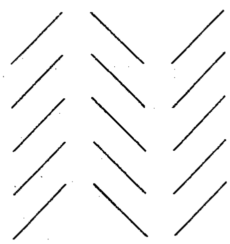
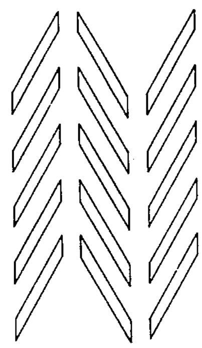
PRODUCTION OF TEXTILE FILAMENTS

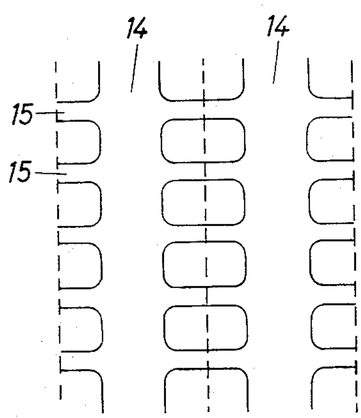
Filed March 11, 1963 3 Sheets-Sheet 1



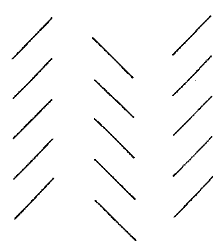
—FIG. 1—



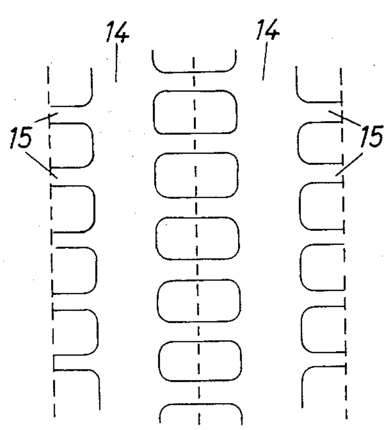
—FIG. 2—



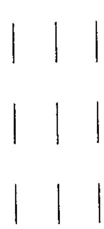
—FIG. 3—



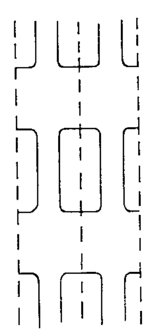
—FIG. 4—



—FIG. 5—



—FIG. 6—



—FIG. 7—

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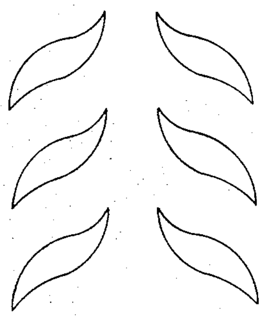
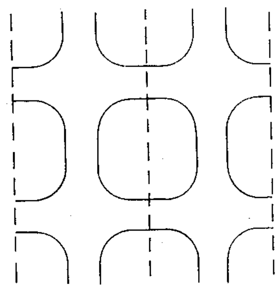
PRODUCTION OF TEXTILE FILAMENTS

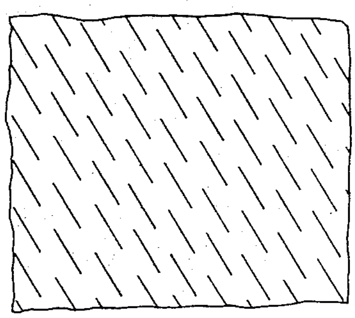
Filed March 11, 1963 3 Sheets-Sheet 2



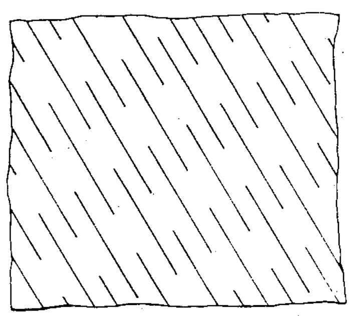
—FIG. 8.—



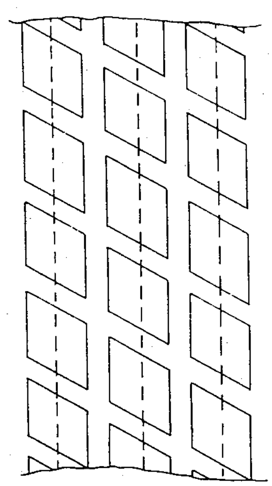
—FIG. 9.—



—FIG. 10.—



—FIG. 11—



—FIG. 12.—

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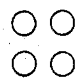
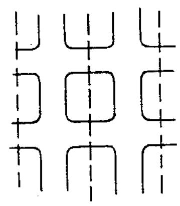
PRODUCTION OF TEXTILE FILAMENTS

