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D. C. FERRIER ET AL

3,229,330

APPARATUS FOR MELT-SPINNING SYNTHETIC POLYMER FILAMENTS

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3 Sheets-Sheet 1

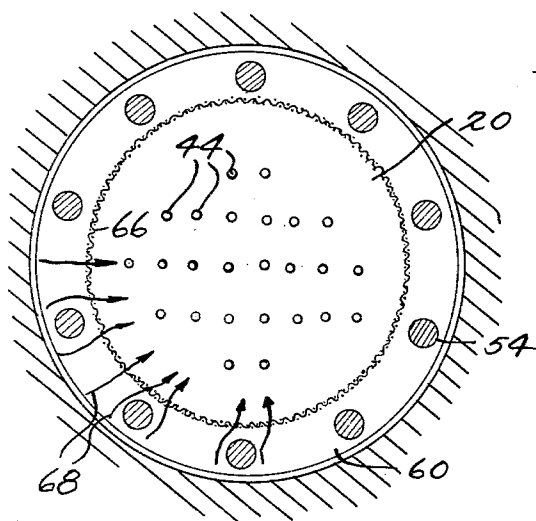


Fig. 3.

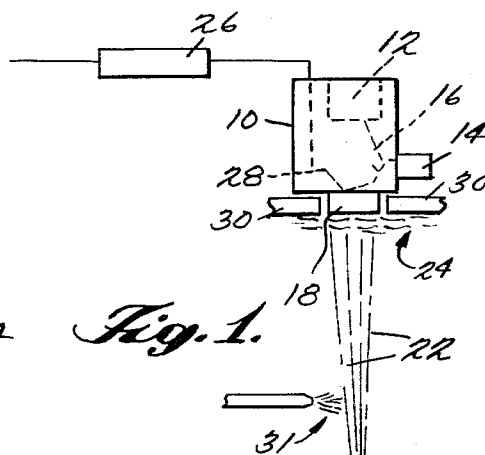


Fig. 1.

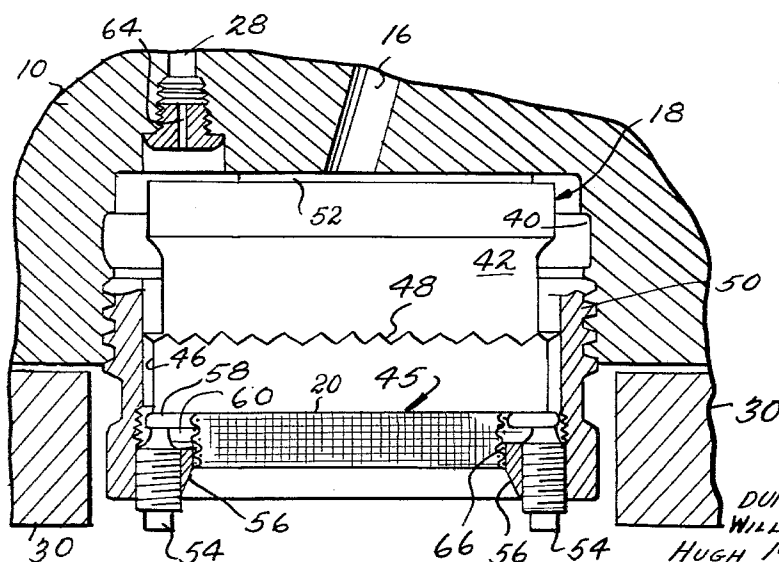
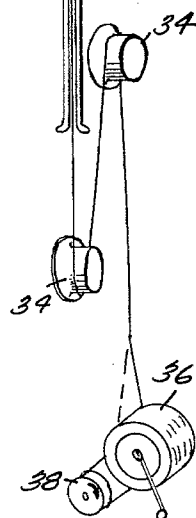


Fig. 2.



