Dec. 10, 1968 D. G. MICHELS ETAL 3,415,253

PROCESS FOR MANUFACTURING RECONSTITUTED TOBACCO SHEET MATERIAL IN A SUBSTANTIALLY CLOSED SYSTEM

Filed Jan. 13, 1967 2 Sheets-Sheet 1

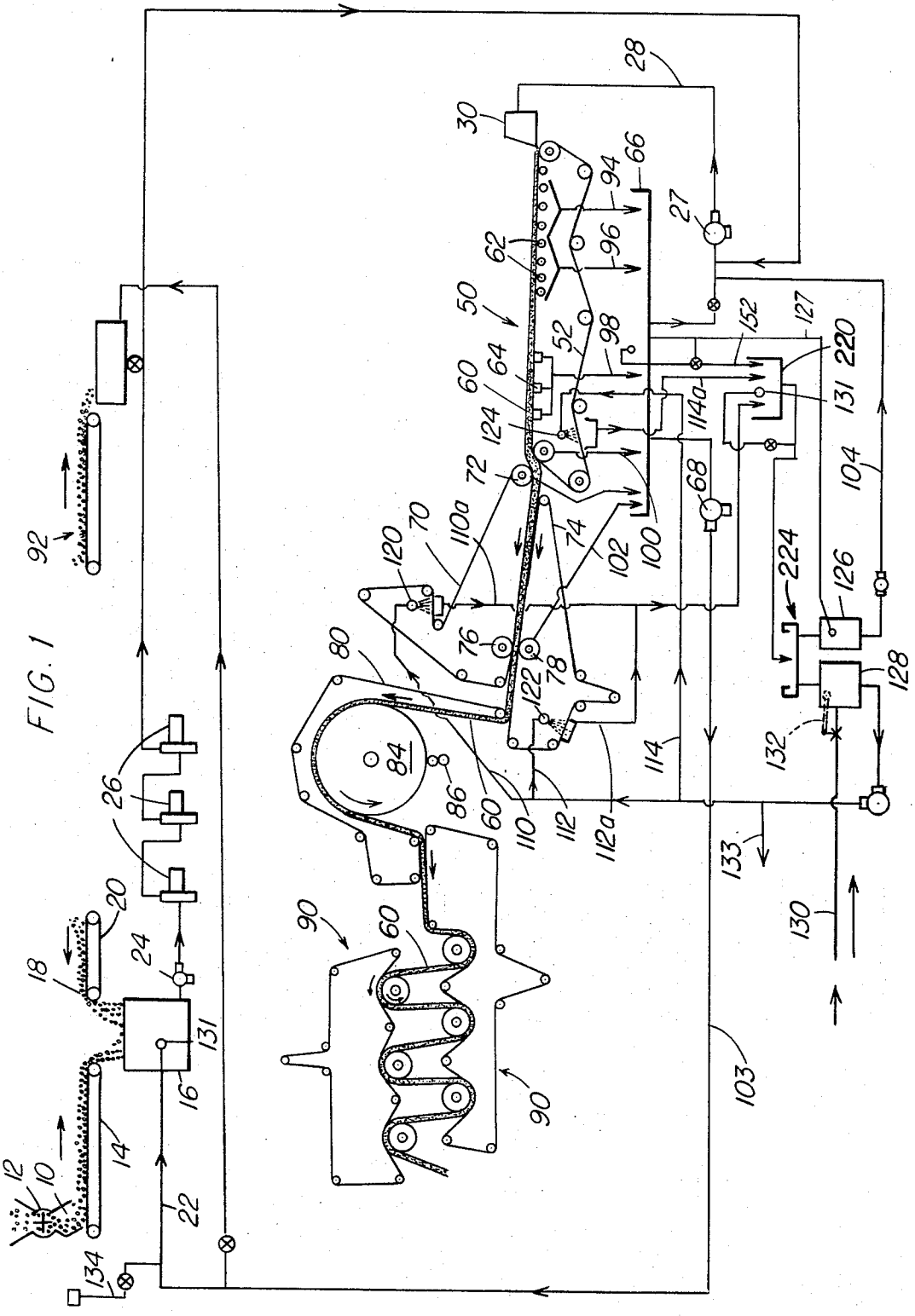

FIG. 1

Dec. 10, 1968 D. G. MICHELS ETAL 3,415,253
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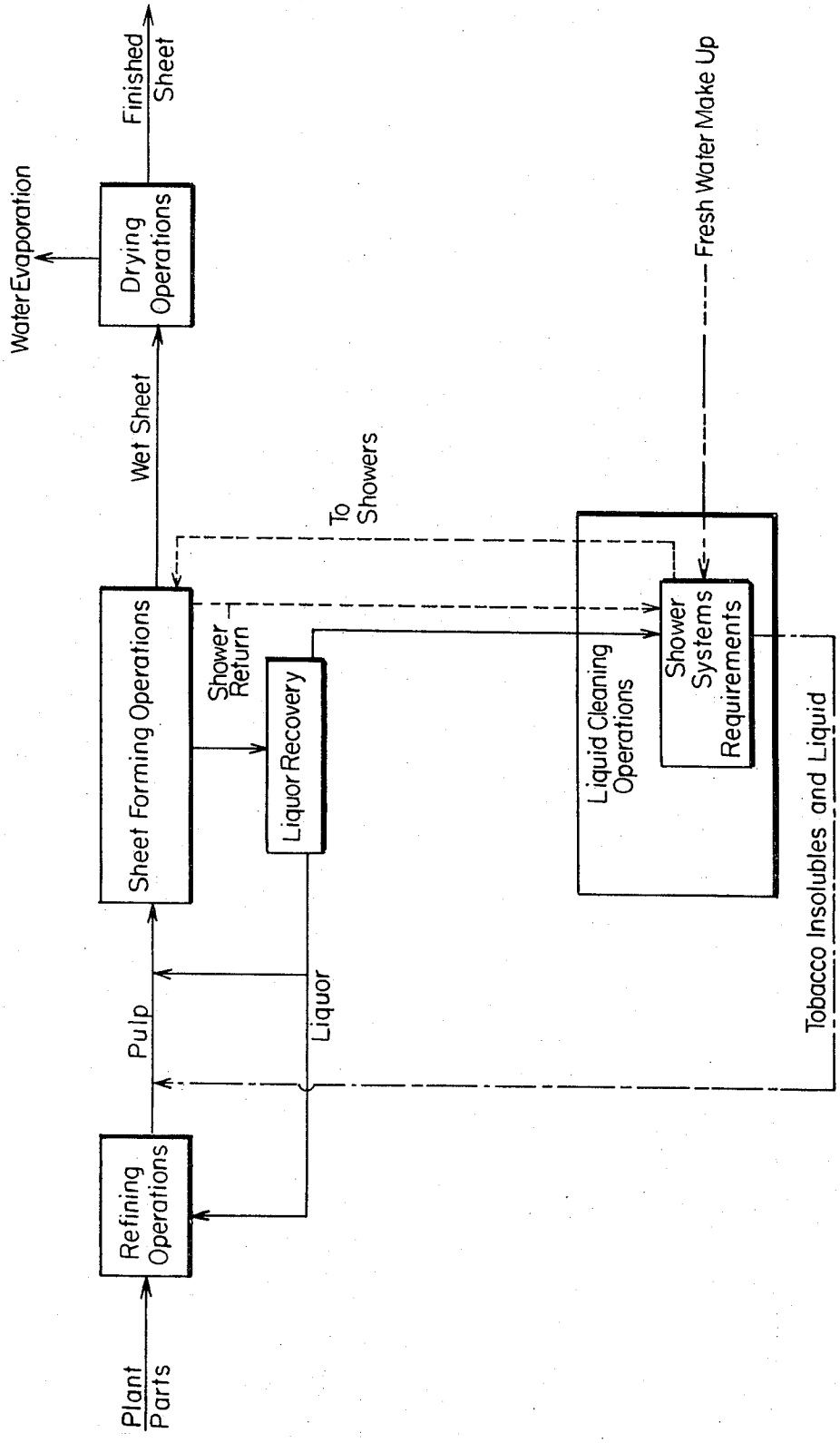

FIG. 2

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3,415,253

PROCESS FOR MANUFACTURING RECONSTITUTED TOBACCO SHEET MATERIAL IN A SUBSTANTIALLY CLOSED SYSTEM

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10 Claims. (Cl. 131—140)

ABSTRACT OF THE DISCLOSURE

A process for producing tobacco sheet in which an aqueous slurry is formed with tobacco plant parts and a process liquor recovered from the sheet forming system and containing tobacco solubles and insolubles. The slurry is cast on a moving foraminous forming carrier to form a wet tobacco sheet which is then removed from the forming carrier with a non-felt type fabric carrier and delivered to a press station at which process liquid is removed from the sheet and returned to the system so as to avoid loss of tobacco solubles. The pressed sheet is thereafter directed through a series of drying units to evaporate water from the sheet down to the dry state weight with the tobacco solubles contained in the water evaporated being retained in the sheet. The process liquid recovered from the system is employed as a rinsing media for cleaning the forming carrier and the fabric carrier thereby avoiding the need to dilute or flood the system with a fresh water rinsing media. The process liquor and process liquid sub-systems are maintained as closed loop circuits within the system and insure that no tobacco solubles or insolubles are lost from the system as a consequence of which, the tobacco sheet has substantially the same tobacco solubles and insolubles content as the plant parts with which it is produced.

BACKGROUND OF THE INVENTION

