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Buell

[11] **3,863,296**

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[54] **PROCESS FOR PREPARING AIRFELT**

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Related U.S. Application Data

[62] Division of Ser. No. 182,795, Sept. 22, 1971, Pat. No. 3,825,194.

[52] **U.S. Cl.** **19/156.3**

[51] **Int. Cl.** **D01g 25/00**

[58] **Field of Search** 19/155, 156, 156.4, 83, 19/88, 89; 241/3, 18, 55, 86, 191, 295

[56] **References Cited**

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2,222,633	11/1940	Sheesley	19/156.4 X
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[57] **ABSTRACT**

Apparatus and process for continuously converting dried cellulosic fibrous sheet material into a dispersion of individual fibers in air and thereafter forming said individual fibers into an airfelt.

1 Claim, 8 Drawing Figures

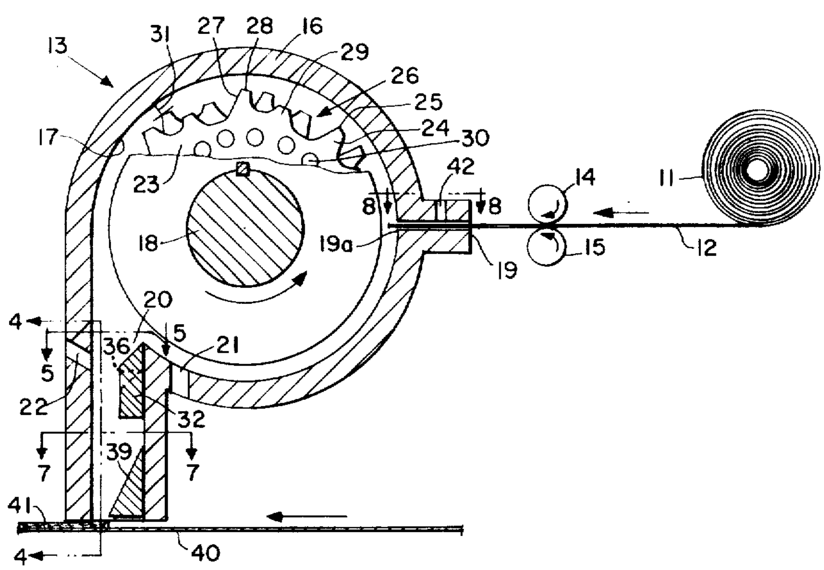


Fig. 1

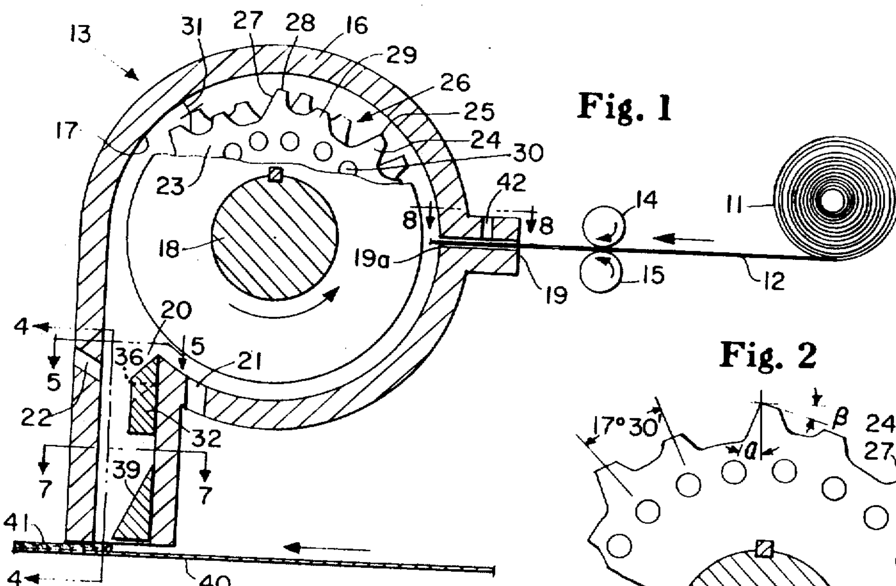


Fig. 2

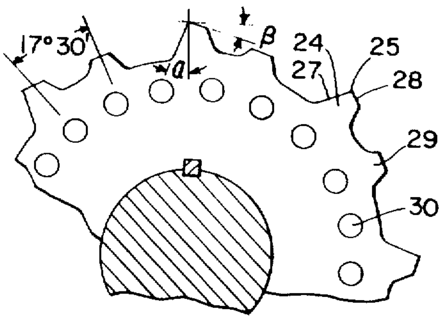


Fig. 3

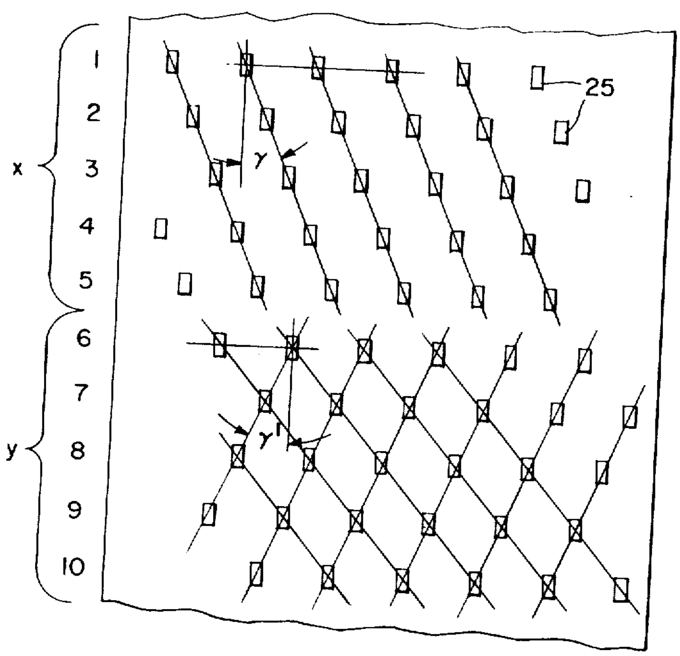
