

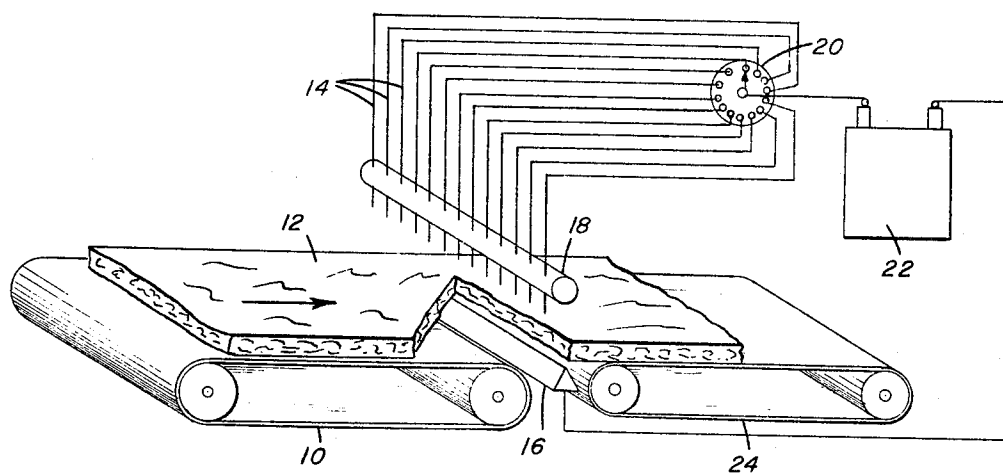
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METHOD OF PREPARING NON-WOVEN FABRICS

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**METHOD OF PREPARING NON-WOVEN FABRICS**  
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This invention relates to non-woven fabrics, and particularly to a method of preparing non-woven fabrics of high loft and low density.

Non-woven fabrics are often prepared from a commingled mass of structural fibers and heat fusible binder material. A web is first prepared which is comprised of heat fusible binder material such as thermoplastic resin, in either fibrous form or particulate form, and structural or base fibers. The heat fusible binder material is substantially uniformly distributed throughout the web. The web is then heated to fuse or melt the heat fusible binder material, and a multitude of small molten globules are formed which tend to migrate to points where two or more structural fibers make contact. Upon cooling, the globules form bonds at the many points where they contact the structural fibers.

Prior art heating methods have not always produced satisfactory bonding results. Owing to the inherent heat insulating properties of the prepared web, it has been difficult to obtain satisfactory heat transfer to the heat fusible binder material disposed within the interior portion of the web. Thus, a substantial proportion of the heat-fusible binder material in the interior of the web is either not fused at all or is inadequately fused and, as a result, does not perform its intended bonding function. The exterior portions of the resulting non-woven fabric are usually bonded to a satisfactory degree while the interior portion is not and consequently, the structural fibers of which the non-woven fabric is comprised are not uniformly bonded throughout. Pressure has been applied during heating or immediately thereafter in an effort to overcome this non-uniform bonding of the structural fibers. The application of pressure is not desirable in the preparation of bonded non-woven fibrous sheet material of high loft.

This invention is directed to a novel method of treating a web comprised of structural fibers and heat fusible binder material whereby the heat fusible material is substantially all fused in a uniform manner and there is produced a well bonded non-woven fabric or fibrous sheet of high loft and low density, the bond strength being substantially uniform throughout the fabric.

For a complete understanding of this invention reference is made to the following detailed description and drawing, in which the single figure shows apparatus adapted for carrying out this invention.

In accordance with this invention an unbonded fibrous web comprised of structural fibers and a heat fusible binder material, either in fibrous form, particulate form, or both, and having a melting point at least about 20° C. below the melting point of the structural fibers, is prepared by methods known in the art. Methods of forming an unbonded fibrous web are well known in the art and include carding, garnetting, air deposition, fluid paper making techniques and the like.

