DIFFERENTIAL FIBER DISPERSING ROLLS AND FELTING THEREFROM

Filed Jan. 21, 1963 4 Sheets-Sheet 1

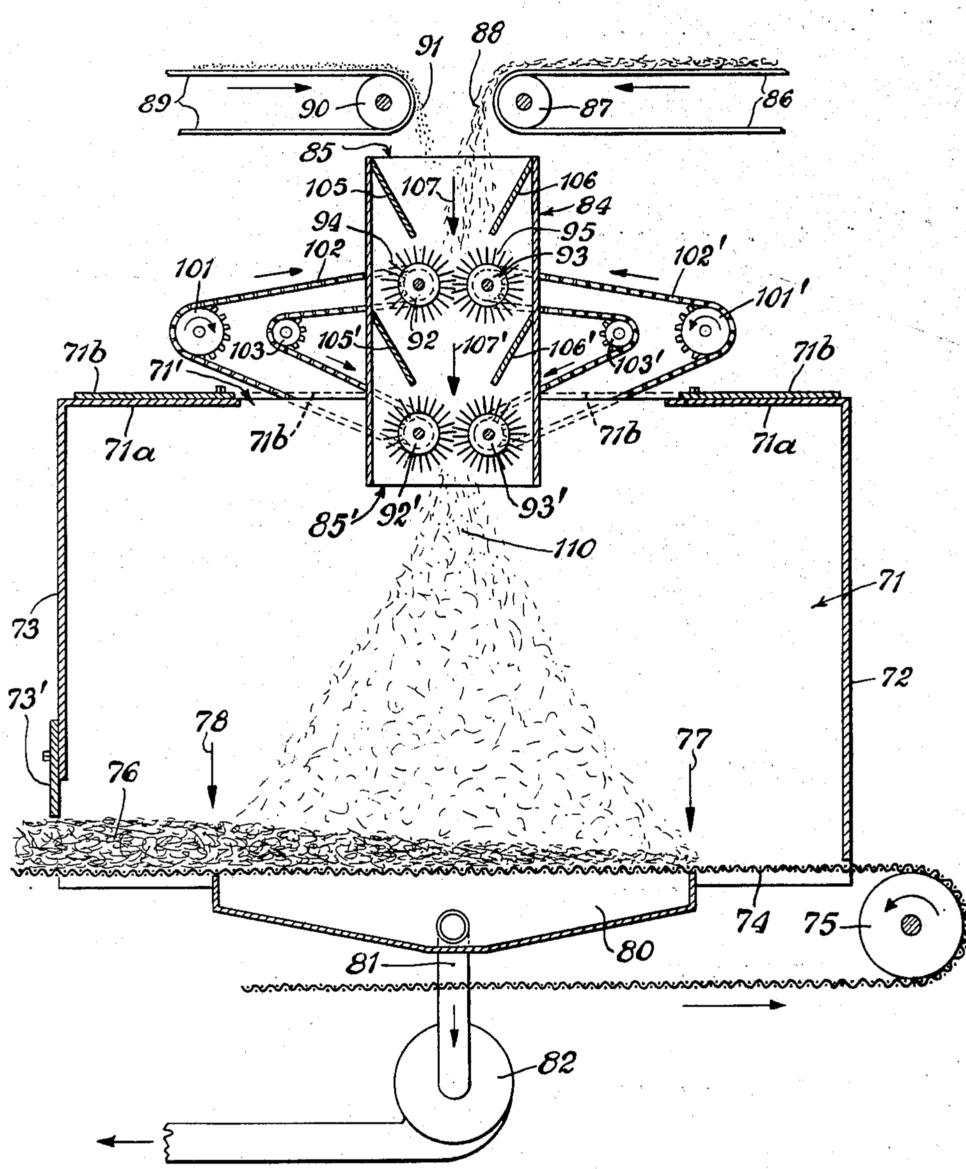

Fig. 1

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May 24, 1966 W. J. OJA 3,252,186

