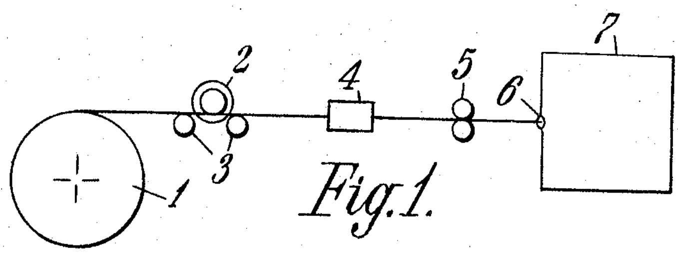

Fig.1.

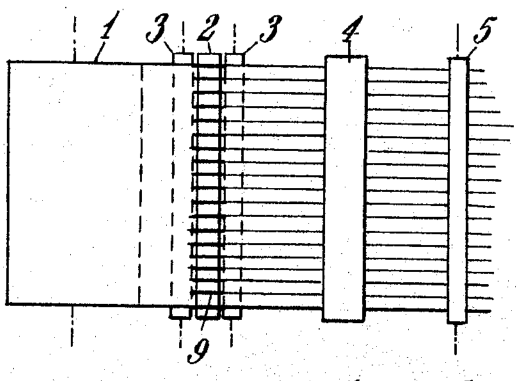

Fig. 2.

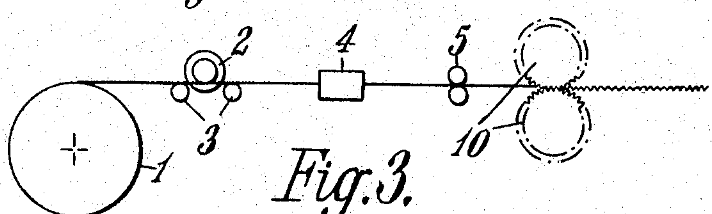

Fig.3.

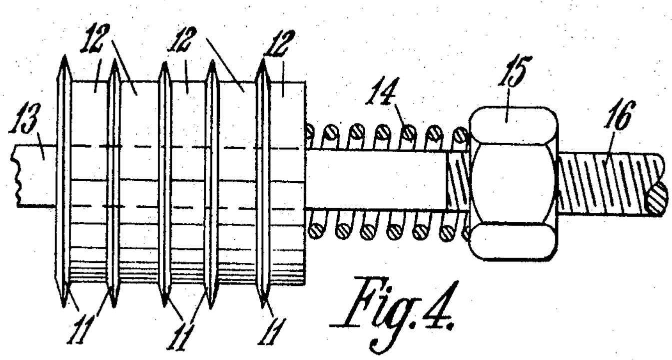

Fig.4.

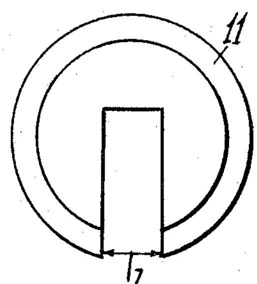

Fig. 5.

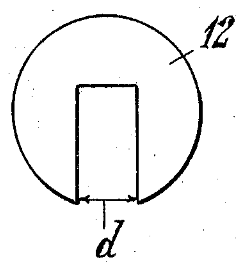

Fig. 6.

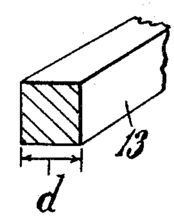

Fig. 7.

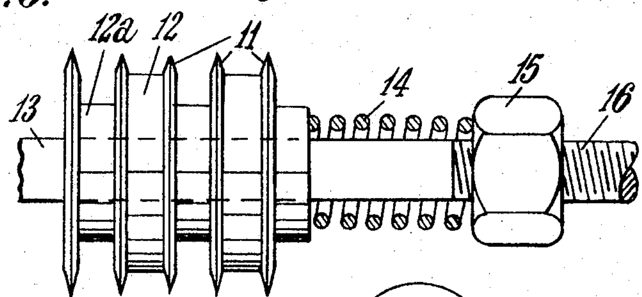

Fig. 8.