The prepared web is subsequently passed under or conveyed beneath a plurality of electrodes emitting visible high voltage discharges hereinafter referred to as electrical sparks. The sparks pass through the fibrous web. The potential of the discharge is adjusted to provide electrical sparks that possess sufficient thermal characteristics so as to fuse or melt the heat fusible binder material disposed within their path. The electrical sparks pass

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through the fibrous web to an electrode disposed on the side of the web opposite the discharge electrodes. The heat fusible binder material located in the interior portion of the web and the heat fusible binder material located on the exterior portion of the web opposite the discharge electrodes are heated to substantially the same degree as the heat fusible material located at or near the surface of the web disposed on the side adjacent the discharge electrodes.

Referring to the drawing there is shown apparatus suitable for carrying out this invention. The apparatus is comprised of an endless conveyor belt 10 adapted to convey a fibrous web 12 between a plurality of discharge electrodes 14 and lower electrode 16. The discharge electrodes 14 are supported in spaced relation by means of electrically insulating member 18. The discharge electrodes are electrically connected to a rotary contractor 20, which in turn is electrically connected to a high voltage source 22. Endless conveyor belt 24 conveys the treated web away from the treating area where it can be wound onto a mandrel, cut to desired lengths, or otherwise handled for storage or subsequent shipment.

The apparatus shown in the drawing is adapted for continuous manufacture of bonded non-woven fibrous sheet material having high loft and low density. In operation, an unbonded fibrous web comprised of structural fibers and heat-fusible binder material, in fibrous form, particulate form, or both, having a melting point of at least about 20° C. below the melting point of the structural fibers is passed continuously between discharge electrodes 14 and lower electrode 16. Electric potential is supplied from high voltage source to rotary contractor which is rotated at relatively high speeds by suitable means (not shown) such for example as a high speed motor. By means of the rotary contractor electrical sparks are intermittently discharged from all discharge electrodes 14. In traversing the gap or space between discharge electrodes 14 and lower electrode 16, the sparks pass through the moving fibrous web. The heat from these electrical sparks fuse the heat fusible binder material with which they make contact whereby a multitude of small molten globules are formed which migrate to points where a plurality of structural fibers make contact and upon solidifying serve as a bond of these structural fibers at this point. Owing to the fact that the electrical sparks pass completely through the web substantially all the heat fusible binder material with which they make contact is substantially uniformly heated to its fusion temperature. The density of discharges per square inch can be adjusted by known means and by so doing various degrees of bonding can be obtained. More binder material will be fused, if a larger number of electrical sparks are passed through the fibrous web thereby providing for more bonding of the structural fibers.

It will be apparent that that portion of fibrous web 12 which has not passed between the electrodes 14 and 16 is unbonded while that portion which has passed between electrodes is a bonded non-woven fibrous sheet material of high loft and low density.

In operation of the apparatus above described suitable high voltage, low amperage conditions are established during operation and can be alternating current potential or direct current potential. The potential employed will depend primarily on the thermal characteristics desired of the electrical sparks emitted from the discharge electrodes which, in turn, will depend on the melting point of the heat fusible binder material employed and the melting point or decomposition temperature of the structural fibers. The potential will be high enough to supply electrical sparks of thermal properties sufficient to fuse the

heat fusible binder material but not sufficient to melt or otherwise affect adversely the properties of the structural fibers. It is well within the skill of those versed in the art, having before them the teachings of this invention, to adjust the potential to provide electrical sparks of desired thermal characteristics to melt or to fuse the specific heat fusible binder material employed. Potentials of from 5,000 to 50,000 volts can be employed, preferably under low amperage conditions of the order of from about 10 milliamperes to 40 milliamperes.

Rotary contactor 20 insures that electrical sparks will be emitted from each of the electrodes. The number of electrodes employed will be sufficient to provide substantial coverage of the web to be treated. The electrodes can be spaced apart any desired distance, usually of the order of from about 2 inches to 4 inches. The distance between the tips of the discharge electrode and lower electrode will depend primarily on the thickness of the web being treated. A distance of about 1 inch will prove satisfactory for  $\frac{1}{8}$  inch thick webs and a distance of about 4 to 6 inches will prove satisfactory for web of a thickness of about 2 to 4 inches.

