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Fletcher

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[54] **OPEN CELL FOAM DEVICE FOR GAS DISTRIBUTION IN FILAMENT QUENCHING CHIMNEYS**

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[52] **U.S. Cl.** ..... **425/72,** 264/176 F, 264/237

[51] **Int. Cl.** **B29c 25/00**

[58] **Field of Search** ..... 18/8; 264/177 R, 177 F, 264/176 F; 425/72

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Primary Examiner—Jay H. Woo

[57] **ABSTRACT**

A chimney used for quenching synthetic filaments after they are extruded is divided into a plenum chamber and a quenching chamber by means of a porous open-celled polyurethane foam rather than a conventional screen assembly to improve quench medium distribution into the quench chamber.

1 Claim, 4 Drawing Figures

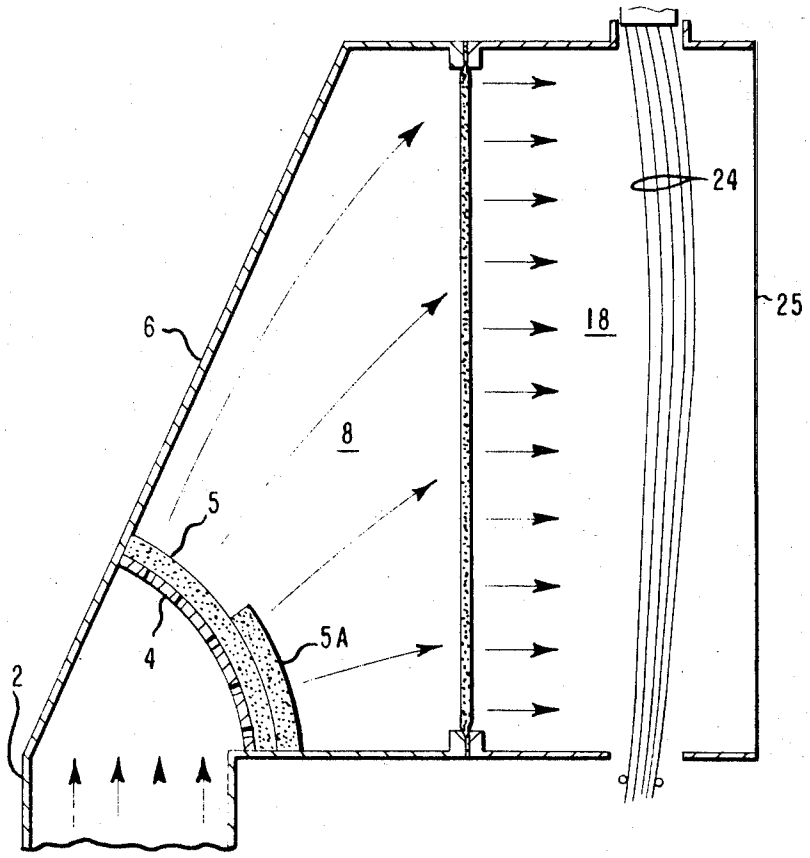


FIG. I
(PRIOR ART)