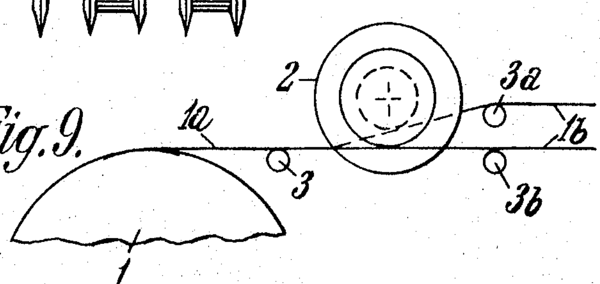

Fig. 9.

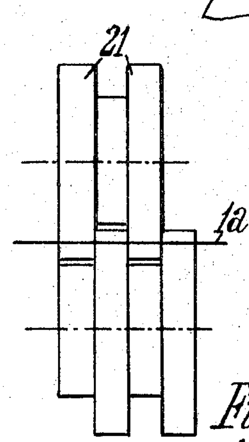

Fig. 10.

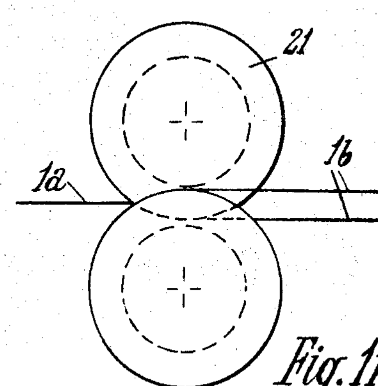

Fig. 11.

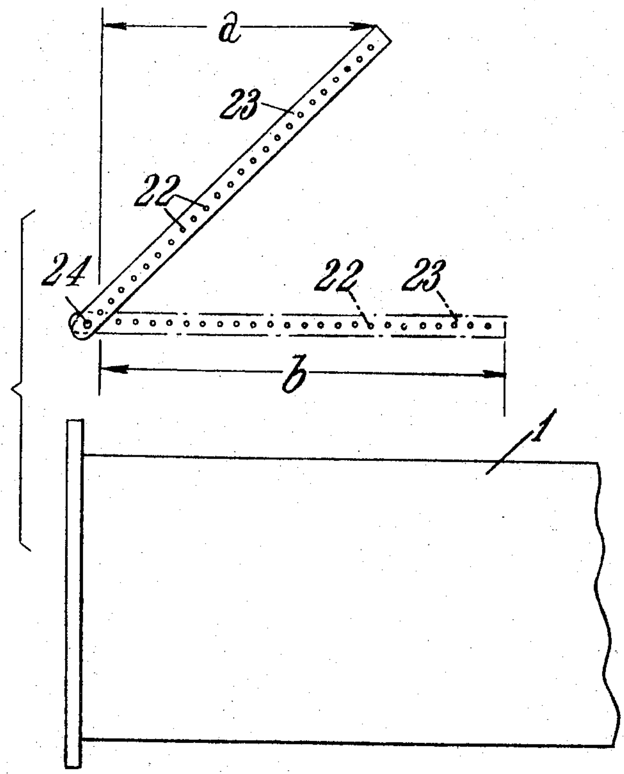

Fig.12.

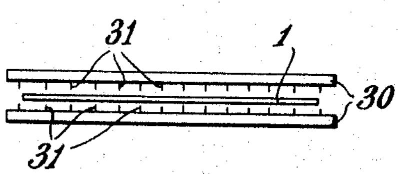

Fig. 14.

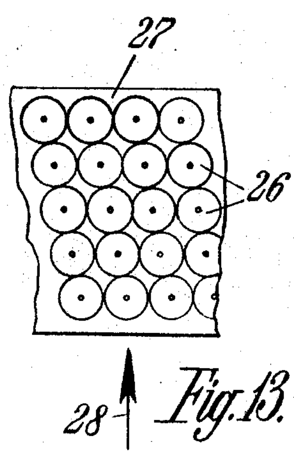

Fig.13.

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METHOD AND APPARATUS FOR PREPARING WARP BY DIVIDING SHEET MATERIAL LONGITUDINALLY

Alexander Mirsky, 12 Montagu Mansions, York St., London W1, England

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18 Claims. (Cl. 28—1)

This invention relates to a method of preparing the warp for weaving or warp-knitting by dividing sheet material longitudinally.

