March 2, 1937. J. C. SHERMAN 2,072,138

MAKING OF PULP ROVINGS, YARNS, AND TWINES

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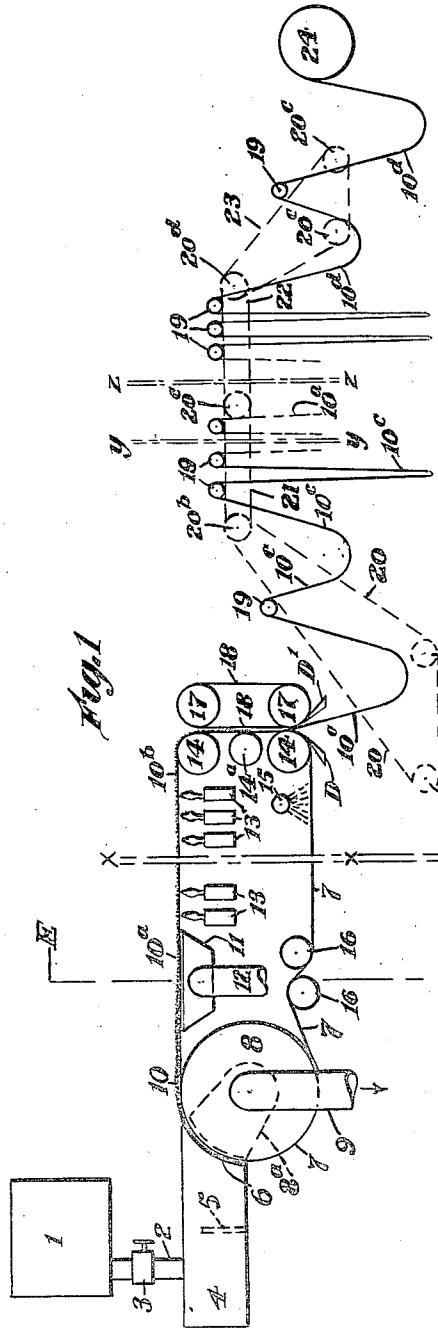


Fig. 1

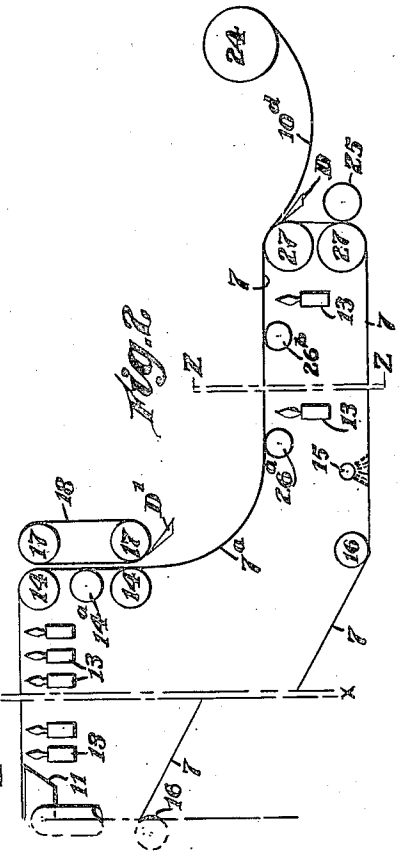


Fig. 2

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MAKING OF PULP ROVINGS, YARNS, AND TWINES

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18 Claims. (Cl. 92—39)

This invention relates to the conversion of paper-making pulp into rovings and thence into stout yarns and twines comparable in physical characteristics to cotton-products of like weight.

I begin with the formation of very thin ribbons of wet pulp and subsequently roll and twist these up while progressively dewatering them.

Such ribbons are best formed on a "cylinder-mold" type of paper-making machine, the cylindrical wall of which is unperforated except along selected, narrow, parallel circumferential drainage zones. Such a cylinder-mold is shown in the United States Patent #603,333, of May 3, 1898, to C. Kellner, though I prefer to fit it with an internal suction-quadrant such as will be hereinafter noted.

When a paper-making screen is placed around such a mold, pulp will form into ribbons only over the circumferential drainage zones. By carrying an endless screen around less than the complete circumference of the mold and letting it extend beyond the mold, one may obtain from the operation of the mold a plurality of spaced wet-pulp-ribbons lying upon the screen for further treatment.

Such ribbon, so formed, may normally contain about nine parts of water to one of fibre, by weight and is here defined as having a "water-to-fibre ratio" of nine-to-one. Other degrees of wetness will be hereinafter defined in like manner.