DIFFERENTIAL FIBER DISPERSING ROLLS AND FELTING THEREFROM

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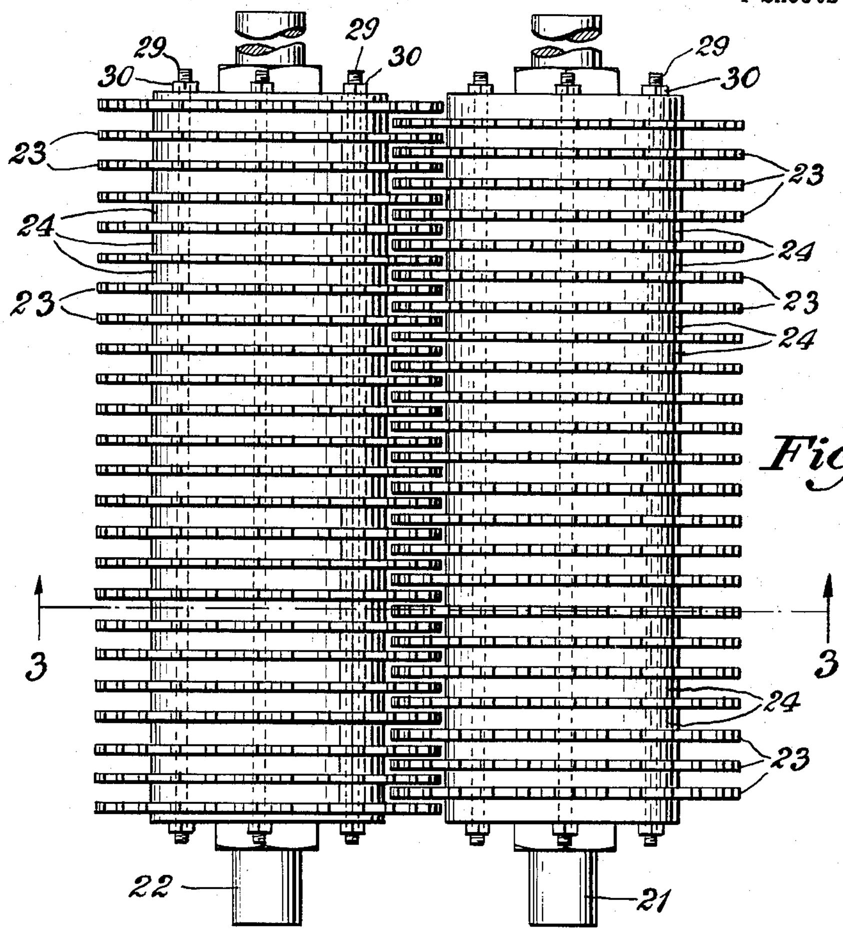

Fig. 2

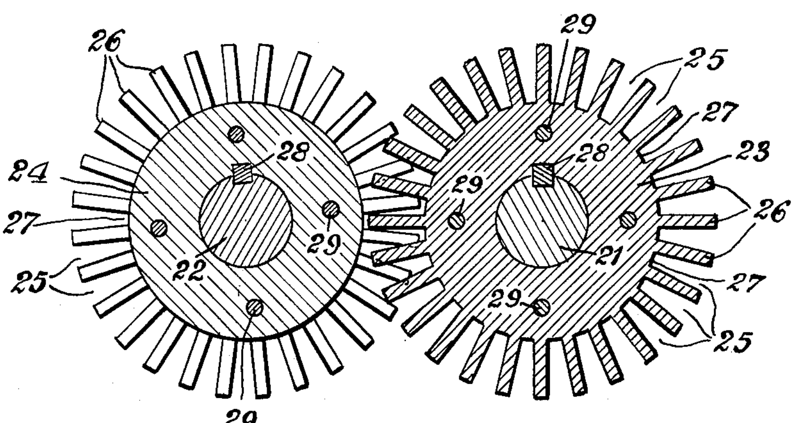

Fig. 3

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DIFFERENTIAL FIBER DISPERSING ROLLS AND FELTING THEREFROM

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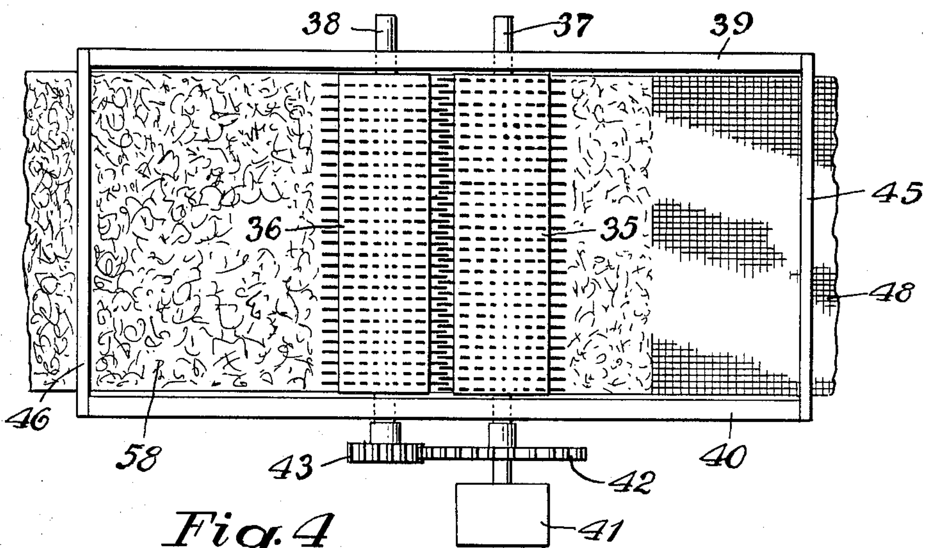

