Dec. 22, 1959 A. L. THOMAS, JR., ET AL 2,917,787

PROCESS AND APPARATUS FOR PRODUCING NON-WOVEN SHEETS OF FIBROUS MATERIALS

Filed March 20, 1956 2 Sheets-Sheet 1

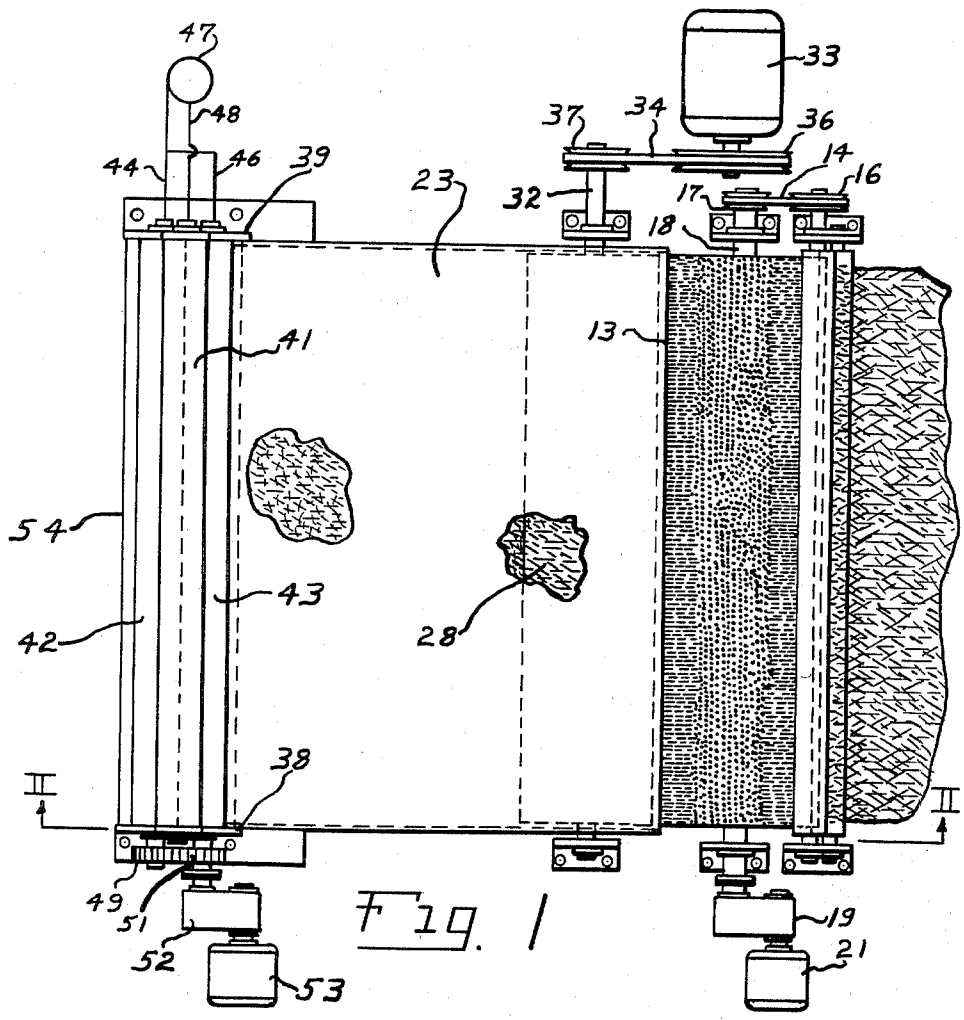


Fig. 1

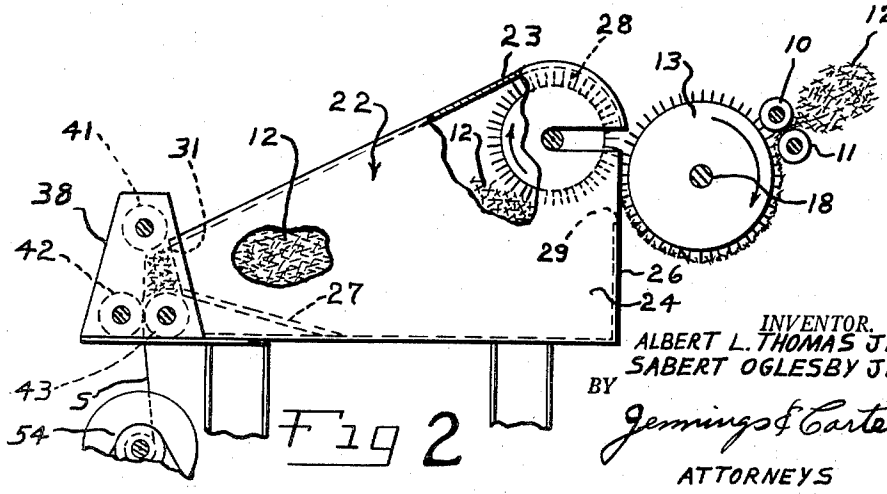


Fig 2

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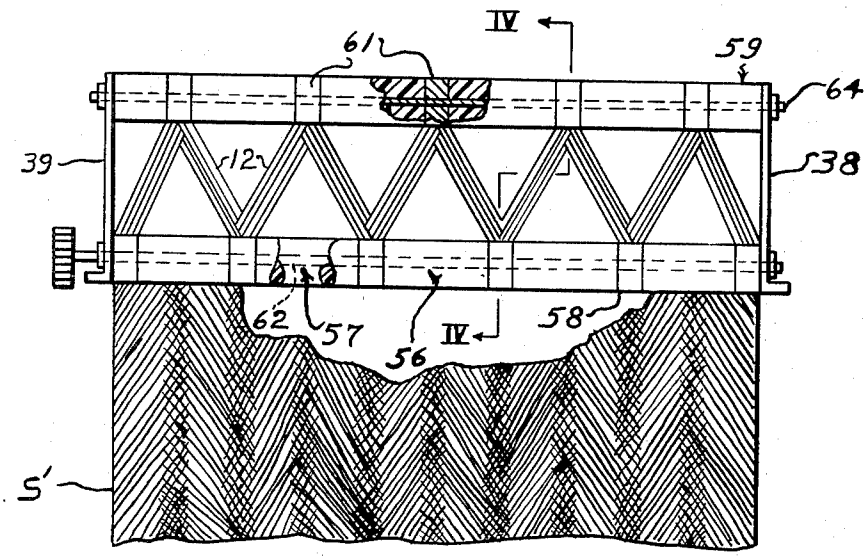


Fig. 3

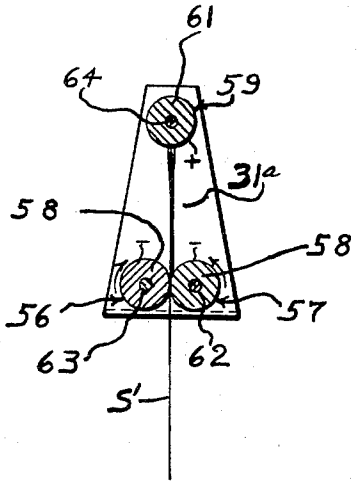


Fig. 4

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PROCESS AND APPARATUS FOR PRODUCING NON-WOVEN SHEETS OF FIBROUS MATERIALS

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3 Claims. (Cl. 19—155)

This invention relates to a process and apparatus for the production of sheets of fibrous materials in which fibers, such as cotton or the like, are gathered together and formed into a sheet without going through the conventional weaving process, and relates generally to the type of process and apparatus described and claimed in our Patent No. 2,711,626 entitled, "Method and Apparatus for Collecting Fibrous Materials, and Forming it into a Strand."

An object of our invention is to form cotton or like fibers into a sheet of material by introducing the fibers, while in a highly separated condition, into an elongated electro-static field axially as wide as the length of the fibers and of a potential to cause the fibers to collect generally in axially parallel relation to each other and to the electro-static field, and then withdrawing the fibers in sheet form generally parallel to the direction of the field.

