suspension, which is the mixture from which the web is made, is an appropriate mixture or suspension of fiber, water and possibly other additives.

The greater the concentration of certain salts, for example calcium salts, in the stock water, the greater the drier adhesion usually encountered.

In addition, various wet strength resins are utilized in the fabrication of special types of tissue webs, such as are used for paper towels and the like. These resins usually act as adhesives for the web on the drier, and substantially increase the difficulty of effecting suitable web release from the drier surface.

Attempts to control the degree of adhesion of tissue webs to drier surfaces have comprised adjusting the hardness and pH of the furnish and stock suspension, limiting the use of wet strength adhesive resins, controlling the nature and types of furnishes and using creping aids such as glues and soaps in the furnish. However, such attempts have been expensive and time consuming, and moreover have not been completely satisfactory in that controlled web release from the drier surface could not always be effected. In this connection, many types of available wood pulps could not be used in the unmodified form for dry creped tissue web manufacture.

Various soaps and similar release agents which reduce the adhesion of tissue webs to drier surfaces have been added to the stock or furnish before fabrication of the tissue webs. Spraying certain types of foam suppressors on the wire also has some small effect on release action. However, addition of such soaps and similar release agents directly to very dilute furnishes has not proven satisfactory in controlling the adhesivity of certain furnishes to the drier, even when utilized in large amounts. Too little of the release agent is generally retained in the system from the point of addition to the drier surface to be effective. In addition, this type of control of drier adhesion generally results in a definite loss of web strength. This loss of web strength is believed due to interference by the release agent with proper fiber-to-fiber bonding during the formation of the web on the web-forming wire.

Use of release agents directly in the stock is further disadvantageous since these agents tend to accumulate in the stock and build up in the white water, so that the degree of drier adhesion cannot be easily controlled. In addition, some of these agents have a tendency to foam, clog, and disrupt formation on the tissue-making machinery, and thus to interfere with the operation of the tissue-making process.

It has now been discovered that the above difficulties can be overcome and tissue webs having improved characteristics and physical properties can be provided by the use of release agents of a specified type and amount at specified points in the tissue-making process. In accordance with the method of the present invention, the release agents are added to the tissue-making system after the tissue web has been formed, and prior to or at the entry of the web into a pressure nip which may be located ahead of or at the point of contact with the drier surface. The method of the present invention provides adequate control of drier adhesion and results in more uniformly creped tissue webs having increased web strength and stretchability over conventionally fabricated creped tissue webs. Furthermore, with certain release agents the webs may have certain improved characteristics, for example, increased limpness and softness. In addition, the tissue webs can be formed from certain wood pulp furnishes hitherto commercially unusable.

In addition, increased creped tissue web production speed may be obtained by the present process because of reduced energy requirements, that is steam consumption in the drier section of the apparatus. This effect is due

primarily to the ability to satisfactorily dry crepe the tissue web at a higher moisture concentration than heretofore obtainable. In addition, release agents generally reduce surface tension and allow more water to be removed at the press roll.

In the present process, the drier surface remains cleaner than in conventional processes, due to the fact that the release agents permit the web to be more cleanly removed in the creping process. Moreover, the release agents in the present process act as conditioning agents for the conveyor felts, keeping them in a clean, absorbent, flexible condition.

Accordingly, it is the primary object of the present invention to provide a faster, more economical method for the manufacture of tissue webs. It is also an object of the present invention to provide a method of manufacturing dry creped tissue webs having increased web strength and stretchability. It is a further object of the present invention to provide an improved method for the manufacture of dry creped cellulosic tissue webs at a lower breakage frequency. It is also an object of the present invention to provide an improved method of controlling drier adhesion through the use of specified release agents on formed tissue webs. Moreover, it is an object of this invention to provide a method for using certain furnishes hitherto considered impractical for use in forming dry creped tissue.

Further objects and advantages of the present invention will be apparent from a study of the following detailed description and from the accompanying drawings, of which:

FIGURE 1 is a schematic representation of the drier section of a papermaking machine arranged for operation in accordance with the method of the present invention;

FIGURE 2 is an enlarged schematic view of a portion of the drier section of a papermaking machine illustrating another method of operation in accordance with the present invention.