This invention relates to reconstituted tobacco products and particularly to processes with which reconstituted tobacco sheet may be produced.

In the tobacco industry substantial effort has been directed toward devising methods with which tobacco plant parts such as stems, scraps and similar tobacco residue evolving from processing of natural tobacco could be utilized effectively in smoking articles rather than merely discarding same. While known methods produce a commercially acceptable reconstituted tobacco product, they depend on the use of elaborate and costly production procedures and machinery, factors which make such methods less economical when it is sought to provide a final product having substantially the same chemical composition of the tobacco raw material used as feed. For example, one prior art method, generally referred to as an "extract and recombine" process involves separating the tobacco plant parts insolubles in feed from the tobacco plant parts solubles and thereafter using the insolubles to form a tobacco sheet in any suitable manner. The previously removed tobacco solubles are then concentrated and recombined with the formed tobacco sheet. The present invention on the other hand, provides a method for using tobacco plant parts such as leaf stems, slivers of tobacco, miscellaneous tobacco fragments and tobacco fines to form therewith a sheet of reconstituted tobacco which method eliminates the need for using costly separation and recombination steps, the method being characterized by its simplicity and economy. Furthermore, the chemical composition of the reconstituted tobacco produced according to this invention can be controlled closely so that the produced sheet is comprised of substantially the same chemical constituents present in the tobacco plant parts from which it is made. The reconstituted tobacco sheet produced according to the teaching of the present invention when used as cigarette filler, possesses coloration, filling capacity and other characteristics quite similar with those of natural tobacco leaf filler.

