Jan. 1, 1963 G. W. THOMPSON 3,070,839

CONTROLLED QUENCHING APPARATUS

Filed Dec. 24, 1958

Fig. 1

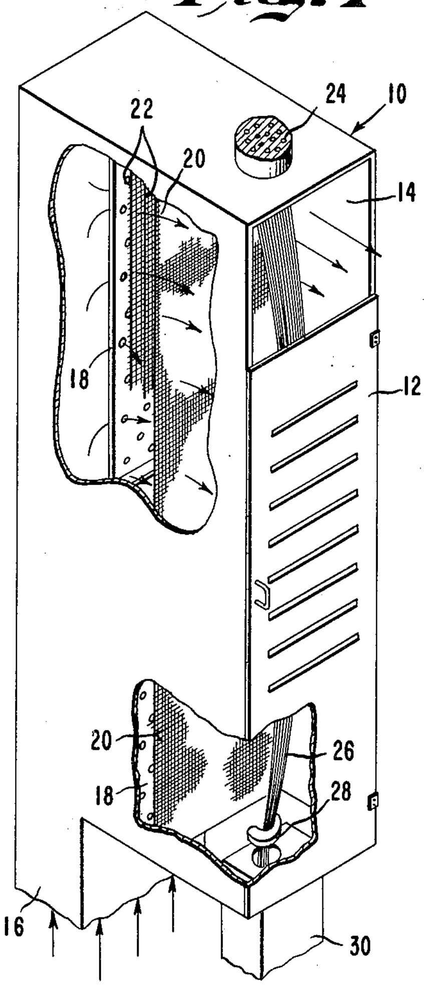


Fig. 2

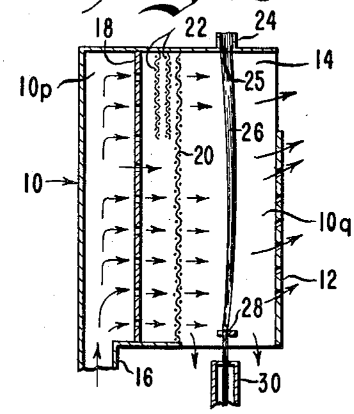


Fig. 3

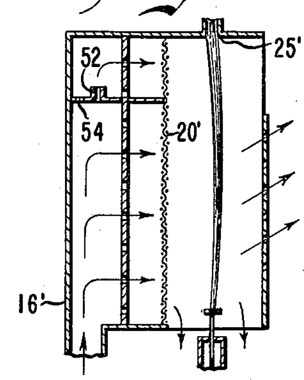


Fig. 4

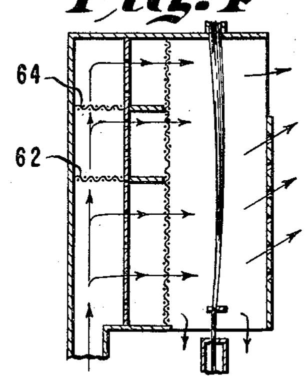
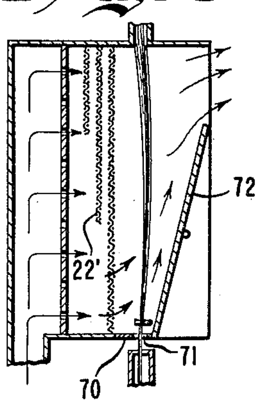


Fig. 5



3,070,839
CONTROLLED QUENCHING APPARATUS

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2 Claims. (Cl. 18—8)

This invention relates generally to the production of synthetic filaments by melt-spinning and, more particularly, to a process and apparatus for cooling the molten filaments as they are extruded from a spinneret.

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

The general objective of the present invention is the improvement of such properties of the yarn as its tenacity, drawability and uniformity, all of which improvements are reflected in subsequent handling of the yarn by way of reductions in the number of draw twister breaks, draw roll wraps, cleaner breaks, and the like.

The most important object of the present invention is the provision of a quenching process and apparatus in which the cooling potential of the quenching medium is increased as the distance from the spinneret increases.

Another important object of the invention is to provide a flow of the quenching medium, at its lowest cooling potential, immediately below the face of the spinneret.

With these and other objects in view, the practice of this invention involves generally the spinning of molten filaments through a quenching chamber, the introduction of an initially cross-current flow of a suitable quenching medium into the chamber, and control of the distribution of the quenching medium into the chamber by increasing its cooling potential as the filaments progress away from the spinneret.

The nature of the invention will be explained more fully hereinafter with reference to the accompanying drawing, wherein:

FIGURE 1 is a perspective view of the preferred embodiment, parts having been broken away to reveal details of construction;

FIG. 2 is a vertical sectional view, on a reduced scale, through the apparatus of FIG. 1; and

FIGS. 3–5 are vertical sectional views of alternate embodiments of the present invention.

In known processes of melt-spinning synthetic polymers, the spun filaments travel a short distance before entering an air-quenching chamber. Toward the remote end of the quenching chamber the filaments are gathered into a bundle by a convergence guide. In high-speed spinning, a steam-conditioning step is required, i.e., the filaments are passed from the convergence guide through a tube which is exposed to a steam atmosphere. The steam conditoning causes the filaments to absorb moisture and to grow in length before reaching the windup bobbin, thus eliminating the possibility of such activity after the filaments have been wound up.