The manufacture of dry creped cellulosic tissue webs in accordance with the preferred method of the present invention comprises the steps of forming a web of cellulosic fiber in the conventional manner, adding to the formed web one or more release agents at a point before a pressure nip and before drying the web, passing the web and release agent through a pressure nip to distribute the release agent uniformly in the web and on a drier surface, drying the web and film of release agent on the drier, and creping off the dried web from the drier surface.

Normally, the sheet or web is formed by a water-laying technique on the usual Fourdrinier-type web-forming equipment. The mat of fibers of which the web is composed is formed by applying to the upper surface of the Fourdrinier wire, as by flowing thereon, a layer of stock containing the required amount of fibers in an amount of water which is sufficient to produce the proper distribution of the fibers in the web, and subsequently eliminating a sufficient amount of the water to produce a coherent web or sheet capable of being couched off the end of the wire.

For the purposes of the present invention, the fibers used may comprise any cellulosic or other fibers which are adaptable for use in the manufacture of creped webs or sheets of tissue weight. In addition, wood pulp fibers hitherto commercially unusable in dry creping can be utilized in amounts comprising up to 100 percent of the entire furnish. However, the proportions and types of the fibers may be adjusted in accordance with the uses to which the creped cellulosic tissue webs or sheets are to be applied. Cellulosic fibers include chemical wood pulp fibers, mechanically produced wood pulp fibers, cotton fibers, etc. Suitable chemical wood pulp fibers include those produced by the sulfite, sulfate, and semi-chemical pulping processes. The fibers may be bleached, but this is unnecessary for the purposes of the present invention.

Various synthetic fibers such as rayon, nylon, glass,

polyvinyl chloride, and cellulose acetate fibers may be added in varying amounts to the furnish to provide webs having certain specific properties.

The tissue web may be formed on a Fourdrinier web-forming machine having an open or spout-type headbox or on a cylinder vat machine. An example of a Fourdrinier machine is shown in part in FIGURE 1.

As produced on such a machine, the formed cellulosic tissue web normally has a moisture content of approximately 85 percent by weight at the time it is couched from the web-forming wire onto the felt. In general, a tissue web useful for purposes of the present invention, should have a basis weight before creping, on a bone dry basis, of between about 3.5 and about 15 pounds per ream of 3000 square feet.

Referring now more particularly to FIGURE 1 of the accompanying drawings, a wet tissue web 5 after being couched in the usual manner from a web-forming wire 6 is carried by a top felt 7 into the pressure nip between two main press rolls, a top press roll 9 and a bottom suction press roll 11, and bottom felt 12. The press rolls 9 and 11 partially dewater the web 5, reducing the moisture content thereof to between about 70 to 80 percent by weight. After the web 5 passes through the pressure nip with the top felt 7 it is carried by the top felt 7 around a tail roll 13. During passage of web 5 between the main press rolls and the tail roll, the web is contacted with a spray of fluid containing a release agent. The spray of fluid is delivered to the web 5 by a suitable means 15.

The release agent for the purposes of the present invention may be one or more compounds miscible with water or another volatile carrier. By miscible is meant dispersible in or soluble in the volatile carrier. Air also may be employed as this carrier. The release agent should be such as to impart a degree of oiliness to steel of less than 0.3 at 20° C. expressed as the coefficient of friction.

As used herein, the degree of oiliness expressed as the coefficient of friction is based on data obtained with a modified Deeley machine used for static friction measurements in the commercial testing of lubricants. This machine utilizes two opposing hard steel surfaces, one provided by a disc about 4 inches diameter, and the other by three ½ inch diameter balls mounted on the underside of a circular carriage and equally spaced around a circle 3 inches in diameter. The carriage engages with a torque measuring device consisting of a coiled spring with an indicating mechanism. The pressure between the engaging surface of the plate and the carriage supported balls can be varied by loading the carriage with weights. The disc or lower friction surface is carried in a bath which contains the lubricant under test, and a gas ring is provided under the bath for heating the lubricant, the temperature being measured by a thermocouple in the bath.