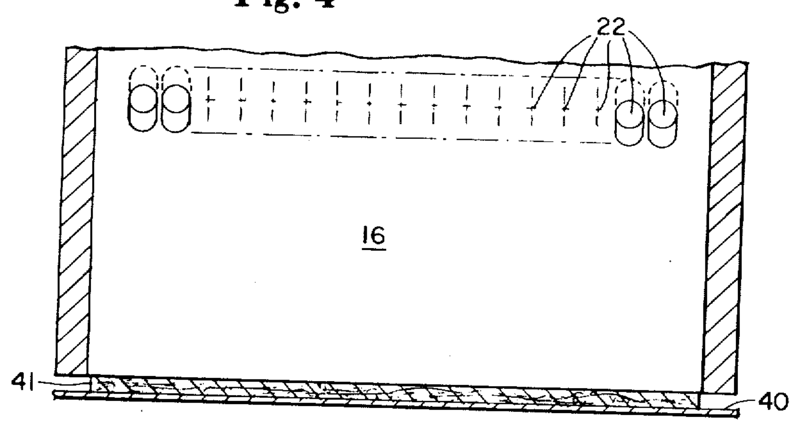


Fig. 4



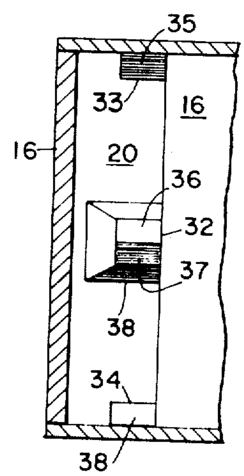


Fig. 5

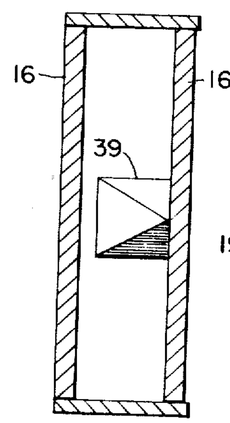


Fig. 7

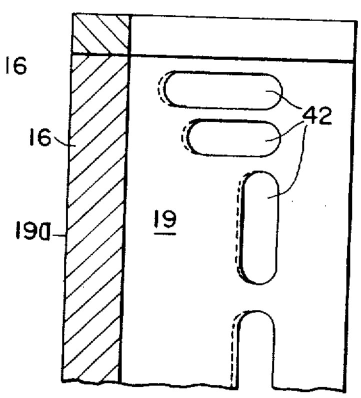


Fig. 8

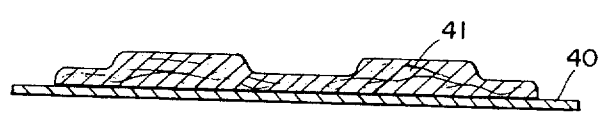


Fig. 6

PROCESS FOR PREPARING AIRFELT

This is a division of application Ser. No. 182,795, filed Sept. 22, 1971, now U.S. Pat. No. 3,825,194.

FIELD OF THE INVENTION

This invention relates to the art of disintegrating fibrous sheet material and using the disintegrated material to form an airfelt. More particularly, it relates to a process whereby a dried cellulosic fibrous sheet is impacted under predetermined operating conditions to cause progressive disintegration of the sheet into individual fibers and thereafter distributing said fibers onto a foraminous support to produce an airfelt.

PRIOR ART

A similar process is disclosed in U.S. Pat. No. 3,519,211 where a disintegration device of the general type utilized herein is disclosed. This patent also envisions the formation of an airfelt pad. Said patent is incorporated herein by reference.

