

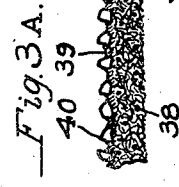
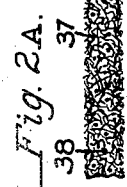
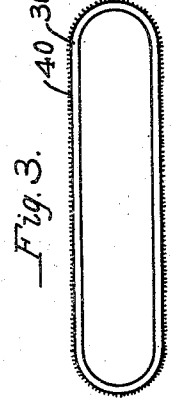
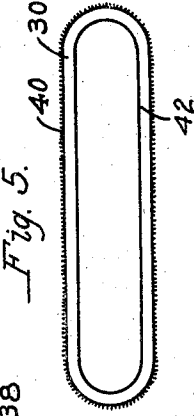
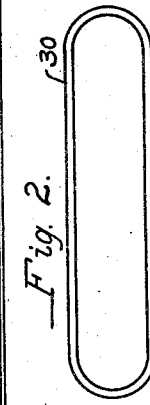
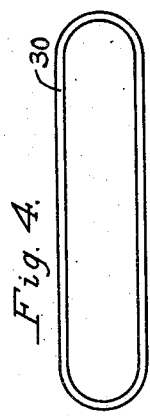
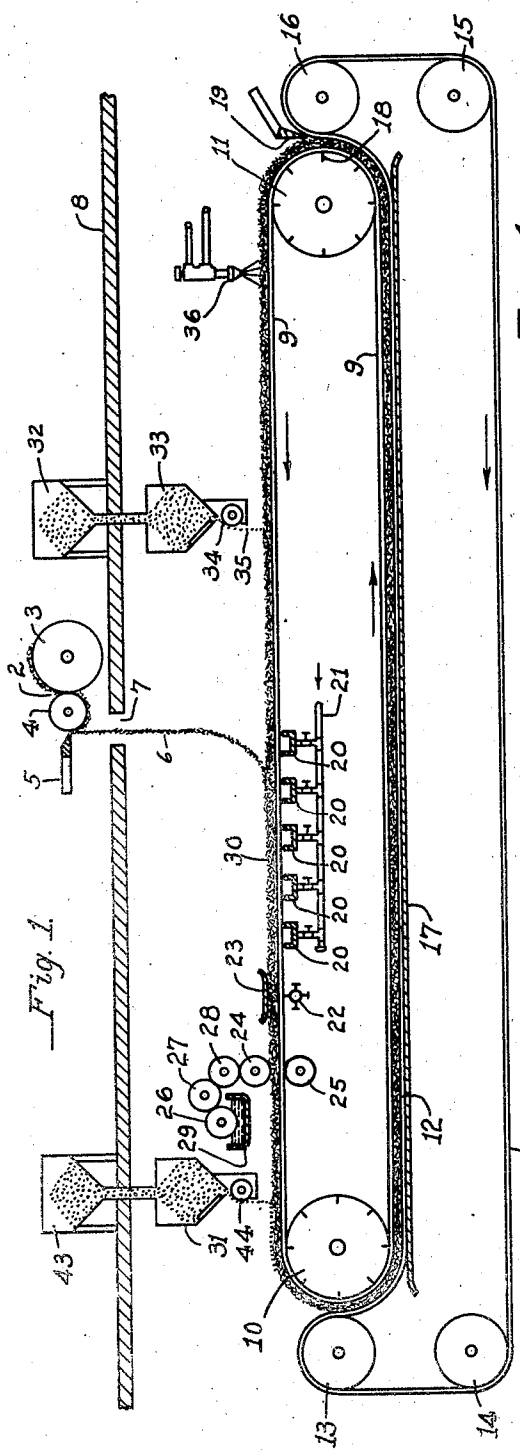
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ABRASIVE BELT

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UNITED STATES PATENT OFFICE

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ABRASIVE BELT

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12 Claims. (Cl. 51-188)

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This invention relates to the manufacture of endless fibrous webs which are substantially non-lamellar in structure and free from joints or splices. More particularly, it relates to the manufacture of endless fibrous webs, in which abrasive grain, adhesive binders and modifying agents are incorporated internally and/or externally of the fibrous web for the purpose of imparting specific properties to the entire, or to certain portions of, the resulting web. It also relates to the article produced by such a process.