But pulp of the stated wetness is much too wet to be roved, (i. e., rolled up on itself in preparation for spinning). Hence the means I shall show for progressive dewatering are of the essence of my invention.

My ribbons must be so formed that in general their component fibres shall lie more or less longitudinally of the ribbons and the ribbons, when dried, shall preferably caliper only from one to two thousandths of an inch in thickness.

Any materially greater thickness makes the subsequent spinning operation less effective. I therefore begin with a paper-making pulp having only about from three to five pounds of fibre in ten thousand pounds of water and run the cylinder-mold very fast.

By applying suction to the cylinder mold I may now form ribbons having a water-to-fibre ratio of about nine to one.

My pulp ribbons, when rounded up (as will be described) will be hereinafter called "rovings"; and for best results I prefer to convert the ribbons into rovings when their water-to-fibre ratio has come down to about one-to-one as in that event my resulting yarns will be bulky and softer than if rounded up while burdened with excess water.

The progressive dewatering which I shall describe is vital since, with the nine-to-one ratio my ribbons do not react well to the roving operation and—even if so roved—cannot be collected in roving cans or on spools or the like without undergoing deformation through the mutual pressure of superposed turns or coils because of the dead weight of their excess water-content. Furthermore, in spinning the rovings, their excess mass from large water-content increases the frequency of their breakage and requires an expensive slowing down of the spinning operation. By the means to be hereinafter disclosed I secure for each step of the conversion process the appropriate degree of progressive drying.

In the drawing these means are conventionally shown in a manner sufficient, with the context, to enable anyone skilled in the textile and paper-making arts involved to carry out my invention.

Fig. 1 shows conventionally in longitudinal elevation the apparatus I prefer to use.

Fig. 2 shows an alternative system of drying which may replace, as indicated, the corresponding details of Fig. 1.

In Fig. 1 a source of pulp-stock is shown at 1, delivering through pipe 2, past valve 3, to the vat 4 in which may be a baffle-plate 5. This vat has no right-hand-end-wall and its vertical side walls terminate on the right in an arcuate curve 6 adapted to abut upon the endless screen 7 which runs around the cylinder mold 8 for a distance less than the circumference thereof. The cylinder mold is internally fitted with a fixed suction-quadrant dotted at 8a through which water from the vat is drawn by suction through the outlet 9. The pulp ribbons are formed upon the screen 7, and one of them is shown stippled at 10. As the screen passes over a stationary suction box 11 the ribbons become slightly compacted as shown at 10a. The suction box is evacuated through the suction-outlet 12. Because of the peculiar formation of the cylinder-mold, as already described, the pulp which would ordinarily be formed in a wide sheet now forms in separate, parallel-lying ribbons, and the ribbon 10 to be here followed through the ensuing description is typical of the one hundred or more such ribbons on the apparatus.

On leaving the top of the suction box 11—the employment of which is optional—the screen 7 carries the pulp ribbons in their partially dewatered form 10a directly into the heat of in-

candescent material which, in the drawing, consists of flaming gas from the gas-jets **13**, **13**, etc. The ribbons leave this heated area in a still more dewatered form **10***b* and are carried by the screen over the rollers **14**, **14**, the screen then returning to the cylinder mold, passing on its way under the shower-pipe **15** and over and under the guide-and-take-up rolls **16**, **16**. As the screen passes downward under considerable tension over rollers **14**, **14**, a suitable frame (not shown) carrying rollers **17**, **17** with an endless belt (of wire, leather or other material) stretched on these rollers is brought into proximity to the screen **7** to bring the belt **18** into snug engagement with the ribbons upon the screen. An adjustable pressure-roller **14***a* is provided to permit precise control of the said engagement.

The rollers **17**, **17**, the belt **18** and the frame which carries them constitute a device familiar to the textile arts wherein it is used to round up ribbons of shoddy or the like and will hereinafter be called the "rubbing device".

I cause these rollers **17**, **17**, to oscillate on their axial lines—that is, in a plane perpendicular to that of the drawing in a to-and-fro motion of one-quarter inch or less amplitude. Provision should be made by suitable cam-action to control this amplitude. One or both of the rollers **17** must be so driven as to maintain the speed of the belt substantially equal to that of the screen. This rubbing action changes the ribbons into "rovings", which emerge at **10***c* to be swept up onto the first of a series of festoon rods, **19**, **19**, etc., of a festoon dryer.