It is known to divide sheet material longitudinally into a plurality of longitudinally-extending filaments, and then to wind these filaments off onto bobbins, cops or cones. For weaving or warp-knitting, these bobbins, cops or cones must then be set up and the filaments reeled off the bobbins, cops or cones onto a warp beam. The warp beam is then positioned adjacent to a loom or warp-knitting machine, and a fabric incorporating warp filaments is then woven or knitted.

It is an object of this invention to reduce the time and cost of preparing the warp filaments before weaving or warp-knitting.

This invention consists in a method of weaving, knitting or preparing a warp beam, including dividing a sheet material into a plurality of longitudinally-extending filaments, and either feeding these filaments continuously into a weaving loom or warp-knitting machine, or winding the filaments continuously off onto a warp beam. The filaments can subsequently be wound off the warp beam into a weaving loom or warp-knitting machine. For convenience, the dividing operation is referred to as "slitting" herein, although some dividing operations may not be strictly slitting operations.

The great advantage of this method is that the filaments need not be individually wound off onto for instance separate cones, but can be kept generally in their planar sheet-like relationship, excluding costly warp preparation; the filaments however can be given a "lease" (i.e. separated into at least two layers) if desired for ease in manipulation or handling, to reduce mechanical friction or chafing and the propensity for the generation of or the effect of static electricity, a lease may be provided by using inter-engaging shear discs for slitting.

In addition to obviating the need to spin, wind and warp the warp yarn, factory space can be saved and fast continuous production of warps can be achieved.

Thus in weaving, the sheet may be rolled on the warp beam, and slit after being unrolled from the warp beam, the filaments being passed through the eyes in the healds. In warp knitting, the filaments can in a similar manner be led through eyes in the knitting head, so that warped yarn as such is not required. This obviates any need for warping as such, and for providing warp yarn before weaving or warp knitting.

If the filaments are wound off onto the warp beam, the warp beam may be prepared away from the weaving loom or warp-knitting machine, i.e. in a separate unit comprising slitting means and a beaming-off stand containing the warp beam onto which the slit filaments may be directly wound to any length that may be required. Subsequently, the warp beam can be inserted into the weaving loom or warp-knitting machine as appropriate.

In this manner, slitting may be carried out at high speed from a larger roll than could be accommodated on an individual loom or warp-knitting machine, and each individual loom or warp-knitting machine may be given the length of warp required for its scheduled production run.

Furthermore, using a separate unit for preparing the warp beam, more even filaments may be produced than is the case in a loom or warp-knitting machine which is subject to vibrations and in which the linear speed of the warp filaments is low. The eveness of the filaments may be critical in cases where high density warps are used, or where levelness is in itself important in the structure of the fabric or where in certain fabrics level appearance is of importance.

To facilitate winding on and off the warp beam, sheets, e.g. of paper, can be interleaved with the filaments, continuously or spasmodically.

When one roll of the sheet material is nearly expended, the end of another roll can be attached to the end of the first roll, such as for instance by welding if the material is a thermoplastic resin, with the use of a heated transverse clamp. If suitable, chemical means or adhesives can be used for attaching the ends together and an adhesive tape could be stuck transversely to join the rolls. When the ends of the rolls are attached together, there is no need for any re-threading and thus continuity of operation can be provided. Naturally, the attachment must be such that when the sheets are slit, the individual filaments so formed do not come apart at the joint.

The slitting may be effected by for instance stationary, rotary or oscillatory blades, shearing, the application of electrical energy (e.g. using sparks to slit plastics material), chemical energy, heat or light energy, hot wires, nibbling action, pneumatic means, or hydraulic means. Some slitting methods are already known. Hence the slitting may be effected by a plurality of parallel cutters, for instance thin blades, spaced apart to a suitable distance, and preferably arranged and mounted such that they can be rotated during the slitting. Wherever the slitting is effected using blades or by shearing action, sharpening means may be provided. As an example, the rotary cutters can be aranged to be self-sharpening or sharpening means may be mounted adjacent to the cutters so as to contact each portion of the cutting edge once in every revolution, or periodically, as required. The cutters may in addition or alternatively be arranged to be quickly replaceable. It is found desirable to be able to replace the cutters either singly, or in groups, and change the density of the cutters by simple replacement.

