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QUENCHING CHAMBER

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Fig. 1

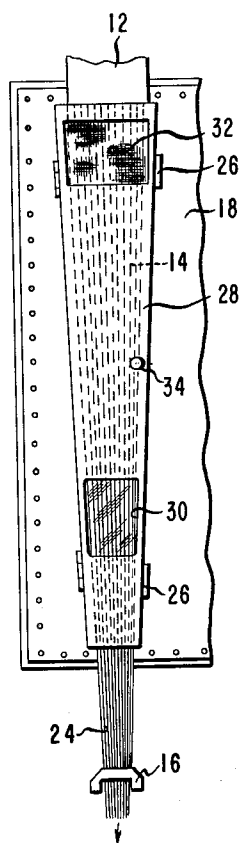
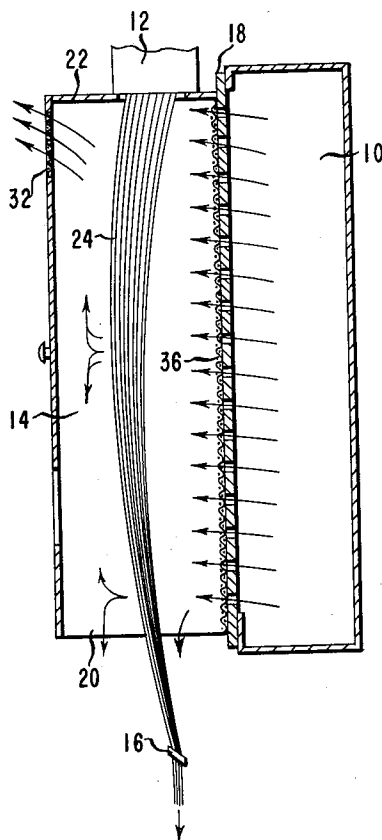


Fig. 2



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QUENCHING CHAMBER

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4 Claims. (Cl. 18—8)

This invention relates generally to the production of filaments, yarns, ribbons and the like from fiber-forming synthetic polymers and, more particularly, to improvements in the apparatus employed in cooling the molten structures extruded from a spinneret.

According to known procedures, melt-spun structures travel a short distance from a spinneret before entering a quenching chamber in which a cross-current flow of a quenching medium is substantially uniform from end to end of the chamber.

The general objective of the present invention is the over-all improvement of such properties as the denier uniformity, tenacity and dyeability of the spun structures.

The most important object of the invention is to provide a quenching chamber in which there is, in addition to the improvements in product properties, a more efficient use of the quenching medium.

These and other objects are accomplished by the provision of a quenching chamber defined by a convergent chimney having a pair of converging rectangular side walls, a foraminous, trapezoidal rear wall, and a trapezoidally-shaped door as its front wall. Additional structural features of the improved quenching chamber will become apparent in the following specification wherein reference is made to the accompanying drawing in which:

FIGURE 1 is a front elevational view of a quenching chamber made in accordance with the teachings of the present invention and shown in association with a plenum chamber; and

FIG. 2 is a vertical sectional view through the quenching and plenum chambers.

The apparatus embodiment chosen for illustration includes generally a plenum chamber 10, a spinneret 12, a convergent quenching chamber 14 and a convergence guide 16. The plenum chamber 10 has imperforate top, bottom, side and rear walls as well as a front distribution plate 18 which is suitably perforated at the location of each of a plurality of quenching chambers. Each quenching chamber includes a pair of wings or side walls 20, and a top wall 22 which is provided with an opening through which a plurality of filaments 24 travel directly from spinneret 12 to chamber 14 and guide 16. The side walls 20 are attached to plate 18 by means of suitable mounting pads 26 and one of the side walls has hingedly attached thereto a front wall in the form of a door 28. The latter has an observation window 30, a screened aperture 32 and a handle 34. The rear wall of chamber 14 is defined by a perforated area of plate 18 and a screen 36 which extends from side to side and end to end of the chamber. It would also be possible to integrate the rear wall into the chimney structure and adapt it for attachment to plate 18 in covering relationship to an appropriate aperture. In either event, a quenching medium, usually air, flows under pressure through the foraminous rear wall into chamber 14 for cross-current flow through filaments 24.

As is apparent from FIGURE 1, the rectangular side walls 20 converge toward the bottom of chamber 14 in such a manner that the door 28 and screen 36 are trapezoidal in elevation. The side walls 20 are closely adjacent to the paths of travel of the outermost filaments. As a minimum, the distance between a side wall and the closest filament should not be less than the distance between the two closest spinneret holes. Usually, the illus-

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trated apparatus is physically located above its associated windup area and the filaments 24 pass downwardly thereto through a cylindrical transfer tube. In some instances, when the apparatus is placed in operation, a bundle of filaments is forced downwardly through the transfer tube to the windup area by compressed air. Once the individual filaments and the bundle as a whole are running properly through the tube, they are separated and located on the guide 16. Another possibility is to apply a vacuum to the bottom of the transfer tube and draw the filaments out through a flexible hose suitably connected to a fan and filter system. The hose can be used to draw off the filaments to a waste-collecting system while the individual filaments are being strung-up.