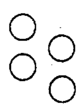
Filed March 11, 1963 3 Sheets-Sheet 3



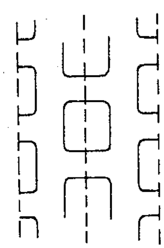
—FIG. 13.—



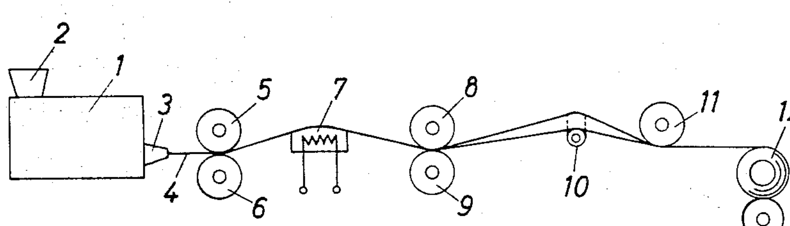
—FIG. 14.—



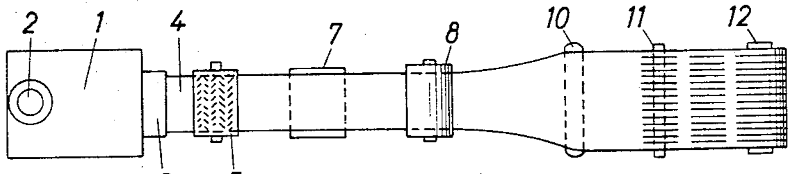
—FIG. 15.—



—FIG. 16.—



—FIG. 17.—



—FIG. 18.—

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PRODUCTION OF TEXTILE FILAMENTS

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Claims priority, application Great Britain, Mar. 9, 1962, 9,082/62
16 Claims. (Cl. 264—147)

Our invention relates to the production of textile filaments of branched form of the type described in British patent application Nos. 41,955/60 and 20,111/61 and has for its object an improved and simplified method for the production of such filaments.

In the specifications referred to above means are provided for casting or cutting a desired filament shape and thereafter drawing the resulting filament so as to secure adequate strength. In the present invention the methods described are modified in that the basic material is a sheet of suitable synthetic material such as nylon, "Terylene" (R.T.M.), polypropylene, or cellulose diacetate. This sheet is first slit in a manner similar to that employed to produce the so-called expanded metal, except that the slits are located in a herringbone form with the ends of the slits overlapping. As many rows of slits may be made in the material parallel to one another as is required to give the necessary width of filament, and the sheet is thereafter drawn without further slitting. Because the original sheet can be extruded or cast and subsequently immediately cooled we find that the degree of draw possible, either cold or hot, depending on the nature of the material employed, can be much greater than that at present used in the production of non-branched continuous textile filaments. Thus, in the latter case, a draw of about four to one is regarded as being a normal maximum, whereas in the case of a sheet which is rapidly cooled after formation the draw can be ten to one or even greater. This means that since the sheet reduces in width during drawing, the slit pattern can be formed several times wider than the width of the filament desired.

After the draw the sheet is expanded sideways by means of a device such, for example, as an expander, the resulting shape being that of a series of continuous strips of drawn sheet connected by a number of rungs also of drawn material, so that the resultant material resembles a plurality of adjacent parallel-sided ladders. This material is now passed through a cutting machine having a plurality of knives each knife slitting the rungs or branches between adjacent parallel strips, so that the result is a plurality of filaments, each filament having branches extending therefrom.

