United States Patent

Lenk

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[54] **ADJUSTABLE SPINNING SHAFT FOR MELT-SPUN YARNS**

[72] Inventor: **Erich Lenk,** Remscheid, Germany

[73] Assignee: **Barmag Barmer Maschinenfabrik Aktiengesellschaft,** Wuppertal, Germany

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.**.....**425/72,** 65/11 W, 264/176 F

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

[58] **Field of Search**.....18/8 QM, 8 QD, 8 F; 264/176 R, 264/178 F; 65/4, 11 W; 425/72

[56] **References Cited**

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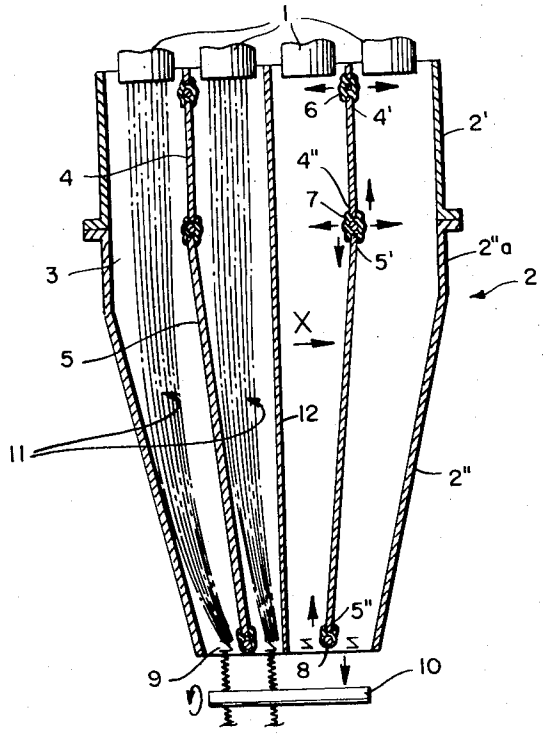
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Primary Examiner—J. Spencer Overholser
Assistant Examiner—Michael O. Sutton
Attorney—Johnston, Root, O'Keeffe, Keil, Thompson & Shurtleff

[57] **ABSTRACT**

A partitioned spinning shaft to receive and separate filaments converging downwardly in their direction of travel from a plurality of spinning heads in a melt-spinning apparatus, the partitions being adjustably mounted to provide shaft sections of a predetermined narrowing width corresponding closely to the converging paths of the separated filaments without contacting the filaments.

6 Claims, 6 Drawing Figures



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SHEET 1 OF 2

FIG. 1

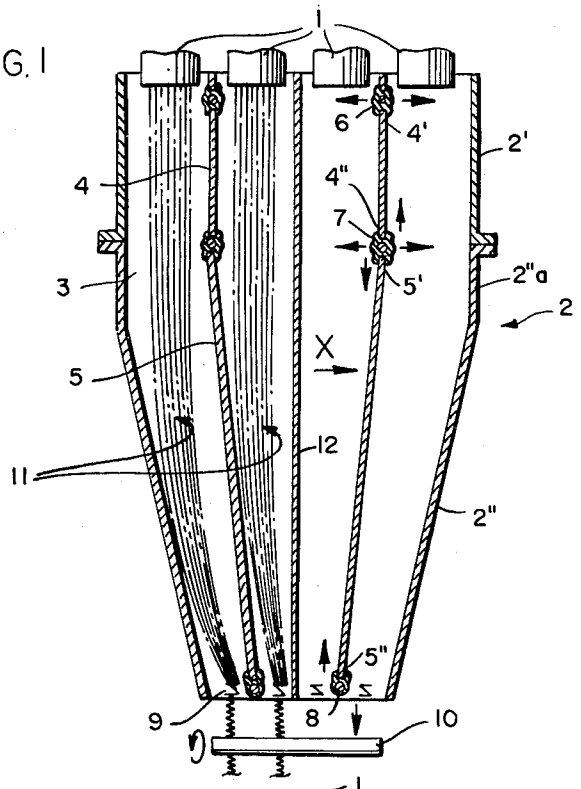
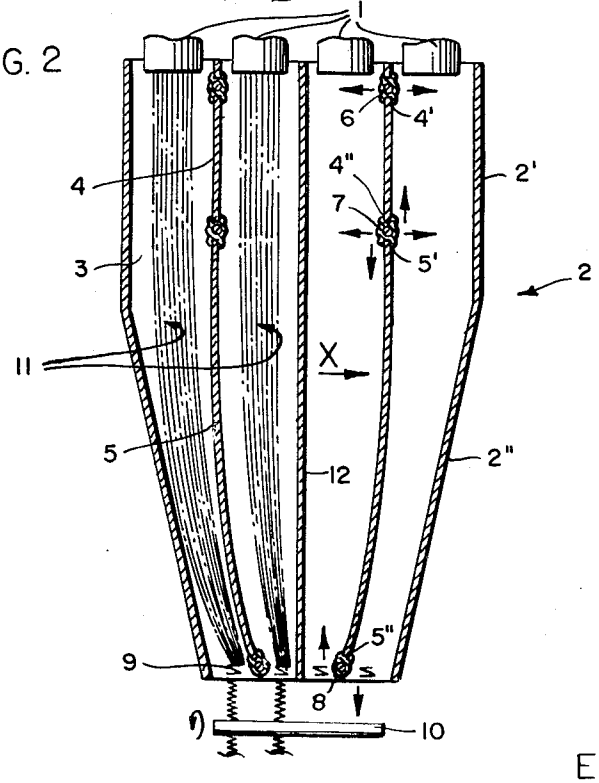