Heretofore the practice in forming abrasive belts has been to cut a strip of coated abrasive material of proper length and then splice the ends together to form a continuous belt. The resulting joints have proven objectionable, because they present points of potential weakness in the belts and also interfere with accurate and smooth tracking of the belts in operation. Belts have therefore often been made with liners or backings to give added strength and support to the belt as well as to improve the tracking characteristics of the belt. Such belts, in addition to the added cost, have been subject to loosening and parting of the laminations with consequent failure during use. Other belts, particularly wide belts, have been made by using a spiral of narrower material with the terminus portions of the belt material located remotely one from the other in order to avoid any single point in the belt being completely traversed laterally by a splice.

As illustrative of the above and other difficulties confronting those who make and use endless belts, reference may be had to the abrasive grinding and polishing art. The present invention, for the purpose of convenience and simplicity of explanation, will mostly be described and set forth as it is used in the abrasive art to which it is particularly well adapted, and to which it lends numerous improvements and advantages which will become readily apparent, although the invention is not necessarily limited thereto. Endless abrasive belts are widely used in this field for polishing and grinding various surfaces. It is often desirable to abrade or polish expansive flat surfaces, in which case it is preferable to use extremely wide belts having a width of 60 inches, 72 inches and even up to 100 inches. In addition to the objectionable features of jointed or laminated belts inherent in themselves and already pointed out, splices or joints and other even slight irregularities in endless abrasive belts produce flaws of various types in the work being surfaced. Among such surface blemishes or defects so produced and attributable to a large ex-

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tent to splicing or joining of the ends in endless belts are "revolution" marks or "profile" marks, which are longitudinal scratches or lines produced in the finished surface. At other times the surface is scarred with dark spots or discolorations. Furthermore, splices or poorly joined laminations in a belt result in uneven or bumpy operation of an abrasive belt and poor tracking behavior, thereby yielding an objectionable unevenness in the finished surface. For these and other reasons it has long been desired to obtain spliceless, endless abrasive belts.

In accordance with the present invention endless belts are provided which are continuous in structure throughout their length, i. e., are free from any splicing or joint, and moreover are free from any distinct laminations or layers which can become separated during use. Other advantages in addition to meeting the problems set forth above will become apparent as the description of the invention proceeds herein.

The invention may be more clearly understood by reference to the accompanying drawing, in which

Figure 1 is a vertical cross-section, largely diagrammatic, of an apparatus for making endless belts or webs in accordance with the teachings of the present invention.

Figures 2, 3, 4 and 5 are illustrative of various belt structures embodying the present invention.

Figures 2a, 3a, 4a and 5a are greatly enlarged vertical cross-sections through longitudinal fragments of the belts shown in Figures 2, 3, 4 and 5, respectively, and are presented to clearly show the freedom from any distinguishable laminations in the belts depicted.

Referring further to the apparatus shown in Figure 1, the reference character 2 indicates a carder assembly consisting of a carding roll 3, a stripper roll 4 and a comb 5 for removing the fibrous carded membrane from the roll 4. The carded membrane 6 may consist of any animal, vegetable or synthetic fibrous material capable of being carded into yarn or sheet form. Among the fibres suggested for use are such natural fibres as cotton, wool, jute, flax and the like, or any of the newer inorganic or organic synthetic fibres such as fibrous glass or various resinous materials. The carded membrane is fed by gravity through an orifice or slot 7 in the floor 8 on to a moving carrier belt 9 which is slightly wider than the width of the deposited membrane and may have deckle edges for guiding the oncoming web on to the traveling belt. The carrier belt is rotated about the supporting rolls 10 and 11,

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either one or both of which are adjustable horizontally in order to permit slackening or tensioning of the belt at will. The carrier belt 9, preferably, should be porous in character and may be made of 60 mesh bronze wire screening or smooth, sized canvas of open weave. The rate of delivery of the carded web 6 and the speed of carrier belt 9 are synchronized by adjustment of the speed of rotation of the carder roll and the carrier belt 9, in order that no appreciable strain or pull is exerted on the thin membrane during its deposition.