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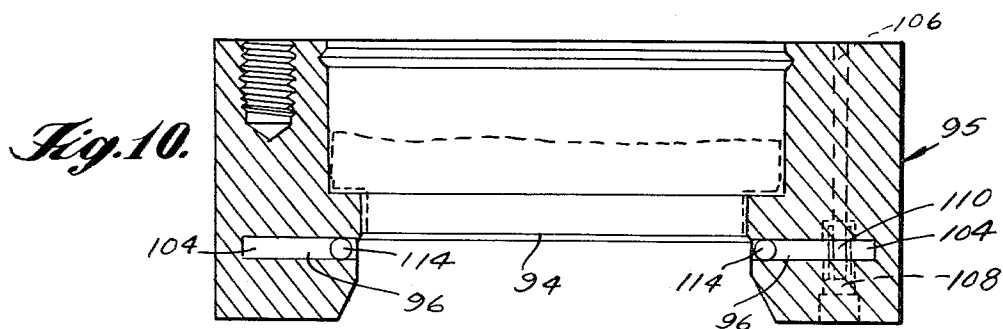
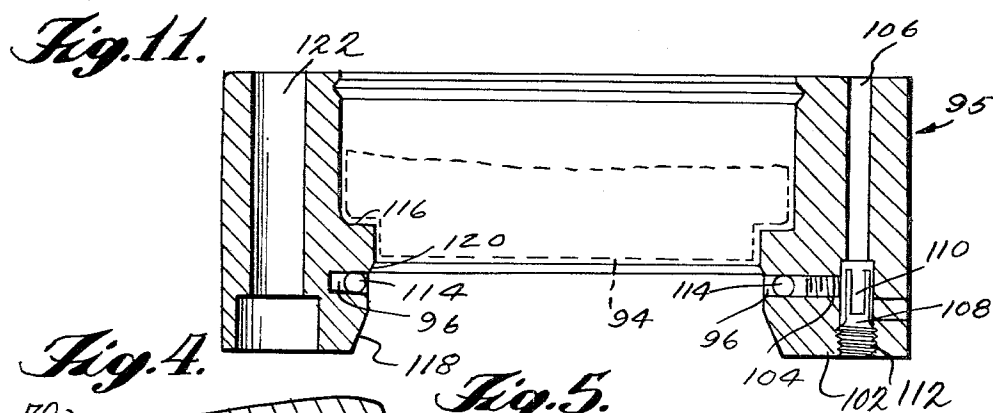
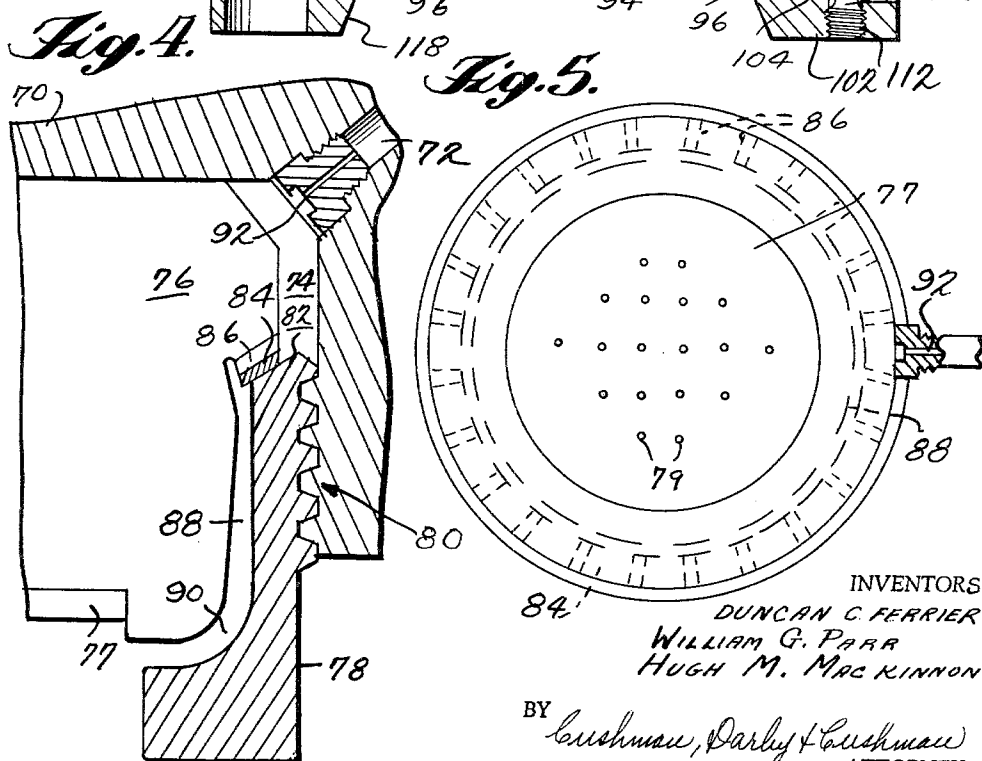
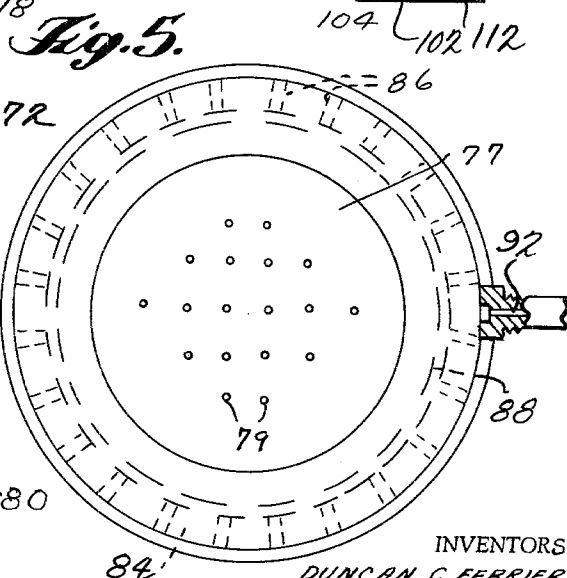
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Fig. 9.

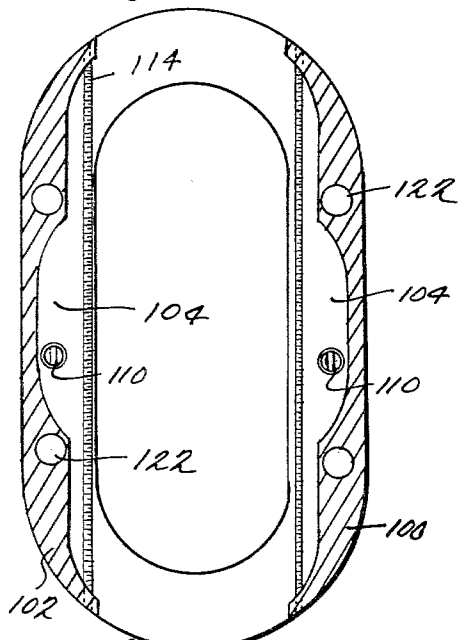


Fig. 6.