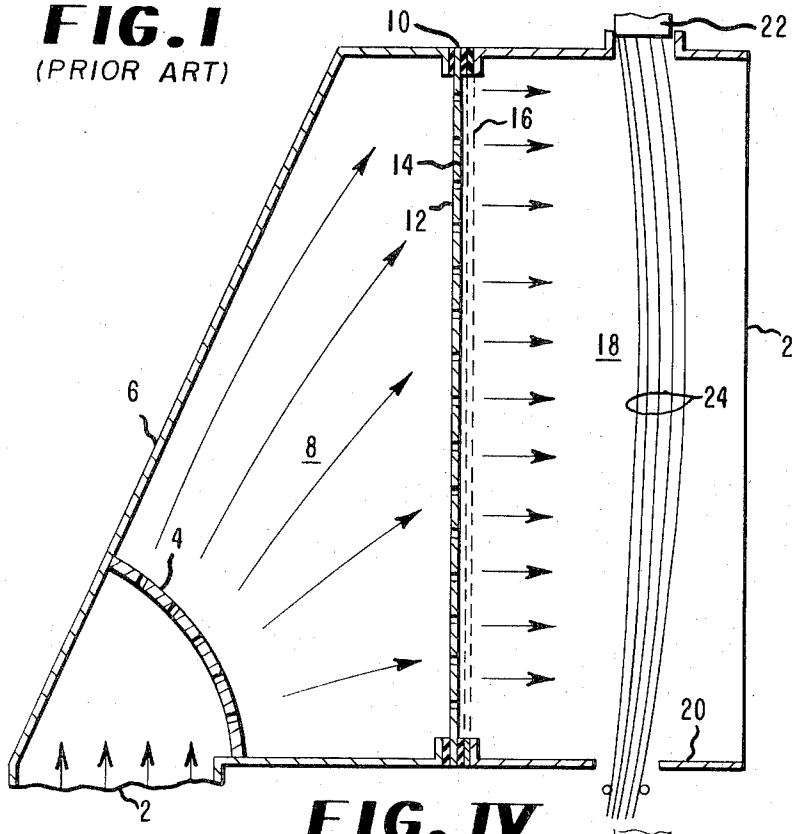


FIG. II
(PRIOR ART)

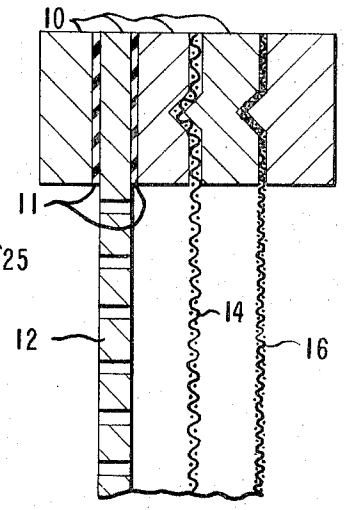


FIG. IV

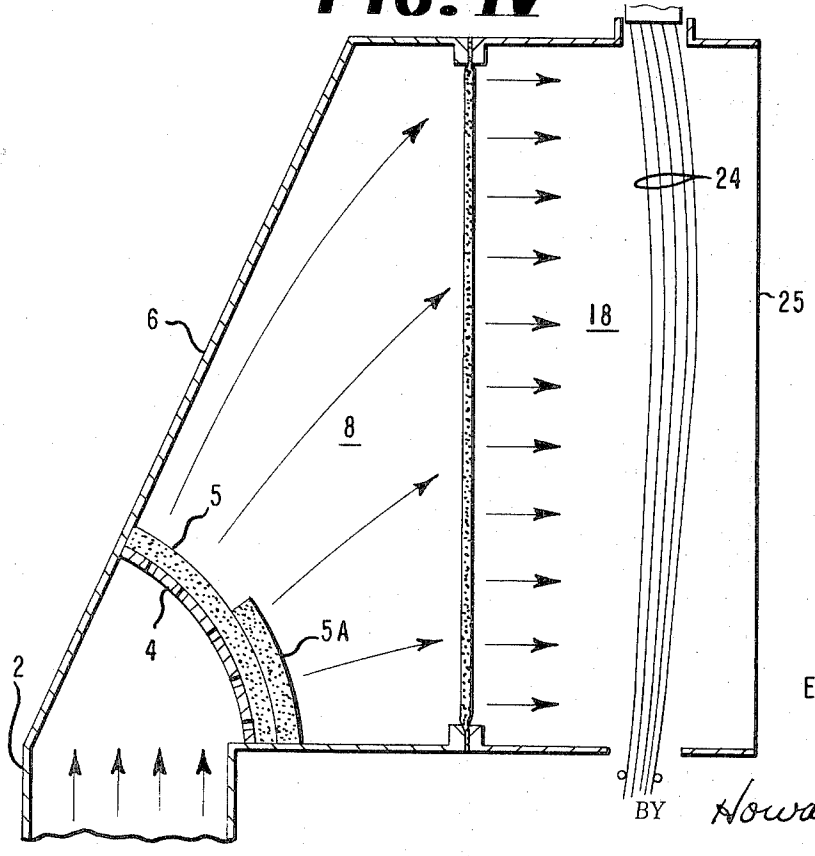
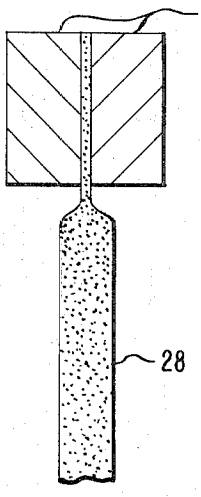


FIG. III



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OPEN CELL FOAM DEVICE FOR GAS DISTRIBUTION IN FILAMENT QUENCHING CHIMNEYS

BACKGROUND OF THE INVENTION

This invention concerns the quenching of filaments, more specifically, it relates to a device for directing and distributing the fluid entering the quenching area.