It will be understood that the screen **7** is of considerable length so that the wet ribbons shall be exposed to the flames of the jets **13** for from one to three seconds. To indicate this construction I have broken the drawing on the vertical dotted double line *x*—*x*.

Similarly, the festoon dryer to be now described is of substantially extension, to suggest which I have broken the drawing of it on the vertical dotted lines *y*—*y* and *z*—*z*. The festoon rods may be elevated by a chain system shown dotted at **20** and carried by rollers **20***a*, **20***a*, **20***b* of which **20***b* may be the driving roller. The rods may then be transferred to a horizontal track-system **21** of relatively rapid motion, said system returning over idler **20***c*; the rods thence transferred to the slower track-system **22** which may be driven by driver **20***d*. The rods may then be transferred to a descending elevator chain-system **23** driven by driver **20***d* and spaced over idlers **20***c*, **20***c*. The rovings shown entering the festoon in partially dewatered form, as at **10***c*, emerge as at **10***d* sufficiently dried to be caught up on a warp beam or spool **24** or spread out laterally and distributed among numerous individual collectors of like form. Scraping blades D and D′ may be applied to the screen **7** and the belt **18**.

Fig. 2 shows an alternative form of apparatus beginning on the line E—E—E of Fig. 1, and is to be regarded as a substitution of the parts shown for those of Fig. 1 to the right of that line, similar reference letters and numbers applying to both figures.

In Fig. 2 the screen **7** is lengthened so that after it has passed the rollers **14**, **14** it continues in a free curve **7***a* until it rests on one or more table rollers **26***a*, thence continuing over additional batteries of flame, **13**, **13**, thence over table rollers **26***b*, thence over rollers **27**, **27** and in frictional contact with driving roller **25** whence it returns under shower **15** and one of two take-up rollers **16**, thence over the other take-up roller **16** to the cylinder mold.

The ribbons, of which one appears in further-dewatered form at **10***d*, are reeled up as at **24**.

Since Fig. 2 is a condensed view, it is broken on the line *x*—*x* as is also Fig. 1, and also broken on the line Z—Z to indicate the optional extension of this second flame-drying operation.

In further explanation of the drawing I have observed that I may rapidly reduce the water-content of the pulp-ribbons on their way from the cylinder mold to the rubbing device from a water-to-fibre ratio of nine-to-one to a ratio of one-to-one by exposing them to a blue-flame gas fire without injury to the fibres if such exposure is very brief. With small, thickly massed gas jets placed directly under the screen the wet ribbons will endure exposure to flame of from one to three seconds without charring. With the suction box **11** in use (whereby the water-to-fibre ratio can be reduced by suction alone to three-to-one) I may shorten the period of flame-exposure to from one to one and a half seconds; and, with the screen moving forward five hundred feet a minute, the stretch of flame-bathed screen need not exceed 12 feet.

By the means illustrated and described the excess water is violently driven off from the fibre without need of subjecting the ribbons to any wringing or squeezing operation after they leave the zone of influence of the suction quadrant within the cylinder mold, unless for expediency one uses the additional suction means **11**. Inasmuch as the success of my invention lies in the subsequent intertwisting of individual fibres, and this in turn is contingent upon their lying more or less longitudinally of the ribbon, it is evident that I must, by preference, do as much drying by flame and as little by suction as conditions permit, since suction cannot twist but only jumble the fibres.

Within the general range of time-intervals stipulated above, it is found that the incident heat is utilized to (so to speak) explode and drive off the water without raising the temperature of the ribbons or the screen to a harmful extent; but if by chance such heat is held upon an element of the screen for a time long enough to drive off all the protective water-content (say, five seconds) the ribbons burst into flame and the screen is soon ruined. Therefore it is essential that the gas-jet valves be so yoked to the motive apparatus of the screen that, upon stopping or slowing down the machine, the gas jets shall sink instantly to mere pilot-jet size, or else that protective shutters be interposed between the jets and the screen in emergencies.

Apparently my flame-drying effect reaches first the superficial water within the ribbons, and does not remove all the water which is, so to speak, "entrapped" upon or within individual fibres as the so-called "water of hydration". The process as described eliminates the undesired excess of water, instantaneously conditioning the ribbons to be rubbed and rounded while their constituent fibres are still limp and responsive to such rubbing and rounding operations.