Structural fibers that are employed in preparing bonded non-woven fabrics employing a heat fusible binder material as a bonding medium therefor, are preferably those having a melting point in excess of about 20° C. of the melting point of the heat fusible material employed. The structural fibers can be the known synthetic resin fibers having the desired melting point, natural fibers, and fibers prepared from inorganic materials. The structural fibers can vary in length from about  $\frac{1}{4}$  inch to as much as 8 inches or more. The preferred length in preparing non-woven fabrics or fibrous sheet material is from about 1 inch to about 3 inches. The denier of the structural fibers can be as great as about 60 denier per filament, but for ease of handling and the greater pliability, toughness, and the like of the bonded non-woven fibrous sheet material prepared therefrom, it is preferred to use fibers of from about  $1\frac{1}{2}$  to 20 denier per filament. Mixtures of structural fibers can be employed. Thus, for example, mixtures of two or more manmade fibers can be used, mixtures of two or more natural fibers can be used, and mixtures of manmade and natural fibers can be used.

Natural fibers suitable for use as structural fibers include wool fibers, cotton fibers, silk fibers, asbestos fibers, and the like.

Artificial or manmade fibers suitable for use in the manufacture of bonded non-woven fibrous sheet material include those prepared by known methods from synthetic resins such as the organic acid esters of cellulose, specific examples being cellulose acetate, cellulose butyrate, cellulose acetate propionate, cellulose triacetate, cellulose acetate butyrate and cellulose propionate; resins comprising copolymers of acrylonitrile such, for example, as a resin comprised of, by weight, 10 parts of methyl acrylate and 90 parts of acrylonitrile, one comprised of, by weight, 5 parts of vinyl acetate, 20 parts of vinylidene chloride and 75 parts of acrylonitrile, and one comprised of, by weight, 10 parts of methyl acrylate, 10 parts of methyl methacrylate, and 80 parts of acrylonitrile; polyester resins such as the polyester derived from 1,4-cyclohexanedimethanol and terephthalic acid in accordance with the method described in Patent 2,901,466, and polyethylene terephthalate; the polyamides such, for example, as nylon 6 (polycaprolactam), nylon 6/6 (polyhexamethylene adipamide), nylon 6/10 (polyhexamethylene sebacamide); polyolefins such as polyethylene and polypropylene; rayon or regenerated cellulose (cellulose xanthate) or often referred to as viscose; and the like.

The heat fusible binder material employed in carrying out this invention can be employed in either fibrous form or particulate form. If it is employed in fibrous form it can be employed in lengths of from about  $\frac{1}{4}$  inch to 8 inches or more. The preferred length of fibers is from about 1 inch to 3 inches. The denier of the potentially

heat fusible binder material can be as great as 60 denier per filament; however, for ease of handling and the like it is preferred to employ fibers having from about 2 to 9 denier per filament.

As above set forth the choice or selection of the structural fibers will in most respects dictate the selection of the heat fusible binder material to be employed in preparing the bonded non-woven fibrous sheet material in accordance with this invention. The heat fusible binder material should be selected so as to have a melting point of at least about 20° C. lower than that of the melting point or decomposition point of the structural fibers employed. Suitable binder materials include polyamides such as polycaprolactam, plasticized cellulose acetate, plasticized ethyl cellulose, saran, polyvinyl chloride, polyethylene, polyurethane, polystyrene, polyvinylidene cyanide, and the like.

The fibrous webs treated in accordance with this invention can be comprised of, by weight, from about 10% to 90% of structural fibers and from about 90% to 10% of heat fusible binder material.

The following examples are illustrative of this invention.