Numerous variations in the slit pattern may be employed. Thus for example the overlaps of the slits may coincide on each side of each filament, or alternatively the overlaps may occur at different places on each side of the filament. Again, instead of being herringbone formation, the slits may be formed so as all to lie parallel with one another and in parallel rows. The latter formation produces a filamentary structure in which adjacent filaments have short thick branches extending in opposite directions, and it is thought that this form of filament construction may be preferable where a yarn having closely adherent filament structure is desired, since in this case the branches of adjacent filaments, pointing in opposite directions, may readily interlock.

Although it is feasible to employ straight slits, it is also readily possible to use slits which are curved or otherwise shaped, so as to secure branch or filament formations of any desired characteristic. Thus, for example, the spaces between adjacent slits may be thinned so that the result-

ing branches are tapered towards their ends. Again, a sheet of material may be slit in the same way as that employed to produce expanded metal, in which case the material after expanding would be cut as described above to form a series of continuous filaments, each filament having branches of substantially the same cross-section as itself.

A process for manufacturing filaments on an industrial scale is envisaged as comprising a machine for continuously extruding or casting a sheet of suitable filament forming material. This sheet is fed either directly or after storage into a slitting machine which may employ suitably shaped rotary slitting knives. From this machine the cut sheet passes to a drawing machine in which input rollers feed the sheet over a hot surface such as a heated pin, over which the sheet is drawn by a further set of output rollers rotating at a higher speed in order to achieve a desired draw. Thereafter the sheet is extended by an expander, and at least some of the branches are slit, and the resulting filaments wound up on a beam, or they are combined to form a yarn which is given a low twist and then wound up on a bobbin.

Dyeing of the material can be effected at any stage of the process, but is preferably done before the drawing stage, as it is found that more uniform dyeing occurs on undrawn material than on drawn; the material may have dye incorporated in it before the sheet is formed, or the sheet may be run over a dye-carrying roller.

If necessary the branches of the structure may be partially or fully heat set whilst the material is in its expanded form and before severing of the branches, in order to ensure that the latter project at a suitable angle from the body of the filament. This may be effected by running the material in the extended form over a heated surface or between heated rollers.

If necessary the filaments and/or branches may be crimped by any suitable method in order to provide a resultant yarn which is fully bulked or expanded.

Reference should now be made to the accompanying drawings in which FIGURES 1 to 16 show various patterns of slotted material in both undrawn and drawn conditions, and FIGURES 17 and 18 are side and plan views of one form of a slitting and drawing machine respectively.

Referring first to FIGURES 17 and 18, it will be seen that our process may be carried out by employing a sheet extruding press **1** having an input hopper **2** for extrudable material. If this material is thermoplastic then the press preferably contains means for heating the material to a plastic condition, and a screw or like device for conveying the plastic material to a slit **3** from which the sheet **4** is emitted.

The sheet after extrusion is cooled by passage through a short air space, or otherwise hardened, and is then conducted between a pair of slitting rollers **5**, **6**, which rotate at a predetermined speed. The roller **6** has a facing of resilient material such as polyurethane and the roller **5** has a series of small sharpened blades projecting from its surface, these blades being arranged so as to produce a slit pattern of required form as described later. After leaving these rollers, which have impressed the required slit pattern on the sheet, the latter passes over a heater **7** which is automatically maintained at a constant predetermined temperature, and then between drawing rollers **8**, **9**. These latter are pressed together and their peripheral speed is several times higher than the peripheral speed of the rollers **5**, **6**. This causes the sheet to be drawn longitudinally, thus orienting the molecules of the material and converting the slit sheet into one suitable for the construction of filaments.

After leaving the rollers **8**, **9**, the slit and drawn sheet passes over a curved bar 10. The effect of this curved bar is to expand the sheet sideways thus separating the slits and reforming the material into a suitable pattern of filamentary form for a further slitting operation. The latter is effected by a device 11 consisting of a plurality of circular knives mounted on a shaft by means of which they are rotated at a constant speed, the knives acting to slit the ladder-form expanded sheet into a plurality of filaments having side branches. These filaments are finally wound on to a beam 12 resting on a driving roller 13 whereby the wound filaments are given a constant peripheral speed.

