Sept. 13, 1966 R. D. LIVINGSTON 3,272,231

APPARATUS FOR DIVIDING FLOW

Filed March 5, 1964 2 Sheets-Sheet 1

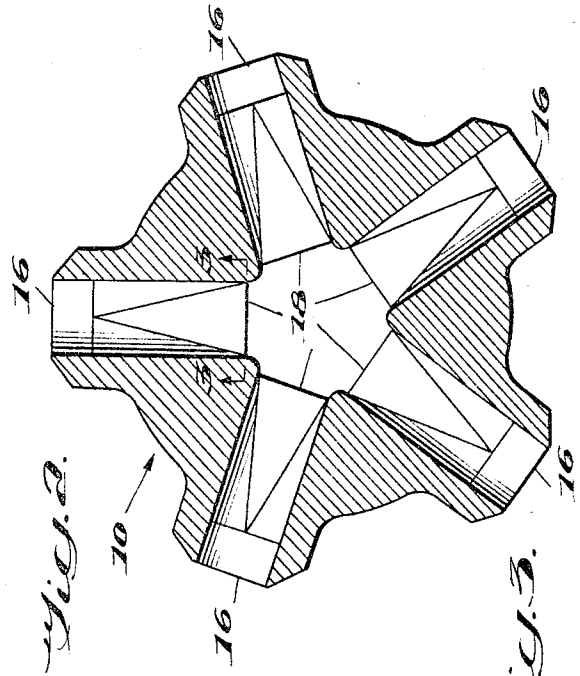

Fig. 2.

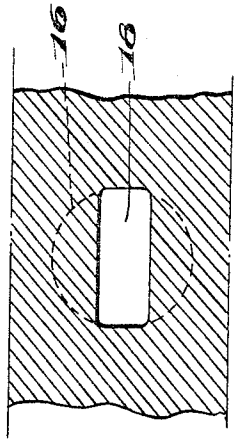

Fig. 3.

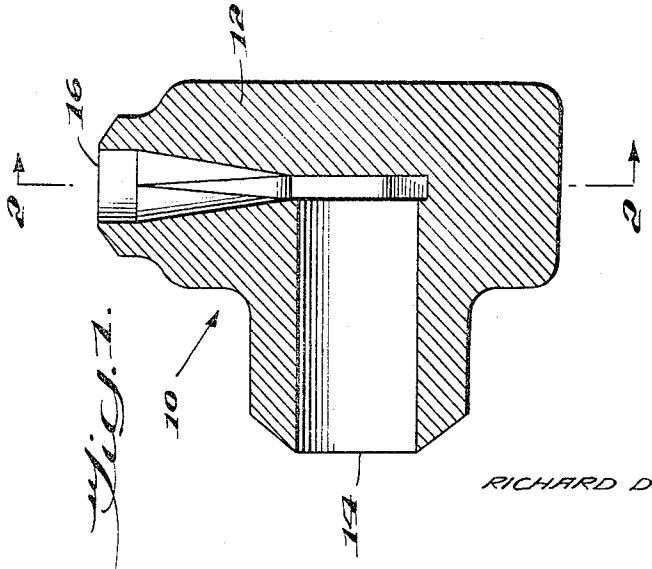

Fig. 4.

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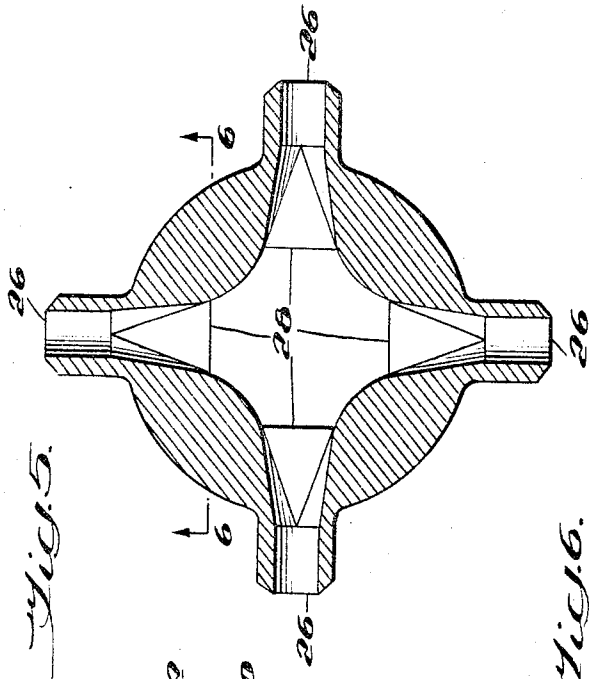


Fig. 5.