FIG. 2



INVENTOR:
ERICH LENK

BY

Johnston, Root, O'Keeffe, Keil, Thompson & Shurtleff

ATT'YS

FIG. 3

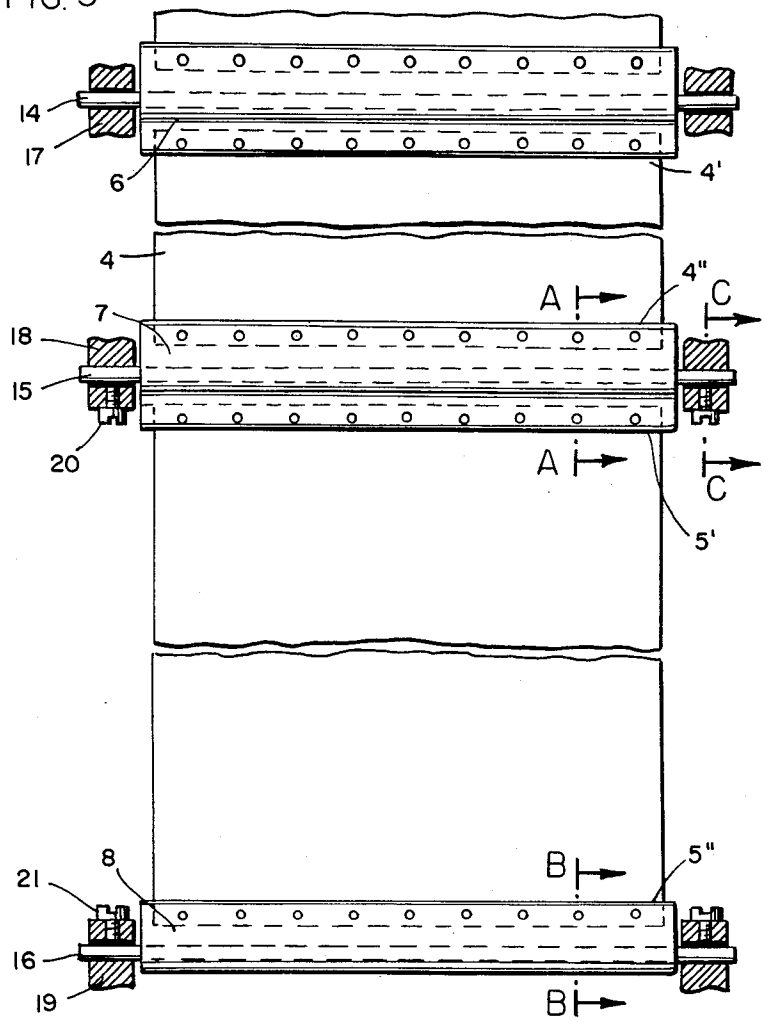


FIG. 4

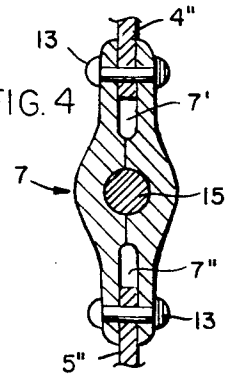


FIG. 5

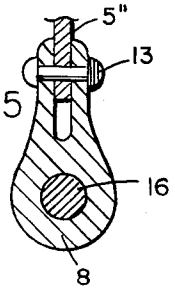
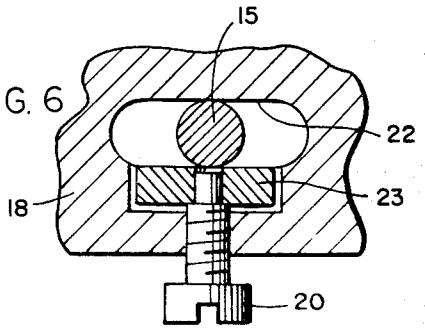


FIG. 6



INVENTOR:
ERICH LENK

BY
Johnston, Root, O'Keeffe, Keil, Thompson & Shurtleff
ATT'YS

ADJUSTABLE SPINNING SHAFT FOR MELT-SPUN YARNS

Spinning shafts are generally known in combination with apparatus for the melt-spinning of thermoplastic fiber-forming polymers. Such shafts serve the purpose of receiving the filaments emerging from spinning nozzles and, by heat exchange with a cooling gas passed through the shaft to rapidly cool the filaments and subsequently solidify them so that they have adequate properties for further processing into finished fibers or threads, in particular an adequate strength. It is often desirable to arrange a spinning shaft in common for several spinning heads, and it is also a known practice to arrange partitions inside the thread shaft so as to separate the filaments extruded by the different spinning heads from each other during cooling and solidification.

In those systems in which certain thread guide elements, especially guide pins, eyelets or the like and also sizing or finishing rollers, are arranged perpendicularly and directly underneath the center of each spinning head at the bottom end of the spinning shaft, no difficulties occur in separating the individual filaments or bundles of filaments from one another, because the corresponding individual spinning shafts all have an approximately constant width in the filament running direction, i.e. over their vertical height, and it is sufficient to simply install vertical partitions extending approximately parallel to one another.

