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(54) **SPINNING APPARATUS**

(76) Inventors: **Holger Brandt**, Ehndorf (DE); **Henning Rave**, Leezen (DE); **Arnold Beck**, Neumunster (DE); **Joachim Dreyer**, Aukrug (DE); **Oliver Schirber**, Neumunster (DE)

Correspondence Address:
SMITH MOORE LLP
P.O. BOX 21927
GREENSBORO, NC 27420 (US)

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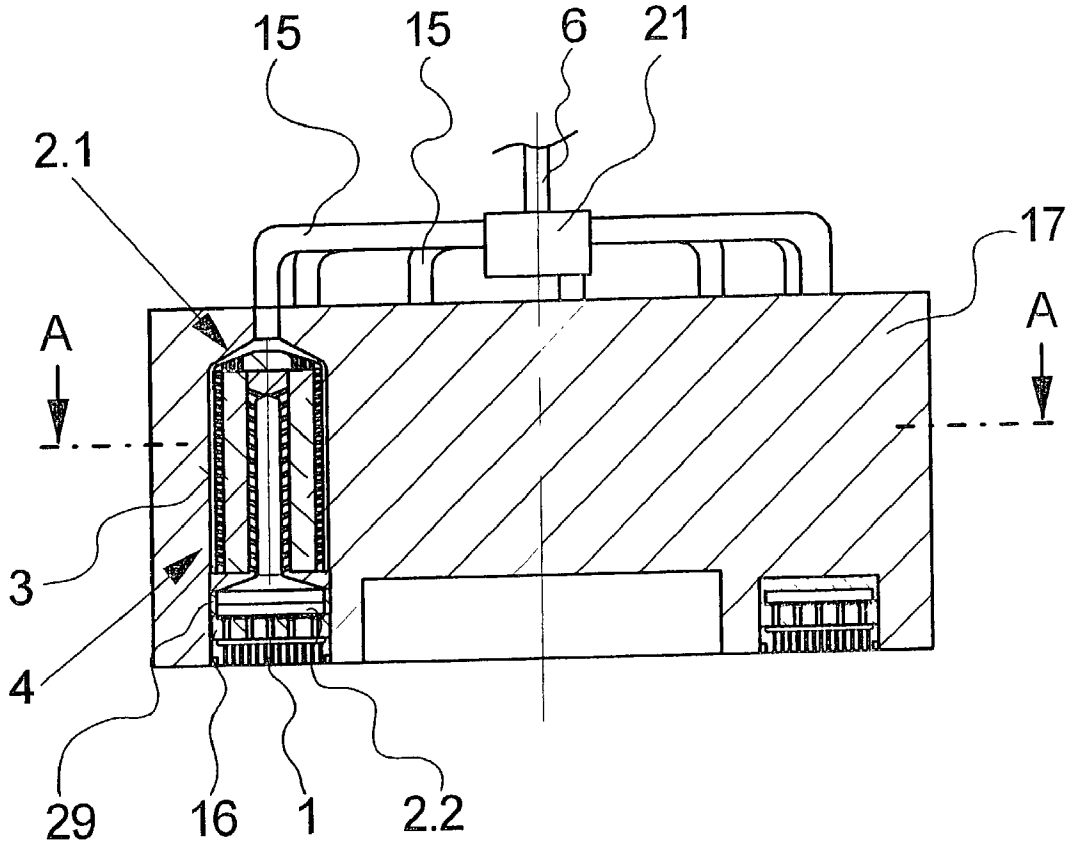
(57) **ABSTRACT**

A spinning apparatus for extruding a group of filaments by means of an annular spinneret. An annular collection chamber is arranged upstream of the spinneret, which is provided with a plurality of nozzle bores. The collection chamber has an upper inlet area and a lower annular outlet area, which is connected to the upper inlet area. In the inlet area of the collection chamber a filter device is disposed, upstream of which is a melt feed. The inlet area of the collection chamber is formed by a plurality of filter chambers, which are each provided with a melt inlet and a melt outlet. The filter device has a plurality of substantially cylindrical filter elements, which are each provided with a powdered filter medium. One of these filter elements is assigned to each filter chamber. This ensures a large filtration area and deep bed filtration of the polymer melt.