As the screen **7** leaves the cylinder mold it carries no continuous "filter-mat" or web of fibres covering its surface but carries only narrow spaced longitudinal bands or ribbons of pulp. If the attempt be made to dewater these ribbons by suction alone, then the uncovered stretches of the screen tax the capacity of the suction pump and

militate against successful dewatering. Even if suction, so impaired, suffices so to dewater the ribbons that they may be formed into rovings and also to rid the open meshes of the screen from water, water will still flow from the ribbons themselves into these meshes between the ribbons, resulting in a continuous redistribution of free water. If, in the act of rounding up the ribbons in the rubbing device, free water is so interchanged any single droplet accumulated and passed again into a ribbon often causes a local weakness and either causes the roving to break or to split longitudinally. By my present invention not only is the ribbon adequately dewatered but the screen itself is effectively freed from excess water.

Further, if wet pulp is dried by powerful suction upon a screen, fibres—especially the relatively long fine fibres required for textile uses—tend to become entangled upon and within the screen structure, and my ribbons are too narrow and too thin to endure much stress from such entanglement. Hence I use suction sparingly and avoid crushing or matting the fibrous mass.

Further, in the prior art, rovings formed with an excessive water content have been too weak for conveyance from the rubbing device to any distant collecting means since no such rovings take on adequate strength until spun. This trouble is also eliminated by my present invention.

Furthermore, the flame I prefer to use actually tends to lift the wet ribbons from the screen, this effect serving to facilitate the removal of the rovings from the screen since it eliminates entanglement of individual fibres by the screen.

The simultaneous production of a large number of very fine rovings in closely spaced parallel lines on screen **7** is easy, but the subsequent conveyance of these in unbroken lengths calls for care, and the apparatus outlined in Fig. 2 is best suited to cope with the problems incident to conveyance when one is making rovings to be formed into yarns of #12 or finer count as reckoned on the established scale for cotton yarns. Such yarns take on great stoutness when twisted or spun but are tender in their unspun condition.

The natural tendency of the rovings is to fall free from the rubbing device, and in Fig. 2 they fall in contact with the free-curving stretch **7***a* of the screen which gently cradles them as it conveys them to the horizontal position over the second battery of flames **13, 13**. Since it is necessary to sustain this free curvature **7***a* without avoidable vibration one or more table rolls of which one is shown at **26***a* may be located adjacent the curved stretch, and one or more similar rolls **26***b* lying under the horizontal stretch of the screen will augment the steadying effect.

The second exposure of the rovings to flames as in Fig. 2 is preferably either briefer or less intense than the first exposure since in this latter phase the rovings now have an insufficient water-content to save them from injury through prolonged or too intense heat.

My rovings may be collected in various ways, as in roving "cans" or warp "beams" or on spools or creels but—except when the rovings are dropped into cans—the linear speed of reeling up must be in step with the delivery speed of the production-process. It is further desirable, in collecting the rovings, to conserve their remaining water-content since stout yarns are best formed from rovings still wetted with their original water, and intermediate drying and rewetting do not make for best results.

The unbroken formation and collection of my rovings is facilitated by the lifting action of the flames upon the wet ribbons while they lie on the screen. This reduces the risk of their entanglement and makes for high-speed operation.

My system of progressive dewatering has a further advantage in conserving whatever stretchability the rovings may possess, since in the prior art the unduly wetted rovings have undergone some stretching during conveyance because of their wet-mass, whereas my rovings are better dried and again the flames I use have a certain shrinking effect on the fibrous ribbons. This consideration is weighty in relation to the desired festoon-drying. My rovings may enter the festoon with a relatively low water-content and be so much the better fitted to endure suspension without elongation.

While not limited to the use of a cylinder-mold, since I may alternatively use a fourdrinier type, I prefer to use a cylinder-mold fitted with the type of internal suction shown in U. S. Patent #1,758,167, of May 13, 1930 to W. H. Millspaugh as best ensuring that the fibres shall be "fished" from the pulp "end-on", and a suitable surfacing cylinder for such device (to take the place of the usual screen-surface) is described above and as shown in sufficient detail in the above-named U. S. patent to Kellner.

The specifications and drawing herein contained are submitted as descriptive of my preferred types of apparatus and not as implying limitations beyond the requirements of the prior art.

I am indifferent as to the "furnish" of pulp materials used, and filling and/or sizing ingredients are at the user's option. My invention contemplates the use of chemical wood-pulp alone or in admixture with ground wood, or any other type of pulp whether "free" or "slow" since I do not depend on suction alone for its dewaterment prior to roving. In fact for very stout yarns I may by choice employ a rather "slow" pulp for the sake of the important qualities it may have to ensure the firm interbonding of component fibres, though in general a "slow" pulp militates against softness of roving and/or yarn.