The present invention differs from the apparatus and process of U.S. Pat. No. 3,519,211, in one aspect, by providing an air control system which keeps individual fibers distributed in a minimum amount of air to minimize the problem of separating the fibers from the associated air. This invention also comprises an improved design and arrangement of impacting elements and the provision of means to prevent the buildup of fibers in the inlet of the disintegrator. A further aspect of the present invention involves control of the fiber density across the disintegrator discharge outlet so as to produce an airfelt which varies in basis weight across its width in a predetermined manner.

OBJECTS OF THE INVENTION

The principal object of the present invention is to improve the operation of prior devices as represented by U.S. Pat. No. 3,519,211.

Another object of this invention is to provide a process which will disintegrate fibrous sheet material into its component fibers and thereafter, with a minimum time lag, use said fibers to form an airfelt.

SUMMARY OF THE INVENTION

The nature and substance of this invention is best exemplified, in one aspect, in an apparatus for preparing an airfelt comprising:

A. A disintegrator for fibrous material comprising:

1. a rotary cylindrical disintegrating element rotatable about its cylindrical disintegrating element rotatable about its cylindrical axis, said element having teeth generally randomly disposed on said disintegrating element's periphery with the impacting faces of said teeth inclined inwardly in the direction of rotation at an angle of from about 15° to about 40° from the radii drawn through the front edges of the teeth's tips and the top surfaces of said teeth being inclined inwardly to form a relief angle of from about 20° to about 60°; and

2. a casing for said disintegrating element comprising a support element for said fibrous material to continuously hold said fibrous material while it is being fed into a position where said disintegrating element can impact the fibrous material to separate said material into its individual fibers, the distance between said disintegrating element and said support element being from about 0.010 to about 0.080, preferably from about 0.025 in. to about 0.035 in., said casing defining, in cooperation with said disintegrating element, a restricted air flow channel to keep the current of air and entrapped individual fibers, which results from rotating said disintegrating element to disintegrate said fibrous material, within a minimal cross-sectional area, said casing having a primary discharge outlet for the air and fiber current, said discharge outlet being tangentially directed with respect to said disintegrating element, said casing having an air inlet immediately adjacent the said primary discharge outlet and between said primary discharge outlet and the point where the fibrous material is impacted, said casing having secondary air inlets in the casing across the width of said primary discharge outlet; and said casing having vacuum air outlets in said support element about 1 inch to about 4 inches from the point where the disintegrating element impacts said fibrous material; and

B. A moving foraminous support element across the opening of said discharge outlet adapted to collect the individual fibers to form an airfelt while permitting the air to escape through said foraminous support element, said foraminous support element being at a distance from the center of said disintegrating element of from about ¾ to about 2 diameters of said disintegrating element but no further than about 3 feet.

THE PROCESS

In accordance with another aspect, the present invention comprises a process of disintegrating dried cellulosic fibrous sheet material in a process comprising the steps of:

A. Feeding said fibrous sheet into a disintegrator comprising a disintegrating element having a plurality of impacting elements which have tips and a casing having a slotted opening terminating in a sheet support element, said casing defining, in combination with said disintegrating element, a restricted channel;

B. Supporting said sheet in said slotted opening;

C. Moving said disintegrating element such that the tips of said impacting elements move at a velocity of at least about 6,000 feet/minute;

D. Impacting said tips against the end of said fibrous sheet so that impact is substantially normal to the plane of said sheet whereby said fibrous sheet is disintegrated into individual fibers;

E. Mixing said fibers with air in said restricted channel with said impacting elements while maintaining a relatively even fiber density gradient and air flow velocity gradient across the axial width of said channel; and

F. Removing the fiber/air mixture from the disintegrator along a tangent to the direction of motion of said impacting elements at the point of removal to a foraminous support positioned no more than about 3 feet away from said point at which the fiber/air mixture leaves said impacting elements, said air passing through said foraminous support and leaving said fibers on said foraminous support in the form of an airfelt.

BRIEF DESCRIPTION OF THE DRAWINGS

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter regarded as forming the present invention, it is believed that the invention will be better understood from the following description taken in connection with the accompanying drawings in which:

FIG. 1 is a vertical cross sectional view of one embodiment of the disintegration and airfelt forming apparatus of the present invention;

FIG. 2 is a fragmentary side elevational view of an individual rotor;

FIG. 3 is a fragmentary plan view of a surface development of the periphery of the axial rotary cylindrical disintegrating element rotatable about its cylindrical axis schematically showing, in flattened form, the tooth tip array;

FIG. 4 is a fragmentary elevational view of the discharge outlet portion of the casing as viewed along line 4—4 of FIG. 1, showing a series of air inlet ports;

FIG. 5 is a cross-sectional view of the discharge outlet taken along line 5—5 of FIG. 1;

FIG. 6 is a transverse cross-sectional view of an airfelt product having a transversely varying basis weight;

FIG. 7 is a cross-sectional view of the discharge outlet taken along the line 7—7 of FIG. 1; and

FIG. 8 is a fragmentary cross-sectional view of the vacuum ports taken along the line 8—8 of FIG. 1.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings, a preferred embodiment of the apparatus and process will be described with particular reference to the disintegration of a dried cellulosic fibrous sheet. In order to simplify the disclosure, elements which form no part of the present invention and which can be readily supplied by persons of ordinary skill in the art have been omitted. Such elements include structural members, bearings, power transmission arrangements, and the like.