The initially deposited membrane or lap 6 is retained in place on the carrier belt 9 by a supporting belt 12 during the process of building up the fibrous web to the desired thickness. The supporting belt 12 is mounted on a system of pulleys 13, 14, 15, 16 and a plate 17 and driven by suitable means (not shown) to operate at the same surface speed as that of the carrier belt and the deposited membrane. Means are provided for quickly disengaging the supporting belt from contact with the web. This may be accomplished by lowering the entire supporting belt, pulley and pressure plate assembly or by lateral movement thereof.

A suction box is incorporated in the roll 11 at the point indicated by the reference character 18 in order to retain the web membrane in place as the direction of travel is changed. This action may be supplemented by means of a doctor blade or air knife 19 which prevents the web from adhering to the surface of the supporting belt.

Fibres leaving the carder assembly are arranged in a generally parallel position which is normally assumed as a result of the carding action. When deposited on the carrier belt in this state the fibres take for the most part a position substantially parallel to the surface of the belt and, if undisturbed, would be matted down by any additional layers and a laminated web produced which would be easily separated. It is highly desirable that an interlocking fibrous structure be produced in which many of the fibres of each membrane will project upwardly at acute or right angles to the surface of the web and not only intertwine with one another but also interlock and knit together with the fibres of the succeeding layer. For this reason means are provided to disturb the fibres from their normally parallel positions and raise or up-end large numbers of them for interlocking with the fibres of superimposed membranes. To accomplish this action the present apparatus is provided with air boxes 20, connected to an air supply duct 21, and positioned directly below the upper surface of the carrier belt 9 so as to direct a gentle flow of air or other gas through the pores of the belt itself and through the deposited membrane. This stream of air is supplied at low pressure so as not to rupture the membrane and may be continuous or of a pulsating nature. Additional currents of air may be set up above the carrier belt surface to create some alteration of the fibre direction before deposition of the membrane upon the belt.

Further intertwining and interlocking of the fibres may be produced by a rotating beater roll 22 which is equipped with projecting fins and adapted to set up a vertical vibration of the carrier belt 9. The amplitude of this vibration is controllable and the action is limited by a baffle plate 23 located above the belt and at a point directly over the beater roll.

In the manufacture of an endless belt an initial layer of carded fibrous web, extending completely

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around the peripheral surface of the carrier belt, is first deposited and then, as the succeeding layers are deposited, the action of the air currents and vibrating roll cause the fibres of the initial layer to assume positions ideal for interlocking therewith. Thus each succeeding fibrous membrane is firmly intertwined with the previously applied layer and a non-laminated web is produced. This operation is continued without interruption until a sufficient thickness of felted web has been built up on the carrier belt, at which time the flow of fibrous material from the carder is stopped.

After a web of the desired thickness has been formed in the manner described it is ready to be compacted to a greater density for added strength, and at the same time it is usually desirable to impregnate the web with adhesive binder material to additionally strengthen it. The adhesive binder when applied to the web at this stage in the operations is usually applied in liquid form. The web is compacted by lowering the pressure roll 24 the desired amount and rotating the belt and supported web between pressure roll 24 and supporting roll 25.

Application of the impregnating binder is usually carried out after compacting, although it is optional and may be applied earlier in the process. Sometimes it is desirable to add the impregnant in increments or continuously between deposition of the various individual membranes, in which case any suitable device (not shown in the drawing) may be located somewhere along the path of travel of the web for applying the impregnating substance, which may be handled in the form of a liquid spray or a powdered spray, although other manners of placing the adhesive such as sifting it on the belt may be used.

