May 14, 1968 T. M. VEAZEY 3,382,534

PLATE TYPE FLUID MIXER

Filed Aug. 19, 1965 3 Sheets-Sheet 1

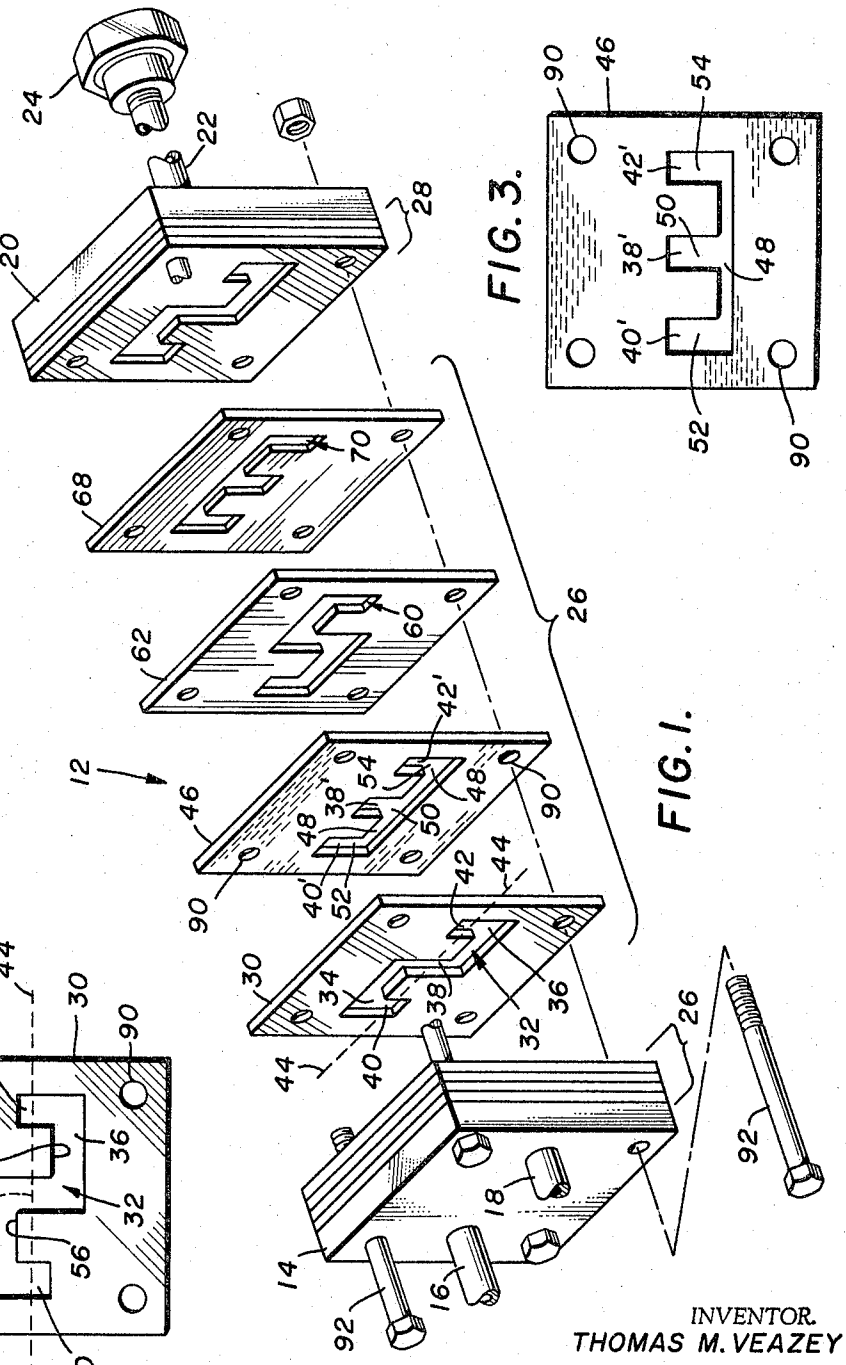


FIG. 1.