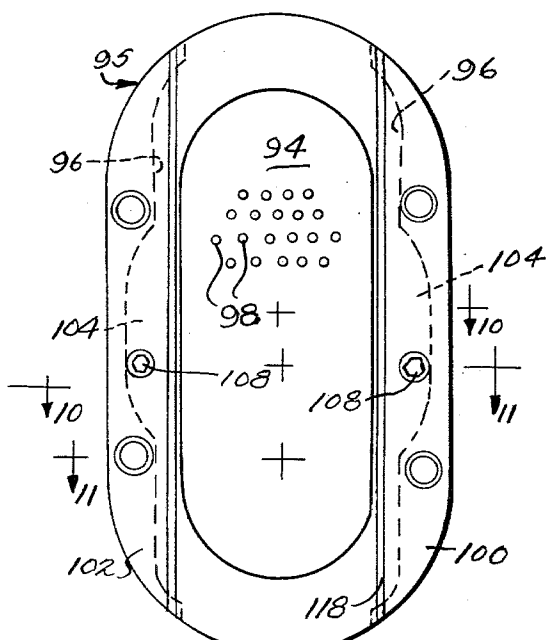


Fig. 8.

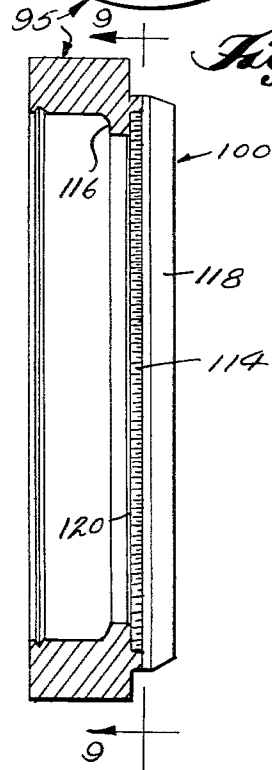
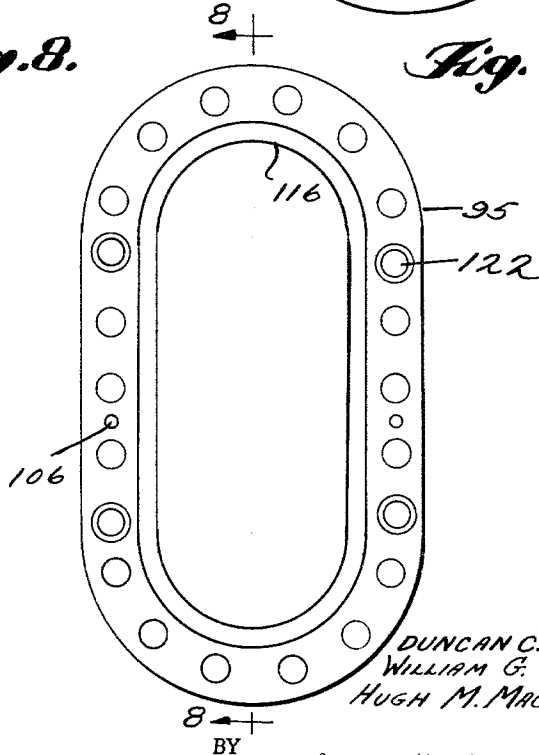


Fig. 7.



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APPARATUS FOR MELT-SPINNING SYNTHETIC POLYMER FILAMENTS

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5 Claims. (Cl. 18—8)

This is a continuation-in-part of application Serial No. 106,340 filed April 28, 1961, now Patent No. 3,129,272, dated April 14, 1964.

The present invention relates to apparatus for melt-spinning synthetic polymer filaments and in particular to apparatus in which a spinneret plate is blanketed with an inert gas for the purpose of improving the flow of the extruded filaments from the spinneret plate.

In the melt-spinning process, which is the process used for the extrusion of filaments from such fiber-forming materials as the synthetic linear polyamides, polyesters, polyethylenes and polypropylenes, molten fiber-forming material is continuously supplied from a melter of a continuous polymerization apparatus to a spinneret containing one or more small orifices, and the material is extruded through the orifice or orifices under the pressure exerted on it at the back of the spinneret, such pressure usually being brought about by the action of a rotary metering pump in the supply line of the molten material. It is a common practice in such melt-spinning processes to include a fine grain filter between the metering pump and the spinneret in order that the material to be extruded shall be as free from air bubbles as possible and in order that any foreign bodies in the molten material may be prevented from reaching the spinneret. Such a filter often comprises sand or other fine-grain, inert, particulate substance; and the filter and spinneret are often combined in apparatus known as a pack which can be handled as a unit for insertion in, or removal from, a port in the melt-spinning unit itself.

When inserted in a port of the melt-spinning unit, the pack, which in addition to the spinneret and the filter may also contain wire mesh or perforated plate screens above and below the filter, has to be screwed tightly in place in order that there shall be a liquid-tight seal between the output pipe of the metering pump and the top of the pack itself. To this end, the pack may, for instance, be carried in a holder which is capable of being screwed into the pack-receiving port of the melt-spinning unit; and subsequently the pack itself is forced upwardly, relative to its holder and against a gasket, by tightening up a number of grub screws in the bottom lip of the holder which screws bear against a metal ring positioned between said lip and the bottom of the pack. Laterally, the pack is a relatively loose fit within the holder, although, of course, there is no actual looseness between them once the pack has been forced into position by the tightening of the grub screws.