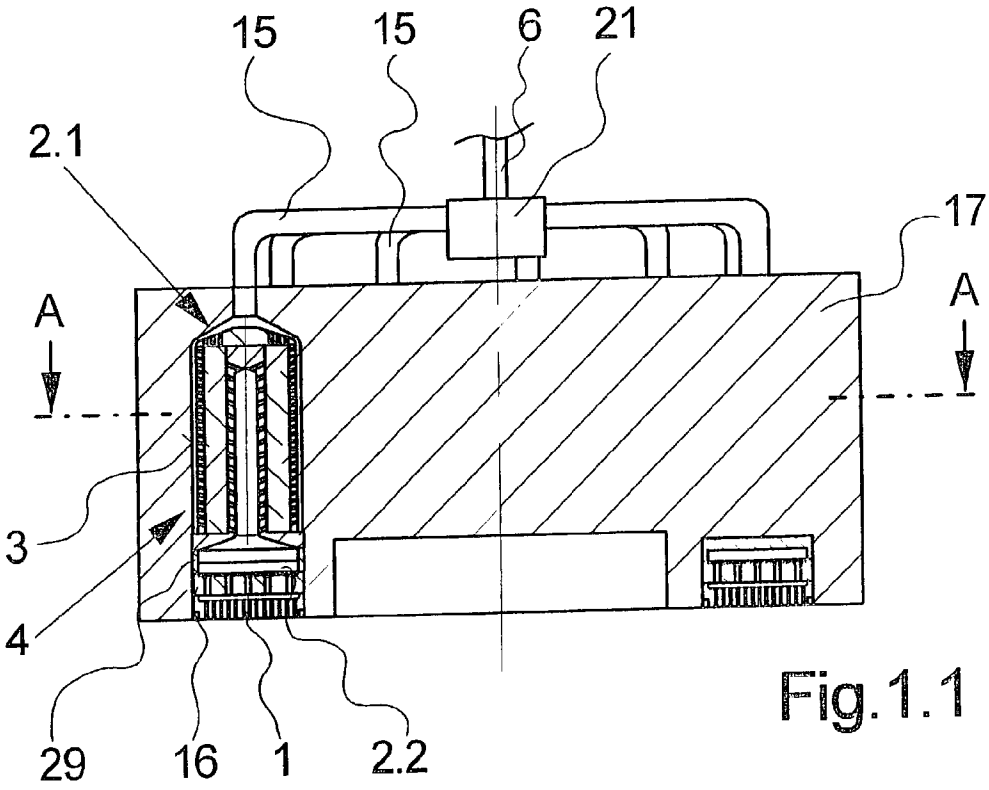


Fig.1.1

A-A

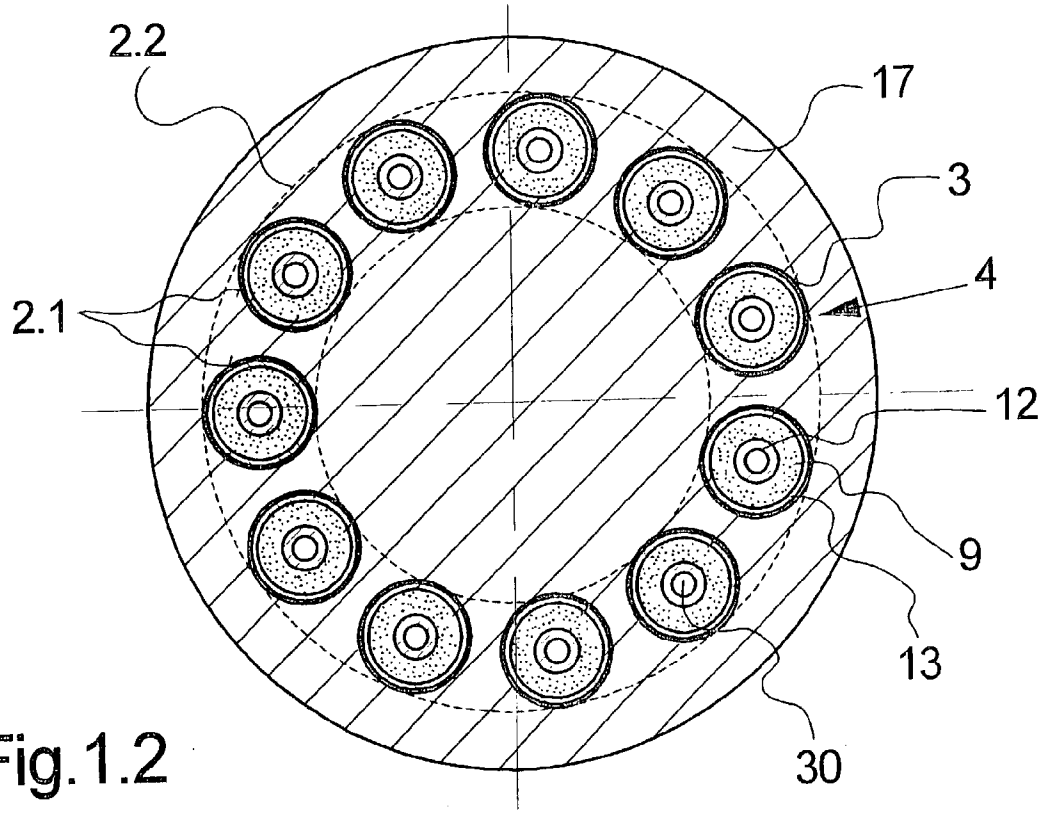


Fig.1.2