More recently, it has been recommended that all of the individual filaments or filament groups emerging from several adjacent spinning heads be brought more closely together under the spinning shaft for subsequent treatment in common, i.e. over a single thread guide and/or in contact with a single finishing roller or the like, thereby avoiding excessive duplication of such members. In this instance, the spacings of the separate filament groups at the lower end of the spinning shaft are considerably smaller than the original spacings or lateral intervals between the spinning heads. This makes it possible and usually essential to reduce the dimensions of the spinning shaft, especially the overall shaft width at its lower end, with a corresponding reduction of space. In such spinning shafts of decreasing width in the running direction of the filaments, the partitions situated between the filament groups have been securely and permanently joined with the overall shaft, and in this known arrangement, the partitions run substantially parallel to the converging outer walls of the common spinning shaft.

These known partitioned shafts, however have now been recognized as presenting certain disadvantages in that they can be assembled optimally only for a certain filament or yarn size, i.e. the denier of the filaments being produced, as well as for a specific thermoplastic polymer. The reason for this resides in the fact that the filaments, in contrast to the permanently installed partitions, are conducted not in a rectilinear manner as they converge from the spinning heads which are laterally spaced more or less far apart to the thread guides located closer together at which the collected filaments emerge from the shaft, but instead the filaments or filament groups follow a non-linear converging path in which they hang approximately in a parabolic or very similar curved line. The linearly converging

partitions can be adapted only to the passage of a certain type of filament. If the sag changes when using a different type or size of filament, then the dimensioning of the spinning shaft is no longer optimal and is often inoperable.