Discontinuity in the melt-spinning operation may arise from several causes, of greater or lesser frequency. Thus, the whole spinning unit itself will have to be removed for internal cleaning after some weeks of spinning; but, prior to that complete cessation, interruptions in normal spinning can, and often will, occur due to metering pump failures, pack leakage or blockage and spinneret defects.

It is with the lessening of the frequency of the latter type of interruption that this invention is principally concerned.

Despite very great care being taken in the manufacture and use of spinnerets, there are always likely to be minor blemishes either in the orifices of the spinneret or on the

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face of it, which may lead to irregular flow of the molten material through and out of the orifices. But even such blemishes are not themselves responsible for the most frequent interruption in normal spinning arising from spinneret defects, the primary cause of which, in the case of polyhexamethylene adipamide certainly, is now thought to be the build-up, in time, of a black deposit at the discharge end of an orifice and depending from the spinneret face, which deposit forms an uneven "ruff" around the filament emerging from the orifice. In the course of the build-up, which may take only a few hours, it is likely that one side of the "ruff" will become longer than the other, and the effect of this will be to cause the line of flow of the filament to become bent out of the vertical, first to form what is known as a "knee," and finally to be bent to such an extent that the filament touches the spinneret face, ceases to flow as a filament, and forms instead what is known as a "drip." Apart from the blemishes of the spinneret above referred to, the factors most likely to give rise to a propensity for "dripping" are the nature of the synthetic polymer itself, including the amount of delustrant which it contains, and the size and shape of the orifices, for instance whether they are circular or are tri-dentate, tri-lobal or other complex shapes, the latter being particularly prone to "drips."

The actual occurrence of a "drip" will normally be forestalled by the routine procedure known as "wiping," in which the face of the spinneret is cleaned; naturally, however, such a procedure involves a disruption to the normal spinning operation and is consequently a wasteful and limiting necessity, the frequency of which is desirably kept as low as possible.

Although other techniques for ameliorating the trouble are known and practiced, one line of approach which has previously been used is to provide means for blanketing the face of the spinneret with an inert gas, such as nitrogen, so as substantially to exclude free oxygen from the filaments as they emerge from the orifices of the spinneret. It is at the basis of such a line of approach that the "dripping" phenomenon is caused initially by oxidative degradation of some of the fiber-forming material as it emerges from an orifice, at the high temperatures involved, e.g. 280° C. The manner of blanketing the spinneret face previously used was to inject the gas radially inwardly towards the center of the spinneret face from a number of equi-spaced jets at the top of a cylindrical shield surrounding the spinneret face. An apparatus of this type is more fully disclosed in United States Patent No. 2,252,689 to Bradshaw. A somewhat similar apparatus, which directs a stream of air upwardly and inwardly against the face of the spinneret plate is disclosed in United States Patent No. 2,821,744 to Spohn et al.

For a number of reasons the above-described apparatus for blanketing the spinneret face has not been found to operate successfully. It appears likely that the apparatus interferes with the desired conditions of extrusion and cooling of the filaments, either by providing too stagnant and deep an atmosphere near the spinneret or because the separate jets below the spinneret are not adequate to exclude free oxygen and are actually prejudicial to the proper flow of the filaments. That is, if a shield is used, the layer of inert gas will be too deep for proper extrusion and for the production of good quality filaments. On the other hand, if a shield is not used streams of air will be induced between the streams of inert gas so that the gas below the spinneret will be a gas/air mixture, with consequently diminished effect on the dripping propensity. As a result, the previously-described apparatus, even if it were to have been modified so as to effect a proper blanketing of the spinneret face, was prone to introduce substantial physical irregularities in the filaments

extruded, for example too wide a range of denier variation; or, alternatively, the blanketing was not adequate enough substantially to reduce the frequency of "drips."

Whatever the reasons for this comparative failure, however, it has now been found that the "drip" frequency of certain synthetic linear polymer melt-spinning processes, particularly processes for melt-spinning polyhexamethylene adipamide filaments, can be reduced many times by an apparatus which effects the introduction of an inert gas immediately below the spinneret face in such a manner that the face is uniformly and completely blanketed by the gas without, however, bringing about any substantial alteration to the normal extrusion and cooling conditions of the filaments in the process concerned. By "an inert gas" is meant gas, such as steam or nitrogen, having no chemical action on the molten filaments as extruded.

It is therefore the primary object of the invention to provide an apparatus for melt-spinning a synthetic linear polymer which continuously and uniformly produces a substantially homogeneous and laterally unconfined shallow layer of an inert gas in contact with the entire surface area of the spinneret plate of the apparatus.

It is a further object to provide an apparatus for providing a shallow layer of an inert gas immediately below the spinneret plate of a melt-spinning unit, to blanket the face of the spinneret plate and keep air out of contact therewith in a manner that does not interfere with or impair the ordinary incidents of melt-spinning such as the flow of the filaments from the plate or their uniform cooling subsequent to extrusion.

It is a further object to provide an apparatus of the above type which avoids interference with the filaments by delivering the inert gas to the face of the spinneret plate at a velocity just sufficient to maintain the required flow for blanketing the face. This may be accomplished, when steam is employed as the inert gas, by providing for full expansion of the steam upstream of the spinneret plate.

It is a still further object to provide an apparatus of the above type which achieves the desired uniform, non-interfering blanket of inert gas, at pressures of atmospheric level or above, by providing annular distribution of the gas around the outside of the filter pack of the apparatus and leading into an annular space surrounding the spinneret plate.