A more specific object of our invention is to provide elongated parallel electrodes which are spaced from each other a distance slightly greater than the average length of the fibers whereby the fibers parallel themselves between the elongated electrodes and may be readily removed in sheet form.

A further object of our invention is to provide apparatus of the character designated in which means is associated with one of the electrodes whereby the fibers are withdrawn in sheet form axially out of the electrostatic field in timed relation to the collection of the fibers in the field.

A further object of our invention is to provide a process and apparatus for producing sheets of fibrous materials in which there is controlled orientation of the fibers within the sheet, thereby controlling the strength of the sheet in selected directions.

A still further object of our invention is to provide a process and apparatus of the character designated in which the individual fibers or groups of fibers extend at an angle to other groups of fibers.

Heretofore in the art to which our invention relates, it has been the general practice to form non-woven sheets of cotton and like fibers by various means such as matting, blowing the fibers against perforated drums, screens and the like. Such processes for producing non-woven sheets generally are wasteful of fiber due to lack of uniformity of weight of the sheet. The sheets lack uniformity of strength, and the rate of production is relatively low. Further, preliminary preparation of the fiber such as carding it as practiced in some prior processes is expensive. As is well known, repeated operations on cotton fiber reduce the natural concatenation of the fiber and consequently reduce the strength and life of the cloth made therefrom, whether woven or non-woven.

To overcome these and other difficulties, we provide a process and apparatus for forming a non-woven sheet of fibrous material directly from the fibers by passing a stream of airborne fibers through an elongated electrostatic field of such potential as to cause the fibers to

assume a substantially parallel relationship relative to each other and to the field, and then withdrawing the fibers in sheet form generally axially of the field. To add further strength to the material, alternately spaced electrodes may be provided to form the sheet of material, whereby the orientation of the fibers within the sheet may be controlled to obtain added strength in certain directions.

Apparatus illustrating features of our invention and which may be employed to carry out our improved process is illustrated in the accompanying drawings, forming a part of this application, in which:

Fig. 1 is a plan view, certain parts being broken away, showing our invention in operation;

Fig. 2 is a sectional view taken generally along the line II—II of Fig. 1, partly broken away and in section; and,

Fig. 3 is a detail view showing a modified electrode arrangement which provides for controlled orientation of the fibers within the sheet; and,

Fig. 4 is a detail sectional view taken along line IV—IV of Fig. 3.

Referring now to the drawings for a better understanding of our invention, we show a pair of feed rolls 10 and 11 between which a bat of fibers, such as cotton fibers 12, may be fed from any suitable source. The fibers from the rolls 10 and 11 pass onto a wire surfaced roller 13 which may be similar to the usual licker-in of a card, or, may be in the form of individual wires projecting from the surface of the roll. The uppermost roll 10 may be driven by means of a belt 14 and pulley 16 from a pulley 17. The pulley 17 is mounted on a shaft 18 which supports the roller 13. As shown in Fig. 1, the shaft 18 is driven through a reduction gear box 19 by means of a motor 21.

Mounted adjacent the roller 13 is the rear end of a housing or chamber indicated generally by the numeral 22 which comprises an upper curved wall 23, side walls 24, a rear wall 26 and a bottom wall 27 which slopes upwardly toward the forward end thereof. Mounted within the housing 22 adjacent the curved upper wall 23 is a doffing brush 28 which contacts the adjacent surface of the wire surfaced roller 13 to remove the fibers 12 therefrom. As is well understood, the brush 28 delivers the fibers 12 from the roller 13 either as individual fibers or as relatively small groups of fibers. A suitable slot 29 is provided in the rear wall 26 permitting contact between the brush 28 and the roller 13 whereby the fibers 12 are introduced into the housing 22. As is also understood, the rotation of brush 28 generates sufficient air blast to entrain the fibers and cause them to move to the forward end of the chamber, opposite from the slot 29. An elongated discharge slot 31 is provided at the forward end of the housing 22 and is defined between the bottom wall 27, the upper wall 23 and the side walls 24.

As shown in Fig. 1, the brush 28 is supported in suitable bearings on a transverse shaft 32. The shaft 32 is driven by a motor 33 through a belt 34 and pulleys 36 and 37.

