United States Patent

Bydal

[54] APPARATUS FOR DIVIDING AND RECOMBINING FLOW

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[45] **Feb. 8, 1972**

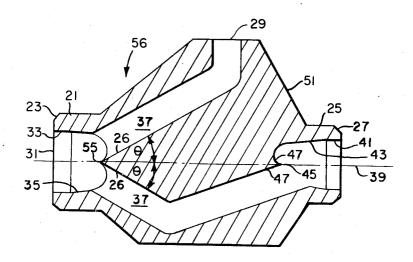
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Primary Examiner—William R. Cline Attorney—Howard P. West, Jr.

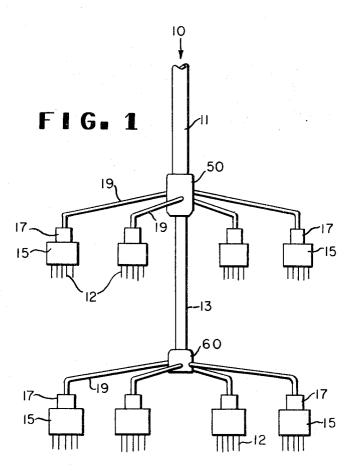
[57] ABSTRACT

An apparatus for dividing a flowing multicomponent viscous stream into a plurality of sectors, each having the same weight percentage of each component as in the stream, includes a body member having an entrance and a plurality of exits connected by a plurality of passages. The passages, at one end, all intersect with the axis of the entrance at a common point and are equispaced from each other around the entrance axis.

2 Claims, 9 Drawing Figures



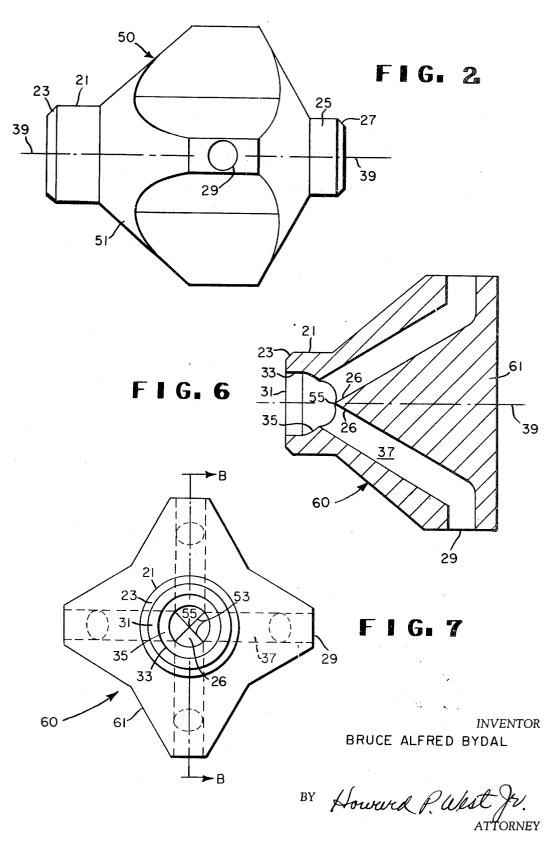
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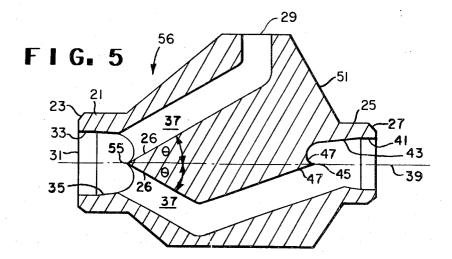
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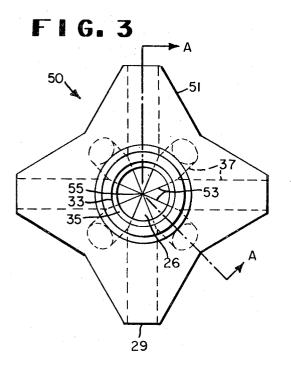