The layer of gas should only be at the most an inch or two in depth, in order that the ordinary effects of the ambient atmosphere on the filaments shall not be substantially excluded in the critical region around the point of extrusion. Also, the apparatus must introduce the gas in a steady uniform manner such that the layer of gas immediately beneath the spinneret face is substantially complete and uniform, and not turbulent.

Super-heated steam is the preferred inert gas, owing to its low density compared with air which permits a shallow layer of the gas automatically to be maintained in close contact with the spinneret plate. This important feature is not achieved without special care with other, less buoyant, gases. Steam is also cheap, and convenient owing to its availability in melt-spinning machines.

If the gas, such as super-heated steam, is preheated to a temperature equivalent to that of the spinneret itself, the gas blanket will neither heat up, nor cool, the spinneret from the desired extrusion temperature of the synthetic polymer in question, nor will the gas, if cold, draw heat from the melt-spinning unit if its supply pipe is led therethrough. According to one embodiment of the invention, the gas is introduced into the vicinity of the spinneret plate via an uninterrupted annular slot, for instance one formed between the lip of the pack-holder and the spinneret. No specific means, such as a cylindrical shield, is employed laterally to bound the layer of gas; but, if desired, a perforated diffuser ring may be fitted inwardly of the aforementioned slot, such ring being shallow and not having any actual confining effect. In

certain constructions of a pack, it may be possible to fit a porous sintered metal ring actually within the annular slot, instead of an inner diffuser ring.

In one embodiment of the apparatus of the invention super-heated steam, for example at a pressure of 25 lbs. per square inch (gauge) and temperature of 280° C., is led through a pipe fitted in drillings within the metal block at the lower end-portion of the melt-spinning unit to a position above the pack and outside the top gasket between the pack and the output pipe of the metering pump. Steam from the pipe is allowed to emerge into the space between the pack casing and the walls of the port, at a rate controlled by the size of an orifice within a plug fitted in or near the output end of this pipe, and finds its way down between the pack casing and the walls of the pack-holder. The screwed joint between the pack-holder and the port serves as a crude seal to prevent steam from escaping, and finally the steam emerges through an annular slot between the lower lip of the holder and the spinneret to converge from all sides uniformly towards the center of the spinneret face. This is a convenient arrangement, since, prior to starting to extrude through a new pack, the spinning parts including the pack may be purged with the inert gas, in this case steam, so as to remove any air bubbles therefrom. The purging must be effected before the pack has been screwed completely home, so that the gas can enter the top of the pack itself, whence it is normally excluded by the tight fit of the pack, gasket and melt block. Gas can then, if desired, be drawn through the pack by applying suction to the spinneret face, although simply diffusing it through the pack from the top thereof will normally be sufficient.

In another embodiment the means for continuously supplying an inert gas to the vicinity of the face of the spinneret plate include a plurality of gas outlet holes equispaced around the outside of the filter pack and leading into an annular space surrounding the face of the plate. The annular space should have sufficient length and the number of holes should be high enough to ensure that the individual streams from the holes have merged into one unbroken stream at the inner boundary of the space whereby the need for any other diffusing means, such as a perforated diffuser ring at the edge of the plate, is obviated.

In still another embodiment it is possible for opposing transverse gas streams to be a more suitable way of providing the gas blanket. When, for example, the spinneret plate is of elongated shape, such as oblong with convex short sides, the provision of two elongated slots along opposite edges of the plate in a direction substantially parallel to the longest chord of the plate achieves the desired blanket.

The invention will be further understood from the following detailed description in conjunction with the drawings in which:

FIGURE 1 is a schematic side elevational view of a melt-spinning apparatus embodying the principles of the present invention together with an apparatus for winding the filaments;

FIGURE 2 is a fragmentary sectional view, on an enlarged scale, of the lower portion of the melt-spinning apparatus of FIGURE 1;

FIGURE 3 is a diagrammatic horizontal sectional view taken generally through the passage 60 of FIGURE 2;

FIGURE 4 is a fragmentary sectional view, similar to FIGURE 2, of a second embodiment of the apparatus;

FIGURE 5 is a diagrammatic bottom view, partly in section, of the apparatus of FIGURE 4;

FIGURE 6 is a bottom view of the lower portion of a third modification of a melt-spinning unit;

FIGURE 7 is a top view of the modification of FIGURE 6;

FIGURE 8 is a longitudinal sectional view taken on the line 8—8 of FIGURE 7;

FIGURE 9 is a longitudinal sectional view taken on the line 9—9 of FIGURE 8; and

FIGURES 10 and 11 are transverse sectional views taken on the lines 10—10 and 11—11, respectively of FIGURE 6.

Referring firstly to FIGURE 1, there is shown the lower end-portion of a melt-spinning unit comprising a metal block 10 in which is housed a melter 12 in which fiber-forming material, such as polyhexamethylene adipamide, is melted and is then withdrawn from a pool of molten material by a rotary metering pump 14 and fed via a passage 16 to a filter pack 18. The molten material is forced through the filtering medium of the pack and emerges from holes in a spinneret plate 20 in the form of continuous filaments 22. A laterally unconfined atmosphere of super-heated steam 24 is maintained in the immediate vicinity of the spinneret plate 20, the steam having been brought to that region via a super-heater 26 and then through a passage 28 in the block 10 to the top of the pack 18. As will be described with reference to FIGURES 2 and 3, the steam flows through the pack-securing parts, to emerge as a substantially uninterrupted circular stream just below, and directed towards the mid-point of, the face of the spinneret plate 20. A platen heater 30 surrounds the pack 18, serving to maintain the latter at the correct temperature for extrusion of the molten material. The filaments 22 are cooled by a transverse air stream 31, solidify, and are brought together into a converged bundle to pass downwardly through a stream conditioning tube 32. The converged bundle of filaments is drawn down by godets 34, and is then wound upon a package 36 driven frictionally by a drive roll 38.