Referring now to Figure 1 of the drawing, after the web is compacted an impregnating adhesive is applied in the following manner. A liquid, contained in the pan 29, is picked up by the roll 26 and applied to the upper surface of the fibrous web 30 by the transfer rolls 27, 28 and the pressure roll 24. Pressure is maintained between rolls 24 and 25 in order to distribute the adhesive throughout the web until sufficient has been applied. After the belt has been compacted and impregnated the rolls 24 and 25 are raised and lowered, respectively, to release the belt, and the supporting belt system 12 lowered or moved away laterally to clear the belt. The resulting endless web may then be removed by slackening the rolls 10 and 11 and dried and cured elsewhere in any well known manner, or the web may be dried while still rotating under tension upon the carrier belt, and later removed ready for use.

During the application of the adhesive the belt may be maintained, if desired, in a controlled atmosphere of high humidity which will prevent drying or gelling of the adhesive until the entire belt has been impregnated. By thus delaying and controlling the drying of the web adhesive any lapping of the adhesive at the point where the adhesive application is started and ended is prevented, thereby increasing the uniformity of the belt throughout its length.

The present method is particularly applicable to the making of abrasive and other types of modified endless belts. Such belts are formed by the addition of abrasive grain or other non-fibrous modifying agents to the surface of the belt before or after compacting and/or the incorporation of such materials into the interior of the belt during its fabrication.

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According to one modification of the herein described method of making abrasive belts, a layer of adhesive and abrasive grains may be applied immediately after the fibrous web has been built up and compacted as above described. An additional coating of adhesive is applied to the outer surface of the belt by means of the glue pan 29, rolls 26, 27, 28, 24 and supporting roll 25. After this, abrasive grains are applied from the supply bin 43, control hopper 31 and adjustable distributing roll 44 onto the adhesive coated surface of the web. The abrasive coated belt is then dried or cured sufficiently to secure the grain in place and a further sizing coat of adhesive is applied by glue rolls or sprayed, as desired. In certain instances it is more desirable to apply the surface coating of adhesive and abrasive grain before the web is compacted. We have found that this causes the abrasive grains to be more firmly held in place because of the fact that they are partially lodged between the interlocking fibres of the upper part of the web.

Another modification of the present invention involves the step of incorporating abrasive grain in the interior of the belt. This feature is especially applicable to the making of abrasive polishing belts in which a relatively fine grit grain is used. According to this method of making endless belts the abrasive is incorporated internally of the belt by adding the grain to the deposited membranes during the process of building up the web. Figure 1 shows apparatus for carrying out this step and includes a bin 32, for holding abrasive grain, a control hopper 33, and adjustable feed roll 34 for feeding a thin stream of abrasive grain on to the deposited membrane. After the first few layers of fibrous membrane have been deposited on the carrier belt and the fibres suitably interlocked by operation of the vibrating and air pulsating equipment previously described, the feed roll 34 is adjusted to feed a thin stream of abrasive grain 35 onto the deposited membrane. Additional membrane is deposited over the top of the layer of grain and the operation continued by deposition of grain between the individual laps, the fibres of which intertwine and weave about the grain to securely hold it in place. To assist in holding the grain firmly, an adhesive binder may be added by means of one or more spray nozzles 36 positioned above and across the top surface of the belt. This adhesive may be a liquid glue binder, a synthetic or natural rubber adhesive, a resinous binder in a liquid solvent, or a powdered adhesive. As an alternative manner of incorporating a binder with the grain, the grain may be treated by applying a coating of a binder prior to feeding it onto the belt. After the fibrous web containing the abrasive grain with or without binder, has been built up to the required thickness, the belt is compacted as earlier set forth. A further surface coating of grain may be added if so desired before drying and curing the belt.

The endless belts may be further modified by the application of various modifying agents during various stages of the building up of the belt in the same way in which the adhesive is added and in any required amount. For example, the belt can be waterproofed by applying a continuous spray of waterproofing agent during the laying down of the membrane upon the carrier belt. Again, antifriction ingredients, such as graphite, soapstone and the like, may be incorporated in those laps or membranes making up the portion of the belt immediately adjacent the inner sur-

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face, and at any stage in the manufacture flexibilizing agents may be similarly incorporated.