In order to avoid any possible contact of the sagging filaments with the partitions, the spacing of the permanent partitions from one another had to be made sufficiently wide to receive the most extreme types of spun filaments capable of being processed in the same spinning shaft. As a result, the spinning shafts had to be given very large dimensions which would not be required for optimal adaptation of the partitions to the converging path of less extreme types of filaments.

With smaller dimensions, which would always be desirable, it becomes necessary to accept into the bargain repeated contacts of the freshly spun threads with the partitions, causing distortions in filament profile, denier fluctuations and also entanglements of the filaments due to a mechanical overstrain of those filaments not yet completely solidified.

One object of the present invention is to provide a common spinning shaft in combination with three of more spinning heads for cooling and solidifying the filaments as they are drawn downwardly in distinct curvelinear converging paths through separate partitioned sections of the shaft, whereby the same common shaft can be readily employed with all types of fiber- forming polymers regardless of their spun denier, melt viscosity or other properties causing substantial changes in the hanging curved path of travel through the shaft sections. It is also an object of the invention to completely avoid contact of the filaments with the interior walls of the partitioned spinning shaft, regardless of the type of filament or the spinning conditions. It is a further object to provide a common spinning shaft which is economically constructed and easily adapted to all spinning conditions without rebuilding or relocating the overall common shaft with reference to its associated multiple spinning heads. Other objects and advantages of the invention will become more apparent from the following detailed disclosure.

It has now been found, in accordance with the invention and the specific concept of the problem set forth above, that one can improve the apparatus for melt spinning filaments having a plurality of at least three spinning heads arranged laterally across the top portion of a common vertically elongated spinning shaft partitioned into a corresponding plurality of approximately vertical shaft sections which separate the filaments being drawn or hanging downwardly from each spinning head in converging paths, e.g. to a common guide or similar collection point, by providing individual partitions adjustably mounted in at least the lower portion of the common shaft for selected displacement in the direction of the shaft width, thereby variably narrowing each shaft section to accommodate the converging paths of the separated filaments while remaining free of contact therewith.

The partitions are preferably attached within the common shaft by transverse or laterally positioned fastening means which permit a shifting adjustment of the entire partition and/or a deformation of the partition in the direction of the shaft width. In the former case, the partition can be adjusted in its position by

fastening means preferably attached along its upper and/or lower edges in the running direction of the filaments and/or in the direction of the shaft width. In the latter case, such fastening means along the upper and/or lower edges is turnably secured or rotatably mounted and tightened in predetermined positions capable of imparting a bending movement or flexing deformation to the partition which is then expediently constructed as a preshaped, thin, flexible sheet metal plate, e.g. such as an aluminum or thin stainless steel sheet.

These and other preferred embodiments of the invention are illustrated by way of example in the accompanying drawings in which:

FIG. 1 is a partly schematic vertical sectional view taken transversely through one common spinning shaft executed in accordance with the invention to provide relatively straight non-deformed partitions;

FIG. 2 is a sectional view similar to FIG. 1 in which some of the partitions have been purposely deformed to provide a gradually curved configuration in the lower portion of the shaft;

FIG. 3 is an enlarged elevational view of two superimposed and interconnected partitions taken from one side with a common shaft as viewed in the direction of the arrow "X" in the previous figures, certain portions being omitted or only partly shown in cross-section;

FIG. 4 is an enlarged cross-sectional view taken on line A—A of FIG. 3 to illustrate the linking or fastening member interconnecting the superimposed partitions;

FIG. 5 is a similar enlarged cross-sectional view taken on line B—B of FIG. 3 to illustrate the fastening member at the lower edge of the lowermost partition; and

FIG. 6 is an enlarged cross-sectional view taken on line C—C of FIG. 3 in order to illustrate a slotted supporting means adapted to receive an extension of the fastening or linking member of FIG. 4.