Referring now to FIGURES 2 and 3, the pack 18, fitted within a port 40, comprises a casing 42 containing within it layers of sand, or other inert particulate matter, of graduated grain-size, having the layer of coarsest grain size at the top. The sand, or other particulate material, is bounded at top and bottom by fine mesh metal screens; and the spinneret plate 20, with orifices 44, is located beneath the lower screen at the bottom 45 of the pack. A so-called metal "bottle cap" 46 having a serrated top edge 48 surrounds the lower half of the pack to hold together the spinneret, lower screen and casing, and the serrations serve accurately to locate the pack centrally within a holder 50, which is screwed into the block 10 at the lower end of the port 40.

The final tightening of the pack 18 against a gasket 52, surrounding the outlet of the passage 16, is effected by a plurality of grub screws, two of which, 54 are shown, in the lip 56 of the holder 50. The grub screws are tightened against a metal bearing ring 58 fitted between the bottom 45 of the pack and the lip 56, so that the pack is forced hard upwardly against the gasket 52, thus forming a liquid-tight seal between the passage 16, containing the molten polymer material, and the top of the pack, and creating a substantially continuous annular slot 60 between the ring 58 and the lip 56. The superheated steam at 25 lbs. gauge pressure is supplied through the passage 28 at the top of the port 40.

A plug 62 having a small orifice 64 through the middle thereof, is screwed into the passage 28 near its point of emergence through the top wall of the port 40 and the size of the orifice determines the amount of steam allowed to escape into the empty spaces of the port, in unit time. An orifice of a diameter between 0.025 inch and 0.035 inch is satisfactory, allowing for a steam supply of, for example 1½ pounds of steam per hour. Too great a supply of steam must be avoided as it may create too deep a layer beneath the spinneret plate 20.

Surrounding the spinneret and the pack holder 50 is the platen heater 30. A steam diffusing ring 66 of wire mesh is inserted inside the lip 56 and has the effect of slightly impeding the steam flow and of thus remov-

ing any slight discontinuities, for example in the region of grub screws 54, which there may be in the annular supply of steam emerging from the gap 60, as explained hereafter.

The steam passing through the orifice 64 passes downwardly between the casing 42 and the walls of the port 40, then between the serrations 48 of the bottle cap, or gasket 46, and between that cap and the pack holder 50, and finally behind the bearing ring 58 and then radially inwardly through the diffusion ring 66, as indicated by the arrows 68 in FIGURE 3, toward the mid-point of the face of the spinneret plate 20, in a continuous annular stream from the gap 60. It will be observed that this arrangement provides a relatively shallow homogeneous layer of steam in contact with the entire surface area of the face of the spinneret plate, the flow of which can be controlled so as to allow for at least substantially complete blanketing of the spinneret face without any adverse effect on the filament flow from the spinneret, and without having any material effect on the conditions, particularly of temperature, of extrusion and cooling of the filaments, owing to the practically normal impingement of the ambient atmosphere on the spinning unit.

As an example of the efficacy of the invention, there are compared the results achieved when melt-spinning 40 denier/13 filament yarns of polyhexamethylene adipamide, containing 2% by weight of titanium dioxide delustrant and having a relative viscosity of 33.5, both with and without the specified atmosphere of the preferred inert gas, superheated steam, in the vicinity of the face of the spinneret plate.

Two filament bundles of 13 filaments each were spun from the 26 holes of each of the spinneret plates employed, the holes being of 0.013 inch diameter, such that the polymer throughout was 4 pounds weight per hour. The bundles were wound up separately at a speed of 3930 feet per minute.

A steam atmosphere was maintained continuously in the close vicinity of half the number of spinneret plates employed in the trial, while the remainder had no such inert gas atmosphere. No routine "wiping" of the faces of the spinneret plates that were steamed was undertaken; while the others were "wiped" every 4 hours (with consequential interruption to the spinning process). Even without such routine "wiping," the "drip" rate of the steamed spinnerets was less than that of the others, with a figure of 0.03 per 100 pounds of polymer spun compared with 0.05 per 100 pounds.

Further evidence of the advantages of the invention is apparent from the following tests:

I

(A) Using a 2 inch deep shield on the apparatus illustrated in FIGURES 2 and 3, and with superheated steam at 280° C. provided as the inert gas, the extrusion break rate, in a process extruding 13 filaments of polyhexamethylene adipamide (for collection and drawing to a 40 denier multifilament yarn), was over 1 per 100 lb. of polymer extruded, and the mean continuous denier ratings (indicating denier uniformity) were all excessively high, e.g. between 3.4 and 6.2 in various tests. Even with no steam supplied (i.e. merely extruding the filaments within the shield) the mean continuous denier rating was 2.2, probably owing to the trapping of hot air within the shield.