Various modifications may be made to this arrangement, which shows the process of our invention in principle only. Thus, if the material used for sheet formation requires to be chemically set from a solution, then the press 1 may be followed by a spray of suitable setting fluid acting on the material 4 so as to convert it from a liquid to a solid form. Again, the cutters 11 may act on the material to be slit whilst this material runs over a backing roller, and the said cutters 11 may themselves be heated in order to cut the yarn material more effectively. The slitting roller 5 may also be heated when thermoplastic materials are being cut. Again, the beam and roller 12, 13 may be replaced by a ring and traveller system if the filaments are to be twisted together.

Referring now to the remaining figures, FIGURE 1 shows a pattern of slits which may be applied to a sheet or strip material in order to form branched filaments therefrom. After drawing longitudinally, the material resembles the pattern shown in FIGURE 2, in which parallelograms represent holes in the material achieved by the drawing process. FIGURE 3 is a diagram illustrating the shape of the material after sideways extension by the stenter, the dotted lines indicating the places where the cutting knives of the roller 11 sever the strip. The portions 14 of the material form the base or trunk of each filament and the sideways extensions 15 form the branches.

In an alternative form of slitting, the rows of slits are displaced relatively one to another as compared with FIGURE 1 in a vertical direction, with the result that a sheet structure as shown in FIGURE 5 results, the difference between this structure and that shown in FIGURE 3 being that the branches extend from the trunk alternately in opposite directions.

FIGURE 6 shows a still further alternative arrangement of straight slits, the resulting drawn and expanded sheet being as shown in FIGURE 7. This type of slitting produces a filament having a relatively thin trunk and thick branches, a yarn made from the filamentary material shown being particularly suitable, for example, for keying on to a material such as rubber.

FIGURE 8 shows a pattern of curved slots, in this case portions of the material being punched out of the original sheet instead of forming slits only. Such a pattern when expanded in both dimensions gives a final sheet pattern of FIGURE 9 in which the branches taper, being thickest at their roots.

FIGURE 10 shows a pattern of transverse or tilted slots which when expanded in the direction in which the slots lie give a pattern as shown in FIGURE 11. Stentering produces a sheet as shown in FIGURE 12, the latter being slit along the dotted lines to give a series of branched filaments as before.

Finally, FIGURES 13 and 15 illustrate patterns of circular dot punchings which when expanded by the method described above produce slittable sheet patterns as shown in FIGURES 14 and 16.

It should be understood that many other slitting or punching patterns are available, the ones shown in the drawings being illustrative only.

What we claim is:

1. A process for manufacturing branched textile filaments, comprising the steps of piercing a thermoplastic undrawn sheet according to a predetermined pattern providing longitudinal rows of piercings in said sheet; drawing the thus-pierced sheet in at least one direction which expands the sheet in said direction and which enlarges said piercings to form therefrom longitudinal rows of openings extending along said sheet with continuous, uninterrupted longitudinal sheet portions extending longitudinally of said sheet between said rows of openings; and then cutting the thus-drawn sheet longitudinally between said continuous uninterrupted sheet portions through each of said rows of openings to provide separate filaments havings trunks formed by said longitudinal, uninterrupted, continuous sheet portions and branches extending laterally from said trunk and formed from the portions of said sheet which are located in said rows between said openings.

2. A process for manufacturing branched textile filaments, comprising the steps of piercing an undrawn thermoplastic sheet according to a predetermined pattern providing rows of piercings extending longitudinally of said sheet, drawing the thus-pierced sheet in a pair of different directions expanding the sheet and forming from said piercings rows of openings extending longitudinally of said sheet separated longitudinally of said sheet by longitudinal, uninterrupted continuous sheet portions and separated within said rows by sheet portions which extend between said longitudinal continuous sheet portions; and longitudinally cutting the sheet between said continuous uninterrupted sheet portions through each of said rows of openings to form branched filaments having trunks formed by said longitudinal, uninterrupted continuous sheet portions and branches formed by said sheet portions which extends between said longitudinal continuous sheet portions.