FIG. 3.

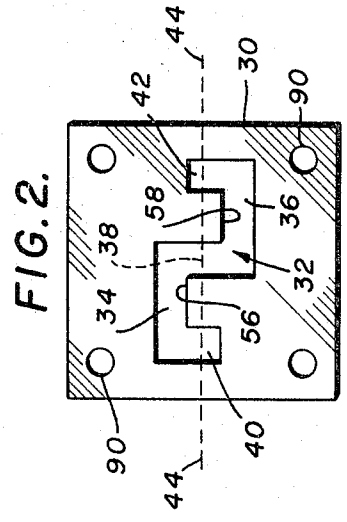


FIG. 2.

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PLATE TYPE FLUID MIXER

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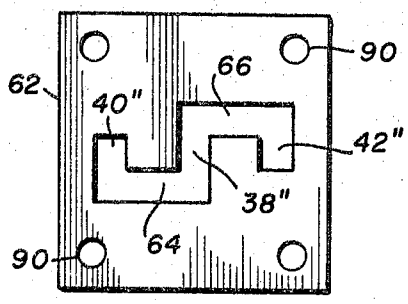


FIG. 4.

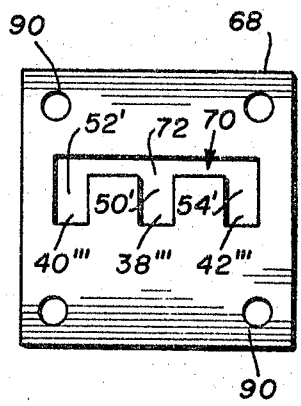


FIG. 5.

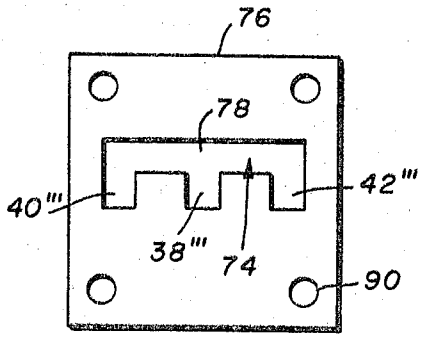


FIG. 6.

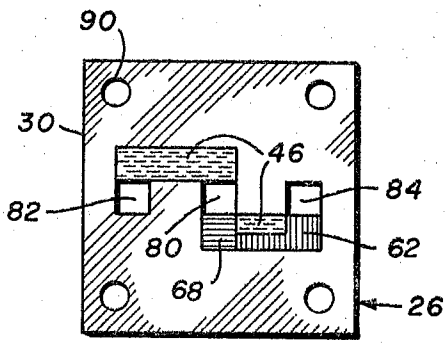


FIG. 7.

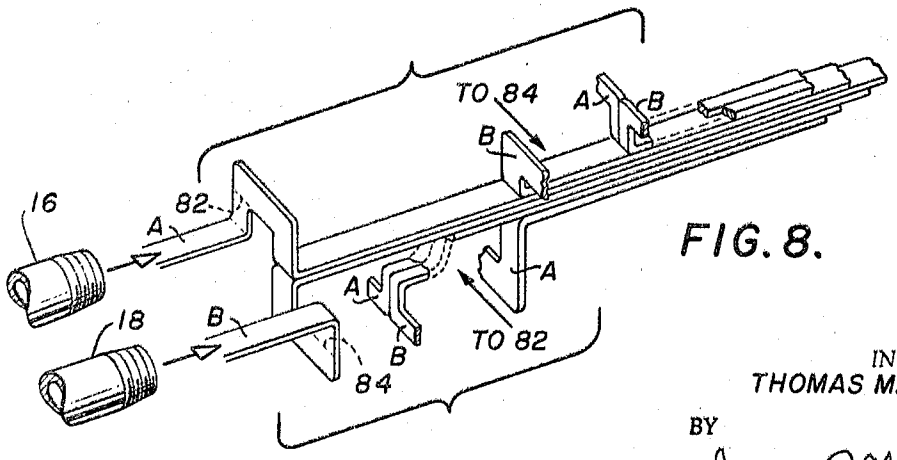


FIG. 8.