Two basic types of chimneys for quenching filaments are the cross-flow type and the radial type. In the cross-flow quench chimney, filaments are supplied from a spinneret into a chamber and into this chamber quench air is introduced at essentially right angles to the path of the filaments. This quench medium crosses the filament path moving around and through the bundle of filaments and then vents from the quenching chamber essentially in straight-line flow. In a radial quench device, the quenching medium is supplied around the periphery of the bundle of filaments, is forced radially inward through the bundle, and thereafter passes from the quenching chamber cocurrently with the filaments. Quench medium is supplied from a central manifold into the plenum chamber at each spinning position. Once in the plenum chamber the quench fluid must be properly distributed by a perforate member so as to be properly directed onto the filaments. The plenum chamber is separated from the quench chamber by a suitable resistance which serves to distribute the quench medium in the plenum, to break up swirls and eddies and to cause the quench gas to flow in an essentially straight line onto the filaments.

Various porous materials have been used to effect distribution of plenum quench air to control the treatment filaments receive in the quench chimney. Early quenching chambers used felt and textile fabric as air distributing means but these have been abandoned since they plug readily and deteriorate rapidly in the spinning cell. Moreover, porosity of these materials is difficult to control. Porous paper suffers from the same limitations. Sintered metal and porous earthenware are also disclosed as suitable but these are expensive, difficult to clean, and also subject to damage, especially the ceramic materials. Moreover, sintered metal can be damaged by the operator during routine maintenance, such as spinneret wiping and pack changing.

Metal screens of various porosities in a multiple layer arrangement are generally used to provide the resistance to flow for quench chamber air distribution. These materials, while providing more precise control of the pore size through which quench gas passes, have the disadvantage of being difficult to install. When assembled in frames, they are thick and heavy to handle and in service are readily plugged. It is also difficult to obtain a smooth surface in installing the screens in the frame since they become kinked and are difficult to stretch and hold flat while being mounted. The tension required to stretch them smooth results in warping of the frames with subsequent sealing problems. Hence, there are undesirable position-to-position variations in quenching characteristics. Operators inadvertently damage the very fine mesh screens at the outside of the stack when their wiping tools strike and smear the soft metal surface.

It is an object of this invention to provide an improved means of distributing air for uniformly quenching filaments. It is further an object to provide a cheaper, more easily installed material than has been heretofore used.

SUMMARY OF THE INVENTION

The invention comprises the use of a soft, porous, open-celled foam, such as polyurethane, for directing and distributing quench gas in a filament quenching chimney. Tests of this material in place of the metal screens previously used show improved air distribution at the same or lower plenum pressures as indicated by velocity profile tests and also in the production of filaments with improved denier uniformity. Sheets of this soft, rubbery, foam material can be easily stretched into place with uniform tension for every screen frame serving as its own gasket when pressed between the halves of the metal frame, thus minimizing leakage from the plenum chamber into the quench chamber at the edge of the frame. This foam material is manufactured in black providing good threadline visibility, whereas screens typically used require a relatively expensive dyeing step to provide this color contrast. In operation, it is found the soft material deflects when struck by spinneret wiping or pack changing tools, thus avoiding the smear damage discussed for metal screens.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a sectional side view of a typical chimney of a cross-flow type.

FIG. 2 shows a detail of the screen frame assembly of FIG. 1.

FIGS. 3 and 4 show the conventional screen frame assembly and restrictor assembly of FIGS. 1 and 2 replaced by the structure of this invention.

DETAILED DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a prior art filament quenching chimney of the cross-flow type in which quench air is supplied from a central manifold through the connecting conduit 2 and passes through the perforated restrictor plate 4 which provides a resistance permitting the changing of screens without affecting adjacent spinning positions. Quench air passes into plenum chamber 8 defined by wall 6. Attached to the front wall of the plenum chamber 8 is the screen frame assembly 9 which provides sufficient resistance to flow to uniformly distribute air vertically along and across the plenum chamber 8. This frame assembly includes, successively in the direction of air flow, a perforated metal plate 12, a 50-mesh screen 14 and a 100-mesh screen 16 all sandwiched between multi-layered metal frame 10. The perforated plate and screens are clamped into the frame members and are bolted to the plenum chamber 8. Quench air flows through the assembly 9 into the quench chamber 18. Filaments extruded from a spinneret 22 are collected and fed downward through quenching chamber 18 as a bundle 24 to a collecting means (not shown). Quench air confined by walls 20 located on both sides of the filament bundle flows across and through the filament bundle 24 exiting the quench chamber at the front opening 25.

As best shown in FIG. 2, chimney screen frame assembly 9 is designed to seal around the edges of the perforated plate 12 with suitable gaskets 11 as well as to stretch the screens in the frame. The assembly 9 is preassembled and installed as a unit when screens in service must be replaced. Gasketing is required around

the perforated plate as well as the back of the frame to prevent quench air leakage.