SUMMARY OF THE INVENTION

The invention generally provides that reconstituted tobacco sheet may be produced in a manner and with apparatus similar to that used for making paper, characterized by (1) the additional novel features that the entire system operates as a "closed loop system" with respect to the "process liquor" and "process liquid" therein to provide maximum controlled recovery of tobacco plant parts solubles and insolubles during sheet production, and (2) the use of non-felt type fabric carrier and transfer belts for moving the tobacco sheet through the system apparatus. The use of non-felt type fabrics allows for washing or showering of the belts with "process liquid" instead of fresh water and thus avoids excessive dilution of the system with attendant loss of feed. Moreover, the system is designed to operate with minimum volume capacity thereby reducing the size of pumps, tanks and like devices required for system operation. In accordance with one embodiment of the invention, a quantity of stems and tobacco leaf scrap including tobacco dust are mixed with "process liquor" and thereafter pulped to form a predominantly aqueous slurry. The pulp mixture or slurry is then further diluted with additional "process liquor" and thereafter flowed onto the moving wire forming carrier of a Fourdrinier unit to form a wet tobacco sheet, the Fourdrinier unit functioning in the manner conventional to papermaking procedures. "Process liquor" is recovered from the wet sheet while it is on the Fourdrinier wire, and is recycled to the system, being used to dilute the slurry feed and also being returned to the Fourdrinier headbox. Removal of the wet tobacco sheet from the Fourdrinier unit is accomplished with suction pick-up onto an open weave, non-felt type fabric transfer belt, the transfer belt carrying the tobacco sheet through a pressure roller set at a press station whereat the sheet is pressed to reduce the amount of process liquid (tobacco solubles and water) in the sheet, the non-felt type fabric belt being used because of the facility with which it can be cleaned with process liquid. The latter, as will appear later on is another important aspect of the present invention. On leaving the pressure roller set the tobacco sheet is transferred to other belt carrier means which delivers the wet sheet containing tobacco insolubles and tobacco solubles in a proper proportion to a Yankee dryer unit whereon reduction of the water content (as distinguished from process liquid content) of the sheet is effected by evaporation. On leaving the Yankee dryer unit, the tobacco sheet may then be directed through one or more after-dryer units to complete drying the sheet. The dried sheet can then be processed further in conventional manner accord-

ing to the intended use. For example, it can be "thrashed," that is, be subjected to a size reduction with an impact type mill unit or it can be "diced" with conventional cutting and slitting equipment. The reconstituted tobacco sheet may thereafter be processed in the same manner as natural tobacco (blended etc.) for use as a filler for cigarettes or it can be cut to make filler, binder and wrappers for cigars. During system operation flow equilibrium is maintained at all points in the system as to the "process liquor" and "process liquid" therein save the addition of small quantities of fresh water to account for water evaporation in drying the tobacco web. Thus, the process liquor drawn off from the tobacco sheet in the Fourdrinier unit, the process liquid removed from the sheet in the pressure roll set, that recovered at the various shower stations and that utilized for maintaining gland seals at the system pumps and like devices is maintained within a closed system so that the soluble and insoluble tobacco particles contained therein are maintained in the system and ultimately incorporated in the fabricated sheet. In other words, the final sheet product contains substantially the same quantities of tobacco soluble and insoluble constituents initially present in the tobacco plant parts from which the tobacco sheet is made.

Various other objects, features and advantages of the invention will be made apparent by the description that follows and the illustrative examples described herein and depicted in the drawing. The invention accordingly comprises the several steps and the relation of one or more of such steps with respect to each of the others, and the apparatus embodying features of construction, combinations of elements and arrangement of parts which are adapted to effect such steps, all as exemplified in the following detailed description and the scope of the invention will be indicated in the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings, FIGURE 1 is a schematic representation of a system which may be employed for producing reconstituted tobacco sheet from tobacco stems and scraps in accordance with the principles of the present invention; and FIGURE 2 is a flow diagram associated with the production of the reconstituted tobacco sheet.

Throughout the description like reference numerals are used to denote like parts in the drawings.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