One simple arrangement for accomplishing this comprises a rotary mounting bar having a non-circular profile in cross-section, on which cutters and spacers are mounted, each cutter and spacer having a radial slot so that it can be fitted over the bar, with the cutters and spacers being clamped in position by axial pressure.

To avoid ill-effects due to distortion of the cutter or shearer shafts or supports for other slitting means, the cutters or shearers or other slitting means may be mounted in sections, say of 6–10 inches (about 15–25 cms.) in length, to enable any width of sheet material to be slit. The bands between the sections of cutters or shearers or other slitting means can be reeled off to waste together with the side bands of the sheet material. More particularly, wide filaments which have been divided at the edges of the sheet material and which have been divided on each side by dividing means of adjacent groups are discarded.

Various means may be employed to provide high density warps without jamming and other difficulties in cutting. For example, the cutter blades need not be equidistantly spaced, and if found desirable, certain threads may be cast out, say by being rolled off. Milling cutters or a nibbling action may be employed to provide more space between individual filaments.

For pneumatic or hydraulic slitting, high velocity needle jets of gas or liquid may be directed against the sheet material and to improve the slitting effect, the gas may be used with solid particles, e.g. sand. If individual nozzles are required, these may be staggered (e.g. in three or more rows) in relation to the direction of travel of the sheet material to give a fine transverse spacing between the jets. Such staggering is more generally applicable to the slitting means, and for instance heated wires or electric spark points may be staggered.

Means may be provided to reduce the generation of, or to discharge, static electricity. If the known anti-static oils are not efficient enough for high speed production, conductors, e.g. contact brushes, may be provided touching the filaments, or the slitting may be performed in a conducting liquid. This liquid may be used to cool the cutter or shearer or other slitting means, or alternatively an air blast could be used for cooling.

In preparing for weaving, in order to simplify threading the filaments through the eyes in the healds, a twisting and/or tying in frame may be used with the slitting means mounted on the frame itself. This can enable the thread density and/or wrap character to be changed conveniently.

The minimum width of the filaments will depend on the material itself, its thickness and the slitting means, employed. For example, a polyester film of ¼ thou' (about 0.006 mm.) thickness can be split by rotary cutters to a width of 2 mm. or less.

The density of the filaments may be readily alterable by mounting a line of suitable slitting means (e.g. hot wires or elastic sparking means) on a support which can be pivoted about an axis at right angles to the plane of the sheet material and thus the maximum filament width (and minimum density) is given when the line of slitting means is at right angles to the longitudinal axis of the sheet material. Such an arrangement may be used with or without guide pins (referred to below).

The number of filaments can be increased by using two or more layers of the sheet material, preferably slitting all the layers simultaneously. The filaments from the various sheets can be led through the eyes in the healds or guides in the knitting head, or the warp beam, in an appropriate manner. Whether one layer or more than one layer is used, the filaments can be fanned out or condensed, such as by using guide pins. For versatility, these guide pins may be mounted on a pivoted bar so that the effective spacing can be altered. For instance, a triple 10" (about 25 cms.) sheet could thus provide three times as many filaments which in turn with the help of guide pins, could provide any suitable width of warp section required, either less or more than 10" (about 25 cms.) in width.

When slitting one or more layers of the sheet material, the resultant filaments may either be used as monofilament or multi-filament thread. For example, when slitting a single layer of sheet material to a density of say 30 filaments per inch about 12 filaments per cm., each single filament may be used as one thread, or alternatively, two or more filaments may be used together to form one thread. As another example, three layers may be slit together at a density of say 30 filaments per inch (about 12 filaments per cm.) in each layer, thus cutting 90 filaments per inch (about 36 filaments per cm.) simultaneously, and which 90 filaments could likewise be used in a variety of thread densities.

Particularly in warp knitting, a fine reed or comb may be used to align the flat filaments before they reach the knitting head, and this may also be of assistance when weaving. It will be appreciated that if say, a sheet of ½ thou. (about 0.013 mm.) thickness is being slit at say 30 filaments to the inch (about 36 filaments per cm.) the filaments are still relatively flat. One advantage of this arrangement is that any rubbing and chafing between the individual filaments can be liminated or reduced, thus reducing the generation and effects of static electricity, and mechanical interference.

