

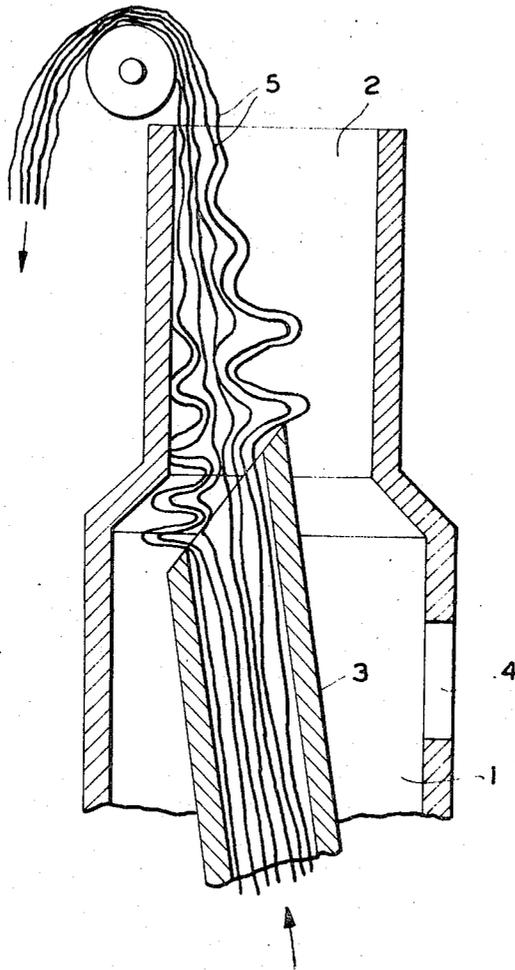
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METHOD OF AND AN APPARATUS FOR CRIMPING SYNTHETIC YARNS

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**METHOD OF AND AN APPARATUS FOR  
CRIMPING SYNTHETIC YARNS**

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2 Claims

**ABSTRACT OF THE DISCLOSURE**

The invention relates to a process for preparing crimped multifilament yarns of synthetic, high molecular weight polymers by treating the filaments in a gas stream. The filaments being introduced into an oscillating gas column and deflecting the crimped filaments out of the gas stream without reducing the crimp contraction.

This invention relates to a process for crimping endless synthetic yarns by means of an oscillating gas column.

It is known that endless multifilament yarns can be crimped by lateral folding, for example by stuffing, and by fixing the yarns thus folded. The machines used for this purpose have the disadvantage that the individual filaments are easily damaged and deformed because folding necessarily involves a mechanical process. Damage of this kind occurs in particular when, to obtain a particularly fine fold, the counter-pressure and bearing pressure are extremely high during stuffing whilst the width of the crimping rollers is kept very narrow. Another disadvantage is that the individual filaments are readily pushed out sideways from the chamber walls in the feed zone, again resulting in damage to the yarn.

A process for crimping multifilament yarns of synthetic high polymers has now been found in which the individual filaments are allowed to travel in the same direction as the flowing medium of an oscillating gas column in which the filaments are deflected once to form an arc and stuffed or compressed once for each oscillation of the oscillating gas column, the yarn as a whole being deflected out of the gas stream immediately after crimping. In this process, the individual filaments are made to oscillate by means of an oscillating gas column, are separated and the arcs of individual filaments issuing from the inlet pipe into the gas column are compressed and at the same time fixed, suitable means being provided to prevent the crimps from being straightened out again by the hot gas stream issuing at a high rate of flow.

An apparatus suitable for carrying out this process is shown in the accompanying drawing. The apparatus comprises a nozzle-supporting chamber 1 provided with an inlet 4, a nozzle 2 and an inclined guide tube 3. The treatment medium is fed centrally straight into the nozzle-supporting chamber through inlet 4 and, after being diverted through an angle of 90°, goes out into the open through nozzle 2. The transfer surface from the nozzle-supporting chamber 1 to the nozzle amounts to 45°. The guide tube 3 leads through the nozzle-supporting chamber. It is inclined, carries a lip at its upper end and terminates at the junction between nozzle-supporting chamber and nozzle. The yarn 5 to be crimped travels through the guide tube 3.