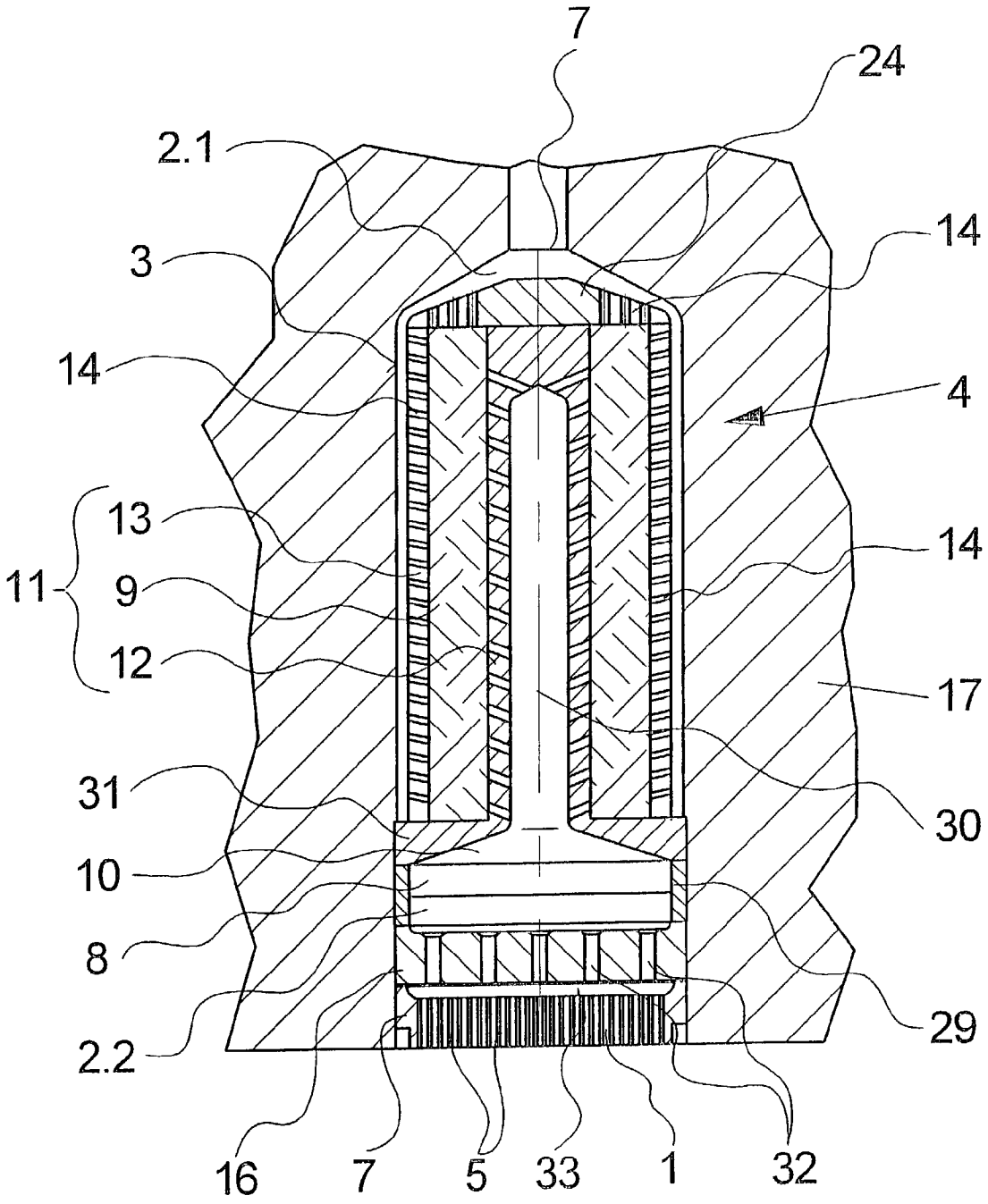
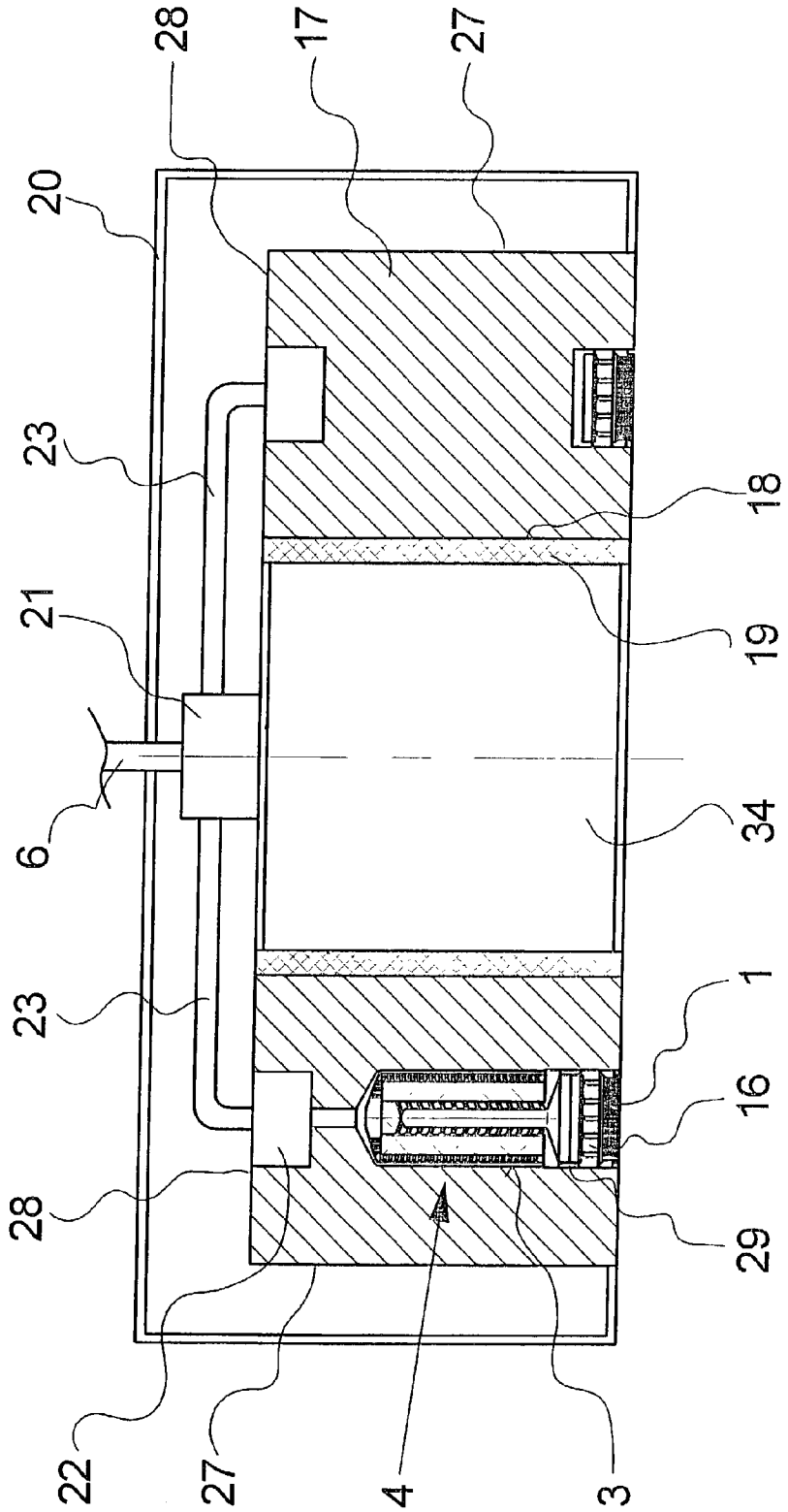


Fig.1.3

Fig.2



SPINNING APPARATUS

BACKGROUND OF THE INVENTION

[0001] The invention relates to a spinning apparatus for extruding a group of filaments comprising an annular spinneret.