The actual sheet material used depends upon the woven or knitted fabric required, as does the nature of additional materials used, for instance for the weft. The sheet material may be transversely pre-corrugated.

The following materials are suggested as being suitable for the sheet material: paper, plastics materials, for instance acrylic polymers, polyesters, polyamide resins such as nylon or polyolefins; felts or other bonded fibers, such as fiberglass; bonded slivers; rubber; elastomers; composite materials; and metal.

The fabrics that may be produced include: Backing cloth for woven or tufted carpets; rugs; furnishing fabrics; curtains; industrial cloths such as filter cloths; blankets; apparel cloths; woven or warp-knitted ribbons; webbing and bunting.

If the material is sufficiently plastic at ambient temperatures or on heating, the properties of the filaments may be modified by drawing the filaments. This can not only alter the cross-sectional shape, for instance by rounding-off the rectangular cross-section, but change the denier of the filaments and alter the crystalline or molecular structure. By using a thermoplastic resin, for instance, the filaments may be heated prior to drawing them, though this may not be necessary with say other plastic filaments or with fine metal filaments. Alternatively or in addition the filaments may be heated after drawing, according to the degree of stability required. The drawing can be effected by passing the flat plane or planes of filaments through two pairs of rolls rotating at differential speeds, or by using the roll of sheet material itself in place of one of these pairs of rolls.

The fineness of the filaments may be altered by changing the gauge of the sheet, prior to slitting, by stretching the sheet.

The filaments may be formed with a crimp by passing the sheet or the filaments through the nip of a pair of serrated rolls so that the serrations cause a deformation of the thread. Often it will be necessary to subject the sheet or filaments to some form of treatment to set the sheet or filaments with the deformation present. This treatment will depend on the nature of the thread material; for instance, if the thread is formed of a thermoplastic resin, the sheet or filaments can be heated prior to, during its passage through, or after passing through, the serrated rolls, and then cooled, the sequence depending on the materials used, and the effect it is desired to achieve. The shape of the serrations can be chosen to suit the type of crimped thread required.

The invention also comprehends apparatus for carrying out the method described above, and wound warp beams or fabric produced by the method.

The invention will be further described, by way of example, with reference to the accompanying drawings, of which:

FIGURE 1 is a schematic diagram of apparatus for carrying out a method in accordance with this invention;

FIGURE 2 is a schematic top view of a part of the apparatus of FIGURE 1;

FIGURE 3 is a schematic diagram of modified apparatus for carrying out a method in accordance with this invention;

FIGURE 4 is a diagrammatic view of a rotary cutter used in the apparatus of FIGURE 1;

FIGURE 5 is a view of a cutter blade;

FIGURE 6 is a view of a distance piece;

FIGURE 7 is a perspective view of a portion of the mounting bar;

FIGURE 8 is a diagrammatic view, similar to FIGURE 4, but showing a modified cutter;

FIGURE 9 is a diagrammatic side view of the part of the apparatus of FIGURE 1, modified to show the cutter of FIGURE 8, and on a slightly larger scale;

FIGURE 10 is a diagrammatic view of a shearer;

FIGURE 11 is a diagrammatic side view of the shearer of FIGURE 10, showing the shearer in operation;

FIGURE 12 is a schematic horizontal section through a hot wire slitter and a roll of sheet material;

FIGURE 13 is a schematic top view of a pneumatic or hydraulic slitting means; and

FIGURE 14 is a diagrammatic view showing the use of sparks for slitting the sheet material.

In FIGURE 1, a roll **1** of sheet material is mounted on the warp beam, and the sheet material is led to a rotary cutter **2** operating in conjunction with support rolls **3**. The cutter **2** slits the sheet material longitudinally into a plurality of filaments, and these filaments are passed through a heating unit **4** and on to draw rolls **5** rotating at such a speed as to stretch the heated filaments. The position of the heating unit may be varied to heat the sheet material prior to passing through or during its passage through the cutter **2**. In cases where oriented film is used, the heating unit may not be necessary. Also for certain other applications, oriented film may not be necessary and so for many applications the heating unit may be superfluous. The filaments pass through guides **6** and are subsequently woven or warp-knitted in a machine **7**. The machine **7** is not illustrated in detail, but suitable weaving or warp-knitting machines are well-known in the art. If the machine **7** is a weaving machine, the guides **6** can be the eyes in the healds. The machine **7** could alternatively be replaced by a beam-off stand.