This invention is particularly useful in disintegrating comminution grade wood pulp in "dry lap" form of the kind found in commerce. Such dry lap sheets typically have a basis weight, air-dried, of between about 100 and about 200 lbs. per thousand aquare feet and generally have a caliper of at least about 0.04 in. or greater. A dry lap sheet of this type usually has a moisture content of about 6%. However, sheets having lower moisture contents can be used in connection with the present invention and, in fact, those having moisture contents of about 1% have been found to produce excellent results. Sheets having moisture contents higher than about 10% can be used, but these must be disintegrated at lower rates, or they will be incompletely disintegrated.

As used herein, the term "dried cellulosic fibrous sheet" describes any type of fibrous sheet material capable of disintegration by the process of this invention. On the other hand, a dry lap sheet will be understood to mean a wood-fiber material of the above-described characteristics to which the invention is preferably applied.

Referring now to FIG. 1, a roll 11 of dry lap material is unrolled into a sheet 12 which is advanced to the disintegrator 13. The sheet 12 is fed radially into the disintegrator 13 by a pair of counter-rotating metering infeed rolls 14 and 15 which are mounted on the infeed side of the disintegrator 13. A motive power source, which may typically be an electric motor, but which preferably is tied to the speed of the subsequent converting line's main drive to provide exact basis weight control. This motive power source is connected to the infeed rolls 14, 15 in a conventional manner (not shown) to provide a driving force.

The disintegrator 13 comprises a casing 16 having a generally cylindrical bore 17. A shaft 18 is journaled in the closed ends of the casing 16 such that one end of shaft 18 extends outside the casing 16 to permit coupling the shaft in a conventional manner to a motive source such as an electric motor. The motor continuously drives the shaft 18 in a counter-clockwise direction, as shown.

The casing 16 comprises an inlet portion 19 which is slotted to provide an inlet opening having an inner end 19*a*. The inlet opening receives the dry lap sheet 12 and guides it to the inner end 19*a* which defines a sheet support element an edge portion whereat the dry lap sheet 12 is disintegrated. The inlet opening is essentially the same size as the sheet 12 with a clearance of from about 0.040 to about 0.200 inch, preferably from about 0.80 to about 0.125 inch, larger clearances being desirable along the edges to permit using slightly damaged sheet 12. A relatively large tangential discharge outlet 20 is provided in the casing 16 at a point of from about 5° to about 270° from the inlet portion 19 in the direction of rotation of shaft 18. FIG. 1 of the drawing shows an approximate 180° separation between the inlet portion 19 and the discharge outlet 20. It is to be emphasized that the angle referred to is the angle of separation, i.e., the angle subtended on the surface of the casing between the slot in the inlet portion and the edge of the discharge outlet and not the angle between the axis of the inlet and discharge openings. Preferably, the discharge outlet 20 is sufficiently far from the inlet opening 19 to permit the fibers to be completely disintegrated before discharge. The discharge outlet 20, in cross-section, has a width approximately equal to the length of cylindrical bore 17 and a depth of from about 2 inches to about 4 inches, preferably 3 inches. Air inlet openings 21 are provided near the discharge outlet 20 to permit air to be forced into the casing 16 at a slight positive pressure from a suitable blower (not shown) or the like, for the purpose of preventing the recycling of the fibers through the disintegrator 13 and for other purposes disclosed hereinafter.

Suitably, the air inlet opening 21 can be one or more slots from about ¼ inch to about 1 inch wide running the entire width of the casing 16 near the tangential discharge outlet 20. Under a pressure of about 2 to about 10 inches of water, the inlet openings can admit air at a velocity of about 6,000 to about 13,000, preferably 8,000 feet per minute.

As shown in FIGS. 1 and 4, additional air inlets 22 are provided for the purpose of adjusting the air flow in the discharge outlet 20. The air inlets 22 are arranged in a straight line across the discharge outlet 20 near the tangential discharge point. In FIG. 4, only a few of the inlets 22 are shown, but it is understood that additional inlets 22 are provided at the indicated points. The inlets 22 are each controlled by valve means (not shown), for example, cap and seat valves such as those used on piccolos and are of a size to deliver air at a velocity of from about 6,000 to about 13,000, preferably 8,000 fpm under 2 to 10 inches of water pressure.