Flexibilizing agents may be incorporated in a portion of the web or distributed throughout, depending upon the type of product desired. Impregnation with a long oil synthetic resin varnish, such as that made by Pratt and Lambert and designated by them as "No. 1767," produces a strong and very flexible web. Sufficient varnish should be incorporated so that it will comprise 20% to 40% by weight of the impregnated fibrous web. The varnish may be cured by heating for approximately 2 hours at a temperature of 200° F.

In cases where a less flexible material is desired I may use a resinous material such as that sold under the trade name "Bakelite" varnish "No. BV-6509" as the impregnant. Sufficient varnish should be incorporated in the web so as to leave a dry residue of 20% to 40% by weight, and then the impregnated material cured from 2 to 4 hours at a temperature of 250° to 280° F.

Various plasticizers, such as glycerine, dibutylphthalate, and the like, may be added to the varnish impregnating agents in order to increase their flexibility. The quantity of such material employed will depend upon the desired flexibility characteristics of the finished product and may in some instances amount to 40% of the combined weight of the varnish and plasticizer.

Figure 2 and Figure 2a which is a greatly enlarged fragmentary cross-section of Figure 2 show an endless belt made according to the above procedure, and in which the individual fibres 37 of the various membranes have been interlocked so as to form a uniform non-lamellar structure impregnated throughout with a binder material 38.

Figure 3 and accompanying Figure 3a show a modified endless belt similar to that shown in Figures 2 and 2a. However, a surface coating of adhesive 39 and abrasive grain 40 has been applied to the belt in this modification.

Figures 4 and 4a show an endless abrasive polishing belt in which abrasive grain 41 has been incorporated internally of the belt, and show how the grain has been felted into the interlocking fibrous structure of the belt in non-lamellar form.

Figures 5 and 5a embody the features of both belts shown in Figures 3 and 4 in the same belt, and in addition show the way in which various modifying agents, such as antifriction agent 42 has been applied to specific portions of the belt to impart desired properties to all or part of the belt.

It is sometimes desirable to produce a serrated, embossed, spiral, fluted or otherwise patterned outer surface on the endless belt after the structure has been impregnated. This can be accomplished by means of a pair of rolls (not shown in the drawing) adjustably mounted one above and one below the belt. The roll in contact with the outer belt surface is suitably patterned or embossed for the purpose at hand. The desired pattern is impressed in the outer surface of the belt by bringing the patterned roll into contact with the belt with sufficient pressure to produce an embossed surface thereon.

Either or both rolls may be temperature controlled to provide the proper conditions for molding a surface upon the impregnated structure. For example, cold rolls may be used when a glue, which has been used to impregnate the belt has gelled and become almost dry, while hot rolls should be used to treat a synthetic resin impregnated belt after the resin has dried thoroughly

and has been advanced partially toward its final stage of cure.

A further modification of the present invention provides for the production of endless belts, of great tensile strength and resistance to crosswise tearing, for use under very severe forms of abrading and other usage. Mechanical reinforcing means, of metallic or non-metallic nature, can be built into the belts in the course of their construction. For example, spaced strands of cotton thread, string, synthetic resinous filaments, or fine diameter wire can be introduced onto the carded layers of fabric as the belt is being formed. Spools of the stranded materials are mounted on a suitable framework (not shown) and the reinforcing material fed into the deposited membrane as the belt is built up by the device shown in Figure 1. The inclusion of the reinforcing strands may be continuous from the start to the finish of the belt constructing operation, or it may be delayed at the start of the operation and interrupted prior to the completion of the article in order to locate the reinforcing elements within the structure. A wave form type of reinforcement is produced by oscillating the framework which carries the spools or reels of stranded material.

As has been pointed out earlier herein, one of the particularly important features of the present invention is the provision of an endless belt structure which is continuous and free from joints of any kind. Another important characteristic of the present invention is the provision of endless belt structures in which various desired properties may be imparted to specific portions of the belt without resort to individual layers or laminations and in which such characteristics may be uniformly set up within the belt.