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PLATE TYPE FLUID MIXER

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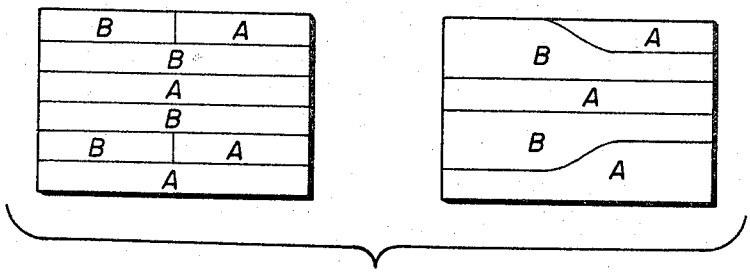


FIG. 9.

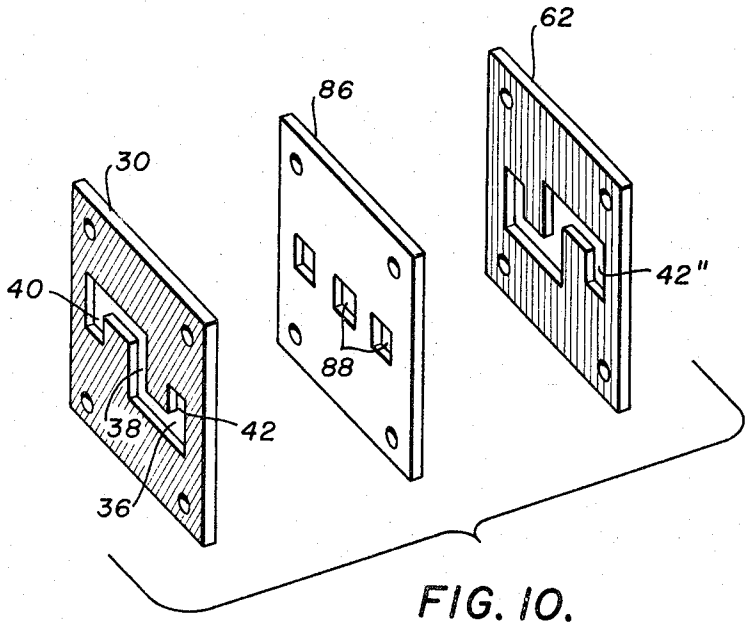


FIG. 10.

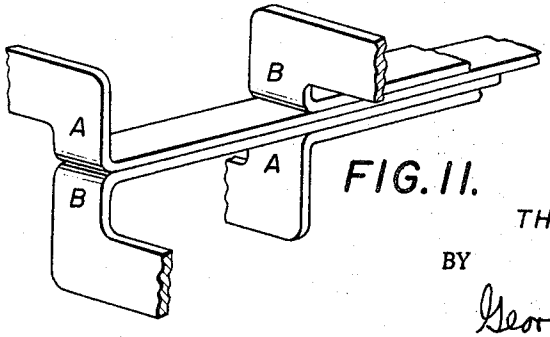


FIG. 11.

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United States Patent Office 3,382,534 Patented May 14, 1968

3,382,534

PLATE TYPE FLUID MIXER

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Filed Aug. 19, 1965, Ser. No. 480,890
11 Claims. (Cl. 18—8)

This invention relates to apparatus for mixing a plurality of fluids and more particularly relates to apparatus for mixing two spinning solutions to form bi-component filaments.