FIG. 3 shows a detail of the structure of this invention consisting of a sheet of porous open-celled foam **28** stretched and clamped between the two halves of the frame **26.** The foam not only replaces the screens but also serves as its own gasket. Gasketing is still required at the back of the frame. To minimize spinning machine down-time, this assembly is also made up in advance. Alternatively, the perforated metal plate shown in FIG. 2 can be left in place and the foam sheet can replace only the metal screens. Also the porous foam sheet can be attached directly to the plenum serving as its own gasket to eliminate one frame member and the separate gasket.

FIG. 4 shows another embodiment of this invention in which a porous open-celled foam is used both to replace the screen assembly and to cover the restrictor plate **4.** Covering the restrictor plate **4** with a layer of foam **5** improves quench gas distribution in the plenum chamber and also permits attainment of various distribution patterns in the plenum. Thus, for example, layers of foam such as **5***a* in combination with **5** could be arranged on the restrictor plate to accomplish this.

EXAMPLE I

This example demonstrates improved denier uniformity obtained with the apparatus of this invention. The 50-mesh, 100-mesh quench chimney is replaced by a 0.5-inch thick sheet of polyurethane open-celled foam 45 pores per linear inch (approximately 18 pores/cm.) in spinning a conventional 70-denier 26 filament yarn count. The sheet foam is installed in a conventional frame under slight tension to provide a smooth, flat surface. After 1.5 months of tests, Uster data show 0.85 percent vs. 0.95 percent for the control, that is, the conventional process. Yarns with completely satisfactory physical properties are obtained. After 16 weeks service, the foam is still performing well. Service life for a typical metal screen is about 10 weeks.

EXAMPLE II

This example demonstrates the improved quench air distribution resulting from use of foam. A 0.5-inch thick sheet of open-celled polyurethane foam 60 pores per linear inch (approximately 24 pores/cm.) is substituted for the conventional perforated plate, 50-mesh, 100-mesh screen assembly in a standard frame. The frame is mounted in a conventional chimney and the same amount of quench air is applied as to the screen assembly. At the nominal air velocity of 60 ft. per minute (19.5 meters/min.), the pressure drop across the foam is the same as across the metal screens — approximately 2 inches (5 cm.) of water. Air velocity is measured from top to bottom of the chimney and ranges from 61 to 65 feet per minute (20.2–21.5 meters/min.). The standard deviation is 1.365. Velocity along the conventional screen assembly ranges from 56 to 64 (18.5–21 meters/min.) and the standard deviation is 2.84.

The nominal pore size of the 45 pores per inch (approximately 18 pores/cm.) foam is 31 mils (0.79 mm.) vs. an average pore size of 11 mils (0.28 mm.) for 50-mesh and a pore size of 5 mils (0.13 mm.) for 100-mesh screen. In view of the larger pore size of the foam, the improved air distribution as indicated by the improved Usters of Example I is surprising. One possible explanation is the foam provides a tortuous path for each stream. An air stream passing through the foam encounters overlapping and intersecting pores which break up the principal stream into smaller streamlets, thus eliminating eddies and swirls which would be transmitted undiminished through a larger pore.

The non-blinding characteristic is demonstrated by the change in dye depth with time in service for filaments quenched using urethane foam vs. the standard brass screens. Using a diagnostic dye, filament dye depth increases approximately 10 percent from the time a brass screen is installed until it must be removed. In contrast, foam screens show no pronounced dye depth cycle even though operated longer between changes than the brass screens.

It has also been found particles of the foam can be gouged out through accidental contact by pack replacement and spinneret wiping tools without affecting yarn properties provided the foam is not torn all the way through. Also, drops of polymer melt which contact and fuse to the foam sheet can be peeled off without affecting the air distribution or yarn properties provided the sheet is not torn through.

This foam sheeting may also be used in spinning filaments from solution where the foam remains stable to the quenching medium at the temperatures encountered.

What is claimed is:

1. An apparatus for the production of synthetic filaments including an elongated chimney, a porous open-celled foam sheet dividing said chimney longitudinally into a quenching chamber through which filaments pass in a path from an extrusion device to a collecting means and a plenum chamber, conduit means connected to said plenum chamber for supplying a quenching medium thereto, the improvement for restricting the flow of quenching medium into said plenum in a varying distribution pattern comprising: a perforated plate positioned across said conduit means upstream of said plenum chamber; and a layer of porous open-celled foam of varying thickness attached to said plate, thereby permitting the attainment of a varying distribution pattern for said quenching medium entering said plenum chamber.

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