For the sake of convenience of description, a preferred system for producing reconstituted tobacco sheet, which is depicted in FIGURE 1 of the drawings, will be described first with respect to the overall system arrangement followed by a description of the sub-systems thereof. As a preliminary, it should be noted that the chemical constituents of plant parts will vary somewhat. In general, however, plant parts contain water in a range of 0% to 20% dry weight of the parts and on the average about 10%. The tobacco solubles present in the plant parts generally range between 30% to 60% dry weight of the parts and on the average represent 45% to 50% of the dry weight. The remaining dry weight of the plant parts is comprised of tobacco insolubles so it will be seen on the whole that the plant parts contain substantially equal weights of tobacco solubles and tobacco insolubles constituents. With reference now to FIGURE 1, plant parts, i.e., tobacco stems **10** as a by-product of natural leaf tobacco processing are delivered to a stem breaker device **12** of known construction, which comminutes the stems, reducing them to a length intended to facilitate pulping and which on an average will be in a range of between ¼ inch to whole stem lengths. The comminuted stems are then fed by means of conveyor **14** to pulping tank **16**. The stems may be a blend of the stems from the various types of tobacco used for making cigarettes, as for example, burley and bright leaf tobacco. Also, leaf scrap **18** and dust are delivered at this point to the pulping tank by means of conveyor **20**. The plant parts are mixed in the purping tank **16** with process liquor recovered from the system producing a slurry containing tobacco solids of about 25% to 30% by weight of which about 2% to 8% by weight are in the form of tobacco insolubles and 17% to 28% by weight tobacco solubles, with the process liquor supply line being denoted in the drawings at **33**. In other words, the plant part tobacco solubles become dissolved in the process liquor, and the plant part insolubles suspended therein. The mixing of the plant parts with the warm process liquor produces a temperature of the slurry in pulping tank **16** generally between 100° F. to 120° F. While the temperature of the slurry can be allowed to go as high as 150° F., it is preferable that temperatures in excess of 120° F. be avoided at this point in the operation since the grinding operation to be described shortly adds heat to the slurry and excessive slurry temperature levels tend to darken the finished tobacco sheet. If it is required, the slurry temperature can be controlled by directing it through a suitable heat exchanger device. As used herein "process liquor" is understood as being comprised of water, tobacco solubles and tobacco insolubles. "Process liquid," on the other hand, is used to denote the water-tobacco solubles mixture utilized in the shower system for cleaning the various fabric belts (more fully described later on in the description) the process liquid being substantially devoid of any insoluble tobacco particles. The process liquid in the shower return system will, of course, contain insolubles picked up from belt cleaning operations. However, the shower return process liquid is clarified to remove the insolubles so that the shower supply process liquid comprises only water and tobacco solubles. It will be apparent in the course of this description and as will be readily appreciated by those skilled in the art, that the description herein is presented in terms of the conditions of system steady state operation. Thus, the process liquor delivered to the pulping tank **16** contains a concentration of tobacco solubles and insolubles in the ranges set forth above as evolved after operating the system for some time after start-up. In other words, an initial charge of fresh water is provided to the system at start-up so that the process liquor drawn from the Fourdrinier unit will gradually become more concentrated with tobacco insolubles and solubles until steady state equilibrium condition is reached several hours after start-up. Thereafter, the only fresh water added to the system is make up to replace losses to evaporation, etc. As used herein, the term "insolubles" is descriptive of insoluble tobacco ingredients including cellulose, pectic materials and petroleum ether extract. "Solubles," on the other hand, include sugars, salts, alkaloids, etc. The insolubles content of the slurry at the pulping tank is generally comprised of between 2% to 4% insoluble tobacco fibers delivered from the fresh plant part charge and zero to 4% tobacco insolubles as fines returned in the process liquor. From the pulping tank **16**, the slurry is pumped by means of pump **24** through a series of wet grinders **26** which break down the stems and scrap to fiber sizes, the temperature of the refined slurry being raised from 120° F. to about 150° F. by the friction generated in the grinding operation.

The refined slurry is then further diluted with process liquor (supplied by means of pipe **28**) at the headbox **30** of a Fourdrinier unit **50** similar to that use in making paper this additional process liquor having substantially the same tobacco solubles-insolubles content as the process liquor being recycled to the pulping tank. The slurry is caused to flow from the headbox onto a foraminous forming carrier **52** (preferably a wire mesh carrier) and as the forming carrier moves through the Fourdrinier unit, a wet sheet of tobacco **60** is formed thereon by depositing out substantially all of the plant part insolubles contained in the slurry, the wet sheet also containing water tobacco solubles solution. A Fourdrinier wire hav-

ing 75 openings/inch in the machine direction and 56 openings/inch across the machine direction retains about 99% of the plant part insolubles in the slurry. About 98.5% by weight of the process liquor in the slurry is drawn off in the Fourdrinier unit, being removed by gravity through the wire forming carrier, and by suction at the suction boxes **64**. The process liquor drawn off is directed to a suitable collection vessel at **66** from which it is returned to the headbox by means of pump **27** or to the pulping tank by means of pump **68**.

The formed wet sheet of tobacco **60** on reaching the terminal end of the Fourdrinier unit is removed from the wire forming carrier and is transferred to an open mesh non-felt fabric type pick-up belt **70**. The tobacco sheet at this stage generally contains about 70% by weight water and has a generally fragile structure and for that reason the pick-up of same preferably is achieved with a vacuum applied in the usual manner through the pick-up belt with a vacuum pick-up roll **72**. The advantage of using a non-felt fabric type pick-up belt **70** is that the belt will not trap tobacco insolubles in the same manner as a felt type fabric belt and it can therefore be washed with a shower employing the process liquid present in the system. If a felt fabric (wool) belt is used for this initial transfer of the tobacco sheet from the forming carrier, there is a tendency for it to retain insolubles to the extent that showering of same would require using fresh water with consequent buildup of excess volume in the system ultimately requiring sewering of the excess. As part of the excess volume discarded, would be lost tobacco solubles. The loss of tobacco solubles defeats the purpose of the invention, i.e., an all tobacco final product comprised of substantially the same chemical constituents present in the raw feed. A sufficient buildup of insolubles in the pick-up belt diminishes or precludes application of a vacuum therethrough from the pick-up roll to the tobacco sheet and removal of the wet web from the forming carrier. A further advantage of using a non-felt type belt is avoidance of the likelihood that felt particles (lint) will adhere to the tobacco sheet and become incorporated in the finished product. Representative of the non-felt fabric types useable for pick-up belt **70** is a Formex nylon fabric as manufactured by the Huyck Corporation of New York, N.Y. This fabric is particularly suited for the purposes described as it possesses a long service life, has a minimum tendency to act as a filter in the manner of a felt and thereby trap tobacco insolubles, and is readily cleaned with a process liquid shower. This nylon fabric also is preferred for the structure of any other transfer belts which may be used in the system. Thus, another belt member **74** is utilized in the system and cooperates with the pick-up belt **70** to support the tobacco sheet during travel from the Fourdrinier to the press section. The press station, as shown in the drawings, comprises a pressure roller set **76, 78** employed to effect further extraction of process liquor from the tobacco sheet, one of the rollers **78** of the pressure roller being a suction type for returning the process liquor to collection vessel **66**. The tobacco sheet and belts **70** and **74** are fed intermediate the pressure roller set as shown, which serve to reduce the water content in the tobacco sheet to about 60% to 65% by weight by applying a compression in a direction normal to the travel. On exiting the pressure roller set, the tobacco sheet is carried a short distance by belt member **74** alone and is then transferred to another pick-up belt **80** by means of suction pick-up and is carried by this latter pick-up belt around the heated drum surface of a Yankee dryer unit **84**. The Yankee dryer unit **84** is a drying device of known construction, an embodiment thereof suited for use with the system of the present invention having, by way of example, a drum diameter of about 5 feet and being rotatively driven at a speed commensurate with production requirements. The drum surface of the Yankee dryer onto which the tobacco web is delivered is maintained heated at a temperature of between 250° F. and 290° F. by means of steam supplied to the dryer drum at a pressure of between 30 to 75 p.s.i.g. with the drum functioning to evaporate water from process liquid in the tobacco sheet thus leaving the tobacco solubles in the sheet. In general, the wet tobacco sheet on entering the Yankee dryer contains 60% to 65% by weight water and upon exiting the drum contains 50% to 55% by weight of water. Thus, 10% to 15% by weight of water is removed from the sheet by evaporation on the drum.