As the man-made textile fiber industry developed, it was soon found desirable to produce individual filaments formed from two or more polymeric components of different characteristics arranged in an adherent side-by-side relationship. For example, such filaments constructed of two polymers having different thermal shrinkage characteristics will, when exposed to heat, develop a spiral crimp similar to the natural crimp found in wool. Further, pleasing multicolor effects can be achieved in a single dye-bath upon dyeing of a composite filament in which the individual polymeric components have differing dye receptivity characteristics. Alternatively, one component can be left white while another is dyed or pigmented prior to spinning so that a multicolor effect is achieved even though the same polymeric composition is used in all segments of the composite filament.

For over twenty years the devices utilized for spinning of composite filaments have been exceedingly complex, difficult and expensive to construct, and limited to a relatively small number of spinning orifices. While the patent literature abounds with modifications and improvements on spinnerettes for the production of composite filaments, almost without exception all are based on the principle of forming, either inside or immediately adjacent to the spinning orifice, the composite fluid stream which is extruded in its entirety through either a single spinning orifice or at most a single row of orifices geometrically aligned with the interface of the composite stream.

The difficulties of the problem and the complexity of prior spinnerettes are illustrated in Patent 2,386,173, issued Oct. 2, 1945, to Kulp et al., which discloses a spinnerette for side-by-side conjugate filaments with septa behind the orifices, and in Patent 3,182,106, issued May 4, 1965, to Fujita et al. which discloses a spinnerette for forming separate laminar fluid streams and bringing them into contact with the interface aligned with a row of spinning orifices.

It has now been found that the careful alignment of the interface of the spinning fluids with the spinnerette orifices is unnecessary and that in fact such fluid streams may be dispersed in laminar relationship to each other at one location and transported over appreciable distance through conduits of varying geometry without losing the essentially laminar relationship of the discrete fluids. Thus, in the present invention, a plurality of spinning fluids which may be either solutions or melts and are derived from polymers which have different shrinkage or other characteristics are mixed to form a single stream comprised of alternating layers of the individual fluids. This laminar fluid stream is then conducted to a conventional spinnerette either immediately adjacent or remote from the mixing device.

It has been found that with fluids of normal spinning viscosity, the lines of demarcation between adjacent layers are well defined and remain well defined even when the mixed fluid is, for example, changed from a square cross-section exiting the mixing device to a round cross-section within a conduit of ¾" internal diameter, conducted for a distance of four feet including two right angle bends within the conduit, and finally expanded to a circular

cross-section of four inches within a spinnerette holder immediately prior to extrusion through a conventional spinnerette. Where one of these lines of demarcation intersects an orifice in the spinnerette, a composite filament is formed. In actual practice it has been found that tows comprised of 80–90 percent composite filaments may be spun easily and consistently from conventional spinnerettes even when the spinnerette contains over 25,000 individual spinning orifices.

The apparatus for accomplishing the layered stream includes a stack or series of plates, the total number of which depends upon the number of layers desired, each plate having a single aperture of particular configuration pierced through its central area. A first plate has an aperture of square cut S-configuration positioned so that the center of the cross arm of the S lies in the central portion of the plate and the two extremities of the S are aligned with apertures in an inlet plate connected to at least two sources of spinning fluid. The second plate has an aperture of square cut E-configuration while the third plate is a mirror image of the first plate and the fourth plate is a mirror image of the second plate. When assembled into a stack and secured together with their broad surfaces in contiguous parallel relationship, two continuous passageways are formed through this thickness of the stack of plates at the outer extremities of the apertures therethrough, and a central continuous passageway is formed by the central arms of the S and E and their mirror images which communicates with an outlet connected to a conventional spinnerette. Thus, the fluids in the outer passageway are mixed into a multi-layer fluid in the central passageway by lateral flow through the non-aligned cut-out portions of the plates.

The apparatus depends for its operation upon the topological relationship of the assembled stack of plates. Exact dimensions are not critical and the individual plates may be formed easily and quickly by a simple stamping or punching operation from thin sheet material inert to the fluid under the conditions of mixing. For the mixing of acrylic spinning dopes, 14 gage to 26 gage thickness plates of aluminum or stainless steel are preferred.