Referring first to FIGS. 1 and 2, four spinning heads 1 of identical construction and equipped with conventional spinning nozzles on the bottom face extrude individual filament groups 11 downwardly into the common spinning shaft 2, the supply of molten polymer to the spinning heads being accomplished in a conventional manner from above, e.g. from a supply of granulated polymer to a heating grid and then passing the polymer melt through a pressurizing and metering pump into each spinning head. The upper portion 2' of the spinning shaft is likewise conventionally connected to a gas line (not shown) for blowing a cooling gas onto the freshly spun filaments and this upper portion 2' may therefore be referred to as the blowing zone where the filaments hang in a substantially vertical path. The lower portion 2'' of the shaft is substantially longer and permits the filaments to become solidified before they are collected at the bottom end of the shaft. The filament groups from the two right-hand spinning heads have been omitted in these figures merely to avoid repetition or obscuring certain reference numerals and legends. Each half of the shaft is essentially identical so that the same reference numerals are employed to identify the same parts or elements.

The common spinning shaft 2 represents a permanent installation with reference to the outer wall structure, i.e. a complete shaft or elongated housing of rectangular cross-section enclosed on all four sides including oppositely disposed front and back walls 3 as well as the side walls 2' and 2''. In FIG. 1, this common shaft is composed of two separate stampings in flanged connection of which the upper stamping forms parallel side walls 2' while the lower stamping forms the converging side walls 2'' in the lower region and parallel side walls 2''*a* in the upper region. In FIG. 2, the upper side walls 2' which are parallel and the lower side walls 2'' which converge are made from a single stamping.

The common shaft 2 is divided laterally into four separate shaft sections by means of the co-acting adjustable partitions 4 and 5 superimposed end for end above each other and spaced laterally outwardly from the non-adjustable central partition 12 which can be a continuous, straight plate of sheet metal where it forms the boundary or partition line between even numbers of spinning heads or filament groups located on either side. Each bundle or group of filaments 11 passes downwardly through its individual shaft section, e.g. as formed by the outer walls 2, 3 and the adJustable partitions 4, 5, and is guided by the thread guide 9 to pass over the single finishing roller 10 and then onto a conventional winding or take-up spool (not shown).

The partitions 4 and 5 are mounted in the common shaft 2 according to the invention in such a manner that they can be preferably adjusted at their upper and/or lower edges in the generally vertical filament running direction and/or in the approximately horizontal direction of the shaft width as indicated by the arrows extending from the fastening and adjusting members 6, 7 and 8 (described in greater detail below). In other words, these upper and/or lower fastened edges are preferably adapted to be shifted into different parallel positions by the indicated movement or displacement, such that each partition can conform as closely as possible to the converging paths of the filament groups 11.

A variety of adjustments for optimum placement of the partitions can be achieved as will be apparent from FIGS. 3–6. Thus, it is possible to adjustably position the edges 4'' and 5' of the interconnected partitions 4 and 5 within the corresponding deep grooves 7' and 7'' of the transverse fastening bar or plate 7 and to fasten these edges in the groove by means of suitable bolts, screws or rivets 13. Moreover, this fastening of the partition edges 4'' and 5' can be accomplished by clamping the edges tightly between two identical halves of the transverse fastening bar 7 using the bolts 13 or any other releasable clamping means to secure the partition edges in a desired position within the deep grooves. The other clamping bars 6 and 8 can be constructed in the same manner to adjustably hold edges 4' and 5''. The amount of movement in each case is relatively slight but does permit an overall extension or contraction of the partitions in the filament running direction.

It is particularly desirable to provide the fastening bars or clamps 6, 7 and 8 with a bearing shaft or rod 14, 15 and 16, respectively, which extends or projects from opposite sides of the partition as shown in FIG. 3 and which is in turn mounted for adjustment in a supporting structure schematically shown in FIG. 3 as the bearing members 17, 18 and 19, respectively. These latter supporting structures or bearing members are expediently provided by the outer front and rear walls 3 of the com-

mon shaft 2, although additional framework may also be most advantageously employed. Thus, the bearing supports 18 and 19 can be provided with vertically positioned adjusting screws 20 and 21 for fine displacement of the partition edges 5' and 5'' toward or away from each other. On the other hand, the entire bearing block 18 or 19 can be adjustably supported in supplemental framework as vertically slidable or shiftable members with means to tighten it in place at a predetermined position, thereby permitting an even greater variance in the possible distance of vertical movement.