(B) In comparison with (A) above, the extrusion break rate using apparatus as illustrated in FIGURES 2 and 3 was 0.5 per 100 lb. and the mean continuous denier rating 1.3

II

(A) Using apparatus as illustrated in FIGURES 2 and 3 and with a steam flow of 1.8/lb./hour, the extrusion break rate was 0.5 per 100 lb., the "drip" rate

0.06 per 100 lb. and the mean continuous denier rating 1.3. Most of the packs used were removed for leaks or other defects, e.g. after over 80 hours spinning: and the one pack that did "drip" in the test only did so after 75 hours spinning.

(B) When the diffuser ring 37 was removed however, the break rate increased to 1 per 100 lb. the drip rate to 0.83 per 100 lb. and the mean continuous denier rating to 1.6. The mean time to first drip fell to 28 hours. Smoke tests of the equipment showed that, without the diffuser ring, the steam reached the spinneret recess to separate streams from the gaps between the grub screws 21, inducing streams of air between the separate streams of steam. It is believed that the presence of this air, in the thus-produced steam/air mixture, was responsible for the all-round fall in efficiency.

It is seen from a comparison of I(A) with I(B) that a shield used in conjunction with an inert gas blanket deleteriously affects the extrusion process and the quality of the product. However, merely omitting the shield from prior art type of apparatus would not be expected to overcome the disadvantages of that machine, because comparison of II(A) with II(B) shows that some precaution, such as the presence of a diffuser ring, must be taken to assure that no air reaches the face of the spinneret plate.

The above examples demonstrate clearly that not only does the invention avoid the waste incumbent in routine "wiping" procedure, but also enables much larger spinning cakes to be wound than normally, owing to the increased continuity allowed to the spinning process. In addition, such increased continuity is valuable when, instead of winding-up into cakes at the spinning machine, the yarn is forwarded directly and continuously to a drawing (stretching) stage before winding.

It will be understood that the purpose of the diffuser ring 66 is to remove discontinuities in the steam flow at the edge of the spinneret plate 20 and to otherwise assure that the flow is as uniform and non-turbulent as possible. This is important in achieving proper extrusion and cooling of the filaments because a turbulent steam flow or a flow with gaps in it will impair the quality of the filaments. However, it is not necessary in all cases to provide a diffuser ring 66 because it has been found that certain structural modifications of the apparatus or certain changes in the manner in which the apparatus is used will effect the necessary gas blanket. It is possible, for example, to dispense with the diffuser ring by supplying the steam to the annular slot 60 at atmospheric pressure. This can be accomplished either by employing low pressure steam, for example 8 p.s.i.g., or by arranging that the size and length of the spaces into which the pressurized steam is admitted within the melt block 10 are such that substantially full expansion of the steam can occur before the steam emerges in the vicinity of the plate 20.

Another manner of achieving the required gas blanket without employing a diffuser ring is shown in the embodiment illustrated in FIGURES 4 and 5. In these figures there is shown a metal block 70 of a melt-spinning unit having a supply passage 72 drilled therethrough for discharge into a port 74 in which is fitted a filter and spinneret assembly contained in a pack 76. A spinneret plate 77 having orifices 79 is retained at the bottom of the pack. The pack 76 is forced into operating position within the port 74 by screwing up on a pack nut 78 which threadably engages the port 74 at 80.

The upper end of the pack nut 78 defines a downwardly and inwardly inclined shoulder 82 which bears against a complementarily shaped flange 84 depending from the upper part of the pack casing. Just above the area of contact, a plurality of equispaced holes 86 are drilled through the flange 84, through which holes the steam may pass uniformly into a vertical annular space 88 between the pack 76 and nut 78. This annular space 88

broadens out at its mouth 90 near the spinneret and then bends inwardly so that the steam will be directed inwardly towards the mid-point of the spinneret 77. The shoulder of the pack 76 is chamfered to allow for easy passage of steam around the upper portion of the pack.

In operation, steam under pressure, e.g. 8 lbs. per sq. inch (gauge), is supplied to the upper part of the port 74 through an orifice 92 at a rate controlled by the size of the orifice. It fills the space in the port 74 around the upper portion of the pack 76, and passes downwardly and inwardly through the holes 86 into the annular space 88. Near the mouth of said space, the steam flows uniformly toward the mid-point of the spinneret plate 77 from all around it. Hence, the filaments emerging from orifices 79 will be completely surrounded by an atmosphere of pure, non-turbulent steam in a shallow layer at the point of extrusion.

While the above constructions for providing the required inert gas blanket are satisfactory for most installations, an arrangement for providing opposing transverse gas streams along the spinneret plate is more suitable in some instances. FIGURES 6-11 illustrate a construction of the latter kind in which a spinneret pack of elongated shape in plan, rather than circular as in FIGURES 1-5, is provided. As shown, the spinneret pack which includes a spinneret plate 94 and its accompanying filter structure, is of oblong shape with convex short sides. The pack is retained in any suitable manner in a casing 95 which surrounds the lateral edges of the plate 94 and which provides two elongated slots 96 on opposing sides of the plate 94, the long direction of the slots being substantially parallel to the longest chord of the plate. Preferably, the length of the slots 96 is such that they extend in each direction to points at least as far as those of the intersection of the slots 96 with straight lines drawn perpendicular thereto and with the slots bounding that portion of the spinneret plate 94 which contains the spinneret orifices 98.