It is not necessary to combine an unreasonable number of plates to obtain a major proportion of composite filaments with a conventional spinnerette even when the spinnerette contains a very large number of holes. With the mixing device of this invention, a minimum of seven plates (four layers of each fluid) is found necessary in practice to provide 80 percent composite filaments when spinning a conventional spinnerette of 300 orifices. On the other hand, a maximum of 99 plates (50 layers of each fluid) is sufficient to provide more than 85 percent composite filaments with a conventional spinnerette of 26,664 orifices.

Accordingly, it is an object of this invention to provide apparatus for mixing two fluids.

Another object of this invention is to provide apparatus for producing a single spinning stream composed of a plurality of layers of spinning fluids having dissimilar characteristics to be extruded through a conventional spinnerette.

Still another object of this invention is to provide a fluid mixer made up of a plurality of laminations having openings therethrough at least a portion of which are aligned into passageways.

Still another object of this invention is to provide apparatus for combining two dissimilar fluids comprising alternating plates having openings therein a portion of which are aligned to form continuous passageways and a portion of which are non-aligned to form lateral channels for transporting the spinning solution into a central passageway.

A further object of this invention is to provide apparatus for combining two spinning fluids into a multi-layered spinning fluid in such a manner that composite filaments are formed when the layered solution is forced through a conventional spinnerette.

These and other objects and advantages of this invention will be more apparent upon reference to the following specification, appended claims, and drawing wherein:

FIGURE 1 is an exploded perspective view of the solution mixer according to the instant invention with the various plates color coded to distinguish therebetween and showing the configuration of the various plates, their interrelationship and relationship with an inlet plate leading to a plurality of spinning fluid sources, and an exit plate leading to a spinnerette;

FIGURE 2 is a view showing the face of the "brown" plate having an aperture therein which assumes a squared Z-shape as the plate is rotated clockwise about an axis perpendicular to its broad face;

FIGURE 3 is a view similar to FIGURE 2 but showing the "gray" plate having an aperture which assumes the shape of an E when rotated in the aforedescribed manner;

FIGURE 4 is a view similar to FIGURE 2 but showing an aperture which when rotated in a clockwise direction assumes the shape of a squared S;

FIGURE 5 is a view similar to FIGURE 3 but showing an aperture which when rotated in a clockwise direction assumes the shape of a squared numeral 3;

FIGURE 6 is a view similar to FIGURE 5 but showing an embodiment of the invention in which the aperture is larger in area;

FIGURE 7 is a front elevation of the plates shown in FIGURES 2 through 5 assembled in the relationship shown in FIGURE 1 and viewed from the inlet plate toward the exit plate;

FIGURE 8 is a diagrammatic view of the flow pattern produced by the plates shown in figures through 5 when assembled in the relationship shown in FIGURES 1 and 7;

FIGURE 9 is a cross sectional view of the diagrammatic flow pattern of FIGURE 8 compared to the actual distribution of spinning fluid produced by the apparatus of FIGURE 1;

FIGURE 10 is a view similar to FIGURE 1 but illustrating an arrangement in which three plates are utilized to produce layered multi-component spinning fluid; and

FIGURE 11 shows diagrammatically the flow pattern produced by the combination of mixer plates shown in FIGURE 10.

In order to better understand the construction and use of this novel apparatus, it will be described in relation to the production of filaments formed from a plurality of spinning fluids. It is to be understood, however, that various other uses may be found for this novel device such as the dyeing of a solution or the combining of various substances such as metallic particles, thermoplastic particles, and other natural or man-made substances with a fluid. Other uses will be readily apparent to those skilled in the art.