A backing roll may be provided mounted on the other side of the sheet material to the cutter **2** to provide an anvil for cutting, and cooling means and anti-static electricity means may be provided.

It will be appreciated that in FIGURE 2, the spacings between the blades **9** of the cutter **2** have been greatly exaggerated.

In FIGURE 3, the roll **1** provides sheet material which is led into the cutter **2** and thence through the heating unit **4** and rolls **5** in a manner similar to that illustrated in FIGURE 1. From the rolls **5**, the filaments pass into the nip of a pair of heated serrated rolls **10**, and the emergent serrated filaments are set in this configuration when they cool.

As shown in FIGURE 4, generally circular cutter blades **11** and generally circular distance pieces **12**, of smaller radius than the cutter blades **11**, are mounted on a mounting bar **13**. The end portions of the mounting bar **13** are not shown in FIGURE 4; however, the left-hand end (with reference to the drawing) of the mounting bar **13** is provided with a stop, and the cutter blades **11** and distance pieces **12** are clamped against this stop by means of a compression spring **14** which is compressed by means of a threaded nut **15** being screwed along a screw thread **16** provided on the mounting bar **13**.

The cutter blades **11** and distance pieces **12** each have a radial slot of a width *d*, which corresponds to the side of the square cross-section of the mounting bar **13**. Alternatively, the bar **13** may be of circular cross-section and have a key, with the distance pieces **12** being shaped appropriately.

In order to replace a cutter blade **11**, or insert distance pieces **12** of different thickness, and at the same time remove or add further cutter blades **11**, if desired, the nut **15** is merely slackened off, the operation carried out, and the nut **15** is then screwed up again.

In FIGURES 8 and 9, lease is imparted to the filaments **1*b*** by using distance pieces **12**, **12*a*** of different diameters and leading the filaments **1*b*** away over spaced rolls **3*a*** and **3*b***. The sheet material is referenced as **1*a***.

In FIGURES 10 and 11, lease is imparted to the filaments **1*b*** using the inherent effect of the shearing discs **21** through which the sheet material **1*a*** is fed. These shearing discs can be arranged to be self-sharpening due to their mutual honing action.

In FIGURE 12, wires **22** are mounted on a support frame **23** to form one section of a slitting means, and the frame **23** is pivoted at **24** on an axis at right angles to the plane of the sheet material coming from a roll **1**. As indicated in FIGURE 12, the maximum effective width of the frame **23** is *b*, and the frame **23** may be pivoted in order to give a smaller effective width *a*, thereby increasing the density of the filaments. Only one section of the slitting means is shown, and the other sections may be transversely adjustable in order to allow for the angular adjustment of the individual frames **23**.

In use, the wires **22** are heated and a suitable sheet material is chosen so that the sheet material is slit by the wires.

FIGURE 13 shows a pneumatic or hydraulic slitting means in which nozzles **26** are mounted on a support **27** for slitting sheet material travelling in the direction of the arrow **28**. As shown, the nozzles have a radius which is considerably larger than the width of each individual filament, and are staggered in five rows in order to give the desired filament width.

In lieu of the wires shown in FIGURE 12, sparking points arranged to be close to and on either side of the sheet material for providing a continuous stream of sparks for slitting the sheet material may be employed. In FIGURE 14, such an embodiment is illustrated and includes holding bars **30** arranged in spaced relationship provided with sparking points **31** and which points cooperate with the sheet material **1**.

It will be understood that modifications and variations may be effected without departing from the spirit and scope of the novel concepts of the present invention.

I claim:

1. A process for manufacturing a fabric including warp filaments, comprising the steps of providing for a material having substantially uniform composition across the width dimension thereof, dividing the sheet material into a substantially large multiplicity of longitudinally extending filaments, winding directly a large number of said filaments onto a single rotary member, transferring the thus wound filaments from the rotary member to fabric producing means, and producing the fabric in the fabric producing means employing the filaments as warp filaments.