It has been found that the application of a release coating to the surface of the Yankee dryer facilitates removal of the tobacco sheet therefrom since tobacco contains certain natural adhesives which create a tendency for the tobacco sheet to cling to the drum surface. A suitable release coating is one comprised of a thin coating of a hydrophobic substance which is applied to the drum surface with a conventional application roller set **86** mounted adjacent the Yankee dryer unit. The use of the release agent is especially beneficial in that it eliminates utilization of a doctor knife for stripping the tobacco sheet from the dryer drum, thereby diminishing the chances of damaging the web. However, a doctor bar (not shown) may be used to keep the surface of the drum clean of tobacco particles.

On leaving the Yankee dryer **84**, the tobacco sheet **60** is directed through a series of after-dryers **90**, the tobacco sheet at this point in the process being self-sustaining. The surfaces of the after-dryers are maintained at a temperature between 190° F. and 240° F. to provide for final evaporation of water from the process liquid remaining in the tobacco web reducing the product water content from 50% to 55% of sheet weight at entry to the after-dryers to about 12% dry state water weight. The finished tobacco sheet may thereafter be "diced" or "thrashed" to reduce its size and then processed in conventional manner for use as cigarette filler or smoking tobacco. It is also possible to cut the tobacco sheet into pieces for use as cigar wrapper sheets or cigar fillers.

The system shown in the drawings can be modified to the extent that instead of adding the stems and tobacco scrap in the pulping tank **16**, scrap ground sufficiently to pass through an 80 mesh screen along with tobacco dust may be added to the defined pulp as at **92**.

The present invention contemplates that the pressure roller set **76, 78** through which the wet tobacco sheet is passed before feeding the sheet onto the Yankee dryer unit include at least one rubber surfaced roller but preferably that the surface of both rollers have an outer surface comprised of a resilient material.

Turning now to the process liquor loop employed in the system, its purpose is to prevent loss of stock both tobacco solubles and tobacco insolubles. Thus, the process liquor loop is a closed loop arrangement featuring the use of collection vessel **66** which can be a pan, tank or like structure, the draw-off of process liquor in the Fourdrinier unit being directed by return lines **94, 96, 98, 100** (and from the roller set **76, 78** by means of line **102**) to the collection vessel. From the collection vessel, the process liquor is returned either to the pulp tank by pump **68** and its associated piping **103**, or to the headbox **30** of the Fourdinier unit. In addition, the process liquor loop has a branch as at **104** with which insolubles recovered in the process liquid shower loop are returned as feed to the Fourdinier unit.

Preliminary to discussing in detail the process liquid shower loop, it must be emphasized that in order to derive a finished product having substantially the same chemical composition as the raw tobacco feed, tobacco solubles must not be lost at any point in the system. This requires that the system operate under flow conditions of volume equilibrium and that no water (other than make-up for evaporation) be added at any location so as to cause loss of this condition. Thus the showers with which the pick-up belt **70**, wire forming carrier **52** and transfer belt **74**

are cleaned must be supplied with a rinsing media from within the system. However, as was previously mentioned, the shower media if it contains insolubles will clog conventional felt fabric belts. The present invention avoids this by using non-felt fabric type belts. In preparing reconstituted tobacco according to the present invention, the tobacco solubles must be saved if the final product is to possess the characteristics of natural tobacco. Thus the present invention provides for ultimate incorporation of substantially all the tobacco solubles in the process liquid in the fabricated tobacco sheet. That this is possible is a consequence of using non-felt type fabrics in the various system belts which can be easily cleaned with process liquid and maintaining a state of operating equilibrium in the process liquor and process liquid shower systems. Referring once again to the drawings, the process liquid shower loop also is a closed loop system and is comprised of supply branches **110**, **112**, **114** with which the corresponding shower units **120**, **122**, **124** employed for cleaning belts **70**, **74** and wire carrier **52** respectively, are supplied with process liquid. The shower process liquid is comprised of water and tobacco solubles (it may also contain some traces of insolubles as will appear) and is used to wash the tobacco insolubles (fibers and fines) which adhere to the forming carrier and belts from these devices. Because the forming wire is a foraminous structure and because the belts **70** and **74** are open mesh, non-felt type fabrics, the adhered insolubles readily wash off and are carried along with the shower process liquid by means of return lines **110***a*, **112***a*, **114***a* to a collection well **220**. From the collection well **220**, the process liquid is delivered to a clarifier unit **224** which may be a centrifuge type, or a tubular clarifier or a gyrating screen type and which functions to separate substantially all of the tobacco insolubles cleaned from the belts and forming wires from the process liquid. The tobacco insolubles along with a small amount of process liquid are collected in a tank **126** and are pumped back into the process liquor delivered to the headbox **30**. The clarified process liquid is on the other hand returned from tank **128** to the showers. A float controlled constant level line **127** is provided between tank **126** and vessel **66** as shown in FIGURE 1. Similarly, a float controlled level line **152** is provided between vessel **66** and tank **220**. Thus it will be seen that both the process liquor and process liquid shower sub-systems are maintained closed to obviate the loss of tobacco stock at any point. Of course, water (but not tobacco solubles) is lost at the Yankee dryer and after-dryer units by evaporation and the dried, finished product contains about 12% by weight water. This water is replaced in the system as fresh water make-up delivered to the tank **128** by way of make-up line **130**. With the system operating at a steady state condition, a float valve **132** can be used to regulate automatically, the make-up feed. Furthermore, since the system is operated under conditions of constant volume regulation, liquid level controls **131** are provided in both the collection vessel **66**, collection well **220** and pulping tank **16** to maintain the process liquor and process liquid therein at requisite levels. The present invention also contemplates that process liquid be used for gland seal purposes at the various pumps and grinders and for that purpose a branch line **133** may be provided in the system to supply clarified process liquid to these devices from the shower liquid loop.