#### Example I

A fibrous web having a weight of 6 ounces per square yard comprised of, by weight, 80% rayon fibers (2 denier per filament, average length about 2 inches) and 20% polyethylene fibers (2 denier per filament, average length about 2 inches) is passed through a discharge zone on apparatus similar to that shown in the single figure of the drawing. The discharge electrodes are spaced apart from one another about 3 inches. A direct current potential of about 20,000 volts at 30 milliamperes is applied to the electrodes. The fibrous web is moved through the discharge zone at a speed of about 10 feet per minute and the rotary contactor is operated at a speed sufficient to provide 1000 electrical discharges per minute. A well bonded non-woven fibrous sheet is produced which retains its initial loft and is bonded to the extent that it can be processed through the normal operations required to form quilted articles without destroying its bonded identity.

#### Example II

A fibrous web having a weight of 5 ounces per square yard comprised of, by weight, 70% of polyester fibers (2 denier per filament, average length 2 inches) and 30% polyethylene fibers (2 denier per filament, average length 2 inches) is prepared. The polyester fibers are prepared from the resinous condensation product of 1,4-cyclohexanedimethanol and terephthalic acid in accordance with the method described in Patent 2,901,466. These fibers are available commercially under the proprietary designation Kodel. The web is treated in a manner similar to that of Example I with the exception that a potential of 25,000 volts at 20 milliamperes is used and the rotary contactor is rotated at a speed to give intermittent discharges at a rate of about 1,500 per minute. The web is moved through the discharge zone at a speed of 15 feet per minute. A well bonded non-woven fibrous sheet of high loft and low density is produced. The bonded non-woven fibrous sheet resists deformation and destruction when put through any of the normal processes for forming quilted articles.

#### Example III

A fibrous web having a weight of 4 ounces per square yard comprised of, by weight, 60% polypropylene fibers (2 denier per filament, average length about 2 inches) and 40% polyethylene fibers (2 denier per filament, average length about 2 inches) is prepared. This web is treated in a manner similar to that of Example I with the exception that a potential of 30,000 volts at 10 milliamperes is used and the rotary contactor is operated at a speed sufficient to provide intermittent discharges at a rate of about 2,000 per minute. The fibrous web is moved

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through the discharge zone at a speed of about 20 feet per minute. A well bonded non-woven fibrous sheet is prepared which shows a break strength in the machine direction of three pounds on a 1 inch wide strip and an elongation of about 80%. A bonded non-woven fibrous sheet prepared by prior art heating methods has only a 1/4 pound breaking strength and a 10% elongation on a same size sample.

#### Example IV

A carded web of rayon is dusted with 20% of its weight of polyethylene powder and treated in a manner similar to that used in Example I, with the exception that a potential of 30,000 volts at 15 milliamperes is applied to the electrodes and the rotary contactor is operated at a speed sufficient to provide intermittent discharges at a rate of about 1,000 per minute. The web is moved through the discharge zone at a speed of about 10 feet per minute. The resulting product is a firmly bonded non-woven fibrous sheet having its original low density. The member has adequate strength and elongation to carry it through all processing operations required for the manufacture of insulated weaving apparel.

Bonded non-woven fibrous sheets prepared in accordance with this invention have sufficient tensile characteristics that they can withstand not only use, but also 20 and more dry cleanings or washings without losing their bonded identity.

It is to be understood that the above description and drawing are illustrative of this invention and not in limitation thereof.

I claim:

1. A method of preparing a bonded non-woven fibrous sheet comprising the steps of forming a heat fusible binder material and fibers into a mat, placing said mat

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between at least two high voltage electrodes, and producing high voltage electrical sparks between said high voltage electrodes and through said web thereby inducing internal heating of said web so that the heat fusible binder material is cured thus producing a bonded non-woven fibrous sheet.

2. A method in accordance with claim 1 wherein the thermal energy of said high voltage electrical sparks is sufficient to fuse said heat fusible binder material without affecting adversely the properties of said fibers.

3. A method in accordance with claim 2 in which said fibers in said mat have a melting point in excess of about 20° C. of the fusing point of said heat fusible binder material.

4. A method in accordance with claim 3 in which said heat fusible binder material is polyethylene.

5. A method in accordance with claim 1 wherein the mat is continuously passed between said high voltage electrodes.

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