Having described and explained the invention it is desired to claim:

1. The method of making a continuous endless and jointless felted fibrous web of homogeneous non-lamellar cross-section which comprises removing a thin continuous membrane of fibrous material from a carder, aerodynamically agitating said membrane to disturb and up-end the ends of the individual fibers from their normally parallel position without rupture of the membrane, feeding said membrane upon a moving endless support, retaining the initially deposited membrane upon said support while repeatedly passing said endless support with the initially deposited membrane beneath the carder to receive additional superimposed membranous layers while the ends of the individual fibers of the deposited membrane on the moving support are up-ended for interlocking with the fibers of that portion of the membrane being deposited to such an extent that the fibers of adjacent membranous layers interengage and interlock sufficiently to produce a homogeneous non-lamellar structure, continuing the deposition of said continuous membrane under said conditions for interlocking and without interruption of the flow of membrane from the carder until a jointless and endless web of the desired thickness is formed on the endless support, breaking the flow of membrane from the carder and removing the resulting fibrous web from said support.

2. The method of making a continuous endless and jointless felted fibrous web of homogeneous non-lamellar cross-section which comprises removing a thin continuous membrane of fibrous material from a carder, aerodynamically agitating said membrane to disturb and up-end the ends

of the individual fibers from their normally parallel position without rupture of the membrane, feeding said membrane onto a moving endless support, agitating the deposited membrane to further raise the ends of a number of individual fibers, retaining the additionally deposited membrane upon the support while repeatedly passing said endless support with the initially deposited membrane beneath the carder to receive additional superimposed membranous layers while the ends of the individual fibers of the deposited membranous material on the moving support are maintained up-ended for interlocking with the fibers of that portion of the membrane being deposited to such an extent that the fibers of the adjacent membranous layers are interengaged and interlocked sufficiently to produce a homogeneous non-lamellar structure, continuing the deposition of said continuous membrane under said conditions for interlocking and without interruption of the flow of membrane from the carder until a jointless and endless web of fibrous material of the desired thickness is formed on the endless support, breaking the flow of membrane from the carder and removing the resulting fibrous web from said support.

3. The method of making a continuous endless and jointless felted fibrous web of homogeneous non-lamellar cross-section which comprises removing a thin continuous membrane of fibrous material from a carder, aerodynamically agitating said membrane to disturb and up-end the ends of the individual fibers from their normally parallel position without rupture of the membrane, feeding said membrane upon a moving endless support, agitating the deposited membrane to further raise the ends of a number of the individual fibers, retaining the initially deposited membrane upon the support while repeatedly passing said endless support with the initially deposited membrane beneath the carder to receive additional superimposed membranous layers while the ends of the individual fibers of the deposited membranous layers on the moving support are maintained up-ended for interlocking with the fibers of the membranous layer being deposited to such an extent that the fibers of adjacent membranous layers interengage and interlock sufficiently to produce a homogeneous non-lamellar structure, continuing the deposition of said continuous membrane under said conditions for interlocking and without interruption of the flow of membrane from the carder until a jointless and endless web of fibrous material of the desired thickness is formed on the endless support, breaking the flow of membrane from the carder, impregnating the fibrous web with an adhesive binder, compacting the impregnated web and removing the resulting web from said support.

4. The method of making a continuous endless and jointless felted fibrous web of homogeneous non-lamellar cross-section which comprises removing a thin continuous membrane of fibrous material from a carder, feeding said membrane onto a moving endless support and aerodynamically agitating said membrane to remove the ends of the individual fibers from their normally parallel position and to raise a number of the ends of the fibers from the plane of said membrane, retaining the initially deposited membrane upon the support while repeatedly passing said endless support with the initially deposited membrane beneath the carder to receive additional superimposed membranous layers, applying adhesive binding material between successively deposited

layers, continuing the flow of membrane from the carder until a web of fibrous material of the desired thickness is built up on the endless support, meanwhile agitating the deposited membrane on the moving support to up-end and render the fibers thereof receptive for interlocking with the fibers of the membranous layers being deposited to such an extent that the fibers of adjacent membranous layers interengage and interlock sufficiently to produce a homogeneous non-lamellar structure, then breaking the flow of membrane from the carder, compacting the resulting fibrous web and removing it from the endless support.