Parameters denoting system operating conditions are listed in the following Table A wherein the respective sheet constituents are expressed in terms of parts of weight per unit area of sheet.

TABLE A

	Off Fourdrinier	After press	Off Yankee	Finished sheet
Insolubles	5.1	5.0	5.0	5.0
Solubles	15.0	5.0	5.0	5.0
Water	45.0	15.0	10.0	1.2

From the foregoing table it will be apparent that under operating equilibrium and at any point prior to entry of the tobacco sheet onto the Yankee dryer unit, the ratio of tobacco solubles to water in the process liquid (including showers) is maintained at about 25%. If this ratio should change for any reason, as for example, if it decreased to 16% in the sheet after press (4 parts solubles/20 parts water), the Yankee dryer and after-dryer units would evaporate about an additional 5 parts water per unit of sheet area beyond that expected to be removed in fully drying the sheet. Thus, the steady state make-up feed flow to the system would be altered by an increased demand—the float valve **132** automatically adjusts the make-up feed flow accordingly. By utilizing closed loop process liquor and process liquid shower subsystems to preclude loss of tobacco feed it is possible to achieve a theoretical 100% tobacco product in-tobacco product out operating condition. In practice, however, the recovery figure is generally about 96%, the differential resulting from inherent unavoidable losses which occur in any mechanical system, as for example, mist at the showers, splash loss, gland leakage and the like. The system thus far described produces an all tobacco product without consequential loss of any of the tobacco constituents which were present in the raw feed. Although certain solubles such as sugars and alkaloids go into solution with water when the slurry is prepared, these solubles are ultimately incorporated in the finished sheet product. If it is desired to add a flavorant to the tobacco sheet, this can be done by adding it to the intake side of the pulping tank **16** by means of a feed line **134**.

The following examples will serve to illustrate further the teachings of the present invention.

Example 1

Tobacco midribs in the following amounts were passed through a hammer mill to reduce them to a size of about ¼" average length.

	Lbs. per hr.
Bright stems	60
Burley stems	15
Winnower spills	12.5

These were then added to a pulping tank into which process liquor was being recycled at the rate of 2680 lbs. per hr., additional tobacco scrap also being introduced to the tank, as follows:

	Lbs. per hr.
Bright leaf scrap	22.5
Burley leaf scrap	8.7
Dust	27.5

The process liquor after the operation of the system had reached a steady state condition, contained substantially 19.7% tobacco solubles and 2.0 insolubles by weight. Tobacco flavorants were added to the process liquor by means of feed line **134** at the rate of 3.6 lbs. per hr. The slurry formed in the tank then was passed through three wet grinder units and the product was diluted further at the Fourdrinier unit headbox with an additional 11,475 lbs. per hr. of process liquor having substantially the same tobacco solubles and insolubles composition as that noted above. The pulp was then pumped from the headbox of a Fourdrinier unit and onto a wire forming carrier to cast it into a wet tobacco sheet. Continuous drawing off of process liquor from the sheet as it was being formed was effected and the tobacco sheet transferred from the forming carrier to a press section with nylon mesh fabric belts. At the press section, the last of the process liquor that could be removed with purely mechanical means was pressed out by the suction press rolls. The tobacco sheet was then passed onto a Yankee dryer unit by means of another nylon transfer belt and a substantial quantity of water was evaporated from the tobacco sheet leaving incorporated in the sheet the tobacco solubles which had been dissolved in the water evap-

orated. From that point the tobacco sheet was directed through a bank of double-tiered after-dryers similar to those used in papermaking. The after-dryers completed drying the sheet. The total weight of water removed from the sheet by the Yankee and after-dryer units was about 205 lbs. per hr. Thus make-up water at the rate of 210 lbs. per hr. was added to the system to replace losses due to evaporation and other unavoidable causes. All process liquor recovered from the forming wire and shower liquid recovered from belt washing and from the sheet was recycled to the system. The sheet on exiting from the dryers then was cut into squares to be used in further processing into cigarette filler.

The reconstituted tobacco sheet, medium brown in color and uniform in appearance and thickness, contained substantially equal weights of tobacco solubles and tobacco insolubles and 13.0% water, had a basis weight of 9.4 gm./sq. ft., a tensile strength of 1.46 kg./in. width, elongation of 3.0% at break, and a Mullen burst strength of 3.2 lbs.