The machine is operated by slowly rotating the disc by means of an electric motor and gearing. The frictional resistance between the surfaces causes rotation of the carriage against the action of the spring, and the disc is rotated until slipping of the surfaces occurs, when a pawl-and-ratchet mechanism prevents the spring from unwinding. The torque produced by the spring on the carriage at slip is thus equal to the friction torque and, as the total load is known, the coefficient of friction is thereby obtained. This value is a measure of the boundary lubrication afforded by the substance tested.

The Deeley machine, the scale of oiliness values and the associated test are described in detail in the Journal of the Institute of Petroleum, vol. 26, No. 195, January 1940, pages 1 to 18; A. Fogg and S. A. Hunwicks, "The Static Friction of Lubricated Surfaces." Wherever reference is made to "degree of oiliness" or "coefficient of friction" in the specification and claims it falls under the above description.

It has been found that at 20° C. the oiliness value or coefficient of friction for steel on steel is 0.6. With benzene present, the value is 0.5, with alcohol 0.42, with trichloroethylene 0.33, and with glycerol 0.2. Mineral oils and fatty oils have values in the range from about 0.12 to 0.15, while oleic acid has an exceptionally low value of about 0.06.

Examples of release agents which are suitable for the purposes of the present invention are the following:

Soaps comprising the sodium salts of oleic, stearic, and other fatty acids; emulsified mineral oil; wax emulsions; silicone emulsions; diglycol laurate; polyethylene glycol dilaurate; emulsified fatty acids of 6 to 18 carbon atom chain length, such as oleic, ricinoleic, palmitic, stearic and lauric acids; triethylene glycol; sulfonated castor oil; rewetting agents of the fatty ester type, and alkyl aryl polyether alcohols; alkyl ketene dimers, such as the ketene dimer of a fatty acid of 12 to 18 carbon atom chain length; softening agents of the sulfonated long chain hydrocarbon type; and, quaternary ammonium chlorides, such as dihydrogenated tallow di-methyl ammonium chloride.

In general, only a relatively minute amount of release agent compared to the weight of the web will be necessary to effect the desired controlled release of the web from the surface of the drying cylinder. This amount will depend on the oiliness of the release agent, the type of furnish and weight of the tissue web being released and the temperature of the dried cylinder surface, among other factors. The amount of release agent can vary as much as 0.01 pound to 25 pounds per ton of finished product, depending on the release agent chosen and the other factors listed above.

Fatty acids which are liquid at room temperature (65° F.) and which have between 14 and 18 carbon atoms in the carbon chain have been found to be particularly effective release agents, as also are mineral oils utilized in an oil-in-water emulsion. The former have been successfully utilized in an amount between .02 and about 2 pounds per ton of tissue web having a basis weight before creping of about 7.6 pounds per ream of 3000 square feet, on a bone dry basis. The latter have been successfully utilized in an amount between about 1 pound and 21 pounds per ton of tissue web having a basis weight before creping of about 7.6 pounds per ream of 3000 square feet, on a bone dry basis.

Since only a relatively minute amount of release agent need be used in achieving effective control of release of the tissue web from the drier surface, as compared with processes where release agents are added to the furnish, the method of the present invention is relatively inexpensive. Moreover, increased web yield, strength, stretchability and softness in the finished creped tissue web, and increased production speed and lower wind breakage frequency render the method of the present invention highly desirable.

The selection of the particular release agent may depend not only on its oiliness value but also on other characteristics of, or imparted by, any particular agent.

The release agent in the volatile carrier is applied to the web 5 by a spray boom means 15, in an amount sufficient to spread evenly in the web 5 and on its surface when the web 5 is passed through a pressure nip 16 between the drying cylinder 17 and the associated rubber covered suction press roll 19. The amount of release agent in the carrier should be sufficient to effect the desired dry creping of the web, as hereinafter more particularly described. The release agent can be applied to the web 5 at any point prior to the pressure nip 16. The release agent can also be applied directly into the pressure nip 16 or the pressure nip between the main press rolls. Inasmuch as it is necessary for the pressure nip to spread the release agent evenly in the web, the optimal point of application of the release agent will necessarily depend on the type and amount of release

agent and carrier applied, the nature of the web, and the rate of the top felt and the web.