Fig. 4

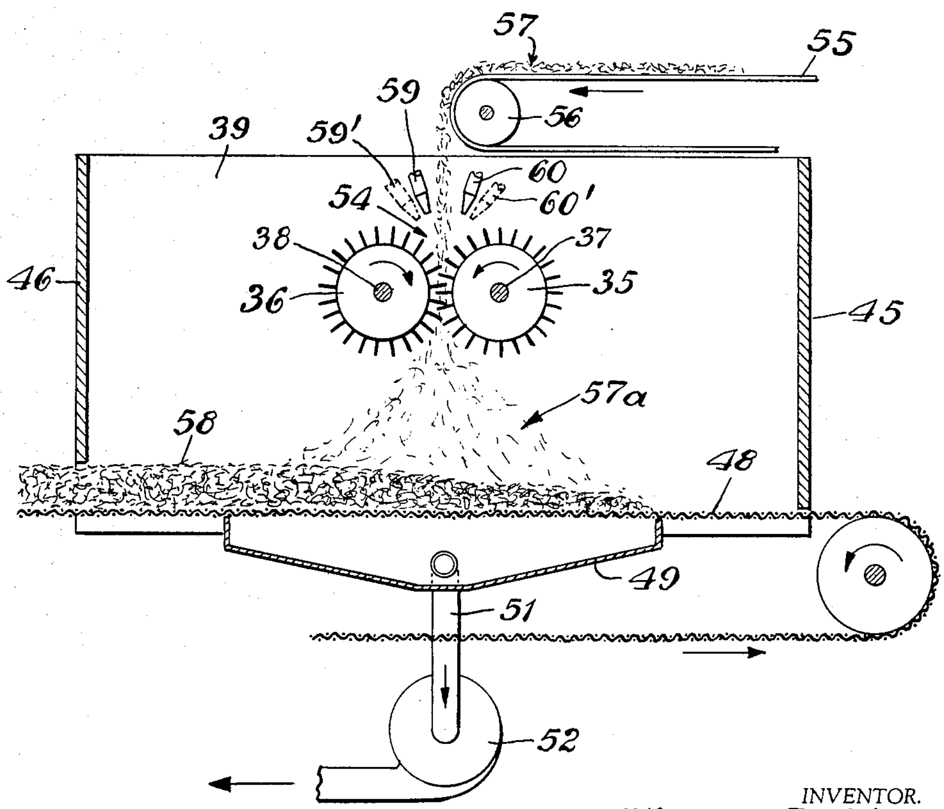

Fig. 5

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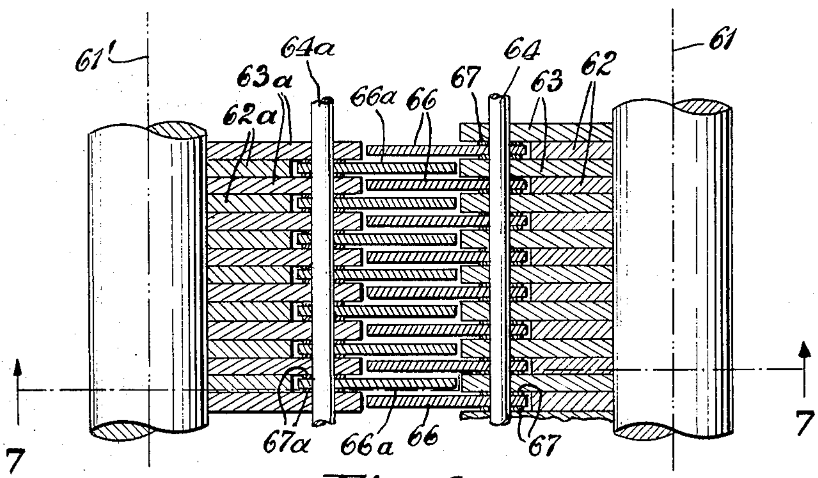