3. A process for manufacturing branched textile filaments, comprising the steps of piercing an undrawn thermoplastic sheet according to a predetermined pattern providing longitudinal rows of piercings in said sheet; drawing the thus-pierced sheet in a first direction; then expanding the thus-drawn sheet in a second direction providing together with said drawing of said sheet enlargement of said piercings to form openings arranged in longitudinal rows along said sheet, longitudinally separated by longitudinal uninterrupted, continuous sheet portions and separated within said rows by sheet portions which extend between said openings and between said longitudinal continuous sheet portions; and longitudinally cutting the thus drawn and expanded sheet between said continuous uninterrupted sheet portions through each of said rows of openings to form filaments which respectively have longitudinal trunks formed by said longitudinal continuous sheet portions and branches extending laterally from said trunks and formed by said sheet portions which extend between said openings and between said longitudinal continuous sheet portions.

4. A process for manufacturing branched textile filaments comprising the steps of piercing an undrawn thermoplastic sheet of the long-chain molecular type according to a predetermined pattern providing the sheet with longitudinal rows of piercings; drawing the thus-pierced sheet in at least one direction providing the sheet with longitudinal rows of openings formed by expanding said piercings and with longitudinal continuous uninterrupted sheet portions situated between said rows of openings and with additional sheet portions in said rows of openings separating said openings from each other and extending between said longitudinal continuous sheet portions; and longitudinally cutting the thus-drawn sheet between said continuous uninterrupted sheet portions through each of said rows of openings to form branched filaments respectively having trunks formed by said longitudinal continuous sheet portions and branches formed by said additional sheet portions.

5. A process for manufacturing branched textile filaments comprising the steps of piercing an elongated sheet of undrawn thermoplastic material according to a predetermined pattern providing the sheet with longitudinal

rows of piercings; heating the thus-pierced sheet; drawing the thus heated and pierced sheet, while it is at an elevated temperature resulting from said heating, in a direction which expands said piercings into openings arranged in longitudinal rows along the sheet and longitudinally separated from each other by longitudinal uninterrupted continuous sheet portions while separated within said rows by additional sheet portions extending between said openings and between said longitudinal continuous sheet portions; and longitudinally cutting the thus drawn sheet between said continuous uninterrupted sheet portions through each of said rows of openings to form branched textile filaments respectively having trunks formed by said longitudinal uninterrupted continuous sheet portions and branches formed from said additional sheet portions.

6. A process for manufacturing branched textile filaments comprising the steps of piercing a thermoplastic undrawn elongated sheet according to a herringbone pattern providing longitudinal rows of slits with the slits of one row being inclined oppositely to the slits of adjoining rows; drawing the thus-pierced sheet in a direction which expands said slits into openings arranged in rows longitudinally of said sheet and separated by longitudinal continuous uninterrupted sheet portions situated between said rows of openings and additional sheet portions located within said rows between said openings and extending between said longitudinal continuous sheet portions; and longitudinally cutting the thus drawn sheet between said continuous uninterrupted sheet portions through each of said rows of openings to form branched filaments respectively having trunks formed by said longitudinal uninterrupted continuous sheet portions and branches formed from said additional sheet portions.

7. A process for manufacturing branched textile filaments comprising the steps of piercing an elongated thermoplastic undrawn sheet with a plurality of relatively small openings arranged in rows extending longitudinally of said sheet according to a predetermined pattern; drawing the thus-pierced sheet in a direction which expands said openings to increase the size thereof so as to provide the sheet with longitudinal rows of openings larger than those which are initially pierced in said sheet and with longitudinal uninterrupted continuous sheet portions situated between said rows of larger openings and with additional sheet portions located within said rows between said larger openings and extending between said longitudinal continuous uninterrupted sheet portions; and longitudinally cutting the sheet between said continuous uninterrupted longitudinal sheet portions through each of said rows of larger openings to form branched textile filaments respectively having trunks formed by said longitudinal continuous uninterrupted sheet portions and branches formed by said additional sheet portions.