5. In the method of making a continuous endless web of fibrous material according to claim 4, the step of applying abrasive grain to said fibrous web during the process of making the web.

6. In the method of making a continuous endless web of fibrous material according to claim 3, the step of applying abrasive grain to the outer surface of said fibrous web.

7. The method of making a continuous endless and jointless felted fibrous web of homogeneous non-lamellar cross-section which comprises feeding a thin continuous membrane of fibrous material from a carder onto the upper surface of a moving endless support, aerodynamically agitating the membrane to remove the ends of the individual fibers from their normally parallel position and to raise a number of the ends of the fibers from the plane of said membrane to an up-ended position suitable for interlocking with the fibers of subsequently deposited membranous layers, retaining the initially deposited membrane upon the support and superimposing additional fibrous membranous layers upon the initially deposited membranous layer, simultaneously applying abrasive grain and adhesive binding materials between successive layers of the membranous material, meanwhile agitating the deposited membranous layers on the moving support to up-end them and render the fibers thereof receptive for interlocking with the fibers of the membranous layer being deposited to such an extent that the fibers of adjacent membranous layers interengage and interlock sufficiently to produce a homogeneous non-lamellar structure, continuing the deposition of said continuous membrane under said conditions for interlocking and without interruption until a jointless and endless web of the required thickness is formed, severing the flow of fibrous membrane from the carder, applying a final surface coating of abrasive grain and adhesive binder to the outer surface of said fibrous web, compacting the web and removing it from the endless support.

8. A continuous endless, jointless belt of felted fibrous materials comprising a plurality of thin

cardable fibrous laps the width of each membranous lap being co-extensive with the width of the belt, a number of the fibres of each individual lap being raised from the plane of said lap to an up-ended position so as to be interlocked with the fibres of adjoining laps to such an extent that the endless belt presents a homogeneous non-lamellar cross-section.

9. A continuous endless, jointless belt of felted fibrous materials comprising a plurality of thin cardable fibrous laps impregnated with an adhesive binder and being further characterized by a number of the fibres of each individual lap being raised from the plane of said lap to an up-ended position so as to be interlocked with the fibres of adjoining laps to such an extent that the belt presents a homogeneous non-lamellar cross-section the width of each membranous lap being co-extensive with the width of the belt.

10. A continuous endless, jointless belt of felted fibrous materials comprising a plurality of thin fibrous laps impregnated with an adhesive binder and having abrasive grain interspersed throughout the belt, said belt being further characterized by a number of the fibres of each individual lap being raised from the plane of said lap to an up-ended position so as to be interlocked with the fibres of the adjoining laps to such an extent that the belt presents a homogeneous non-lamellar cross-section.

11. A continuous endless, jointless belt consisting of a web comprising a plurality of laps of cardable fibrous materials impregnated with an adhesive binder and having abrasive grain distributed internally of the belt and an external coating of abrasive grain adhesively secured to the outer surface of the belt said web being further characterized by a number of the fibers of each individual lap being raised from the plane of said web to an up-ended position so as to be interlocked with the fibers of the adjoining laps to such an extent that the belt presents a homogeneous non-lamellar cross-section.

12. A continuous endless, jointless belt consisting of a web comprising a plurality of laps of cardable fibrous materials, the width of each of the said laps being co-extensive with the width of the belt, said belt being impregnated with an adhesive binder and having an external coating of abrasive grain adhesively secured to the outer surface of the belt, the web structure of said belt being further characterized by having a number of the fibers of each individual lap raised from the plane of said lap to an up-ended position so as to be interlocked with the fibers of the adjoining laps to such an extent that the resulting web structure presents a homogeneous non-lamellar cross-section.

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