Steam under high pressure, preferably 4.0 to 5.7 atms., is used as the medium, and can, for example, be kept at

a constant temperature of 250° C., by means of a superheater, if polyamide filaments are to be treated.

The steam flows out into the open from the nozzle-supporting chamber by way of the annular gap and the nozzle, the cross section being at its narrowest in the annular gap between the nozzle-supporting chamber and the nozzle. Since the nozzle does not widen conically, the critical speed is never exceeded. The enlargement of the cross section after the annular zone resulting from the termination of the guide tube by the lip is an irregular transition which causes oscillations through turbulence. All the adjoining zones are made to oscillate at the basic frequency at least. These basic or fundamental natural frequencies are calculated to be of the order of size of basic oscillations of open or closed pipes which are caused by the steam flowing through the annular zone at a critical rate of flow (oscillating gas columns).

Accordingly, crimping is obtained by producing an oscillation in the individual filaments by means of a vibrating or oscillating gas column which is produced as a resulting oscillation at the inclined outlet of the lip of the guide tube and which manifests its presence in a series of compressions and rarefactions of the steam so that, in the event of rarefaction, the steam between the filaments is expanded. As a result, the individual filaments are bent arcuately outwards. The sharp edge of the guide tube acts as a folding or bending edge. The individual filament is additionally compressed in the following steam work. The yarn is located in the gas stream and leaves the nozzle with the gas stream at high speed. Since the yarn is very hot, the gas stream has to be separated from the yarn so that the crimp cannot be straightened out again by the high rate of flow. However, the frequency of the apparatus should not be affected during separation by preceding baffles and the like because the sensitive oscillating system can be adjusted very easily.

Gas and yarn are satisfactorily separated by using a pin which projects slightly into the gas stream above the nozzle. The yarn automatically winds itself around this pin on account of the weak lateral current, whilst the gas medium flows away in the opposite direction to the pin, being slightly deflected as it does so. The crimped yarn drops down under its own weight and is then further treated. Filaments of polyamides, acrylonitrile polymers and polyesters may be crimped.

The following examples illustrate more particularly the invention.

**EXAMPLE 1**

For a yarn fineness of 2000 den (bundle of polyamide-6 monofils), the crimping device described in the foregoing with a nozzle-supporting chamber 15.5 mm. long, a nozzle 23.6 mm. long and a yarn guide tube 227 mm. long, produces an average of 50 crimps (as counted) over 10 cm. with the assistance of steam under a pressure of 5.7 atms. and at a temperature of 250° C.

On the basis of these length ratios, the speed of sound in the covered nozzle-supporting chamber is calculated at 560 m./sec., in the open nozzle chamber at 520 m./sec. after reaching the critical velocity and in the open guide tube at 451 m./sec. at an air temperature of 200° C.

The uncrimped yarn issues from the air zone of the guide tube into the steam zone of the nozzle at the obliquely cut end of the guide tube, where the gases begin to oscillate as a result of the fundamental oscillations of the three oscillating gas columns, i.e. the nozzle support, nozzle and guide tube.

Superposition of the high-frequency oscillations (nozzle support and nozzle) produces an intermediate oscillation. If this intermediate oscillation is superimposed upon the low-frequency basic oscillation of the guide tube, the overall result is an oscillation whose high-fre-

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quency phases periodically lie mainly in the compression range and then mainly in the rarefaction range of the oscillations.

In the rarefaction range, the expanding gases bend the yarns outwards like arcs, whilst in the compression range the bent yarns are compressed by the inward-flowing gases. (The high-frequency phase produces an intermittent beat arching and compressing in the low-frequency accentuated direction, each point of the yarn being repeatedly placed under strain.)

Due to the draw-off rate of the yarn (which is also low in comparison with the low-frequency), the bends, which represent an image of the low-frequency oscillation, group together producing the crimp.