8. A process for manufacturing branched textile filaments comprising the steps of piercing a thermoplastic undrawn elongated sheet with curved piercings arranged in rows longitudinally of said sheet according to a predetermined pattern; drawing the thus pierced sheet in at least one direction which expands said piercings to form therefrom openings arranged in longitudinal rows along said sheet and separated by longitudinal uninterrupted continuous sheet portions situated between said rows of openings and additional sheet portions arranged within said rows between said openings and extending between said longitudinal uninterrupted continuous sheet portions; and longitudinally cutting the thus-drawn sheet between said continuous uninterrupted sheet portions through each of said rows of openings to form branched textile filaments respectively having trunks formed by said longitudinal continuous uninterrupted sheet portions and branches formed by said additional sheet portions.

9. A process for manufacturing branched textile filaments comprising the steps of piercing an elongated thermoplastic undrawn sheet according to a predetermined pattern providing the sheet with longitudinal rows of piercings; longitudinally drawing the thus pierced sheet; then transversely expanding the thus longitudinally drawn sheet, the expanded and drawn sheet having longitudinal rows of openings formed by enlargement of said piercings resulting from drawing and expanding of said sheet and said longitudinal rows of openings being separated by longitudinal uninterrupted continuous sheet portions arranged between said rows of openings and additional sheet portions located within said rows of openings between said openings and extending between said longitudinal continuous uninterrupted sheet portions; and longitudinally cutting the thus drawn and expanded sheet between said continuous uninterrupted sheet portions through each of said rows of openings to form branched textile filaments respectively having trunks formed by said longitudinal uninterrupted continuous sheet portions and branches formed from said additional sheet portions.

10. A process as recited in claim **9** and wherein said sheet is heated simultaneously with the longitudinal drawing thereof.

11. A process according to claim **9** and wherein said thermoplastic undrawn sheet is extruded and wherein said sheet is pierced as it issues from an extruder.

12. Apparatus for manufacturing branched textile filaments comprising, in combination, piercing means for piercing an elongated thermoplastic undrawn sheet according to a predetermined pattern providing the sheet with longitudinal rows of piercings; drawing means drawing the sheet from said piercing means to longitudinally draw the sheet and to extend each piercing; expanding means laterally expanding the drawn sheet after it progresses beyond said drawing means and laterally expanding each piercing; and cutting means cutting the sheet at a portion thereof located beyond said expanding means, said cutting means comprising a plurality of cutters each cutter being located to cut through one of the rows of piercings after the sheet has progressed beyond said expanding means.

13. Apparatus for manufacturing branched textile filaments comprising, in combination, piercing means for piercing an elongated thermoplastic undrawn sheet according to a predetermined pattern providing the sheet with longitudinal rows of piercings; drawing means drawing the sheet from said piercing means to longitudinally draw the sheet and to extend each piercing; expanding means laterally expanding the drawn sheet after it progresses beyond said drawing means and laterally expanding each piercing; cutting means cutting the sheet at a portion thereof located beyond said expanding means, said cutting means comprising a plurality of cutters each cutter being located to cut through one of the rows of piercings after the sheet has progressed beyond said expanding means; and take-up means for taking up separate filaments formed from said sheet by said cutting means.

14. Apparatus for manufacturing branched textile filaments comprising, in combination, piercing means for piercing an elongated thermoplastic undrawn sheet according to a predetermined pattern providing the sheet with longitudinal rows of piercings; drawing means drawing the sheet from said piercing means to longitudinally draw the sheet and to extend each piercing; expanding means laterally expanding the drawn sheet after it progresses beyond said drawing means and laterally expanding each piercing; cutting means cutting the sheet at a portion thereof located beyond said expanding means, said cutting means comprising a plurality of cutters each cutter being located to cut through one of the rows of piercings after the sheet has progressed beyond said expanding means; and take-up means for taking up separate filaments formed from said sheet by said cutting means, said take-up means, said drawing means, and said piercing means acting on the sheet to longitudinally transport the same continuously from said piercing means to said drawing means and from said drawing means to said expanding means and from said expanding means to said cutting means and take-up means.

15. Apparatus as recited in claim 12 and wherein a heating means is situated between said piercing means and drawing means for heating the sheet while it is drawn.

16. Apparatus as recited in claim 12 and wherein an extruding means extrudes the sheet in advance of engagement of the sheet by said piercing means.

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