In the embodiment illustrated, the casing 95 is constructed of a single block of metal which is of oblong ring shape. The slots 96 are machined into the inner periphery of two depending flanges 100, 102 which extend along the two long sides of the casing 95. As best seen in FIGURES 6 and 9, the depth of each of the slots 96 is greater near the center, the increase in depth occurring along two concave portions. The area of maximum depth near the center of each slot forms a chamber 104 to which inert gas may be delivered through a small vertical passageway 106 which extends upwardly to the top of the casing. The slots 96 extend in their long direction to points beyond the short convex ends of the spinneret plate so that the outer orifices at those ends will be completely blanketed with inert gas during operation.

At the junction of the passageways 106 with their respective slots 96 there is provided a baffle 108 for directing incoming gas into the streams which flow along the length of the slots 96. As shown, each baffle 108 consists of a vertical plug-like member having a slot 110 in its upper end which is disposed within the chamber 104 directly below the passageway 106. The lower end of each baffle is threaded into a tapped hole 112 extending vertically upward from the bottom of the casing 95.

To assure that inert gas delivered to the chamber 104 will emerge uniformly and in unbroken streams along the length of the slots 96 there is provided in each slot a diffuser member in the form of a threaded rod 114. As seen in FIGURES 8 and 10, the thickness of the rods 114 is equal to or slightly less than the width of the slots 96 so that a plurality of passages leading from the slots 96 to the space between the flanges 102 will be formed by the substantial engagement of the threads of the rod with the upper and lower walls of the slots 96. The rods 114 are held in place inwardly of the baffles 108 by being threaded into horizontal, longitudinal holes provided in the flanges 102 at the ends of the slots 96.

In some circumstances it may be possible and desirable to do without diffusing means within the slots 96. For example, if precautions are taken for expanding the steam to atmospheric pressure by the time it reaches the spinneret plate, or if the steam is pre-diffused, then no diffuser is required in the slots.

As best seen in FIGURES 10 and 11, the bore of the casing 95 is stepped to form an upwardly facing shoulder 116 above the slots 96 and is tapered at 118 outwardly and downwardly from below the slots. In addition the upper edge of each slot 96 is tapered slightly upwardly and inwardly at 120. The spinneret pack is disposed within the bore of the casing in a position such that the spinneret plate 94 is very slightly above the upper walls of the slots 96.

The casing 95 is provided with four vertical holes 122 through both the body portion and flanges 100, 102 so that the casing may be attached to a melt-spinning apparatus. In operation inert gas, preferably, superheated steam, is delivered under pressure to the top of the vertical passages 106 in any suitable manner as by providing steam passages in the melt-spinning apparatus which communicate with the passages when the casing is secured in place. The steam flows downwardly to the baffles 108 and then longitudinally outwardly toward both ends of the slots 96. Upon emergence from the slots 96 past the threaded rods 114 the steam, substantially at atmospheric pressure, flows toward the midportion of the face of the spinneret plate 94 in a slightly diverging flow and then outwardly in the direction of the short end portions of the spinneret and downwardly away from the spinneret plate before curling outwardly past the parts of the melt-spinning apparatus in which the pack is fitted. Owing to its lower density compared with that of air, the steam will tend to make contact with the entire surface area of the spinneret in which the orifices are situated. In the case of a "date-box" pack, the number of such orifices may well exceed 100; and filaments spun therefrom are suitable for collection together into yarns for use as tire cord.

It will be appreciated from the above descriptions that the present invention provides blanketing of the spinneret face of a melt-spinning apparatus with a layer of inert gas which is shallow enough to avoid spoiling extrusion performance or yarn quality yet which is continuous over the face of the spinneret face to prevent entry of air. While several embodiments of the apparatus have been described, modifications thereof will be apparent to those skilled in the art without departing from the scope of the invention. Therefore, the details of the described embodiments are not intended to be limiting except as they appear in the appended claims.

What is claimed is:

1. Apparatus for melt-spinning a synthetic linear polymer comprising: a source of molten polymer; a spinneret pack including a filter and a spinneret plate having orifices therein; a casing supporting said spinneret pack and defining an annular space around the same; a metering

pump for forwarding molten polymer from said source to and through said filter and then through orifices in said spinneret plate to form filaments; a source of inert gas under pressure; and means for delivering inert gas from said source to a substantial portion of the periphery of said spinneret plate and for dispersing the gas in a laterally unconfined, shallow, homogeneous layer in contact with the entire surface area of said spinneret plate containing said orifices whereby ambient air is prevented from reaching said spinneret plate, said gas delivery means including means for delivering the gas to said annular space at a location upstream of said spinneret plate and means for guiding and dispersing the gas along said pack to the periphery of said plate and means defining an annular gas discharge slot completely around the periphery of said plate.

2. Apparatus as in claim 1 wherein said source of inert gas is a steam source.

3. Apparatus as in claim 1 further comprising means for directing a transverse flow of a cooling fluid against the filaments.

4. Apparatus for melt-spinning a synthetic linear polymer comprising: a metal block having a port within its lower extremity; a melter for melting said polymer; a metering pump for forwarding molten polymer from said melter through a pipe in said block to the top of said port; a detachable filter pack assembly secured within said port so as to provide a liquid-tight seal between said filter pack assembly and said pipe, said assembly including a filter pack and a spinneret plate and defining channels between the walls of said port and said assembly; a supply pipe for an inert gas led through said block to the top of said port at a position outside the area of liquid seal between said filter pack assembly and said pipe for molten polymer; means defining an annular slot close beneath and surrounding said spinneret plate, said slot communicating with said channels.

5. Apparatus as in claim 4 further including a gas diffuser ring disposed inwardly of said slot.

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