Also, as shown in FIG. 6, a substantial adjustment in the direction of the shaft width can be achieved by providing a horizontal slot 22 in the bearing support 18, the tightening screw 20 in this instance wedging the gib 23 or similar locking means against the projecting end of the shaft or rod 15 to hold this rod and the inwardly connected transverse bar fastener 7 firmly in place. In this respect, it is not essential for the rods 14, 15 and 16 to be circular in cross-section, but with at least the projecting supported ends of these rods having a cylindrical shape, they can be used to provide a positive bending moment on a flexible partition or else they can adapt the fastening bars or clamps 6, 7 and 8 to be turned in the direction of the bowed partitions attached thereto, particularly at the top or bottom edges, i.e. bars 6 and 8.

In FIG. 1, the lower adjustable partitions 5 are substantially straight plates, e.g. aluminum plates with a thickness of about 1 to 2 mm. In FIG. 2, these lower partitions 5 are preformed during adjustment in such a manner that they conform very closely to the parabolic or curved path of the adjacent groups of filaments 11. By adjusting the fastening bars or clamps 7 and/or 8 in vertical or horizontal directions, the configuration and placement of the lower partitions can be influenced in the desired manner by also applying a bending moment which takes place, for example, over the shafts or rods 15 or 16. Thus, it is especially preferred to turnably secure the rod extensions as well as to provide vertical and/or horizontal adjustments of the top and bottom edges of each of the partitions, either by means of adjustable clamps 6, 7 and 8 or by means of vertical and/or horizontal movement of the entire rods together with these clamps or bars 6, 7 and 8.

In order to easily adapt the lower partitions 5 to the curved paths of the filament groups, it is especially recommended that the upper and lower edge regions or zones 5' and 5'' be reinforced to provide a substantially greater rigidity or resistance to bending than the flexible portion intermediate these end regions. This can be readily accomplished, for example, by providing a slightly greater wall thickness in the end regions or a correspondingly thinner intermediate portion. Such reinforcement can also be provided by the fastening or clamping bars (7 or 8) or by thinner extensions thereof which limit the amount of bending near the end regions 5' and 5''.

The upper adjustable partitions 4 as shown in FIGS. 1 and 2 are normally maintained in a relatively straight vertical position, especially adjacent the initial path of the spun filaments 11 as they emerge from spinning heads 1. However, both this upper partition 4 and the lower partition 5 can be further subdivided into superimposed sections with interconnecting bars or clamps similar to 6 or 7, for example as indicated by the cut-off section extending above bar 6. On the other hand, it is also possible to use only a single adjustable unit as a partition extending over the entire vertical length of the shaft 2, i.e. so as to combine 4 and 5 into a single flexible or easily deformable sheet metal plate. In this latter case, one or more fastening or adjusting bar members can be attached or only lightly clamped transversely of the single sheet at intermediate positions.

Further subdivision of the adjustable partitions and/or the addition of more adjustable bars intermediate the top and bottom of the entire shaft are variations which may also be employed, especially if eight or more spinning heads are combined with a common spinning shaft. In this case, there is a relatively pronounced sagging of the filament paths, e.g. as may readily occur in the outermost shaft sections, and one achieves the best saving in space with the optimum flexibility in carefully positioning the partitions to avoid contact with the filaments.

There are a number of alternatives which can be followed to further ensure that the flexible or at least semi-flexible partitions follow the curved paths of the filaments as closely as possible. For example, especially good results are achieved when the partitions are subdivided into at least an upper section 4 and a lower section 5, and the lower section is deformed or preshaped by rolling the individual plates into approximately the desired shape. This initial adaptation to the thread paths can then be further influenced by imparting a counter-tension to the precurved plates or bands when they are clamped in place, i.e. by a slight stretching between the upper and lower edge fasteners or clamps. This same effect can also be promoted by turnably securing the lower partitions along their upper and/or lower edges, e.g. by means of the rotatably mounted shafts or rods, and the imparted bending moment can be transmitted to the partitions either in the same or opposite turning directions of the shafts or rods. In order to accomplish such deformation or bending without causing mechanical damage to the partitions, it is again relatively important to increase the rigidity of the plates or bands in the zones of the upper and lower edges.