2. The process of manufacturing a fabric as claimed in claim 1 in which the fabric producing means is constituted by a weaving loom and the fabric is a woven fabric.

3. The process of manufacturing a fabric as claimed in claim 1 in which the fabric producing means is constituted by a warp knitting machine and in which the fabric is a warp knitted fabric.

4. The process of manufacturing a fabric as claimed in claim 1 in which said sheet material is divided into a large multiplicity of longitudinally extending filaments by dividing means in groups of equi-spaced means wherein the spacing between adjacent groups is greater than the spacing between adjacent individual dividing means in a group, feeding the filaments which have been divided on each side by adjacent dividing means in one group into the fabric producing means, and discarding wide filaments which have been divided on the edges of the sheet material and have been divided on each side by the dividing means of adjacent groups.

5. The process of manufacturing a fabric as claimed in claim 1 including the step of bringing at least pairs of the warp filaments into juxtaposition in the fabric producing means employing at least pairs of the warp filaments as multi-filament thread.

6. The process of manufacturing a fabric including warp filaments, comprising the steps of dividing at least two superimposed layers of sheet material of substantially uniform composition across the width thereof, dividing said layers simultaneously into a large multiplicity of longitudinally extending filaments, winding directly a large number of said filaments onto a single rotary member, transferring the filaments continuously to fabric producing

means, and producing the fabric in the fabric producing means employing the filaments as warp filaments.

7. An apparatus for manufacturing a fabric including warp filaments, comprising means for dividing sheet material of substantially uniform composition across the width dimension thereof into a large multiplicity of longitudinally extending filaments, a rotary member, means for mounting said rotary member for rotational movement, means for rotating the rotary member to wind a large number of the longitudinally extending filaments thereon, a plurality of fabric producing means separate from said means for mounting the rotary member for rotational movement, and means for conveying the large number of filaments to respective fabric producing means.

8. The apparatus for manufacturing a fabric as claimed in claim 7 in which said fabric producing means is defined by a weaving loom and the fabric is a woven fabric.

9. The apparatus for manufacturing a fabric as claimed in claim 7 in which the fabric producing mean is defined by a warp knitting machine and the fabric is a warp knitted fabric.

10. The apparatus for manufacturing a fabric as claimed in claim 7 in which said dividing means is defined by electrical sparking means.

11. The apparatus for manufacturing a fabric as claimed in claim 7 in which said dividing means is defined by heated wires.

12. The apparatus for manufacturing a fabric as claimed in claim 7 in which said dividing means is defined by means providing high velocity needle jets.

13. The apparatus for manufacturing a fabric as claimed in claim 7 in which said dividing means is defined by cutter blades.

14. The apparatus for manufacturing a fabric as claimed in claim 13 in which said cutter blades are rotary cutter blades.

15. The apparatus for manufacturing a fabric as claimed in claim 14 in which said rotary cutter blades include a rotary mounting bar having a non-circular profile in cross-section, cutters and spacers mounted on said bar, each cutter and spacer being provided with a radial slot permitting each cutter and spacer to be fitted over said mounting bar, and means for effecting axial pressure for clamping the cutters and spacers in position on the mounting bar.

16. The apparatus for manufacturing a fabric as claimed in claim 7 in which said dividing means are staggered relative to the direction of travel of the sheet material.

17. The apparatus for manufacturing a fabric as claimed in claim 7 in which said dividing means includes a support, a line of dividing components mounted on said support, guide means for guiding the sheet material in a predetermined plane past the dividing means, and means pivotally mounting said support for movement about an axis at right angles to the predetermined plane for altering the density of the filaments.

18. A process for manufacturing a fabric including warp filaments, comprising the steps of providing for a drawable plastic film having a substantially uniform composition across the width dimension thereof, dividing the film into a substantially large multiplicity of longitudinally extending filaments, drawing the material to deform plastically the film and decrease the widths of the individual filaments, winding directly a large number of said drawn filaments onto a single rotary member, transferring the thus wound filaments from the rotary member to a fabric producing means, and producing the fabric in the fabric producing means employing the drawn filaments as warp filaments.

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MERVIN STEIN, *Primary Examiner.*

L. K. RIMRODT, *Assistant Examiner.*