With continued reference to the accompanying figures wherein like numerals designate similar parts throughout the various views, and with initial attention directed to FIGURE 1, reference numeral **12** designates generally a plate mixer for combining a plurality of spinning fluids having different characteristics into a single stream of stacked alternating layers of the fluids. An inlet plate **14** is constructed with a pair of apertures to receive two spinning fluids from sources (not shown) through tubes **16** and **18**. The outlet plate **20** contains an outlet aperture which receives the single stream of spinning fluid produced by the mixer **12** and directs them into a tube **22** connected to a spinnerette **24**. The plates are grouped in sets **26** of four with the exception of the set **28** closet to the outlet plate **22** which is comprised of a set of three. While the four-three arrangement described above is preferred, it is obvious that other arrangements of plates can be utilized to achieve the desired result.

As best shown in FIGURE 2 the first plate **30** in each set of four, color coded brown, contains an aperture **32** which when rotated in a clockwise direction from the position shown will form a squared Z. This figure is formed by a pair of parallel, spaced, elongated slots **34** and **36** overlapping at the center of the plate **30** and extending outwardly in opposite directions. The central portion of the Z is formed by a square aperture or opening **38** whose width is equal to that of the slots **34** and **36** and interconnects the two at their central extremity. At the outer extremity of he slot **34**, another square aperture or opening **40** is connected thereto and depends downwardly therefrom. Similarly, at the outer extremity of slot **36** a square aperture or opening **42** is connected thereto and extends upwardly therefrom.

As illustrated in FIGURE 2 the square openings **38**, **40**, and **42** are equal in size and are evenly spaced on the surface of the plate **30**. A line **44** drawn through the centers of each of the squares extends parallel to the slots **34** and **36** and divides the plate **30** into two sections. When the plate **30** is oriented in the manner shown in FIGURE 2, the slot **34** lies in the upper section while the slot **36** lies in the lower section.

The second plate **46**, color coded gray, of set **26** is illustrated in FIGURE 3 and, like plate **30**, contains a centrally located square aperture or opening **38'** and two outwardly located square apertures or openings **40'** and **42'**. Again, like plate **30** a line joining the centers of these apertures will divide the plate **46** into upper and lower sections. A slot **48** lying in the lower section extends across the plate **46** with outer extremities terminating opposite the square apertures **40'** and **42'**. The width of slot **48** is approximately one-half the width of the squares **38'**, **40'**, and **42'** for a purpose to be hereinafter set forth. A connecting neck slot **50** provides communication between the square **38'** and slot **48** and, likewise, connecting necks **52** and **54** communicate between the slot and squares **40'** and **42'** respectively.

In describing the configuration of the various apertures in the plates of set **26**, the terms square aperture and slots have been used for clarity. It is obvious, however, that to meet the literal meaning of these expressions imaginary lines must be extended to enclose the geometrical shapes described. For example, in FIGURE 2 a line extended outwardly from the border **56** defining the lowermost extent of slot **34** would complete the formation of square **40** and partially complete the square **38**. Likewise, lines extended outwardly from the border **58** defining the uppermost extent of slot **36** would complete the enclosure of both squares **38** and **42**. In the embodiment of FIGURE 3 squares **38'**, **40'**, and **42'** would be completed by drawing a line across the top of necks **50**, **52**, and **54** at a distance from their tops equal to their width. This use of imaginary constructing lines also applies to the description of the plates illustrated in FIGURES 4, 5, and 6.

The aperture **60** in the third plate **62**, color coded red, of the set **26** is a mirror image of the aforedescribed first plate. In other words, as shown in FIGURE 4, apertures **38''**, **40''**, and **42''** are identical to the square apertures **38**, **40**, and **42** of FIGURE 2, but slot **64** joining aperture **40''** with aperture **38''** is located in the lower section of plate **62** and slot **66** joining apertures **42''** and **38''** is located in the upper section of plate **62** contrary to the arrangement shown in FIGURE 2. Again, the plate **62** is divided into upper and lower sections by a common line joining the centers of squares **40''**, **38''**, and **42''**.