Mounted at the sides of the housing 22 adjacent the forward end thereof are upstanding brackets 38 and 39 which are formed of a suitable insulating material. Mounted between the brackets 38 and 39 adjacent the upper edge of the elongated opening 31 is an elongated rod 41 which forms an electrode for the apparatus. Mounted for rotation between the brackets 38 and 39 adjacent the lower edge of the opening 31 are elongated rollers 42 and 43 which together form the other electrode for the apparatus. Preferably, the electrode 41 is spaced from the electrodes 42 and 43 a distance equal sub-

stantially the average length of the fibers 12. Wires 44 and 46 lead from the electrodes 42 and 43 and are connected to one side of a suitable source of static potential indicated diagrammatically at 47. A wire 48 connects the electrode 41 to the other side of the source of static potential, as shown.

The electrodes 41 and 42—43 are formed of a suitable conducting material and extend the entire length of the elongated opening 31, whereby the fibers 12 collected between the electrodes in generally parallel relation to each other.

The rollers 42 and 43 are operatively connected to each other by means of meshing gears 49 and 51, respectively, whereby they rotate oppositely and at substantially the same speed. Gears 49 and 51 are rotated through a reduction gear box 52 from a motor 53. Mounted beneath the electrode 42—43 is a take up drum 54 which is driven in timed relation to the gears 49 and 51 by means of the motor 53 and reduction gear box 52, whereby the sheet delivered from between the rollers is broken up as fast as it is delivered.

From the foregoing description, the operation of our improved process will be readily understood. The fibers 12, such as cotton fibers, are fed in bat form or otherwise to the feed rolls 10 and 11 where they are dispersed into small groups of fibers or individual fibers by the wire surfaced roller 13. As the fibers enter the housing 22 they are placed in an airborne stream by the doffing brush 28. With a potential across the elongated electrodes 41 and 42—43 sufficient to span the air gap therebetween, the fibers emerging through the discharge opening 31 are separated from the stream of air bearing them along and collect in parallel relationship to each other between the electrodes. With the motors in operation at the proper speed, the fibers are blown in sufficient quantity into the chamber and collected between the electrodes to form a generally uniform sheet. That is to say, the motor 53 is operated in timed relation to the collection of fibers between the electrodes whereby the takeup roll 54 withdraws the sheet, indicated at S, continuously, as sufficient fibers to form a sheet collect between the electrodes. Consequently, by proper speed regulation and by properly regulating the feed to the rollers 10 and 11, we provide a continuous process for forming a non-woven sheet and withdrawing the same from the apparatus, all of which is carried out in timed relation to the collection of the fibers between the electrodes. It will be seen, also, that the fibers enter between the electrodes generally normally of the plane of the electrostatic field, there to be collected. The sheet is withdrawn substantially axially of the field as it is formed. Thickness or weight per square yard of the sheet can be closely controlled by varying the ratio between the rates of delivery of fibers and removal of the sheet.

In forming a sheet of fibrous material from the usual cotton fibers, the electrodes 41 and 42—43 should be placed approximately 1⅛ inch apart, as measured from the bottom of rod 41 to the nip between rollers 42—43. A static potential of approximately 20,000 volts, depending upon the usual factors of humidity, and the like, is ordinarily sufficient to cause the fibers to collect in parallel relationship between the electrodes.