Rotors 23 are keyed to the shaft 18 in juxtaposed relation, each being provided with a plurality of teeth 24 extending outwardly such that their tips 25 are adapted to serve as impacting elements. As used herein, "rotor" refers to thin rotor discs having widths of from about 0.030 to about 0.125 inch. A small clearance of from about 0.023 in. to about 0.035 in. is preferably provided between the tips **25** and the inner end **19***a* of the inlet opening in the inlet position **19** which forms a sheet support for the sheet **12**, as disclosed in the co-pending application of George Morgan entitled "DISINTEGRATION PROCESS FOR FIBROUS SHEET MATERIAL," now U.S. Pat. No. 3,750,962 and incorporated herein by reference. Larger and smaller clearances of from about 0.010 to about 0.080 in. can be used, depending upon the operating rates, provision of cooling means, etc.

With the above arrangement of the parts of the apparatus, successive teeth tips **25** impact the end of the in-feeding sheet **12** as the rotors **23** are turned. The rotors **23** when keyed in place and bolted together form an axial rotary cylindrical disintegrating element **26** rotatable about its cylindrical axis. This configuration is preferred since it permits the favorable internal distribution of stresses set up during operation of the disintegrator. The discharge outlet **20** is generally tangentially positioned with respect to said disintegrating element **26**.

Referring now to FIG. **2**, an individual rotor **23** is shown. Each rotor **23** desirably bears from about **6** to about **18** teeth **24**, preferably about **8** teeth **24**, equally spaced about its periphery with their tips **25** located at like distances from the rotor **23** axis. The impact face **26** of each tooth **24** is formed at the angle α with the radius of the rotor **23** which passes through the tooth tip **25**. The top **28** of the tooth **24** is formed at a relief angle β, i.e., the angle defined by the top **28** of the tooth **24** and a tangent to the rotor **23** passing through the tooth tip **25**. The angle α can vary from about 15° to about 40° and the angle β varies from about 20° to about 60°. Angle α is the more critical of the two angles. Both larger and smaller angles for angle α give poorer total fiberization, the larger limit being most critical. Angle α give poorer total fiberization, the larger limit being most critical. Angle β is important because if the top of the tooth **28** is tangential to the rotor **23**, or is inclined outward, a splinter-like mass of glassined cellulose will be formed along the top of the tooth **28** during operation which will then break off and be discharged along with the individual fibers out the discharge outlet **20**. The individual rotors **23** are relatively thin, typically being from about 0.030 to about 0.125 in. in width. Accordingly, it is desirable to have blunt projections **29** which will help support the teeth **24** of adjacent rotors **23** when, as is preferred, the rotors **23** are bolted together to form said disintegrating element **26**. For the purpose of bolting the rotors **23** together, a series of holes **30** is provided in each rotor **23**.

As shown in FIG. **2**, in one successful rotor design wherein eight teeth **24** are formed in equally spaced relationship about the periphery of an approximately 11½ inch diameter blank having a thickness of about 0.065 inch, the dimensions and angles shown are as follows: Angle α is 22°–30'; angle β is 29°; the teeth tops **28** are about 0.38 wide in the plane of rotation; and the tip **25** is rounded to a 0.030 radius; the radius to the tip of the small support projections is about 5.38 inches and to the tip **25** of teeth **24** is about 5.75 inches; and the holes which take the bolts are 17/32 inches in diameter bored on an approximately 4.7525 diameter.

Referring now to FIG. **3**, which is a fragmentary plan view of a surface development of the periphery of disintegrating element **26**, showing in flattened form the locations of tooth tips **25** of the rotors **23**, as they are preferably connected. It can be seen that the tooth tips **25** are arranged in a staggered pattern so that individual tips **25** are not close together. If the tooth tips **25** on all the rotors **23** were aligned so as to make solid lines of tooth tips **25**, or if one or more of the tips **25** were too close together, disintegration quality would be poor. The tendency in such an aligned arrangement is to tear the fibrous sheet material into chunks rather than individual fibers. Also, the noise of the disintegrating element **26** when it is rotating would resemble a fire siren if the teeth were aligned.

If said disintegrating element **26** had the tips **25** in a completely random array, this would be ideal since it is desired to create a design which will not cause lateral fiber migration or consistent noise and vibration reinforcement. However, using individual rotors **23** with the same number of teeth, in a balanced configuration, a completely random configuration is not feasible. Applicant has found that a reasonable approximation of random distribution can be achieved by arranging the teeth tips **25** in a multiple helical pattern in which there are a plurality of patterns of teeth **24** on a plurality of portions of the circumference of said disintegrating element, each portion covering the entire width of said disintegrating element and each portion being paired with a corresponding adjacent portion which is substantially a mirror image of the first portion, each portion covering from about **30** to about 45° of the circumference of the disintegrating element, the helical patterns having helical angles of from about 10° to about 35°, and each tooth **24** being arranged so that the nearest teeth **24** in all directions are at approximately equal distances. Preferably, the "mirror image" portion is offset slightly from what would be the exact mirror image position.