[0002] An example of a spinning apparatus is disclosed in U.S. Pat. No. 6,171,536.

[0003] This prior art spinning apparatus has an annular spinneret on an underside with a plurality of nozzle bores through which a polymer melt is extruded into strand-like filaments. Such spinning apparatus' are used in staple fiber plants. The group of filaments is combined into a filament bundle after cooling. To enable uniform extrusion of the polymer melt, the polymer melt is filtered immediately prior to extrusion to ensure its purity and homogeneity. For this purpose, the prior art spinning apparatus comprises an annular collection chamber with an outlet area directly in front of the spinneret and an upper inlet area. In the inlet area, a filter device is arranged comprising an annular filter element with an approximately U-shaped cross section. For this purpose, an outer and an inner screen wall are joined at one end and inserted into the annular inlet area of the collection chamber. The opposite ends of the screen walls form the melt inlet of the collection chamber.

[0004] Although the filter device used in the prior art spinning apparatus permits an enlargement of the filtration area, it has the significant drawback that no deep action can be achieved by means of the screen wall. The result is a shorter tool life and decreasing throughputs due to the increasing degree of contamination.

[0005] Another drawback of the prior-art spinning apparatus is that the high melt pressure requires correspondingly strong side walls of the collection chamber to realize the nozzle diameter.

[0006] European Application 0 178 570 A1 discloses a spinning apparatus in which a plurality of filter candles are used to filter a polymer melt prior to extrusion through a spinneret. The drawbacks of this apparatus are that the spinning apparatus is completely unsuitable for extruding an annular group of filaments required for staple fiber production and the deep action of the filter candles is insufficient.

[0007] Accordingly, there is a need in the art for a spinning apparatus for extruding a group of filaments with an annular spinneret in such a way that prior to extrusion the polymer melt is filtered under the action of large filtration areas and deep bed filtration.

BRIEF SUMMARY OF THE INVENTION

[0008] The present invention fulfills this need by providing a spinning apparatus wherein the inlet area of the collection chamber is formed by a plurality of filter chambers, each provided with a melt inlet and a melt outlet, and the filter device has a plurality of substantially cylindrical filter elements, each provided with a powdered filter medium. One filter element is assigned to each filter chamber.

[0009] The present invention is based on substantially cylindrical filter elements, each of which is provided with a powdered filter medium in order to obtain sufficient deep bed filtration. Furthermore, the pressure load in the filter chambers is very small due to the relatively small diameters of the filter chambers in the region of the filter device.

[0010] A particularly advantageous further development of the invention provides that the filter elements are each formed as hollow cylinders with an outlet opening that communicates with the melt outlet of the filter chamber. The filter elements each have a filter shell made of the powdered filter medium through which the molten material flows from the outside toward the inside. A space is formed between the filter shell of the filter element and the filter chamber. This ensures a uniform inflow of the polymer melt over the circumference of the filter element. Due to the hollow cylindrical configuration of the filter element, the paths traveled by the polymer melt within the filter element are equally long in radial direction irrespective of the entry of the polymer melt. This has the advantage that equal retention times are obtained.

[0011] A particularly simple and effective construction of the filter element of the present invention is also provided. The filter shell is formed by an inner tube that is open toward the outlet opening and an outer tube that encloses the inner tube. A closed annular shell casing is arranged between the inner tube and the outer tube to receive the powdered filter medium. In the inner tube and the outer tube, a plurality of passages is provided to allow the polymer melt to enter and exit. An additional screen cover may be arranged along the circumference of the inner tube and/or the outer tube.

[0012] The filter medium is preferably formed by a metal powder or a sand, e.g. a silica sand.