Fig. 6

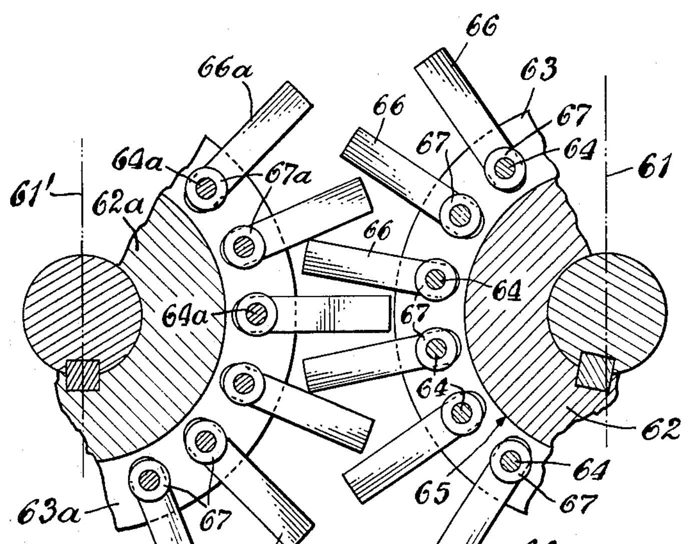

Fig. 7

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3,252,186
DIFFERENTIAL FIBER DISPERSING ROLLS AND FELTING THEREFROM

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4 Claims. (Cl. 19—156.3)

This application is a continuation-in-part of application Serial No. 767,050, filed October 1, 1958, now abandoned.

The present invention relates generally to dispersing fibrous material for various purposes, such as felting, and to apparatus therefor.

In making felts by collecting fibers from a dispersion thereof in air, there are mechanical difficulties in forming and maintaining the desired degree of individualization of the fibers and also continued uniformity of dispersion so that in collecting the fibers as a felt on a moving conveyer a uniform felt is produced.

The present invention provides a mechanical disperser for discharging fibers for felting, or for other uses of a dispersion. Preferably, such a disperser is most useful to discharge into a chamber or other space to form a stream which expands from the delivery end of the disperser. This is in contrast to delivering dispersed fibers into a conduit for conveyance, in which conduit clotting is induced.

It is an object of the invention to provide a first-toothed rotor to receive and hold fibrous material, and to provide in combination therewith a second and intermeshing toothed rotor of which the teeth rake through the teeth of the first rotor.

It is a further object of the invention to employ such a disperser having differential peripheral-speed rolls as the feeder of dispersed fibers to a fiber-collecting member for forming a felt.

Various other and ancillary objects and advantages will become apparent from the following description and explanation of several embodiments of the invention illustrated in the accompanying drawings, in which:

FIG. 1 is a cross-section of dispersing rotors in a housing which discharges fibers and air from the rotors into a depositing chamber to form a felt on an endless conveyer which when foraminous may move over a suction box.

FIG. 2 is a plan view of two rotors each having two sets of plates one with projecting fingers so arranged as to intermesh with fingers of the opposite rotor.

FIG. 3 is a cross-section taken on the line 3—3 of FIG. 2.

FIG. 4 is a fragmentary plan view of a felting chamber in which rotors of the present invention are mounted.

FIG. 5 is a vertical cross-section of a chamber such as indicated in FIG. 4.

FIG. 6 is a cross-section of two intermeshing rotors similar to those of FIG. 3, but modified so that the projecting fingers are swinging hammers.

FIG. 7 is a fragmentary cross-section taken on the line 7—7 of FIG. 6.

In general, the disperser involves two rotors having parallel axes, each with an axial roll or mandrel from which a multiplicity of elements projects. The elements of the two rotors are arranged to intermesh or by-pass during rotation, and in certain types of rotors, they are so constructed and arranged that the ends of the elements of each rotor just clear the periphery of the axial roll or mandrel of the other in a manner to prevent accumulation of fibrous material at the periphery of the roll. In operation, the rotors turn in opposite directions, thereby providing a receiving nip for fibrous material to be individualized within the space of the intermeshing elements for discharge of a dispersion of fibers from the other side of the nip.