One such arrangement of teeth **24** is shown in FIG. **3** where the pattern of the teeth tips **25** is shown. Rows **1–5** comprise a "Set X" (i.e., a first portion bearing a helical pattern) in which succeeding rows of tips **25** are offset at a helical angle of from about 10° to about 35° from the preceding teeth tips **25**, i.e., angle γ varies from about 10° to about 35°. Rows 6–10 comprise "Set Y" (i.e., a second adjacent portion bearing a helical pattern which is an approximate mirror image of the pattern in the first portion, offset slightly). It will be noted that row **6** is offset slightly from the position that it would have had had it been a continuation of Set X. Row **6**, then, is the start of Set Y in which the helical angle of offset γ' for each succeeding row 7–10 is the same as γ for Set X but opposite in direction. Then a new row starts a new Set X which is identical to said first Set X but displaced around the periphery of said disintegrating element **26** by 10 rows of teeth tips **25**. Sets of rows of different sizes from two to about 10 rows can be used with essentially equivalent results in that lateral fiber density migration is minimized. The size of the sets is a function of the number of teeth **24** on each rotor **23** and the number of rotors **23** in the disintegrating element **26**. For example, where 264 rotors **23** having eight teeth **24** per rotor are used, it has been found satisfactory to arrange the tips **25** in 16 sets of five rows each, using a helical angle γ of about 23°. In such a case, each row would comprise aligned teeth **24** on every eleventh rotor **23**. It will be recognized that once a single tooth **24** on a rotor **23** has been positioned, all of the other teeth **24** on the same rotor **23** will be automatically positioned.

Some such arrangement of the teeth tips **25** is required to prevent the pattern of the teeth tips **25** from causing lateral migration of the fibers and to minimize noise and vibration reinforcement. The disclosed design keeps a relatively constant distribution of fibers across the air flow channel **31** defined by the casing **16** and said disintegrating element **26**.

The air flow channel **31** is defined by the disintegrating element **26** and the casing **16** which is sized to give from about one thirty-second to about one-fourth inch clearance, preferably about three thirty-two-inch clearance between blade tips **25** and the casing **16**.

Avoidance of preferential lateral migration of fibers to one side of the other and the maintenance of a relatively even air velocity profile across the width of the air flow channel **31** by the methods described hereinafter are essential if one is to obtain an airfelt having a laterally constant basis weight when the disintegrator **13** is "closely coupled" as defined hereinafter.

The air inlet **21** can be a single slot one-half inch wide across the width of the casing **16** (typically about 16 inches) which under a pressure of about 2–10 inches of water will deliver about 6,000 to about 13,000, preferably 8,000 feet per minute air velocity. This is the only air introduced deliberately to the disintegrator **13**.

It should be noted that part of the velocity imparted to the fibers discharged through the discharge outlet **20** is obtained directly from the teeth **24**; and accordingly, it is unnecessary to add large quantities of air to maintain the velocity of the individual fibers through the discharge outlet **20** when the disintegrator **13** is closely coupled as defined hereinafter.

Referring now to FIG. **4**, one can see a row of air inlets **22** having a cross-sectional area of about **1** square inch are desirably provided across the discharge outlet **20** of the casing **16**. When the air flow through each of the individual air inlets **22** is adjusted to provide an air velocity of from about 6,000 to about 13,000 fpm, preferably 8,000 fpm air velocity, by means of a "piccolo" valve, it is possible to control the direction of the high velocity fiber/air mixture flowing through the discharge outlet **20** and thereby vary the fiber density across the axial width of the discharge outlet **20**. The inlets may be slanted down or up, or be perpendicular to the air flow, but are preferably slanted down about 30° from the horizontal. These air inlets **22** provide fine tuning for adjusting the fiber deposition rate across the width of the outlet **20**. When the disintegrator **13** is close coupled as defined hereinafter, this permits the formation of a very even density airfelt. It is contemplated that even rather extreme modifications of the air velocity profile can be accomplished by using these air inlets **22**.

Although the discharge outlet **20** can comprise a smooth rectangular chute in order to produce an airfelt having a laterally constant basis weight, a preferred variation of this invention being shown in FIGS. **1** and **5** for the purpose of forming an airfelt having a predetermined variation in basis weights across its width. Within the outlet **20** are disposed a central diverting vane **32** and two side diverting vanes **33** and **34**. These vanes **32**, **33** and **34** vary the fiber density across the cross-section of the discharge outlet **20** by diverting fiber into the other portions of the discharge outlet **20** to increase the fiber density in these portions. The primary fiber diverting surfaces **35, 36, 37** and **38** and the other surfaces of the vanes **32, 33** and **34** on which fibers can impinge are all slanted a maximum of about 45°, preferably no more than about 25°, from the line of air flow so as to divert the fibers into the approximate centers of the adjacent open areas of the discharge outlet **20**, without buildup of fibers on those surfaces. The vanes **32, 33** and **34** can be solid, hollow, or simply one or more thin plates slanted so as to divert fibers to one side or the other of the vanes **32, 33** and **34**.