Referring now to FIGS. 1 and 2, the numeral **10** designates an elongated chimney which is rectangular in cross section and provided with imperforate top, rear and side walls. The front of the chimney is partially covered by a louvered door **12** which terminates short of the top wall and presents an open passage **14** for air discharging from chimney **10**. At the lower rear side thereof, the chimney **10** communicates with a duct **16** through which quenching air at substantially room temperature is introduced. The interior of chimney **10** is partitioned by a perforated distribution plate **18** and a distribution screen or sheet **20** of a suitable foraminous material. Screen

20 is the boundary between a plenum chamber **10p** to which air is introduced from the inlet duct **16** and a quenching chamber **10q** through which the filaments pass. Between plate **18** and screen **20**, two partial, flow-controlling screens **22** extend downwardly from the chimney top wall and define the extent of a first flow zone in the upper region of quenching chamber **10q**. It is preferred that screens **22** be placed upstream from screen **20** in order to minimize air turbulence in the chamber **10q**.

In operation, filaments are melt-spun from a spinneret **24** directly into the quenching chamber **10q** through an opening **25** provided in the chimney top wall. As against the prior practice of spacing the chimney from the face of the spinneret, the top wall of chimney **10** is flush with the face of spinneret **24**. The filaments **26** pass through the length of chamber **10q** and, after being cooled therein, are gathered into a bundle by a convergence guide **28** before entering a steam conditioner **30**. The quenching medium enters the plenum chamber **10p** through duct **16**, passes through distribution plate **18** and screens **20**, **22** to the quenching chamber **10q**. As the medium passes through screens **20**, **22**, there is a pressure drop and a consequent velocity reduction relative to the flow through the single screen **20**, i.e., the cooling potential of the medium in the first zone of the quenching chamber **10q** is considerably less than the cooling potential of the relatively unimpeded flow through the lower zones. Air flow from quenching chamber **10q** is as indicated by arrows in FIG. 2. For best results, the cooling potential of the quenching medium should increase in the second zone to at least 130% of its value in the first zone, and the first zone should extend through a distance of at least 6 inches from the face of the spinneret. Manifestly, the flow volume is varied with variations in the count and denier of the yarn being spun.

In a conventional quenching chamber, where there is a substantially uniform cross-current flow through the length of the chamber, the filaments are cooled at a high rate in the zone near the spinneret. In this zone, the filament temperature is in the range of 270°–180° C. In the succeeding zones, the cooling rate decreases as the temperature of the filaments decreases below 180° C. By increasing the cooling potential of the medium in these succeeding zones, i.e., by increasing the flow, as disclosed herein, the cooling rate is increased in the zones of lower temperature.

In actual tests of the process and apparatus of the invention, the drawability of the filaments was improved considerably when compared with filaments which were spun through conventional equipment. The comparison showed a reduction of more than 50% in the number of broken filaments and draw roll wraps. The tenacity of the filaments was also substantially increased.

The same principle of increasing the cooling potential of the quenching medium with increases in the distance from the spinneret is employed in the apparatus embodiments of FIGS. 3–5. For example, in FIG. 3 the quenching medium enters the plenum chamber through duct **16'** and passes through a pressure reduction nozzle **52** in a plate **54** which traverses the distance between the rear wall and the screen **20'** to thus define an upper zone of reduced pressure and velocity in the quenching chamber. The medium is evenly distributed through the lower zones at a substantially greater rate. In FIG. 4, the medium which enters the plenum chamber passes through two pressure-reducing screens **62** and **64** to define zones of relatively reduced flow. In FIG. 5, the central partial screen **22'** extends farther into the chimney to define a second zone of intermediate flow in the quenching chamber. Additionally, the embodiment of FIG. 5 is provided with a closure plate **70** and an inclined imperforate door **72**. The effect of inclined door **72** is to induce a counterflow in the lower zones of the quenching chamber. By the addition of closure plate **70**, which has an opening **71** through which the filaments travel, a stronger counterflow is induced in the lower zones and, to some extent, in the upper zone. This additive effect is manifestly dependent on the size of opening **71**. Although the embodiment of FIG. 1 has been described as preferred, it should be noted that the modified apparatus of FIG. 5 is more effective for deniers of 840 and greater.

In carrying out the process, it is essential that, in addition to the conventional steps of spinning and steam-conditioning, the filaments be passed directly from the spinneret into a quenching chamber. In the quenching chamber, the cooling potential of the medium is increased in each of several successive zones between a minimum in the first zone to a maximum in the zone preceding the steam-conditioning step. In the apparatus embodiments chosen for illustration, this increase in cooling potential is accomplished by successively reducing the resistance to flow of the quenching medium between the plenum and quenching chambers.

Other advantages inherent in the practice of this invention will occur readily to those skilled in the art and, accordingly, its extent is intended to be limited only by the scope of the appended claims.

I claim:

1. In combination with a spinneret from which a plurality of filaments is extruded, a quenching apparatus comprising: an elongated chimney having side, front and back walls as well as an end wall flush with the spinneret face, said end wall being provided with an opening through which the filaments pass for travel through the length of the chimney; a sheet of foraminous material dividing the chimney longitudinally into a quenching chamber through which the filaments travel and a plenum chamber, said front wall having an opening therein adjacent said end wall; and conduit means communicating with the plenum chamber for the introduction of a quenching medium, there being at least one additional foraminous sheet traversing said plenum chamber in close proximity to but spaced from said chimney-dividing sheet and in depending relationship to said end wall, said additional sheet being opposite said opening and extending only partially through the length of said plenum chamber.

2. The combination of claim 1 wherein is provided a second additional sheet having a length greater than the length of said one additional sheet and less than the length of said chimney.

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