Similarly, as regards the source of incandescent heat, while naked flame is best, I may substitute for the batteries of gas jets a system of horizontally disposed pipes containing flowing "NS" fluid, such being the commercial name of a mixture of univalent and trivalent metallic chlorine salts fluent when heated and capable of sustaining without sensible pressure on its confining conduit a temperature of 1500 degrees Fahrenheit. The heating and circulating of such fluid is, however, inconvenient, and does not provide for my rovings that uprush of blazing gas which I regard as the especial merit of my gas flames.

Similarly, as to the rubbing device, I may, in a slow-moving apparatus, dispense with the belt **18** and the lowermost of the rollers **17**, letting the oscillation of the roller **17** remaining serve to round up my rovings.

When placing the gas flames and adjusting them I prefer to subject the ribbons at their wettest to the most intense heat, and slightly reduce the incident heat toward the drier phases of the process. This also is within the user's option.

As to the water-to-fire ratios selected for explanation, it must be understood that considerable latitude is possible and indeed desirable to produce yarns of various qualities.

In general the stated ratios are right but it

should be noted that the wetness of a roving promotes strength in the final yarn, while relative dryness makes for softness at some cost of strength. The process here disclosed will convert long-fibred pulp of high alpha-cellulose content into yarns of exceptional stoutness if the intermediate and progressive dewatering of the pulp-ribbons and rovings be not carried to extremes. In fact, such yarns may greatly exceed in tensile strength the cotton yarns chosen for comparison, but at the same time they may be deficient in softness and pliability. If, however, the control of the gas flames be suitably altered to carry the dewatering slightly further, yarns comparable in tensile strength to cotton and of satisfactory softness can be made.

It is with these reservations in mind that I have hereinbefore defined the median range of water-to-fibre ratios which I regard as most consistent with average results, without implying any limitation of the validity of my claim to patentability. With this reservation of rights, I claim:—

1. A method of forming a pulp roving for conversion into yarn consisting in first forming upon a foraminous carrier a ribbon of pulp with a water-to-fibre ratio of at least nine to one, in then dewatering this ribbon by suction to a water-to-fibre ratio of about three to one, in then further dewatering the ribbon by exposure to naked flame until its water-to-fibre ratio drops to about one to one, in then rubbing the ribbon laterally to form a roving, and in then further dewatering the roving.

2. A method of forming and conditioning a pulp roving which consists in this sequence of operations: (1) forming a fibrous pulp of a water-to-fibre ratio of about ten thousand to four; (2) forming upon a foraminous carrier a ribbon of said pulp having a water-to-fibre ratio of said ribbon by suction to about three to one; (4) further reducing the water-to-fibre ratio to about one to one by exposing the ribbon while it lies upon said foraminous carrier to uncovered flames; (5) rubbing the ribbon into a rod-like form; (6) further dewatering the rubbed ribbon.

3. A method of forming yarns from chemical wood-pulp which consists in first preparing an aqueous suspension of paper-making materials including such pulp, in then forming upon a foraminous carrier from said materials a ribbon having a water-to-fibre ratio of about nine to one, in then reducing this ratio by suction to about three to one, in then dewatering the ribbon by direct exposure to flame until its water-to-fibre ratio is about one to one, in then rubbing it while still upon the carrier until it assumes the form of a roving, and in then further dewatering the roving.

4. A method of forming yarns from paper-making pulp which consists in first forming from said pulp a plurality of ribbons positioned in parallel alinement upon a foraminous carrier, in removing by suction a portion of their contained water, in then further dewatering them by exposure to flame, in then rubbing them all simultaneously to individual rovings by the friction of a rubbing device while they lie upon said carrier, and in then further dewatering them.

5. In the formation of pulp rovings these sequent steps: forming upon and longitudinally of the screen of a paper-making machine a plurality of spaced parallel-lying pulp ribbons; then partially dewatering said ribbons by suction, and then continuing their dewaterment by exposing them to naked flame while they rest upon said screen.

6. In the making of pulp rovings the formation from water-dispersed paper-making material upon a foraminous carrier of a plurality of spaced parallel-lying pulp ribbons; the partial dewatering of said ribbons by suction; the further partial dewatering of said ribbons by exposing them to flame while upon said carrier, and the withdrawal of said ribbons upon said carrier from the flame while they still contain sufficient residual water to prevent their ignition.