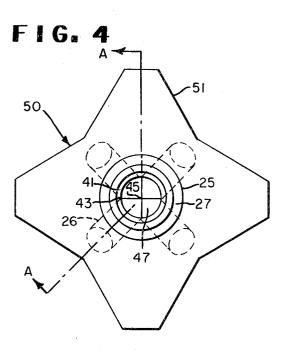
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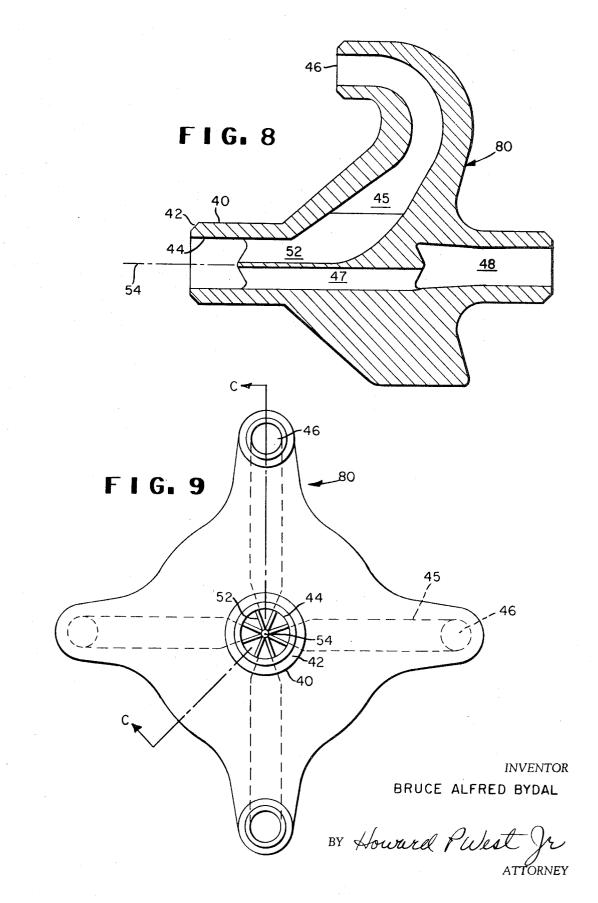


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SHEET 4 OF 4



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BACKGROUND OF THE INVENTION

This invention relates to apparatus for dividing the flow of a molten polymer composition, that is, for distributing the composition from a single source to a plurality of processing points. More particularly, it relates to dividing a stream of molten polymer containing one or more dispersed insoluble materials into a plurality of streamlets each of which has the 10 same weight fraction of each material as was present in the stream.

It is common practice in the melt-spinning of syntheticpolymer filaments to provide a central source of molten polymer and to distribute the melt via suitable piping means to a plurality of processing points (e.g., spinneret assemblies). A well-recognized problem in such distribution systems is that, in flowing along a pipe, the viscous melt flows at different rates over the cross section of the pipe. Thus, near the walls of the pipe, the flow-velocity is low while, along the axis of the 20 pipe, the flow-velocity is a maximum. Frequently, the viscous melt includes one or more additives insoluble in the melt dispersed as particulate bodies. Such bodies, when deformable under flow conditions existing in a pipe, tend to migrate toward the axis of the pipe and result in a heavy concentration 25 near the axis with concentrations becoming lighter as the distance from the axis increases toward the wall of the pipe. Under these conditions, the concentration of those insoluble particulate bodies at a specific distance from the axis of the pipe is different from the concentration at any other distance 30 from the axis and is independent of angular position around the axis. This is known as axisymmetric distribution.

To facilitate in assuring that all melt reaching the plurality of remote processing points has had substantially the same residence time in the flow-distribution system, flow-splitting 35 devices have been developed which successively remove outer concentric layers of the original stream. Also, various arrangements for distribution are known such as piping tees and the like, but none of these have been completely successful for splitting a stream having an axisymmetric distribution into a 40plurality of streamlets such that each streamlet has the same weight-percentage of each component as existed in the initial stream.

SUMMARY OF THE INVENTION

This invention provides a manifold for splitting an axisymmetric stream of molten polymer composition into a plurality of streamlets each of which has the same weight-percentage of each component as existed in the axisymmetric stream.

The manifold of this invention is a unitary body. One end of the body has an entrance into the body adapted for coaxial connection to a pipe for feeding an axisymmetric stream of molten polymer composition to the manifold. The entrance terminates at intersections with a plurality of passages each 55 inclined at the same angle with respect to the axis of the entrance and each passage equiangularly spaced from adjacent exit-bores around the axis of the entrance. All intersections of the passages with each other and with the walls of the entrance lie within the unitary body, and all passages intersect with the 60 axis at a common point. Each of the passages communicates, with a downstream exit in the body. Each exit is adapted for coaxial connection to discharge pipes. The number of exits is less than or equal to the number of passages. Each passage communicates with only one exit and each exit communicates 65 with at least one passage. When more than one passage communicates with one exit, intersection of the passages is preferably analogous to the upstream intersections of the passages with the entrance and all such downstream intersections exist within the unitary body. 70

The term "sector" as employed herein, refers to a shape enclosed within two radii and the corresponding arc of a circle. Reference to "identical sectors" denotes division of the whole transverse area of an axisymmetric stream into equiangular sectors the sum of whose angles is 360°.