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In order to accomplish the desired result, one set of elements rakes through the other, and to that end the raking set has the greater peripheral velocity. When the rotors are duplicates in structure one must rotate at a higher speed. In a case where the raking rotor has a larger diameter than the other, the difference in size may be such that they can revolve at the same or different angular velocities. For the best results, the greater the differential in peripheral velocities of the rotors, the better the dispersion and the greater the production.

Consider two identical rotors rotating at identical speeds, each provided with projecting elements intermeshing and by-passing as described. In such case the elements of each rotor pass through the elements of the other, crossing in the middle, each set raking through the other in the direction of movement into the nip. Where fibrous material is fed to such a nip it is more fed through the nip than dispersed, although there may be a slight degree of dispersion. The present invention contemplates that only one set of elements rake through the other set in the direction of movement through the nip. The action may be visualized by considering one rotor as stationary and the other rotating to rake through it. When a mass of fibrous material is placed in the nip it will be picked away by the rotating rotor and dispersed until the mass is gone. By continuously rotating the supposed stationary rotor, slowly relative to the said moving rotor so as to maintain the same raking action, the process may be made continuous. The faster the two rotors are revolved while maintaining the same relationship, the greater is the capacity of the two rotors to disperse.

In operation, the speed of the slower rotor in part predetermines the rate of feed for a given result, but in so doing, it calls for a greater speed of the faster elements as the speed of the slower elements is increased.

The character of the intermeshing elements may vary widely in accordance with the type of fibrous material fed into them. For loose bulks of fibers the elements may be long and flexible, like brush bristles. For felting pulp laps and other dense fibrous material, the elements may be strong and rigid ones, unyielding in their relation to the mandrel or roll which carries them.

The elements on each rotor may be in ordered or unordered arrangement. In the case of rigid elements, whether fixed relative to their mandrel, or movable peripherally relative thereto, like swinging hammers, they must be arranged to avoid destructive collisions in rotating. Where the elements are relatively long and flexible and rigidly mounted, they may strike and pass each other in rotation, as described hereinafter with reference to FIG. 1.

FIG. 1 shows a deposition chamber **71** which may be open at the top, and which has end walls **72** and **73**. Through the bottom of the chamber passes an endless fiber-collecting conveyor **74**, running over roll **75** outside the chamber. A fiber mat **76** is shown as a felt formed on the conveyor, the first fiber depositing in the vicinity of location **77**, and the last fibers depositing in the vicinity of location **78**. End wall **72** terminates just above conveyor **74** and end wall **73** terminates well above the conveyor **76** and is provided with an adjustable extension or gate **73'** which is positioned to terminate just above the particular felt **76** being formed.

When suction is desired to assist in the felting operation, the conveyor **76** is made foraminous, for example, being a woven wire screen, beneath which is a suction box **80** connected by conduit **81** to a suction fan **82**. The suction area has an extent indicated by the locations **77** and 78, because when suction is employed it predetermines these locations.

Fiber-dispersing means is provided within a housing 84 having closing side walls and an open entrance end 85 and open exit end 85'. Housing 84 is located near the top of the deposition chamber and well above the conveyor 74 to allow spreading of the stream discharged from the housing. As shown, the housing projects into a large opening 71' in the top wall 71^a of chamber 71, the portions of the opening 71' laterally of the housing serving to vent air from the chamber when suction is not employed.

At the open top 85 of the housing means is provided to feed fibrous material to be dispersed for felting, and means to feed other material to be deposited with such fiber, which other material may be a second kind of fiber or material such as a powder form of binder which can be activated by heat in the felt 76.

A fiber feeding means is shown in the form of an endless feeding belt 86 running over pulley 87. Fed fiber is indicated at 88. A second feeder is shown as endless belt 89 running over pulley 90, and feeding, for example, thermosetting resin powder 91 into the housing 84.

In the housing there is at least one set of dispersing rotors, and preferably two sets, which are constructed, positioned, and operated so that as they disperse fibrous material 88, they also draw in air so as to discharge the dispersed fibers in a stream of air. This air can be vented largely at the open areas 71' when suction is not employed, and when suction is employed the open areas may be sealed off by moving gates 71^b to the dotted-line positions shown.