The release agent and carrier alternatively may be applied to the top felt 7 at a point before the pressure nip between the main press rolls or after that pressure nip and before the pressure nip 16. However, when the release agent is applied to the top felt 7, it should be applied sufficiently far ahead of the pressure nip to allow the release agent to soak through the felt 7 and reach the surface of the web 5 before the web and felt enter the pressure nip. Application of the release agent to the top felt 7 has the advantage of keeping the top felt clean and in a flexible and absorbent condition.

In the apparatus of FIGURE 1, the release agent is applied by a spray boom 15 having spaced hydraulic spray nozzles directed at the adjacent surface of the web 5 and extending substantially over the entire width of the web 5. The boom may, for example, have 0.018 inch spray nozzles so spaced as to provide a uniform spray over the entire width of the web 5. The spray pressure means may be pneumatic as well as hydraulic. The spray boom 15 is located close to web 5 and between the tail roll 13 and the main press rolls 9 and 11, as shown in FIGURE 1. Alternatively, it may be located either prior to the main press rolls, or closer to the pressure nip 16.

Any other apparatus which applies the release agent to the web or, alternatively to the top felt 7, in a controlled amount may be utilized in the present invention instead of the spray boom 15. For example, a rubber printing roll may be used. It has also been found that the release agent can be successfully applied to the web by means of the brush roll assembly, as shown in FIGURE 2 of the accompanying drawings.

After the release agent is applied to the web 5, as previously described, the web 5 is carried by the top felt around the tail roll 13 and into the pressure nip 16 between the rubber covered suction press roll 19 and the Yankee drying cylinder 17. The pressure applied at the nip by the press roll 19 spreads and distributes the release agent evenly in the web. It is an important part of the present invention that the release agent be uniformly distributed in the web so that it is present uniformly on the surface of the web as well. This is to assure an even release of the web from the drier during the subsequent dry creping operation. Such even release of the web accounts for uniform creping of the tissue web with a dramatically reduced incidence of breaks in the web during creping and subsequent stretching and rewinding. In addition, the uniform distribution of the release agent in the web assures various other advantages of the present invention.

The press roll 19 acts to press the web 5 firmly onto the surface of the Yankee drying cylinder 17. That cylinder rotates in a clockwise direction as viewed in FIGURE 1, carrying the web 5 with it during rotation. The Yankee drying cylinder is a conventional type of drying means which may be up to 15 feet in diameter. The drying cylinder operates at an even surface temperature between about 190° F. and about 212° F. and may rotate at speeds up to 3000 feet per minute. At this temperature and speed of rotation the web is reduced to a moisture content of between about 3 and about 14 percent by weight before it is creped. Beyond the pressure nip 16, the top felt 7 leaves the web 5, and passes around the return roll 21 for reuse in the processing of tissue web.

After the web 5 is dried on the cylinder 17 to a moisture content of between about 3 and about 14 percent by weight, it is creped off the cylinder by the creping doctor blade 23 and wound onto a reel 24.

The dry creped tissue webs manufactured in accordance with the method of the present invention, exhibit increased web tensile strength, have greater stretchability and have fewer breaks in the subsequent rewinding process. In this connection, it has been found that in one typical processing operation with a web formed from a usual type of wood pulp furnish, the number of breaks per process-

ing day per machine were reduced from 71 to 16 for a frequency reduction of 1.3 to .3 breaks per ton of product, thereby greatly increasing the effective production speed and web yield per day. It has also been found that the relative tensile strength of the web after stretching and rewinding may be 25 percent greater than that of a comparable web untreated with release agent in the manner of the present invention. It is believed the release agent not only provides effective control of the releasing action of the web from the drier surface, but also lubricates the fiber structure of the formed tissue web, so that the fibers slide over one another more easily, or are partially plasticized so that the web can be stretched to a greater extent without rupturing. An added advantage of the method of the present invention is that the creping can be carried out at a higher moisture content than formerly possible, with up to a 10 percent saving in steam requirements for the drying operation. The higher moisture content of the tissue web aids in preventing rupturing of the web during creping and also during subsequent stretching operations.