This product was blended at approximately 20% by weight with natural leaf tobacco and the blend was cut and shredded, and made into cigarettes. The product burned normally, had good aroma and flavor, and was mild and pleasant. The characteristics of a sample cigarette and its smoke were compared with a control cigarette having a filler containing no reconstituted product. The following Table I indicates the results:

TABLE I.—CIGARETTE CHARACTERISTICS AND SMOKE ANALYSIS

[Conventional 20 mm. filter, 65 mm. tobacco cylinder]

	Experimental blend	Control
Cigarette filler weight, gms.	0.865	0.838
Static burn rate, min./40 mm.	8.9	9.1
Filter RTD, in. of water	2.4	2.4
Total RTD in. of water	4.0	4.3
Cigarette circumference, mm.	25.3	25.2
Cigarette length, mm.	84.9	84.6
Puffs per cigarette	9.0	9.3
Filling power index	38	42
Process reconstituted tobacco, percent	21.0	None
Nicotine, mg./cigt.	1.37	1.64
Total particulate matter (TPM), mg./cigt.	22.6	23.9
Organic gas phase, mg./cigt.	5.8	5.8
Phenols, mg./cigt.	67	78
Acrolein, mg./cigt.	105	115
Tars in TRM, mg./cigt.	10.0	10.6

Cigarettes prepared from such experimental blend were submitted for consumer testing side-by-side with an equivalent cigarette having a filler containing commercial reconstituted tobacco product produced with prior art methods. Test results indicated that the blend containing the new product gave a somewhat milder smoke than the blend containing the commercial reconstituted product.

Example 2

RUN A

Tobacco midribs comprising 90.5 lbs./hr. bright stems, 47.5 lbs./hr. burley stems and 12.5 lbs./hr. winnower spills were milled to reduce their size and were added along with 4.9 lbs./hr. bright leaf scrap, 3.0 lbs./hr. burley leaf scrap and 28.6 lbs./hr. tobacco dust to the pulping tank. To the pulping tank was added 2624 lbs./hr. process liquor recycled from the system and a slurry was formed. A steady state condition was reached some hours after system start-up, the recycled process liquor contained insolubles 87 lbs./hr. and solubles 762 lbs./hr. This slurry was then refined, and diluted further with process liquor (6665 lbs./hr. containing 214 lbs./hr. insolubles and 1875 lbs./hr. solubles) before being pumped from the Fourdrinier unit headbox onto the wire forming carrier. The reconstituted tobacco sheet was cast, drained and transferred by suction pick-up to the press section on a Formex nylon fabric wherein it was pressed and finally transferred to the drying system where 327 lbs. of water per hr. was removed. A total of 331 lbs./hr. of make-up water was added to the system.

RUN B

Tobacco midribs comprising 61.0 lbs./hr. bright stems, 32.0 lbs./hr. burley stems and 17.8 lbs./hr. winnower spills were milled to reduce their size and were added along with 6.9 lbs./hr. bright leaf scrap, 4.3 lbs./hr. burley leaf scrap and 65.0 lbs./hr. tobacco dust to the pulping tank. The remaining parameters and procedures for this run were the same as those applicable to Run A.

In Table II are listed the properties of the materials produced by these runs, which differed only as to the ratios of stems and dust used.

TABLE II.—PROPERTIES OF THE RECONSITUTED SHEET

	Run A	Run B
Percent water/dry sheet weight	11.7	12.2
Basis, wt. gm./sq. ft.	9.9	9.5
Tensile strength, kg./in. width	1.70	0.90
Percent elongation (at break)	1.2	1.3

Table III compares the chemical composition of the product of the respective runs with that of the raw materials from which they were produced.

TABLE III.—CHEMICAL CONSTITUENTS OF RECONSTITUTED SHEET, DRYWEIGHT BASIS

Chemical constituent	Run A			Run B		
	Raw material	Sheet	Percent recovery	Raw material	Sheet	Percent recovery
Hot water solubles, percent	52.8	52.6	99.6	53.8	51.2	95.2
Inorganic chlorides, percent	2.46	2.48	100.8	2.37	2.31	97.5
Total Alkaloids, percent	0.98	0.83	84.7	1.02	0.94	92.2
Total reducing sugars, percent	4.2	3.7	88.1	4.5	3.4	75.6
Total ash, percent	23.5	22.6	96.2	23.3	22.6	97.0
Total nitrogen, percent	2.57	2.36	91.8	2.44	2.42	99.2
Petroleum ether, percent extractables	2.7	2.9	107.4	3.1	3.2	103.2
Water, percent	Balance	Balance	Balance	Balance	Balance	Balance

It will be readily apparent from the foregoing description that the present invention produces an "all tobacco" product having substantially the same chemical composition as the tobacco plant parts from which it is made. The tobacco sheet is produced without recourse to additives, particularly binders and adhesives which are so prevalent in reconstituted tobacco produced by

prior art methods. The foregoing is made possible by the utilization of "process liquid" for the showers and the use of easily cleaned, non-felt type fabric belts. No natural tobacco constituents are lost in the processing due to the use of closed "process liquor" and "process liquid" loops. Not only is this beneficial from the standpoint of enabling the production of a true "all tobacco" product but it provides a substantial savings in cost particularly when it is considered that each gallon of process liquid contains about two pounds of tobacco and if lost requires replacement with more than two pounds of raw tobacco stems and scrap.

In general the proportions of the various raw tobacco products fed into the process (stems, leaf, and dust) may be varied over a wide range which will make a satisfactory reconstituted sheet provided not more than 80% dust is used. The content of stems or leaf scrap can be 100% if no dust be used.

It will be apparent to those skilled in the art that utilization of prior art processes to produce tobacco sheet from tobacco plant parts generally will not produce a finished product which is comprised of substantially the same chemical constituents as contained in the raw feed as they make no allowance for avoiding the loss of stock material (primarily insolubles). On the other hand, the endeavor to circumvent these shortcomings by using the known extract-and-recombine process requires expensive redrying and evaporative concentration steps. The present invention on the other hand, by utilizing a recycling closed process liquor and process liquid system produces with uncomplicated equipment a balanced, useful tobacco product with almost no processing loss.