Crossing the housing 84 are two brush rotors indicated by parallel rolls 92 and 93. Each roll has a brush-forming multiplicity of bristles projecting radially, as indicated by the numerals 94 and 95. The ends of the bristles of each rotor just touch or overlap the path of the ends of the bristles of the other rotor during rotation of the two. The rotors are adjustable toward and away from each other in order to control the extent of overlap and also to compensate for wear. The extent of overlap may be up to 3/16-inch, when the rotors are about 12-inches in diameter.

A duplicating set of rotors is shown below the rotors 92 and 93, as indicated by the numerals 92' and 93'. Rotors 92 and 92' are indicated for operation at slow speed, for example, 5 r.p.m., the rotors 93 and 93' for high speed, for example 960 r.p.m. These relative speeds are not critical, since speeds of 1 and 3600 r.p.m. have been used, and also 5 and 765 r.p.m. Where two sets of rotors are operated, the high speed rotors may be slowed somewhat over the effective high speed for a single set, but must have speed sufficient in connection with the air stream through the housing to effect dispersion of the fiberous material fed to the nip.

Also, the nature of the brush rotors may be varied. When the rotors 92 and 92' are 12-inches in outside diameter, the bristles may be steel wire 0.0140-inch in diameter and 3.25 inches long. When the rotors 93 and 93' are 12-inches in outside diameter, the bristles may be steel wire 0.0118-inch in diameter and 2.75 inches long. The bristles are thickly concentrated on the core where they are mounted, both around the rotor and along the rotor, so that at the cylindrical periphery the free ends are substantially uniformly distributed.

With two sets of brush rotors, a single drive means is provided for rotors 92 and 92', such as a driven gear 101 connected by chain 102 to the two rotors outside the housing 84. Chain 102 passes over adjustable idler gear 103 to permit adjustment of either or both of rotors 92 and 92'. For rotors 93 and 93' a second driving gear 101' is provided with chain 102' and idler gear 103'.

Because the high speed rotor 93 or rotors 93 and 93' act as fans, the desired generation of an air stream through the housing 84 is effected by baffles 105 and 106 extending downward from opposite side walls respectively to the vicinity of the tops of the rotors 92 and 93, thus terminating substantially at the tangent to the rotor which is at right angles to the side wall of the housing. These baffles not only guide fed material to enter the nip 107 of the top set, but cut off up-currents of air along the side walls beneath the baffles. Like baffles 105' and 106' are positioned over the second set of rotors.

The material fed to enter the nip 107 is held by the slow rotor 92 which slowly feeds into the nip. The fast rotor 93 combs fibers from the supply and hurls the fibers and any material 91 away from the nip in a stream of air. When two sets are present the air stream is directed toward nip 107' of the second set, which provides additional velocity of movement into housing 84. The discharged stream 110 spreads as it moves toward conveyer 74. When suction is employed, the impact of felting is greater than without vacuum, thus making a denser felt. By control of the degree of suction the density of the formed felt 76 may be controlled. Also, the adjustment of the gates 71^b when using suction is another factor for control.

FIG. 2 is a plan view of a different set of rotors about 12-inches in outside diameter having rigid fingers as the projecting elements. FIG. 3 is a cross-section of FIG. 2 on line 3—3, showing details of construction. On each of the axles 21 and 22, there is a pile of plates, alternating plates 23 with plates 24. Plates 23 are slotted circular flat disks, with generally radial slots 25 (FIG. 3) of uniform depth of approximately 2 inches to provide uniformly long projecting elements 26 in the form of flat-sided blades. The slots are about ½-inch apart giving fingers of like peripheral dimension. The plates 24 are spacers having peripheries radially coincident with the bottoms 27 of slots 25. Thus, the peripheries of plates 24 extended by the bottom slots 25 constitute, in effect, the periphery of a roll or mandrel from which the fingers project. The plates 23 and 24 and the axles 21 and 22 have keways for locking keys 28, and the plates are drilled with registering holes for a purality of holding rods 29 with tightening nuts 30, four being shown. The spacers 24 are thicker than the slotted plates 23, to permit by-passing during the intermeshing indicated in FIG. 2.

FIGS. 4 and 5 show diagrammatically one use of the dispersing rolls such as those of FIG. 2, it being understood that other forms embodying the principles thereof are indicated as part of the combination. FIG. 4 is a plan view of differential peripheral speed dispersing rotors 35 and 36 with their axles 37 and 38 mounted in suitable frame members 39 and 40, which may be side walls of a deposition chamber shown in FIG. 5. To illustrate means for securing differential peripheral speed, the axles 37 and 38 outside the frame 40 are geared together and driven by power means such as motor 41. Motor 41 drives shaft 37 bearing large diameter gear 42 meshing with small diameter gear 43 on shaft 38.