With webs fabricated from the usual types of furnishes the desired release of the web from the surface of the drying cylinder during creping can be achieved through the use of relatively minute amounts for the release agent, in accordance with the present invention. The release agent in these small amounts has no appreciable effect on the nature of the crepe obtained, but significantly reduces the incidence of breaks in the web during the creping and subsequent rewinding and stretching. In addition, effective release from the surface of the drying cylinder during dry creping of webs fabricated from hitherto commercially unusable furnishes can be achieved through the use of release agents applied in accordance with the present invention.

It is important to recognize that the present invention is directed principally to the dry creping process as distinguished from wet creping or semi-creping. That is, the web is dried shortly after forming and is creped directly off the drying cylinder in a continuous process within the previously described moisture concentration range, that is between about 3 percent and about 14 percent by weight. In wet creping the sheet is dried almost completely, then is rewetted and reapplied to a drier and creped therefrom. In semi-creping the doctor blade is used on a drier usually located about half way along in the drier section and produces a minimum of crepe. The products produced by dry creping differ materially from those produced by wet creping or semi-creping, both in their appearance and in their functional characteristics.

FIGURE 2 discloses apparatus for carrying out another method of applying the release agent to the web in accordance with the present invention. The release agent is applied directly into the pressure nip 16' between a drying cylinder 17' and associated press roll 19'. The web 5' is passed with a top felt 7' around a tail roll (not shown) and into the pressure nip 16'. As the top felt 7' and the web 5' enter the pressure nip, a release agent in a suitable liquid carrier is sprayed into the pressure nip 16' by any suitable means such as the brush roll means 15', comprising a receptacle 25 which holds the release agent and fluid carrier, an applicator roll 27, and a brush roll 29. The roll 27 rotates in the receptacle 25 and picks up therefrom suitable amounts of the release agent. The brush roll 29 rotates in a direction counted to the direction of rotation of the applicator roll 27 and is in point contact with the release agent-covered surface of the roll 27. The brush roll 29 is equipped with suitable bristles which contact the roll 27 and act to spray a suitable amount of the carrier containing the release agent into the pressure nip 16', in an amount sufficient to assure distribution of the release agent in the web and on the surface of the web, and in an amount sufficient to effect the desired improved dry creping of the web.

As the web 5' containing the release agent is passed with the top felt 7' into the pressure nip 16', the pressure exerted by the press roll 19' on the nip causes the release agent to be distributed evenly within the web and on the surface of the web which contacts the surface of the drying cylinder 17'. The web 5' and the top felt 7' are separated beyond the pressure nip 16', the web 5' passing onto the surface of the drying cylinder 17' and the top felt 7' continuing on the surface of the press roll 19' for return for processing of additional tissue web. The web 5' is then subjected to drying and creping, as previously described in connection with FIGURE 1.

The modification of the method of the present invention set forth in FIGURE 2 differs from that described in connection with FIGURE 1 only in that the release agent is applied directly into the pressure nip 16' instead of being applied to the web between the main press rolls and the tail roll. In addition, a brush roll assembly is used to apply the release agent rather than a spray boom.

It is obvious that a spray boom or other applying means could be used in the arrangement of FIGURE 2 instead of the brush roll assembly, and also that the release agent could be applied to the top felt 7' or to the web 5' prior to, rather than directly to, the pressure nip 16'. All such modifications of the method of the present invention yield quite satisfactory results with respect to control of drier adhesion and the production of improved tissue webs.

The dry creped tissue web fabricated by the method of the present invention, before being incorporated into tissue products, may be expanded or stretched on any conventional expansion apparatus, such as a rewind machine, preferably to within about 20 percent of its total stretchable length. During expansion, fewer breaks are encountered than with conventionally produced webs, due both to the greater strength of the web and easier pull out. After expansion, the creped tissue web is ready for use in the manufacture of facial tissues, wipes, towels and other tissue products. In this connection, a plurality of webs may be assembled in superposed relation to provide multi-ply, cellulosic tissue products. If desired, the plies of web can be bonded together through the use of bonding agents and/or embossing or other suitable means.