In normal operation, the quenching medium flows cross-current through the filaments 24 at substantially the same optimum velocity as in a conventional rectangular chimney. However, there is a more efficient use of the medium since the reduction in the cross-sectional area of the flow path through the chimney permits a reduction in total air flow while maintaining the same flow velocity. In addition to this highly desirable reduction in quenching medium requirements, there are very striking improvements in the physical properties of filaments spun through a trapezoidal chamber of the type disclosed herein. In one comparative test, polyhexamethylene adipamide filaments were spun and passed through a trapezoidal chamber through which there was a cross-current flow of air at the rate of 98 cubic feet per minute. The filaments showed a mass vibrometer denier variation of $\pm 3.4\%$ as against a variation of $\pm 6.4\%$ when using a rectangular chimney of corresponding length and a flow rate of 163 cubic feet per minute. The flow rates were optimum in each case. In further tests, an equal volumetric flow (75 cubic feet per minute) was passed through rectangular and trapezoidal chimneys of equal length at a velocity which was considered optimum for the rectangular chimney. The flow rate through the trapezoidal chamber was accordingly well above optimum. Despite this undesirable increase in velocity of the cross-current flow, the filaments spun into the trapezoidal chamber showed comparatively lower percentages of shrinkage, retraction and elongation as well as a comparative increase in tenacity as measured in grams per denier. They also showed a mass vibrometer variation of $\pm 2.1\%$ as against $\pm 2.9\%$ for the filaments spun into the rectangular chamber. The latter comparison, in particular, is surprising since an increase in percentage denier variation is usually experienced where the quenching flow is at a velocity considerably higher than optimum. These improvements in the physical properties of filaments spun through a trapezoidal chamber are most likely due to a reduction in turbulence within the chamber. As shown by the arrows in FIG. 2, the quenching medium flowing into the chamber 14 exits through opening 32 and the open bottom of the chimney. With a trapezoidally-shaped chimney, there is space for counter- and co-current flow only in the front portion of the chimney by which time the major portion of the medium has flowed cross-current through the filament bundle. In a rectangular chimney, there is a relatively large amount of space available for counter- and co-current flow at the sides of the bundle. Smoke pattern tests have shown the counter-flow in these side areas of a rectangular chimney to be productive of a considerable amount of turbulence. Reduction of this turbulence is believed to be responsible for the improved quality of filaments spun through a trapezoidal chimney.

The apparatus disclosed herein has particular utility in the spinning of multi-end, multi-filament yarns into a single chimney wherein the as-spun filaments occupy considerable transverse space just below the spinneret. The

same yarns occupy very little transverse space at the lower end of the chimney near the convergence guide.

Although specific reference has been made to the use of polyhexamethylene adipamide, it is apparent that the improvements disclosed herein are equally applicable to the melt-spinning of any organic fiber-forming composition. In this and other respects, it is accordingly intended that the present invention should be limited only by the scope of the appended claims.

I claim:

1. A quenching chamber defined by a convergent, open-bottom chimney, said chimney comprising: a first pair of opposed, elongated, rectangular side walls; and a second pair of opposed, elongated, trapezoidal, substantially parallel side walls, all of said walls being planar, one of said trapezoidal walls being foraminous through a major portion of its area and the other of said trapezoidal walls being imperforate except for an opening provided therein adjacent its divergent end.

2. In a melt-spinning apparatus including a spinneret and a convergence guide to which freshly spun filaments travel from the spinneret, an open-bottom quenching chimney comprising: a pair of opposed rectangular side walls converging from adjacent the spinneret toward the guide; a trapezoidal rear wall; and a trapezoidal front wall, said rear wall being foraminous through a major portion of its area, said front wall being imperforate except for an opening provided therein adjacent the spinneret, said front and rear walls being substantially parallel.

3. In a spinning apparatus including a spinneret and a convergence guide spaced from the spinneret, an elongate quenching chimney through which converging filaments travel between the spinneret and the guide, said chimney comprising: a pair of convergent rectangular side walls; a trapezoidally-shaped rear wall foraminous through a major portion of its area; a trapezoidally-shaped, imperforate front wall having an opening therein adjacent the spinneret; and a top wall flush with the spinneret, said top wall being provided with an opening through which the filaments pass to the chimney, the latter having an open bottom, said front and rear walls being substantially parallel.

4. The spinning apparatus of claim 3 wherein the taper of said trapezoidally-shaped front and rear walls and the convergence of said side walls conform to the maximum convergence angles of the filaments and wherein the side walls are closely adjacent to the path of travel of the nearest filaments.

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