In FIG. 5, the rotors 35 and 36 are shown mounted in the upper part of a deposition chamber having said side walls 39 and 40 and end walls 45 and 46. In the bottom of the chamber there is a fiber-collecting member, preferably foraminous, and preferably in the form of an endless screen 48 on which to form a felt. A suction box 49 is located under at least a cross-wise portion of the screen 48, which box is connected by conduit 51 to a suction fan 52.

Means is provided for continuously feeding a supply of fibrous material, prefrably at a uniform rate, to the nip 54 of rotors 35 and 36. The character of such means and the character of the fibrous material may vary widely. A suitable form is indicated by the conveyer belt 55 over return roll 56 positioned to drop fiber fluff or fibrous elements 57 into the nip 54. The belt 55 may be part of any well-known volumetric or gravimetric feeder. Discharging fibers in a vehicle of air from a conduit is another well-known method for continuously feeding a supply of loosened fibers at a uniform rate.

As the material enters the nip **54**, the rotors individualize the fibers thereof and project them downwardly in a flaring stream **57a** which forms a felt **58** on the screen **48**. The density of the felt may be controlled by regulating the degree of suction in box **49**, other variables being fixed.

The speed of the rotors creates windage which is effective not only to carry dispersed fibers away from the nip, but also to cause the paths of the fibers to curve generally in the direction of the two rotors, more so in the direction of the faster rotor. This effects expansion of the fiber stream and minimizes clotting. This expansion of the fiber stream is thus predetermined by the rotor speed. In order to control this expansion regardless of the speed of the rotors, one or more streams of air may be injected into the nip along with the fibrous material.

In FIG. 5 two banks of air nozzles are designated **59** and **60**, each shown as having other adjusted positions **59'** and **60'** shown in dotted lines. The directions and strengths of the air jets may be controlled to narrow or to widen the angle of dispersion otherwise resulting from the speed of the rotors, and also to direct the flaring stream, more forward or rearward in relation to the direction of the moving conveyer. The generation of windage by the rotors, and also the use of injected air, make it desirable to employ suction at sufficient capacity to draw in all the air of windage and injection, and preferably more in order to prevent delivery of dispersed fiber in directions other than toward the screen **48**.

The invention is not limited to the structures described above. For example, the rigid fingers of FIGS. 2 and 3 may be swinging hammers, such as those found in hammer mills. Of course, for the present invention, they are differently assembled in the two rotors for the intermeshing described.

FIGS. 6 and 7 show one way in which this may be accomplished. Each rotor consists of a stack of circular plates alternating in smaller and larger diameters. One rotor is designated with axis **61**, having the smaller disk **62** and the larger disk **63**. A plurality of tie rods **64** pass through the outer plates beyond the peripheries **65** of the inner plates, to serve as pivotal mountings for hammers **66**. The hammers **66** mounted about the axis **61**, extend outwardly almost to the peripheries of the larger disk **63a** on the companion rotor having the axis **61'**.

In order to avoid collision of opposite hammers, they are made slightly thinner than the thickness of plates **62** and **62a**, and about the rods **64** and **64a** there are spacer rings **67** and **67a**.

The peripheral speeds of the rotors and the relative speeds thereof depend on many factors, such as the character of the fiber supply **57**, the desired rate of producing the felt, and the structure of the rotors **35–36**.

For example, in one case the rotors are of the type shown in FIG. 2, with slotted plates **23** 12-inches in diameter and ⅛-inch thick, with spacer disks **24**, with the fingers **26** at 12°-spacing, 0.5-inch wide in the circumferential direction and of uniform cross-section ½ x ⅛-inches. These rotors as conveniently mounted have a speed range of 870 to 3600 r.p.m., such range being the result of mechanical selections rather than of process limitations. They are also arranged so that either one may rotate up to three times as fast as the other. Thus, in the arrangement disclosed in FIG. 4, when rotor **36** rotates at 2700 r.p.m., rotor **35** will rotate at 900 r.p.m.

In operation in an assembly having a deposition chamber and differential rolls, such as shown in FIG. 5, sulfite fiber is fed to the rolls at the rate of about 100 lbs. per hour. The conveyer screen was advanced at about 8 to 10 feet per minute. Suction under the screen aided in directing the fibers to the screen and in felting them to a density controlled by the degree of impact in part predetermined by the degree of suction.