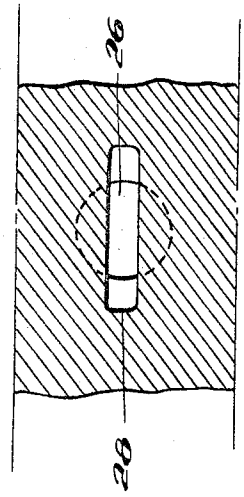
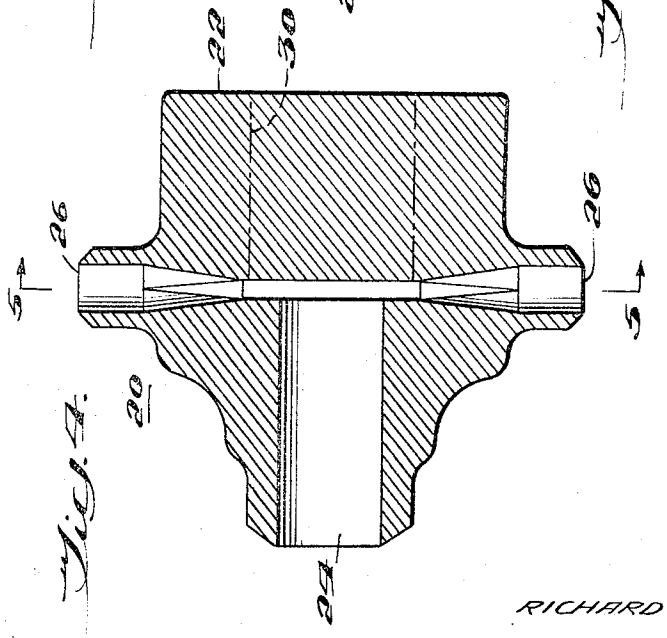


Fig. 6.



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United States Patent Office 3,272,231
Patented Sept. 13, 1966

3,272,231

APPARATUS FOR DIVIDING FLOW

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8 Claims. (Cl. 137—561)

This invention relates to the distribution of a viscous fluid under laminar flow conditions from a single source to a plurality of delivery ports and more particularly to an improved apparatus for insuring proper splitting of the viscous fluid.

Systems for distributing liquids from a single source to a plurality of discharge points are common and various systems have been employed in an attempt to provide even distribution of the liquid. A tree-like cascade manifold is one known convenient way of dividing a main stream of liquid into several streams.

Generally, no difficulty is encountered in the use of the known systems for distribution where the liquid is of low viscosity and relatively stable. However, with highly viscous, relatively unstable systems such as encountered in the handling of molten streams of high polymers such as nylon and polyethylene terephthalate, the problem of maintaining equal residence times in a distribution system for the various streams becomes severe. This is particularly true in the distribution of a molten polymer, such as nylon, to a plurality of devices having extrusion orifices, since the physical properties of the polymer change with time at high temperature. The differences in residence time to the various streams lead to non-uniformities in the final products of the extrusion orifices.

It is also essential in such a distribution system that there be no dead spots where polymer can hold up, stagnate and then slough-off and flow into the main stream and cause degradation of the final product. The elimination of dead spots in round piping is quite simple. However, at the distribution points, that is, the T's or flow-splitting junctions, there is a considerable number of dead spots at the junction of round connections. This invention seeks to eliminate these dead spots in the flow splitters.

It is the object of this invention to provide an improved apparatus for the proper distribution or splitting of viscous liquids from a single source to a plurality of delivery ports, without any dead spots for stagnation of time-dependent materials. Another object is to provide a simple economical apparatus for accomplishing this. Other objects will become apparent from the description and discussion to follow.

The improved flow splitter apparatus of this invention comprises a body member having a circular inlet port therein, a plurality of equi-spaced, coplanar discharge ports substantially perpendicular to the axis of the inlet port and each having an identical circular exit portion and tapering to an identical rectangular cross-section at the intersections with the inlet port. In the preferred embodiment, the dimensions of the rectangular cross-section are such that the longer side, parallel to the plane of the discharge ports, is equal to or greater than the diameter of the circular exit portion, and the shorter side is less than one-half the diameter of the circular cross-sections.

Reference is made to the accompanying drawings in which:

FIGURE 1 is a cross-sectional view of a flow splitter for splitting an inlet stream into five branch streams;

FIGURE 2 is a section view taken along lines **2**—**2** of FIGURE 1;

FIGURE 3 is a section view taken along lines **3**—**3** of FIGURE 2;

FIGURE 4 is a cross-sectional view of another embodiment of a splitter;

FIGURE 5 is a section view taken along lines **5**—**5** of FIGURE 4; and

FIGURE 6 is a section view taken along lines **6**—**6** of FIGURE 5.

Illustrated in FIGURES 1, 2 and 3 is a five-point splitter **10** which comprises body member **12** having therein inlet port **14** leading to the five exit ports **16**. The inlet port **14** is circular through its entire length while exit ports **16** are circular at the exit ends but taper to a rectangular opening **18** at the intersection with the inlet port **14**. In this embodiment, the width of the rectangular opening is the same as the diameter of the exit port **16**. The exit ports **16** and the rectangular openings **18** are coplanar; the plane being perpendicular to the axis of the inlet port **14**. The height of the rectangular opening **18** is less than the diameter of the circular exit port **16**. It is, of course, to be recognized that when this flow splitter is used for the distribution of molten polymers, the flow splitter **10** is suitably encased in a heated jacket.