Further modifications of the process of the present invention are possible. For example, "Broke" can be conveniently returned to the system by diverting it to the process liquid clarifier unit and then bleeding it back from the insolubles collection tank **126** to the Fourdrinier unit headbox. The term "Broke" is inclusive of formed dry tobacco sheet which upon exiting from the after dryer units is inspected and determined not to meet fabrication specifications as well as formed wet tobacco sheet, which never reaches the drying units as, for example, sheet resulting from system start-up and shut-down and sheet produced by faulty system operation.

It will thus be seen that the objects set forth above among those made apparent from the foregoing description, are efficiently attained, and since certain changes in carrying out the above method and in the constructions set forth, which embody the invention may be made without departing from its scope, it is intended that all matter contained in the above description shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A process for producing tobacco sheet from tobacco plant parts characterized in that the tobacco sheet has substantially the same tobacco insolubles and tobacco solubles content as the plant parts from which it is produced, said process comprising

adding the plant parts to a vessel to which is being recycled a process liquor comprised of a water-tobacco solubles solution, and tobacco insolubles suspended in the solution,

forming an aqueous slurry with the plant parts and process liquor by pulping same until the plant part tobacco solubles dissolve in the process liquor water and the plant part tobacco insolubles become suspended in said process liquor,

flowing the aqueous slurry onto a moving foraminous forming carrier to deposit substantially all of the plant part tobacco insolubles suspended in said slurry on the forming carrier as a wet tobacco sheet while drawing process liquor through the forming carrier,

recycling at least part of the process liquor drawn through the forming carrier to said vessel,

transferring the wet tobacco sheet from the forming carrier to a moving open mesh non-felt type fabric carrier.

pressing said wet tobacco sheet while it is on said fabric carrier to remove a substantial quantity of water-tobacco solubles solution from said sheet,

evaporating water from the pressed sheet in excess of the sheet dry state water weight while retaining in the sheet the plant part tobacco solubles contained in the water evaporated,

rinsing the forming carrier and fabric carrier with a media comprised of a water-tobacco solubles solution to remove any tobacco insolubles adhering to said forming carrier and fabric carrier when the wet tobacco sheet is removed therefrom,

clarifying the rinsed media to separate therefrom the tobacco insolubles removed from the forming carrier and fabric carrier, and

returning the separated tobacco insolubles to the process liquor and the clarified rinsing media to the system for further use.

2. The process of claim **1** further comprising diluting the slurry with additional process liquor just prior to flowing it onto said forming carrier, said additional process liquor having substantially the same constituent character as the process liquor being recycled to said vessel.

3. The process of claim **2** further comprising collecting the process liquor drawn through the forming carrier and returning one part thereof to said vessel and the remainder thereof to the slurry.

4. The process of claim **3** wherein the tobacco insolubles separated from the shower media are returned to the process liquor by adding same to the process liquor used for diluting the slurry.

5. The process of claim **1** wherein the open mesh non-felt type fabric carrier is a nylon mesh belt.

6. The process of claim **1** wherein the process liquor and rinsing media are confined within closed loop systems.

7. The process of claim **1** further comprising adding fresh water to said rinsing media in an amount substantially equal to the amount of water evaporated from said pressed sheet.

8. The process of claim **1** wherein the water evaporated from said pressed sheet is evaporated therefrom by directing the pressed sheet onto a moving heated surface.

9. The process of claim **8** wherein said moving heated surface is treated with a hydrophobic release agent to facilitate removing the sheet from said surface.

10. A process for producing tobacco sheet from tobacco plant parts characterized in that the tobacco sheet has substantially the same tobacco insolubles and tobacco solubles content as the plant parts from it is produced, said process comprising.

adding the plant parts to a vessel to which is being recycled a process liquor comprised of a water-tobacco soluble solution, and tobacco insolubles suspended in the solution,

forming an aqueous slurry with the plant parts and process liquor by pulping same until the plant part tobacco solubles dissolve in the process liquor water and the plant part tobacco insolubles become suspended in said process liquor,

diluting the slurry with additional process liquor having substantially the same content characteristics as the process liquor being recycled to said vessel,

flowing the diluted slurry onto a moving foraminous forming carrier to deposit substantially all of the plant part tobacco insolubles suspended in said slurry on the forming carrier as a wet tobacco sheet while drawing process liquor through the forming carrier,

collecting the process liquor drawn through the forming carrier and recycling one part thereof to said vessel and the remainder to the system as the additional process liquor diluting the slurry,

transferring the wet tobacco sheet from the forming carrier to a moving open mesh non-felt type fabric carrier belt,

pressing said wet tobacco sheet while it is on said fabric carrier belt with a compression applied normal to the direction of sheet travel to remove a substantial quantity of water-tobacco solubles solution from said sheet,

returning the water-tobacco solubles solution pressed from said sheet to the process liquor drawn through the forming carrier,

evaporating water from the pressed sheet in excess of the sheet dry state water weight while retaining in the sheet the plant part tobacco solubles contained in the water evaporated,

rinsing the forming carrier and fabric carrier with a media comprised of a water-tobacco solubles solution to remove any tobacco insolubles adhering to

said forming carrier and fabric carrier when the wet tobacco sheet is removed therefrom,

clarifying the rinsing media to separate therefrom the tobacco insolubles removed from the forming carrier and fabric carrier, and

returning the separated tobacco insolubles to the process liquor and the clarified rinsing media to the system for further use.

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