FIG. 1 is a diagrammatic representation of a polymer distribution system employing the flow-splitting manifold of this invention.

FIG. 2 is a side view of a preferred manifold of this invention.

FIGS. 3, 4 and 5 are respective views of the upstream end, the downstream end and a cross section taken as denoted by -A. of the manifold shown in FIG. 2.

FIGS. 6 and 7 are, respectively, a cross section as taken at B-B of FIG. 7 and an axial view of the upstream end of a modified form of the manifold of FIG. 2.

FIGS. 8 and 9 are, respectively, a cross section as taken at 15 C-C of FIG. 9 and an axial view of the upstream end of a second form of the manifold of this invention.

DETAILED DESCRIPTION OF THE ILLUSTRATED **EMBODIMENTS**

FIG. 1 shows in a diagrammetric form the type of distribution system to which this invention is particularly directed. A stream of molten polymer composition flows as indicated by arrow 10 along round pipe 11. Manifolds 50 and 60 are the novel devices of the present invention. In the case shown, manifold 50 divides initial stream 10 into eight streamlets, four of which are led via conduits 19 by pumps 17 to spinneret packs 15 from which the molten polymer composition is extruded to form synthetic polymer filaments 12. The remaining four streamlets are recombined within manifold 50, flow together as a single stream via a second round pipe 13, to manifold 60 where the stream is again divided into four streamlets all of which are let by conduits 19, as before, to separate spinning stations for the formation of filaments 12. Such operations in the melt-spinning of synthetic polymer filaments are widely practiced and well known to those skilled in the art. Manifolds 50 and 60, however, are of a novel construction which simply and inexpensively functions to divide an axisymmetric stream of molten polymer composition into a plurality of identical streamlets.

FIGS. 2, 3, 4 and 5 show different views of a preferred manifold 50 of the present invention which includes unitary body 51 free of any moving parts. Round extension 21 is provided with a taper 23, or other suitable shape, for the at-45 tachment of a pipe (e.g., pipe 11 of FIG. 1) for coaxial input of an axisymmetric stream. The other end has another round extension 25 with taper 27, and is adapted for coaxial connection to a pipe (e.g., pipe 13 of FIG. 1) for the downstream exit of those streamlets which, after division, are internally recom-50 bined for continuing axial flow. Also shown is one of the four exit-openings 29 through which a single streamlet exits manifold 50 for separate conveyance (e.g., via conduit 19 of FIG. 1) to a remote processing station.

FIGS. 3, 4 and 5 show details of internal construction of manifold 50 of FIG. 2. Numbering of corresponding features is uniform throughout. Round extension 21 has round opening 31 communicating with round-entrance bore 33 both of which, when extension 21 is attached to pipe 11, are coaxial with pipe 11. Generally, bore 33 is circular and has a short inwardly tapered length 35 before its internal termination for eliminating stagnant areas. Diverging passages 37 extend downstream from the internal termination of bore 33, each round in cross section with a diameter ordinarily approximately one-half that of bore 33. In the case shown, there are 8 such passages 37. Each forms the same acute angle θ with the entrance bore axis $39(\theta$ is preferably less than 45° for ease in machining). Likewise, all are equiangularly spaced around the axis 39 so that common intersections of passages 37 define lines 53 enclosing identical sectors as seen axially in FIG. 3. Each bore 37 is also positioned along axis 39 such that the inner portions 26 of all bores 37 are inclined away from entrance 33 and intersect at a common point 55 on axis 39. Neither passage diameter nor angle θ is critical provided all passage intersections with each other and with entrance-bore 75 33 (or taper 35) occur within manifold 50. The means for dividing an axisymmetric stream into a plurality of identical streamlets is defined by the complex intersection of bore 33 with bores 37.

With further reference to FIGS. 3, 4 and 5, it is seen that four of the passages 37 communicate with exists 29 where conduits 19 (FIG. 1) for individual streamlets can be attached. The remaining four passages 37 communicate with common downstream exit 41 in exit-extension 25. The bore structure in exit-extension 25 is entirely analogous to that of the entranceend as already described, except for ordinarily being smaller 10 to accommodate half the original flow. Included are the coaxial exit bore 41, usually with tapered length 43. The other end of passages 37 also converge within and toward exit 41 such that the inner wall portions 47 intersect at point 45 on axis 39.