Referring now to Figs. 3 and 4 of the drawing, we show a modified arrangement of electrodes. Mounted for rotation between the upstanding brackets 38 and 39 are elongated cylindrical members such as rollers 56 and 57 having longitudinally spaced annular electrodes 58 mounted thereon. Preferably, the electrodes 58 are in the form of rings of conducting material. Mounted on the upstanding brackets 38 and 39 above the elongated members 56 and 57 is an elongated member 59, which may also be cylindrical. On the elongated member 59 are longitudinally spaced annular electrodes 61 which are spaced substantially equidistant between the electrodes 58 on the cylindrical members 56 and 57. The cylindrical members 56, 57 and 59 are formed of a non-conductive material. The electrodes 58 are connected to the shafts 62 and 63 for the cylindrical members 56 and 57. In like manner, the electrodes 61 are connected to a shaft 64 which supports the elongated member 59. The shafts 62, 63 and 64 are connected to the source of static potential 47, as described hereinabove. The electrodes just described are adapted to be substituted for the electrodes 41 and 42—43 and to be used with the remainder of the apparatus. Cotton or other suitable fibers are fed in bat form into the housing 22 and placed in an airborne stream by the doffing brush 28 as described above. As the fibers pass through the elongated discharge opening 31*a* between the electrodes 58 and 61, groups of fibers parallel themselves between adjacent electrodes, as clearly shown in Fig. 3. That is, the fibers 12 extend between the electrodes 61 and the adjacent electrodes 58, but in an angular direction relative to the direction of travel of the sheet as it is removed. With the fibers 12 thus orientated, they are withdrawn by the elongated rollers 56 and 57 in sheet form with the fibers lying at an angle relative to the length of the sheet S' as shown. By so orientating the fibers whereby a uniform pattern of angularly disposed fibers is formed within the sheet S', the strength of the sheet is greatly increased. It will be apparent that the electrodes 58 and 61 may be spaced at different positions along their respective supporting members whereby different patterns may be formed as a result of the different orientations of the fibers.

In carrying out our process trash and other foreign materials carried by the cotton fed to the rolls 10 and 11 have ample opportunity to fall onto the lower rearwardly sloping wall 27 of the housing 22 where they may be removed by any suitable means, not shown. It will be noted that in forming the sheet in accordance with our improved process, very little mechanical working of the fibers is necessary. Accordingly, we preserve the natural tendency of the fibers to twist about themselves, thus increasing the strength of the sheet ultimately made from the fibers. We thus provide a process and apparatus by means of which the fibers may be taken directly from the baled state and converted to a non-woven sheet. Our process and apparatus is especially useful for high speed production of relatively diaphanous or light weight non-woven sheets. It will be understood that the sheet may, if desired, be treated with any suitable plastic or like materials to bind the fibers together and obtain a more coherent sheet.

As used in this specification and in the appended claims, the expression "electro-static field" means either a field which is of substantially constant potential, or one in which the potential does not remain at zero long enough to permit the fibers to lose their charge and fall from between the electrodes.

While we have shown our invention in but two forms, it will be obvious to those skilled in that art that it is not so limited but is susceptible to various other changes and modifications without departing from the spirit thereof, and we desire, therefore, that only such limitations shall be placed thereupon as are specifically set forth in the appended claims.

What we claim is:

1. The process of forming a non-woven sheet of fibrous material which comprises passing a stream of air borne fibers between a pair of elongated electrostatically charged spaced electrodes which extend substantially parallel to each other whereby the air borne stream passes in a direction generally normal to the longitudinal axis of said electrodes, maintaining the electrodes under a potential sufficient to establish therebetween a thin electrostatic field coextensive in length with the electrodes and substantially as wide as the length of said fibers thereby to cause the fibers to parallel themselves in a thin sheet between the electrodes, and withdrawing the col-

lected sheet of fibers generally normal to the direction of movement of the air borne stream and generally parallel to the lines of force extending between the electrodes.

2. In apparatus for forming a non-woven sheet of fibrous material, a pair of elongated rollers extending substantially parallel and in contact with each other, longitudinally spaced annular electrodes on said rollers extending in planes substantially normal to the longitudinal axis of said rollers, other electrodes between said annular electrodes and spaced therefrom a distance approximately the length of the fibers, means to impress a potential upon said electrodes of a magnitude to establish an electro-static field between said annular electrodes and said other electrodes, means to pass the fibers in a loose state between said annular electrodes and said other electrodes

whereby they collect therebetween in generally parallel relation to each other, and means rotating said rollers whereby the fibers are withdrawn in sheet form.

3. Apparatus as defined in claim 2 in which the electrodes are of conductive material and annular in shape, with said other electrodes positioned adjacent the longitudinal center of the electrodes carried by the rollers.

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