Illustrative examples of the present invention are set forth as follows:

Example I

A wood pulp furnish comprised of approximately 75 percent bleached sulfate fibers, the remainder being bleached sulfite fibers, was processed on a commercial tissue-making machine to produce a cellulosic tissue web having a basis weight of 7.6 pounds per ream of 3000 square feet, on a bone dry basis, before creping. The formed wet tissue web was couched off the forming wire onto the top felt. After going through the main press section it was sprayed with an oil-in-water emulsion of mineral oil at the rate of 1 pound per ton of the tissue web, on a bone dry basis, by means of an hydraulic spray boom operating at 40 pounds pressure. The spray boom had nozzles of 0.018 inch diameter spaced at 3 inch intervals across the width of the web, so as to apply to the web a fairly uniform amount of the mineral oil. The mineral oil used as the release agent in this example was a commercial preparation called Cynol 760 produced by the American Cyanamid Company. This particular emulsifiable mineral oil has been treated to induce therein cationic paper softening agent properties and it is normally used as a liquid, light straw in color and has a specific gravity at 85° F. and a viscosity of 23 to 28 centipoises at 25° C. It was used as a 0.1 percent oil-in-water emulsion. The spray boom was located 10 inches from the web, 36 inches from

the tail roll between the tail roll and the press roll associated with a Yankee drying cylinder.

The tissue web carrying the applied mineral oil was then conveyed by the top felt into the pressure nip between Yankee drying cylinder and associated press roll. The Yankee drying cylinder had a diameter of 12 feet and rotated at a speed of 2300 feet per minute. The temperature of this cylinder was maintained between 190 and 200° F. As the web passed through the pressure nip the release agent was uniformly spread in the tissue web and on the surface thereof. The web was dried on the drying cylinder to a moisture content of between about 5 and 7 percent, and creped off the surface of the drying cylinder with a standard creping doctor blade and wound onto the reel at a crepe ratio of about 2.0.

The dry creped tissue web was rewound on a winder which expanded the web until it had about 20 percent residual stretch. The expanded web had a tensile strength of about 425 grams as opposed to 395 grams tensile strength in a control product. Moreover, during rewinding the web produced by the method of the present invention had only 0.3 breaks per ton of product as opposed to 1.3 breaks per ton of control product. The finished, expanded, dry creped, cellulosic tissue web was very soft and limp.

Example II

A wood pulp furnish comprised essentially of bleached sulfate fibers from southern woods, formerly considered impractical for use in the manufacture of dry creped tissue under standard operating conditions, was formed on a conventional paper machine into a cellulosic tissue web having a basis weight of 7.6 pounds per ream of 3000 square feet, on a bone dry basis, before creping. The formed wet tissue web was couched off the forming wire onto the top felt and carried through the main press. It was then sprayed with release agent, in this case an oil-in-water emulsion of mineral oil at the rate of 21 pounds per ton of tissue web, on a bone dry basis. A pneumatic spray boom was used for this purpose, operating at 40 pounds air pressure and having nozzles with an orifice size of .028 inch spaced at 9 inch intervals across the width of the web, so as to lay upon the web a fairly uniform dispersion of the release agent. The release agent used in this example was an emulsifiable mineral oil sold as a commercial preparation under the trade name Cynol 760 by the American Cyanamid Company, having the same properties as given in Example I. A 6 percent oil-in-water emulsion was used.

The spray boom was located 12 inches from the web and between the tail roll and the press roll associated with a Yankee drying cylinder, as in Example I. The tissue web carrying the applied mineral oil was then conveyed by the top felt into the pressure nip between the Yankee drying cylinder and associated press roll. The Yankee drying cylinder had a diameter of 12 feet and rotated at a speed of about 1600 feet per minute. The temperature of this cylinder was maintained between 190° and 200° F. As the web passed through the pressure nip the release agent was uniformly spread in the tissue web and on the surface thereof. The web was dried on the drying cylinder to a moisture content of about 7 percent and creped off the surface of the drying cylinder with a standard creping doctor blade and wound onto the reel at a crepe ratio of 2.5.