The following oscillation frequencies are derived from these sonic velocities: nozzle-supporting chamber  $9000 \times 1/\text{sec.}$ ; nozzle chamber  $11,000 \times 1/\text{sec.}$ ; guide tube  $1000 \times 1/\text{sec.}$  with a beat wave of  $1000 \times 1/\text{sec.}$

For a rate of yarn travel of 120 m./min., the oscillation frequency amounts to 5 crimps per cm. (50 crimps for every 10 cm.). One method of quick testing is to determine the crimp contraction. So far as the above-described device is concerned, the degree of crimp amounts to 100% at a rate of yarn travel of 120 m./min. (steam at 5.7 atms./250° C.), i.e. the crimped yarn 1 metre long is lengthened to 2 metres under a weight of 0.1 g./den.

When the rate of yarn travel is increased to 180 m./min., the degree of crimp or crimp contraction falls to 70%, corresponding to the reduction in the number of crimps per unit length.

#### EXAMPLE 2

As in Example 1, the nozzle-supporting zone is 15.5 mm. long, but the nozzle chamber is 20 mm. long and the guide tube is 113 mm. long. Under these circumstances, the rate of yarn travel may be almost doubled without any change in the crimp contraction and crimp count of the yarn because the beat count of 1000 in Example 1 was doubled to 2000 in Example 2. When the rate of travel is decreased to 120 m., the crimp contraction increases to 120% for the same denier of 2000. The crimps are smaller, more compact and finer.

#### EXAMPLE 3

For a denier of 1300 den (bundle of polyamide-6 monofils), a nozzle 13 mm. long with a nozzle-supporting chamber 16 mm. long and a yarn guide tube 57.9 mm. long, was found by calculation to give a resulting wave of  $862.5 \times 1/\text{sec.}$ , the steam pressure and temperature corresponding to those in Examples 1 and 2. From twelve yarns, the average number of bends was 3.34 per cm. for a rate of yarn travel of 155 m./min.

In the apparatus described in the three examples, the

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diameter of the nozzle-supporting chamber was 8 mm., the nozzle 3 mm. and guide tube 2 mm.

These diameters may be used in a range of  $\pm 50\%$  of the fineness of 2000 den specified. Yarns with a fineness from 1000 to 3000 den can be crimped. In this range of  $\pm 50\%$  from the average denier, the diameters do not have any effect on the oscillation frequencies, which are governed solely by the lengths. However, they do affect transmission of the oscillation to the yarn passing through. In the case of a fine denier, for example 800 den, the diameters have to be reduced to 8 mm. for the nozzle-supporting chamber, 2.5 mm. for the nozzle and 1.5 mm. for the guide tube so that the oscillations can be satisfactorily transmitted to the yarn.

If this finer denier is crimped on the same device as described in Example 1, the crimp contraction at 120 m./min. falls to 80%. With a higher denier, however, for example 3600 den, the diameters have to be increased because the individual capillaries of the yarn have too little freedom of movement to oscillate.

What we claim is:

1. A process for preparing a bulky yarn composed of a plurality of continuous filaments of a synthetic, high molecular weight polymer having loops regularly spaced along the yarn surface which process comprises feeding said filaments into an air jet in, and passing said filaments through, a guiding tube and thence into a gas column moving generally in the same direction as the filaments, said gas column oscillating so as to deflect the filaments in the form of an arc and against the exit edge of the guiding tube and, in a second oscillation to compress the arc shaped filaments to the form of a crimp and thereafter deflecting the resultant crimped filaments out of the oscillating gas stream without substantial reduction of the crimp.

2. An apparatus adapted for the production of bulky yarn comprising an annular nozzle, an integral nozzle-supporting chamber, a gas inlet into said chamber, a yarn-guiding tube within said chamber having an obliquely cut end forming a sharp edge at the initial portion of said nozzle and within said chamber, a gas-oscillating zone between the initial portion of said nozzle and the inner end of said yarn guiding tube.

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