When a liquid adhesive for bond is desired, such as a starch sol, it may be sprayed in from nozzles entering holes in the side walls of the depositing chamber, preferably at low levels near the top of the forming felt, in order to avoid adhesion of the side walls at higher levels, where festoons could otherwise form.

The formed mat leaving the deposition area may be removed from the screen, provided it has strength to permit it, or if not, it may be compressed sufficiently to give it the necessary strength. Such processing for various uses of the felt is well known in the fiber-deposition field.

I claim:

1. Apparatus comprising two parallel generally cylindrical rotors on parallel axes for dispersing and individualizing fibers from a supply of fibrous material delivered into a nip formed by said rotors, supply means positioned continuously to feed a supply of loosened fibers into said nip to be dispersed thereby, means to rotate one of said rotors on its axis in a direction to feed material through the nip, means to rotate the other rotor in the opposite direction, each rotor having an inner cylindrical axial roll spaced from a corresponding cylindrical axial roll of the other rotor, and each rotor having a multiplicity of elements projecting outwardly from its roll, the ends of the elements of each roll terminating in positions substantially at the periphery of the other roll during rotation, the elements of each rotor being arranged in spaced peripheral alinements alternating in axial positioning from one roll to the other so that peripheral elements of each roll travel in paths between paths traveled by the elements of the other roll, said means for rotating the rotors being so related that only one set of elements rakes through the other set in the direction of movement of the fibrous material through the nip, whereby during rotation said one set of elements disperses material held by the other set of elements, a foraminous fiber-collecting conveyor spaced from the discharge side of the nip directly to receive fibers discharged from the nip and for forming a felt thereon, means positioned laterally of the path of the loosened fibers from said supply means to inject at least one stream of air into the nip of the rotors, and means providing suction on the non-collecting side of said foraminous conveyor and having capacity to draw in at least all of the air injected into said nip.

2. Apparatus according to claim **1** in which the position of the air-injecting means is adjustable to predetermine the direction of injected air whereby to control the expansion of the stream of fiber dispersed by the rotors.

3. Apparatus comprising two parallel generally cylindrical rotors on parallel axes for dispersing and individualizing fibers from a supply of fibrous material delivered into a nip formed by said rotors, supply means positioned continuously to feed a supply of loosened fibers into said nip to be dispersed thereby, means to rotate one of said rotors on its axis in a direction to feed material through the nip, means to rotate the other rotor in the opposite direction, each rotor having an inner cylindrical axial roll spaced from a corresponding cylindrical axial roll of the other rotor, and each rotor having a multiplicity of elements projecting outwardly from its roll, the ends of the elements of each roll terminating in positions substantially at the periphery of the other roll during rotation, the elements of each rotor being so mounted as to let pass the elements of the other rotor in rotation of the rolls, said means for rotating the rotors being so related that only one set of elements rakes through the other set in the direction of movement of the fibrous material through the nip, whereby during rotation said one set of elements disperses material held by the other set of elements, a foraminous fiber-collecting conveyor spaced from the discharge side of the nip on which to gather the discharged fibers as a felt, means to inject at least one stream of air into the nip, and means providing suction on the non-collecting side of said foraminous conveyor and having capacity to draw in at least all the air injected into said nip.

4. Apparatus comprising two parallel generally cylindrical rotors on parallel axes for dispersing and individualizing fibers from a supply of fibrous material delivered into a nip formed by said rotors, supply means positioned continuously to feed a supply of loosened fibers into said nip to be dispersed thereby, means to rotate one of said rotors on its axis in a direction to feed material through the nip, means to rotate the other rotor in the opposite direction, each rotor having an inner cylindrical axial roll spaced from a corresponding cylindrical axial roll of the other rotor, and each rotor having a multiplicity of elements projecting outwardly from its roll, the ends of the elements of each roll terminating in positions substantially at the periphery of the other roll during rotation, the elements of each rotor being so mounted as to let pass the elements of the other rotor in rotation of the rolls, said means for rotating the rotors being so related that only one set of elements rakes through the other set in the direction of movement of the fibrous material through the nip, whereby during rotation said one set of elements disperses material held by the other set of elements, a foraminous fiber-collecting conveyor spaced from the discharge side of the nip on which to gather the discharged fibers as a felt, independent means to inject a plurality of streams of air into the nip, said independent means being adjustable in position to predetermine the direction of its injected air stream, whereby said independent means may control the expansion of the stream of fiber dispersed by the rotors.

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