A dry creped sheet to be used as a control sheet for comparison purposes could not be produced from the same furnish because the excessive drier sticking, which occurred when no release agent was present, prevented removal of a suitable product from the drier.

Example III

A furnish of chemical wood pulps comprised essentially of bleached sulfate fibers from West Coast woods, formerly considered impractical for use in the manu-

facture of dry creped tissue, was formed on a conventional paper machine into a cellulosic tissue web having a basis weight of 7.6 pounds per ream of 3000 square feet, on a bone dry basis, before creping. The formed wet tissue was couched off the forming wire onto the top felt and carried through the main press. It was then sprayed with a dilute emulsified fatty acid at the rate of 0.2 pound per ton of tissue web, on a bone dry basis. A hydraulic spray boom was used operating at 55 pounds' pressure and having nozzles of 0.018 inch diameter spaced at 3 inch intervals across the width of the web. The fatty acid used as the release agent was an unsaturated oleic acid having a coefficient of friction or oiliness value of 0.08 as measured on the modified Deeley machine. The specific oleic acid used in this example is a commercial product called Groco oleic acid and manufactured by A. Gross and Company. It is white in color and has a titer of 5-8° C., an iodine value of 89-92, free fatty acid content of 99-100 percent oleic, an acid value of 197-200, a saponification value of 198-201 and a maximum of 1.5 percent unsaponifiables.

The oleic acid emulsion was prepared by mixing 30 gallons of oleic acid with 30 pounds of Atlox G-2081 (an alkyl aryl sulfonate blended with polyoxyethylene sorbitan esters of mixed fatty and resin acids) manufactured by Atlas Chemical Company, and 30 gallons of water. This was used in a concentration of about 0.05 percent oleic acid.

The spray boom was located 10 inches from the web and in advance of the tail roll. The tissue web carrying the release agent was then conveyed around the tail roll and into the nip formed by a press roll and a Yankee drying cylinder at a speed of about 2400 feet per minute. The temperature of the Yankee drying cylinder was maintained between 190° and 200° F. The treated web was dried to a moisture content of between 4 and 6 percent, creped off the Yankee drying cylinder and wound onto the reel at a crepe ratio of 2.3.

As in Example II, a dry creped sheet to be used as a control for comparison purposes could not be produced from this furnish because a suitable product could not be creped off the drier when no release agent was used.

Examples I, II, and III clearly demonstrate the improved results obtained by the use of a suitable release agent in accordance with the method of the present invention. Examples II and III show that 100 percent sulfate pulp which had hitherto proved impossible to manufacture into a dry creped tissue web by ordinary commercial processes can now be made into a high quality creped tissue web in accordance with the method of the present invention. That is, the web can be effectively released from the drying cylinder with the creping doctor blade when an appropriate release agent is applied to the formed web at a point located prior to a pressure nip. Reduction in the breakage rate of the web is significant enough to make the process commercially useful. Moreover, the finished creped tissue web has a desirable softness and limpness which makes it especially suitable for use in facial tissues and other creped tissue product applications.

In Example I, a creped tissue web, manufactured in accordance with the method of the present invention, was compared with a tissue web prepared from the same furnish but without the use of a release agent. The creped tissue web had fewer breaks and a correspondingly higher overall production speed than the control web. Moreover, the web of the present invention had improved tensile strength, stretchability, softness and limpness over the control web.

As is seen from the above, adequate control of the release of cellulosic tissue webs from the surface of a drying cylinder can be obtained through the application of selected release agents to the formed webs in accordance with the method of the present invention. Even in cases where satisfactory creping results from conventional proc-

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essing, it is desirable to utilize the present method to provide better control over the dry creping process and at the same time reduce the incidence of breaks in the web during rewinding. Such release agent application results in improved creped cellulosic tissue webs having higher yield, tensile strength and stretchability, and increased softness and limpness. Moreover, they can be manufactured at a relatively higher speed and improved economy. The webs so obtained are suitable for use as facial tissues, wiping agents, towels and other creped tissue applications.