[0013] In principle, however, the shell casing formed between the inner tube and the outer tube can be filled with any type of filter medium.

[0014] To obtain a uniform melt feed of the filtered melt over the entire annular cross section of the spinneret, the filter chambers are arranged annularly spaced apart from one another such that the melt outlets of the filter chambers open directly into the outlet area of the collection chamber.

[0015] The melt feed can advantageously be connected with the melt inlets of the filter chambers by a plurality of distribution channels, or it can be connected with the melt inlets of the filter chambers by an annular distribution channel. It is essential that between the melt feed and the melt inlets of the filter chambers, paths of equal length are formed by the distribution channels to avoid different retention times of the polymer melt within the spinning apparatus.

[0016] In a particularly advantageous further development of the invention an annular perforated plate is arranged in the outlet area of the collection chamber upstream of the spinneret to achieve better mixing of the melt streams exiting from the melt outlets of the filter chambers in the outlet area of the collection chamber.

[0017] To supply a cooling air stream required to cool the group of filaments, the spinneret and the filter device are held by an annular carrier. The melt-carrying parts of the spinning apparatus are heated by a heating element arranged on the inside of the carrier. The heating elements used for this purpose are preferably electric heater bands.

[0018] The remaining areas of the carrier can advantageously be heated by means of a heat transfer fluid. The shell

of the carrier and the end face of the carrier are connected with a heating box that contains the heat transfer fluid.

BRIEF DESCRIPTION OF THE FIGURES

[0019] An exemplary embodiment of the inventive spinning apparatus will now be described in greater detail with reference to the attached drawings in which:

[0020] **FIG. 1.1** is a schematic sectional view taken in longitudinal direction of the spinning apparatus according to a first embodiment of the present invention;

[0021] **FIG. 1.2** is a schematic cross section of the spinning apparatus according to the first embodiment of the present invention;

[0022] **FIG. 1.3** depicts an enlarged detail of the sectional view of **FIG. 1.1**.

[0023] **FIG. 2** is a schematic sectional view of a second embodiment of the spinning apparatus according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0024] Unless express reference is made to one of the figures, the following description applies to all of the figures.

[0025] The spinning apparatus of the present invention comprises a heated carrier **17**. The heating elements required to heat carrier **17** are not depicted. Carrier **17** serves to receive an annular spinneret **1**, which is mounted to the underside of carrier **17**. Spinneret **1** has a plurality of nozzle bores **5**. Above spinneret **1**, an annular collection chamber is formed, which comprises a lower annular outlet area **2.2** and an upper inlet area **2.1**. The outlet area **2.2** of the collection chamber is annular and covers the entire surface of spinneret **1**. Within the outlet area **2.2**, a perforated plate **16** and an intermediate plate **29** are arranged. Perforated plate **16** comprises a plurality of vertical bores **32** through which an annular chamber **33** formed between spinneret **1** and perforated plate **16** is connected with the remaining sections of outlet area **2.2** of the collection chamber. The intermediate plate **29** forms the connection between the inlet area **2.1** and the outlet area **2.2** of the collection chamber.

[0026] The inlet area **2.1** of the collection chamber is formed by a plurality of filter chambers **3** that are spaced apart from one another. In a preferred embodiment, a total of eleven filter chambers **3** are introduced into carrier **17** so as to be uniformly distributed over the annual cross section of outlet area **2.2**. The number of filter chambers **3** is given by way of example. Filter chambers **3** each have an upper melt inlet **7** and a lower melt outlet **8**. Melt outlets **8** of filter chambers **3** are formed in accordance with the partitioning of the filter chamber arrangement in the intermediate plate **29**.

[0027] The inlet area **2.1** of the collection chamber serves to receive a filter device. The filter device comprises a plurality of filter elements **4**, each of which are arranged in a filter chamber **3**. Filter elements **4**, of which there is a total of eleven in a preferred embodiment, are hollow and cylindrical and have a permeable filter shell **11**. The diameter of filter shell **11** is selected in such a way that a gap is formed between the wall of filter chamber **3** and filter element **4**.