As shown in FIG. 1, use of manifold 50 presumes the sub- 15 sequent use downstream of another manifold 60, as shown in FIGS. 6 and 7. Manifold 60 is of the same basic structure as manifold 50 except for being adapted to terminal ends of a distribution system. Corresponding parts are numbered as for manifold 50. It will be seen that the number of passages 37 is 20 identical to the number of exits 29 for separate flow of each streamlet via conduits 19 (FIG. 1).

The manifolds of FIGS. 2 through 7 are particularly adapted to fabrication by machining of solid metal pieces. Manifolds may also be fabricated by casting and FIGS. 8 and 9 show a 25 form particularly adapted to casting. The cast manifold 80 as shown is analogous to manifold 50 (FIGS. 3 and 5). Attachment to upstream piping is via round extension 40 which has tapered edges 42 and an internal entrance bore 44. Manifold 80 divides an input stream into 8 sectors, alternate 30 parent to those skilled in the art. streamlets passing via passages 45 to downstream openings 46 and the remaining streamlets passing via passages 47 into communication with larger exit-bore 48 where all 4 streamlets merge and pass to a manifold (not shown) analogous to that of FIGS. 6 and 7. Each of ducts 45 and 47 is enclosed such that 35 their upstream terminations form walls 52 which divide a stream over its whole area into identical sectors. All walls 52 are joined at the axis (shown as 54). Walls 52 and their intersection 54 are necessarily of appreciable thickness and are, therefore, narrowed to fine edges at their upstream termina- 40 connected to an exit, one of said exits being coaxial with said tions

It is customary, as shown in FIG. 1, for each spinneret block 15 to receive molten polymer composition at the same volume flow-rate, provided by pumps 17. Proper operation of the manifold of this invention requires that, for all streamlets di- 45 vided as sectors from an inlet stream, the volume flow-rates be the same. Thus, in FIG. 1, manifold 50 splits the stream into 8 sectors, each of which has a volume flow-rate governed by one of the 8 pumps 17. Four of the sectors are recombined within manifold 50, and are split again in manifold 60 before going 50directly to pumps 17. Their corresponding volume flow-rates are nevertheless governed by the pumps through which they ultimately pass. It is sometimes desirable to split each streamlet passing via conduits 19 into two symmetrical substream-55

lets, each of which substreamlets leads to a separate pump 17 and spinneret-block 15. In this case, constant flow rate through each sector is assured by providing two pumps per sector.

The manifolds of this invention facilitate providing to the 5 spinneret blocks streamlets of molten polymer composition all of which have had the same mass-average residence time in the distribution system. This is true whether or not insoluble particulate bodies are present and results from the fact that each sector of the stream which is split off is composed of equal fractions of the slower moving and faster moving portions of polymer. Thus, the molten polymer composition itself is an axisymmetric composition comprising a multitude of polymer species of differing residence times; and the manifold equally well splits this axisymmetric stream of polymer species into identical sectors. After the identical sectors are split off, their individual mass-average residence times must be kept identical. It is well within the skill of the art to vary lengths and diameters of conduits to provide the necessary uniformity in residence times. It is also desirable to provide a mixing device for each streamlet just prior to filament-extrusion so as to establish concentration uniformity of all components throughout the streamlet. Means for accomplishing such mixing are numerous and well known.

This invention is particularly suitable for dividing into streamlets a molten polymer composition containing dispersed deformable particulate additives. While only particular forms of the manifold are shown and discussed in detail, suitable alternative devices will be immediately ap-

What is claimed is:

1. An apparatus for dividing a flowing viscous stream into a plurality of identical sectors and recombining some of said sectors into a single stream comprising: a body member having a circular entrance and a plurality of exits connected by a plurality of passages within said body member, there being more passages than exits, said entrance having a longitudinal axis, one end of each passage terminating at a common point on said axis in said entrance, the other end of each passage being entrance, said passages in said entrance having equal crosssectional areas and being both equispaced angularly from each other around said axis and equiangularly inclined away from said axis in the direction of flow to divide said entrance into identical sectors extending from said axis to the inner periphery of said entrance, there being more than one passage connected to said exit coaxial with said entrance and only one passage connected to each of the other exits.

2. The apparatus as defined in claim 1, there being a single entrance, five exits and eight passages, four of said exits diverging from said axis, the remaining exit being coaxial with said entrance, four of said passages being connected to said remaining exit.

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