The release agents can also be applied to formed cellulosic tissue webs or felts prior to pressure nips in accordance with the present invention, to achieve certain improved results in the fabrication of machine glazed tissue. Such tissue is usually fabricated on conventional tissue making machinery and is usually glazed on a Yankee type drier. Adequate control of release of the tissue web from the drier surface without creping can be readily achieved through the use of the release agents previously described herein.

Other suitable modifications of the method of the present invention and the equipment for carrying out the same, as are within the skill of those versed in the art are contemplated as being within the scope of the present invention.

I claim:

1. An improved method of manufacturing dry creped cellulosic tissue, said method including the steps of water-laying a web of cellulosic tissue, reducing the moisture content of said web to less than about 85% of the weight of the web and effecting fiber to fiber bonding, applying to the formed tissue web before drying a fluid containing a release agent, said release agent having an oiliness value of less than 0.3 to 20° C. expressed as the coefficient of friction as obtained on the modified Deeley machine, said release agent being present in said applied fluid in an amount of .01 pound to 25 pounds per ton of tissue, said fluid being sufficient to be spread evenly in the web and on the surface of said web in a pressure nip to control the degree of adhesive of said web to a drier surface, passing said web together with said applied fluid into a pressure nip whereby said release agent is evenly distributed in said web and on the surface of said web, drying said web on a heated rotating member to a moisture content of between about 3 and about 14 percent by weight, and creping the dried web from said member to obtain

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a creped cellulosic tissue web having improved web strength and stretchability, said release agent substantially retaining its oiliness during said creping.

2. An improved method of manufacturing dry creped cellulosic tissue, said method including the steps of water-laying a web of cellulosic tissue, reducing the moisture content of said web to less than about 85% of the weight of the web and effecting fiber to fiber bonding, applying to the formed tissue web before drying a fluid containing mineral oil as a release agent, said mineral oil being present in said applied fluid in an amount of .01 pound to 25 pounds per ton of tissue, said fluid being sufficient to be spread evenly in the web and on the surface of said web in a pressure nip to control the degree of adhesion of said web to a drier surface, passing said web together with said applied fluid into a pressure nip whereby said mineral oil is evenly distributed in said web and on the surface of said web, drying said web on a heated rotating member to a moisture content of between about 3 and about 14 percent by weight, and creping the dried web from said member to obtain a creped cellulosic tissue web having improved web strength and stretchability, said mineral oil substantially retaining its oiliness during said creping.

References Cited in the file of this patent

UNITED STATES PATENTS

Re. 23,637	Montgomery	Mar. 24, 1953
1,534,622	Wandel	Apr. 21, 1925
1,641,739	Cofrin	Sept. 6, 1927
1,772,185	Liebeck	Aug. 5, 1930
1,863,813	Alden et al.	June 21, 1932
1,871,702	Kallander et al.	Aug. 16, 1932
1,958,202	Novak	May 8, 1934
2,018,244	Alm	Oct. 22, 1935
2,030,625	Ellis	Feb. 11, 1936
2,077,438	Rowe	Apr. 20, 1937
2,380,043	Hochwalt	July 10, 1945
2,725,640	Voigtman	Dec. 6, 1955
2,819,184	Smith et al.	Jan. 7, 1958
2,940,890	Braun	June 14, 1960
2,944,931	Yang	July 12, 1960

OTHER REFERENCES

Casey: "Pulp and Paper," vol. II, 1952, Interscience Publishers, Inc., N.Y., page 844.

**UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION**

Patent No. 3,014,832

December 26, 1961

Harold F. Donnelly

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 5, line 29, for "dried" read -- drier --; column 8, line 72, for "85° F." read -- 75° F. --; column 11, line 35, for "to" read -- at --; line 41, for "adhesive" read -- adhesion --; column 12, line 2, for "reelase" read -- release --.

Signed and sealed this 24th day of July 1962.

(SEAL)

Attest:

ERNEST W. SWIDER
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