[0028] Filter element **4** has an inner tube **12**, which is closed at one end and open at the opposite end. The open end of the inner tube **12** forms the outlet opening **10** of the filter element, which is connected with the melt outlet **8** of filter chamber **3**. Along the circumference of the inner tube **12**, at its open end, a circumferential collar **31** is formed, which in axial direction rests against intermediate plate **29** and in radial direction against carrier **17** forming a seal. On the side of collar **31** opposite intermediate plate **29**, an outer tube **13** rests against collar **31**. This outer tube **13** encloses the inner tube **12** at a distance and extends up to the closed end of inner tube **12**. At the closed end of inner tube **12** a cover **24** is provided which connects the inner tube **12** with the outer tube **13**. This creates a closed annular shell casing into which a powdered filter medium **9** is introduced. Outer tube **13**, inner tube **12** and cover **24** have a plurality of passages **14**. Filter element **4** is inserted upright in filter chamber **3**. Collar **31** forms a partition in filter chamber **3** between melt inlet **7** and melt outlet **8**.

[0029] The filter elements **4** of the filter device are preferably configured identically to achieve uniform filtration of the melt.

[0030] The melt inlets **7** of filter chambers **3** are connected with a melt feed **6**. For this purpose, a distribution line system is provided, assigning a separate distribution line **15** to each individual filter chamber **3**. This distribution line system is supplied by a spin pump **21**. Spin pump **21** is connected with a melt generator, e.g. an extruder.

[0031] In the embodiment of the spinning apparatus shown in **FIG. 1, a** polymer melt stream is supplied by spin pump **21** to distribution lines **15**. Distribution lines **15** each feed a partial melt stream to one of the melt inlets **7**. Thus, a partial polymer melt stream enters into each of the filter chambers **3**. In filter chamber **3**, the polymer melt is distributed over the entire circumference of filter shell **11** and penetrates through passages **14** of outer tube **13** into filter shell **11**. The polymer melt passes through the powdered filter medium **9** and via passages **14** of inner tube **12** is guided into a central melt channel **30**. From this central melt channel **30** the partial stream reaches melt outlet **8** of filter chamber **3** via outlet opening **10**. From melt outlet **8** the partial melt stream passes into outlet area **2.2** of the collection chamber. All the partial streams flowing through filter chambers **3** are combined in outlet area **2.2**. The polymer melt is then guided through bores **32** of perforated plate **16**, such that additional mixing takes place in annular chamber **33** between perforated plate **16** and spinneret **1**. The polymer melt is then extruded through nozzle bores **5** of spinneret **1**. A group of filaments is created resulting in a closed filament curtain corresponding to the annular arrangement of the spinneret.

[0032] To filter the polymer melt, filter elements **4** preferably contain metal powder or a silica sand in filter shell **11**. This ensures deep action during filtration of the polymer melt. In addition, filter shell **11** is constructed and integrated in filter chamber **3** in such a way that the retention times of the polymer melt during filtration are substantially independent of the entry location. Furthermore, relatively high differential pressures can be realized during filtering of the polymer melt. The pressure load is limited to the diameter of filter chambers **3**, which is small compared to that of the spinneret.

[0033] The construction of the filter element in the embodiment shown in **FIG. 1** is only an example. It is possible, for instance, to arrange additional filter screens in the inner and outer region of the tubes. It is also possible to use any type of filter medium in the shell casing.

[0034] **FIG. 2** depicts a further embodiment of the inventive spinning apparatus. Components with like function are provided with identical reference numerals. The construction of the embodiment according to **FIG. 2** is substantially identical to that of the preceding embodiment, so that only the significant differences will be described below.

[0035] The embodiment of the spinning apparatus according to **FIG. 2** has an annular carrier **17**. This annular carrier **17** is integrated in a heating box **20** such that shell **27** of carrier **17** and the upper end face **28** of carrier **17** can be heated by a heat transfer medium contained in heating box **20**. In its center, carrier **17** forms a seat **34** for a cooling device (not depicted). On the inside **18** of carrier **17**, a heating element **19** is arranged. Heating element **19** is preferably embodied as a heater band, which heats the entire interior **18** of carrier **17**.

[0036] Carrier **17** serves to hold a spinneret **1**, a perforated plate **16**, an intermediate plate **29** and a plurality of filter elements **4**. The arrangement and configuration of spinneret **1**, perforated plate **16**, intermediate plate **29** and filter elements **4** is identical to the embodiment shown in **FIG. 1**, so that reference is made to the preceding description.