The fiber impinging edges should either be rounded or slanted a maximum of abut 45° from the line of air flow to avoid fiber buildup. The length and width of the vanes can be sized as required to produce a desired cross-sectional variation of basis weight in the airfelt product. FIG. **6** shows a cross-section of the product of the arrangement of FIGS. **1** and **5**.

Referring now to FIG. **7**, another preferred variation of this invention shows a second pyrimidal vane **39** disposed against the wall of the casing **16** to redivert fibers which may migrate back into the space in the discharge outlet **20** directly below the first central diverting vane **32**.

By a combination of vanes such as **32, 33, 34**, and **39**, and by modulating the air input through the air inlets **22**, it is possible to provide airfelts having very precise basis weights and variations in basis weights across the width of the airfelt.

The airfelt is eventually formed on the moving support element **40** with the air passing through the moving support **40** leaving the airfelt **41**. Support element **40** can comprise a 22 × 24 mesh wire screen which is about 40% open with a paper tissue running on top, the tissue having a basis weight of about 12 pounds per 3,000 square feet.

It is a special advantage of the disintegrator of this invention that due to the tangential discharge outlet **20** and the relatively low volume of air flow required, the disintegrator **13** can be close-coupled to the support element **40**, i.e., the distance from the center of said disintegrating element **26** to the support element **40** is from about three-fourths of said disintegrating element's **26** diameter to about 2 diameters, but with an absolute distance of no more than about 3 feet. Greater distances are less desirable since the residence time in the system becomes too great and the velocity of the fibers drops to an undesirable level. This close-coupling arrangement makes it possible to lay an even airfelt with very little air in the fiber/air mixture, thus minimizing the problem of passing the air through the support element **40**. Another advantage of close-coupling is the ability to start and stop the associated converting line without changing the basis weight of the airfelt because of the minimal amount of fiber held up in the system at any time. Typically, fiber/air ratios (by weight) of from about 0.02 to about 0.50, preferably from about 0.10 to about 0.40, are used.

Referring now to FIG. **8**, it is preferred to provide certain vacuum air discharge outlets **42**, each having a cross-sectional area of about one-half square inch in the casing **16** communicating with inlet opening **19**. These communicate with a source of a vacuum of from about 10 to about 40 inches of water to induce an air flow out through the outlets **42** and thereby remove whatever fibers migrate from the airflow passage **31** into the inlet opening **19**. Along the lateral edges of the inlet opening **19** the air outlet holes **42** are slightly larger, closer together, and closer to the tip support edge 19*a*, e.g., approximately an inch away, and in the middle of the inlet opening 19 the air outlet holes 42 are approximately 2 to 4 inches away from the edge of the support element 19*a*. Although holes 42 are shown only in the top portion of the casing 16 defining inlet opening 19, it is desirable, and preferable, to provide similar holes 42 in the bottom portion of the casing 16 defining inlet opening 19. The holes 42 should not be too close to the airflow passage 31 or the flow of air into the outlet holes 42 may draw in fibers, but the air outlet holes 42 should be sufficiently close to the edge of the support element 19a so that any fibers which naturally migrate into the inlet opening 19 will be removed. Otherwise, inlet opening 19 can become stopped and clogged with fibers preventing the sheet 12 from feeding into the disintegrator. If desired, the fibers which are removed through the outlet openings 42 can be conveyed to the support element 40 to help form the airfelt.

More specifically, using the apparatus described hereinbefore, the process of this invention comprises disintegrating dried cellulosic fibrous sheet material in a process comprising the steps of:

A. Feeding the fibrous sheet 12 into the disintegrator 13;

B. Rotating the cylindrical disintegrating element 26 at a speed sufficient to move the tips 25 of the teeth 24 of the disintegrating element at a velocity of from about 6,000 feet/minute to about 30,000 feet/minute, preferably about 15,500 feet/minute, whereby the tips 25 of the teeth 24 impact against the end of the fibrous sheet 12 to disintegrate the fibrous sheet 12 into individual fibers;

C. Adjusting the amount of air flowing through the air inlets 21 to minimize recycling of the fibers;

D. Adjusting the amount of air flowing through secondary air inlets 22 so as to achieve the desired fiber/air profile across the width of the discharge outlet 20;

E. Adjusting the air flow through vacuum air discharge outlets 42 to remove fibrous material which migrates into the space defined by the support element 19*a* and the sheet 12; and

F. Directing the fiber/air mixture from the disintegrator 13 through the discharge outlet 20 and a moving foraminuos support 40, leaving the fibers on the foraminous support 40 in the form of an airfelt 41.