7. A method of forming pulp rovings and conditioning them for spinning consisting in this sequence of operations:—(1) forming from dilute paper-making pulp upon a foraminous carrier a plurality of parallel-lying ribbons substantially as described and having a high-water-content; (2) reducing the water-content of said ribbons by direct exposure to heat of incandescence; (3) withdrawing said ribbons upon said carrier beyond the reach of said heat while they still retain sufficient water to prevent their destructive distillation by said heat; (4) rubbing said ribbons while they are upon said carrier into the form of rovings.

8. A method of forming pulp rovings and conditioning them for spinning consisting in this sequence of operations: (1) forming from paper-making pulp upon an endless foraminous carrier a plurality of parallel-lying ribbons substantially as described and having a high water-content, (2) reducing the water-content of said ribbons by brief exposure to heat above the charring temperature of their dry-fibrous content, (3) removing the ribbons upon the carrier from the heat while they still contain enough water to prevent their becoming charred, (4) rubbing the ribbons upon the carrier.

9. A method of forming pulp rovings and conditioning them for spinning consisting in this sequence of operations:—(1) forming from paper-making pull upon an endless foraminous carrier a plurality of parallel-lying ribbons substantially as described and having a high water-content, (2) reducing the water content of the ribbons by brief exposure to heat above the charring temperature of their fibrous content, (3) removing the ribbons upon the carrier from the heat while they still contain enough water to prevent their ignition, (4) rubbing said ribbons upon said carrier as described, (5) further dewatering them by direct exposure to the heat of incandescence.

10. Apparatus substantially as described comprising in combination an endless foraminous carrier, means for progressively depositing on said carrier separate ribbons of wet pulp, means for partially dewatering said ribbons by brief direct exposure to heat of a higher degree than 500 degrees Fahrenheit, means for rubbing the partly dewatered ribbons into the rounded form of rovings, and means for further dewatering said rovings.

11. Apparatus substantially as described comprising in combination an endless foraminous carrier, means for progressively depositing on said carrier separate ribbons of wet pulp, means for partially dewatering said ribbons by brief exposure to heat of a higher degree than 500 degrees Fahrenheit, means for rubbing the partly dewatered ribbons into the rounded form of rovings and means for again briefly exposing the rovings to heat of a higher degree than 350 degrees Fahrenheit.

12. An instrumentality for the partial dewatering of wet pulp ribbons comprising in combination an endless foraminous carrier for the ribbons, a closely-adjacent source of incandescent heat, and means for progressively withdrawing said ribbons upon said carrier from the zone of said heat.

13. Mechanism substantially as described comprising in combination a vat containing an aqueous suspension of paper-making materials, a suction-cylinder-mold coacting with said vat, said cylinder mold being perforated to permit the drainage of water into its interior over narrow spaced circumferential zones, an endless foraminous carrier passing over said cylinder-mold and receiving upon its surface deposits of partially compacted pulp ribbons, means for subjecting said ribbons to the heat of incandescence, and means for rubbing-up said ribbons upon said carrier into the form of rovings.

14. Means for converting wet ribbons of paper-making pulp into rovings consisting in combination of a foraminous carrier whereon said ribbons move rapidly and continuously forward, a source of incandescent heat closely adjacent to said carrier, and means for rubbing said ribbons upon said carrier into the form of rovings immediately upon their emergency from the locus of said heat.

15. As a step in the process of delivering and conditioning wet pulp rovings to be spun, the conveyance of said rovings in spaced parallel rows upon a foraminous carrier, said carrier moving through a free-swinging arc from a downwardly-moving to a substantially horizontally-moving position, said rovings remaining upon said carrier during their partial dewatering and being then progressively removed from said carrier for collection.

16. As a step in the formation of rovings from initially wet pulp ribbons upon a foraminous carrier, the subjection of said wet ribbons initially and briefly to the full incidence of incandescent heat and their subsequent subjection to the modifed incidence of such heat.

17. As a step in the formation of rovings from initially wet ribbons of pulp upon a foraminous carrier, the subjection of said wet ribbons initially and briefly to the direct incidence of naked flame through the apertures in said foraminous carrier and their subsequent subjection to the incidence of flame of lesser intensity through said apertures.

18. In the preparation of initially wet pulp ribbons for spinning, these sequent steps:—(1) the brief subjection of said ribbons to incandescent heat while they are sufficiently wet to ensure their immunity from injury by said heat; (2) their conversion into rounded rovings by rubbing and (3) their then being partially dried on a festoon drier at a temperature substantially less than that of incandescence.

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