In use, the molten polymer is brought to the inlet port **14**, flows to the center of body member **12** where it is split into five separate streams. The polymer leaves the inlet port area through the rectangular openings **18**. These rectangular openings **18** intersect one another in such a manner that there are no dead spots at the distribution point. Equal portions of the fast-moving inner-core material and slower-moving outer-material coming in inlet port **14** are distributed to each exit port **16**. With the flat bottom of the inlet port **14** and the rectangular openings **18**, the molten polymer sweeps clean as it moves to the exit port **16**. There are no recesses, crevices or dead zones where molten polymer can be held-up and either degrade or change characteristics due to a longer time at the elevated temperature.

In FIGURES 4, 5 and 6 another embodiment is illustrated. Similar to the five-point splitter **10**, the four-point splitter **20** consists of body member **22** with a circular inlet port **24** and four circular exit ports **26**. The exit ports **26** taper to rectangular openings **28**. In this embodiment, the height of the rectangular opening **28** is less than the diameter of the exit port **26** and the width of the rectangular openings **28** is larger than the diameter of the exit port **26**. While the taper of the five-point splitter **10** between the exit port **16** and the rectangular port **18** has a simple angle, the taper on the four-point splitter **20** has a compound angle. Either can be used with either embodiment, depending upon the design that is desired. The essential point is that there are no dead spots between the inlet port **24** and the openings **28**, and between adjacent openings.

Also shown in FIGURE 4, in dashed-outline form, is opening **30** into which can be placed a temperature or pressure probe. The only limitation on this probe is that it fits into opening **30** in such a manner that no dead spots develop.

These flow splitters can be used in any distribution system. For example, they could be advantageously utilized with a screw melter supplying molten polymer which would first go to a five-point splitter and then to five four-point splitters, thus distributing to 20 extrusion heads from a single source of supply. Another variation that might be used is to have a three- or four-point splitter after the source of polymer melt, each exit from the splitter leading to a plurality of distribution systems such as that shown by U.S. Patent 3,103,942, issued to Sharp, dated September 17, 1963.

While any known machining technique can be used, the preferred method of making these splitters is by the investment casting process.

Specific examples of the dimensions of the flow splitters of this invention can be given. These examples are intended to be merely illustrative of the invention but not in limitation thereof. The width of the rectangular opening represents the longer side and is parallel with the plane of the discharge ports. The first example is a five-point splitter with the inlet port having a diameter of .891 inch, the exit ports having diameters of .577 inch, the width of the rectangular opening being .577 inch, and the height of the rectangular opening being .180 inch. The total included angle of the taper from the exit port to the rectangular opening is 20°.

A second example is a four-point splitter with the diameter of the inlet port being .577 inch, the diameter of the exit port being .286 inch, the width of the rectangular opening being .500 inch and the height of the rectangular opening **18** being .080 inch.

A third example is a three-point splitter with the diameter of the inlet port being 2.24 inches, the diameter of the exit port being 1.94 inches, the width of the rectangular opening being 1.94 inches and the height of the rectangular opening being .84 inch.

Referring to the terminal portions of inlet ports **14** and **24** in FIGURES 1 and 4 respectively, it should be recognized that the configuration does not have to be flat. For example, the terminal portion could be in the shape of a pyramid or be conical or be some rosette-type of shape which would project above or below the plane of the flat bottom. The only requirement is that the terminal portion should be radially symmetrical with respect to the exit ports.

It is to be understood that the foregoing description is by way of example only and that various modifications and changes in the details may be made without departing from the spirit of the invention and the scope of the following claims.

What is claimed is:

1. An improved flow splitter apparatus for the distribution of a viscous liquid from a single inlet to a plurality of outlets which comprises a body member having a single inlet port therein, a plurality of equi-spaced, coplanar discharge ports substantially perpendicular to the axis of said single port and each having a circular exit portion and tapering to a rectangular cross-section in contact with said single inlet port.

2. An improved flow splitter apparatus for the distribution of a viscous liquid from a single inlet to a plurality of outlets which comprises a body member having a single inlet port therein, a plurality of equi-spaced, coplanar discharge ports substantially perpendicular to the axis of said single port and each having a circular exit portion and tapering to a rectangular cross-section in contact with said single inlet port, and the dimensions of said rectangular cross-section being such that the longer side, parallel with the plane of said discharge ports, is equal to or greater than the diameter of said circular exit portion and the shorter side is less than one-half the diameter of said circular exit portion.

3. The improved flow splitter apparatus of claim **2** wherein there are five equi-spaced, coplanar discharge ports.

4. The improved flow splitter apparatus of claim **3** wherein the longer side of said rectangular cross-section is equal to the diameter of said circular exit portion.

5. The improved flow splitter apparatus of claim **2** wherein there are four equi-spaced, coplanar discharge ports.

6. The improved flow splitter apparatus of claim **5** wherein the longer side of said rectangular cross-section is greater than the diameter of said circular exit portion.

7. The improved flow splitter apparatus of claim **2** wherein there are three equi-spaced, coplanar discharge ports.

8. The improved flow splitter apparatus of claim **7** wherein the longer side of said rectangular cross-section is equal to the diameter of said circular exit portion.

No references cited.

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