Referring to FIG. 1, when the sheet 12 is fed into the disintegrator 13 through the slotted inlet opening in the inlet position 19 at a rate of about 60 fpm., the inner end 19*a* provides a support for the sheet 12. The disintegrating element 26 rotating in a counterclockwise manner, disintegrates the sheet 12 when the tips 25 impact the sheet 12 at a speed of at least 6,000 feet/minute, preferably about 15,500 feet/minute. Individual fibers are then mixed with the air which is inserted through the air inlet 21 at the rate of about 8,000 fpm. The air, which is inserted through the air inlet 21 prevents the rotation of the disintegrating element 26 from drawing air from the rest of the cavity within the disintegrator 13, i.e., it prevents recycling.

When the air in air flow channel 31 is mixed with the individual fibers at the point of impact of the tips 25 with the sheet 12, the resulting fiber/air mixture flowing through the channel 31 has a relatively even velocity distribution and consequently an even fiber density profile across the width of the channel 31. It is at this point that disintegration to individual fibers is completed by the action of the teeth 24, the shearing and abrasion effects resulting from the interaction between the blades and the casing, and the turbulence in the restricted channel 31. If such a restricted passageway is not provided, or if the channel 31 is too short, then disintegration is incomplete. This even velocity profile and fiber density profile is maintained since the pattern of the teeth 24 on the surface of the disintegrating element 26 does not preferentially divert fibers to either side of the air flow channel 31. Since the distance from the disintegrating element 26 to the support element 40 is very short and in a straight line, this fiber density profile does not have a chance to redistribute and accordingly, it is possible to lay a very even basis weight airfelt on the support element 40. If required, variations in the air flow velocity profile and fiber density profile can be made by adjusting the input of air through the individual air inlets 22.

It is also possible to modify the basis weight distribution of the airfelt by means of the vanes 32, 33 and 34, and secondary diverters like diverter 39. It should be noted that these vanes 32, 33 and 34 have slanted edges and diverting surfaces 35, 36, 37 and 38 to divert the fibers rather than to simply stop the fibers. This avoids buildup of fibers on the surfaces 35, 36, 37 and 38. Similarly, the diverter 39 has slanting edges and surfaces to avoid fiber buildup. The diversion of the fibers builds up the other areas which are not underneath the vanes 32, 33 and 34 at the same time that the fibers are being prevented from depositing on the area underneath the vanes 32, 33 and 34. Thus, the effect of the vanes 32, 33 and 34 on the difference between basis weights of these adjacent areas is greater than the effect of the vanes 32, 33 and 34 on the basis weight of the area directly under the vanes 32, 33 and 34.

Another preferred embodiment of the invention involves the process of keeping the inlet opening 19 free of disintegrated fibers. This is done by pulling a vacuum of from about 10 to about 40 inches of water on the holes 42, the vacuum being of sufficient strength to remove those fibers migrating into the inlet 19, but preferably not sufficient to pull large amounts of additional fibers into said slotted inlet 19. It is desirable that the holes 42 in the middle of the slot inlet 19 be from about 2 to about 3 inches from the support element 19*a*. However, the holes 42 along the sides of the slot inlet 19 can be closer to the support element 19*a*, i.e., about an inch. Placing the holes 42 so close to the support element 19*a* along the sides of the slot inlet 19 may cause some fibers to migrate from the air flow channel 31 into the slot of the inlet portion 19; however, the need to remove fibers from the sides of the slot of the inlet portion 19 is sufficiently great to justify drawing additional fibers in. Failure to remove the fibers from the slot of the inlet portion 19 results in a buildup of fibers which eventually will jam the slot of the inlet portion 19.

What is claimed is:

1. A process of disintegrated dried cellulosic fibrous sheet material and laying an airfelt therefrom comprising the steps of:

A. Feeding said fibrous sheet into a disintegrator comprising a disintegrating element having a plurality of impacting elements which have tips and a casing having a slotted opening terminating in a sheet support element, said casing defining, in combination with said disintegrating element, a restricted channel;

B. Supporting said sheet in said slotted opening;

C. Moving said disintegrating element such that the tips of said impacting elements move at a velocity of at least about 6,000 feet/minute;

D. Impacting said tips against the end of said fibrous sheet so that impact is substantially normal to the plane of said sheet whereby said fibrous sheet is disintegrated into individual fibers;

E. Mixing said fibers with air in said restricted channel with said impacting elements to complete disintegration while maintaining a relatively even fiber density gradient and air flow velocity gradient across the axial width of said channel; and

F. Removing the fiber/air mixture from the disintegrator along a tangent to the direction of motion of said impacting elements at the point of removal to a foraminous support positioned no more than about 3 feet away from said point at which the fiber/air mixture leaves said impacting elements so that said fiber/air mixture retains sufficient kinetic energy imparted thereto by the impacting elements to form an airfelt on said foraminous support, said air passing through said foraminous support and leaving said fibers on said foraminous support in the form of an airfelt.

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