[0037] Melt inlets **7** of filter chambers **3** are connected with an annular distribution channel **22**. Distribution channel **22** is connected with a spin pump **21** and a melt feed **6** via one or more melt lines **23**. Distribution channel **22**, melt lines **23** and spin pump **21** are arranged in heating box **20** and are heated.

[0038] In contrast to the preceding embodiment of the spinning apparatus, a polymer melt is first conveyed into the annular distribution channel **22** via spin pump **21**. From distribution channel **22** the polymer melt enters into the associated filter chambers **3** in respective partial streams. After filtering, the partial streams are combined again and mixed in the outlet area of collection chamber **2.2**. After passing through perforated plate **16**, the polymer melt is extruded by means of spinneret **1** to form the plurality of filaments.

LIST OF REFERENCE NUMERALS

[0039] **1** spinneret

[0040] **2** collection chamber

[0041] **2.1** inlet area

[0042] **2.2** outlet area

[0043] **3** filter chamber

[0044] **4** filter element

[0045] **5** nozzle bore

[0046] **6** melt feed

[0047] **7** melt inlet

[0048] **8** melt outlet

[0049] **9** filter medium

[0050] **10** outlet opening

[0051] **11** filter shell

[0052] **12** inner tube

[0053] **13** outer tube

[0054] **14** passages

[0055] **15** distribution line

[0056] **16** perforated plate

[0057] **17** carrier

[0058] **18** interior

[0059] **19** heating element

[0060] **20** heating box

[0061] **21** spin pump

[0062] **22** distribution channel

[0063] **23** melt lines

[0064] **24** cover

[0065] **25** openings

[0066] **26** screen wall

[0067] **27** shell

[0068] **28** end face

[0069] **29** intermediate plate

[0070] **30** melt channel

[0071] **31** collar

[0072] **32** bores

[0073] **33** annular chamber

What is claimed is:

1. Spinning apparatus for extruding a group of filaments comprising:

an annular spinneret comprising a plurality of nozzle bores;

an annular collection chamber arranged upstream of the spinneret comprising:

an upper inlet area; and

a lower annular outlet area connected to the upper inlet area;

a filter device arranged in the inlet area of the collection chamber; and

a melt feed arranged upstream of the filter device;

wherein the inlet area of the collection chamber is formed by a plurality of filter chambers each having a melt inlet and a melt outlet;

wherein the filter device comprises a plurality of substantially cylindrical filter elements which each comprise a powdered filter medium; and

wherein each one of the filter elements is assigned to one of the filter chambers.

2. Spinning apparatus as claimed in claim 1:

wherein the filter elements are each formed as a hollow cylinder with an outlet opening that is connected to the melt outlet of the filter chamber;

wherein the filter elements each have a filter shell comprising the powdered filter medium through which melt flows from the outside toward the inside; and

wherein a space is formed between the filter shell of the filter element and the filter chamber.

3. Spinning apparatus as claimed in claim **2**:

wherein the filter shell is formed by an inner tube that is open toward the outlet opening and an outer tube that encloses the inner tube;

wherein a closed shell casing exists between the inner tube and the outer tube to receive the powdered filter medium; and

wherein the inner tube and the outer tube each have a plurality of passages.

4. Spinning apparatus as claimed in claim 1, wherein the powdered filter material is a sand or a metal powder.

5. Spinning apparatus as claimed in claim 1, wherein the filter chambers are annularly spaced apart from one another within the inlet area and wherein the melt outlets of the filter chambers open directly into the outlet area of the collection chamber.

6. Spinning apparatus as claimed in claim 1, wherein the melt inlets of the filter chambers are connected to the melt feed by a plurality of distribution lines.

7. Spinning apparatus as claimed in claim 1, wherein the melt inlets of the filter chambers are connected to the melt feed by an annular distribution channel.

8. Spinning apparatus as claimed in claim 1, wherein an annular perforated plate is arranged upstream of the spinneret within the outlet area.

9. Spinning apparatus as claimed in claim 1, wherein the spinneret and the filter device are held by an annular carrier and wherein a heating element is arranged on the inside of the carrier.

10. Spinning apparatus as claimed in claim 9, wherein the heating element is an electric heater band.

11. Spinning apparatus as claimed in claim 9, wherein the carrier is connected to a heating box such that a shell of the carrier and an upper end face of the carrier can be heated by a heat transfer fluid.

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