In order to determine the best possible displacement of the partitions in the direction of the shaft width over the entire vertical length of the common shaft and especially the lower portion thereof, one can carry out a brief preliminary experiment with a particular polymer melt under actual spinning conditions but without the partitions in order to observe and measure or diagram the actual sagging curved path of the filament groups, e.g. by means of a photograph or short series of photographs. A simple group of templates can be made and inserted into the common shaft to represent the filament paths. The flexible partitions are then quickly installed to conform to these templates with a minumum gap space sufficient to avoid subsequent contact with the filaments as might arise from minor variations in the predetermined path.

Surprisingly, it is not essential for the adjustable partitions to fit accurately against the front and back walls of the common shaft, in part because the same cooling gas can be supplied simultaneously to all of the shaft sections in the upper or blowing zone thereof where an

accurate fit is most feasible while leakage from one shaft to the other in the lower or spinning zones thereof does not represent a serious problem. In this respect, it should be noted that adjustable walls in spinning shafts have been disclosed in German Patent specification, No. 1,435,480, but in this known apparatus, these walls serve an entirely different purpose of evening the flow of cooling gas over the entire length of the shaft, i.e. these adjustable walls do not act as partitions but as flow baffles.

By comparison, the adjustable fastening and positioning of the partitions according to the present invention, i.e. so as to move the upper and/or lower edges of the partitions in the running direction of the filaments and/or in the direction of the shaft width and further so as to transmit a bending moment or to preshape and/or tension curved partitions where relatively extreme curves are needed, makes it possible to achieve a very close conformity between the partitions and the paths of the filament groups.

In essence, the invention provides tensioning means in the form of the above described clamps or fastening bars which not only place the individual partitions under longitudinal tension but also provide at least one adjusting force in a direction approximately perpendicular to the tension forces. This permits the partitions to be very carefully adjusted according to predetermined requirements not only along the generally converging rectilinear path between the spinning heads and the collection point at the bottom of the shaft but also in the direction of the shaft width of the individual partitioned sections. Continuous spinning operations can be carried out over very long periods of time without any significant damage to the individual filaments or reduction in quality of the finished threads.

The invention is hereby claimed as follows:

1. In an apparatus for the melt-spinning of filaments including a plurality of at least three spinning heads arranged laterally across the top portion of a common vertically elongated spinning shaft which is partitioned into a corresponding plurality of approximately vertical shaft sections separating the filaments drawn downwardly from each spinning head in converging paths, the improvement which comprises:

individual partitions adjustably mounted in at least the lower portion of the common shaft for selected displacement in the direction of the shaft width, thereby variably narrowing each shaft section to accommodate the converging paths of said separated filaments while remaining free of contact therewith;

laterally positioned fastening means secured to at least one of the upper and lower edges of each of said partitions; and

means to adjustably mount said fastening means at different positions on the front and back walls of said common vertically elongated shaft.

2. Apparatus as claimed in claim 1 wherein said fastening means includes a laterally extending rod member projecting from opposite sides of the partition and a slotted supporting member to receive each projecting end of the rod with means to tightly secure said rod ends in the supporting members at predetermined positions.

3. Apparatus as claimed in claim 1 wherein said partition is a preshaped, thin, flexible sheet metal plate, and said fastening means includes a laterally extending rod member projecting from opposite sides of the partition with the projecting ends rotatably secured in a predetermined position.

4. Apparatus as claimed in claim 1 wherein said partition is a preshaped, thin, flexible sheet metal plate, and said fastening means includes a laterally extending rod member projecting from opposite sides of the position, said rod member being adjustably secured to the plate at positions parallel to the adjacent edge of said plate and having its projecting ends adjustably mounted for both rotatably positioning the rod about its longitudinal axis and shiftable displacement of said rod into parallel positions in an approximately horizontal plane.

5. Apparatus as claimed in claim 1 including at least two vertically superimposed adjustable partitions extending over both the upper and lower portions of each shaft sections and having their adjoining edges interconnected by said laterally positioned fastening means.

6. Apparatus as claimed in claim 5 wherein each of the upper and lower edges of all vertically superimposed partitions are secured to a laterally positioned fastening means.

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