As shown in FIGURE 5 the fourth plate **68**, color coded blue, of set **26** contains an aperture **70** which is a mirror image of that in plate **46**. The slot **72** lies in the upper section of plate **68** and is connected to each of the square openings **48'''**, **40'''**, and **42'''** by necks **50'**, **52'**, and **54'**.

In the embodiment of the invention illustrated in FIGURE 6, an aperture **74** extending through plate **76** includes

a slot 78 similar to slot 72 in plate 68. The need for communicating necks 50', 52', and 54' is eliminated, however, inasmuch as the slot 78 is twice as wide as the slot 72 and communicates directly with the square openings 38''', 40''', and 42'''.

When assembled into a set 26 the plates 30, 46, 62, and 68 appear as shown in FIGURE 7 when viewed perpendicularly to the plate faces. As clearly shown in FIGURE 7, the interrelationship of the various apertures in these plates create a central passageway 80 and two outer passageways 82 and 94 from end to end through the laminate set 26. Obviously, the outer passageways are created by aligning each of the square apertures 40, 40', 40'', 40''' and 42, 42', 42'', and 42'''. The central passageway 80 is created by alignment of square apertures 38, 38', 38'', and 38'''. It is further seen from an inspection of FIGURES 1 and 7 that slots 34 and 36 provide full width channels extending from passageways 82 and 84 respectively and oppositely exiting into the central passageway 80. Slot 48 in the second plate 46 provides in conjunction with communicating neck 52 a channel from passageway 82 and in conjunction with communicating neck 54 a channel from passageway 84, both channels co-incidentally exiting through communicating neck 50 into passageway 80. Similar to plate 30, slot 64 provides a full width channel from passageway 82 to passageway 80, and slot 66 provides a full width channel from passageway 84 to the central passageway 80. Unlike the arrangement of plate 30, however, slot 64 from passageway 82 exits into the bottom of passageway 80 while slot 66 from passageway 84 exits into the top of passageway 80. This reversal is carried forward in plate 68 which, as opposed to plate 46, contains a slot 72 providing a channel from passageways 82 and 84 coincidentally exiting through communicating neck 50' into the top rather than the bottom of the passageway 80.

The flow of spinning fluids through the various channels and passageways is illustrated diagrammatically in FIGURE 8. The stream A is indicated as flowing through passageway 82 while stream B is indicated as flowing through passageway 84. As shown, stream A flows through the channel created by slot 34 into the top of passageway 80 while stream B flows through the channel created by slot 36 into the bottom of passageway 80. Thus, a stream having an A and B layer is created. Plate 46 introduces a single stream containing a one-half width stream A and a one-half width stream B into the bottom of passageway 80. The third plate 62 introduces stream B through the channel created by slot 66 into the top of passageway 80 while stream A exits into the bottom of passageway 80 through the channel created by slot 64. The fourth plate 68 reverses the procedure of plate 46 by introducing a single stream composed of one-half width stream A and one-half width stream B into the top of passageway 80. Thus, as shown in FIGURE 9, the set 26 of plates formed into a laminate creates a single stream having alternating layers composed of the plurality of streams introduced to it.

For the sake of clarity the single stream composed of one-half fluid A and one-half fluid B as introduced through slots 48 and 72 in plates 46 and 68 respectively, is shown separately from wide width streams B and A in FIGURE 9. Actually, however, the half-width stream B introduced through slot 48 in plate 46 is combined with the full width stream B introduced through slot 36 in plate 30, and the half width stream A introduced through slot 48 in plate 46 is combined with the full width stream A introduced through slot 64 in plate 62 and at the bottom of neck slot 50 with full width stream B introduced through slot 36 in plate 30. Similarly, the half-width stream B introduced through slot 72 in plate 68 is combined with the full width stream B introduced through slot 66 in plate 62 and the half-width stream A introduced through slot 72 is combined at the bottom of neck slot 50' with the same full-width stream B. Thus two laterally bowing multi-component streams are combined to produce a double thickness at one edge of the full width streams creating a main stream having wedge shaped layers as shown in FIGURE 9. Obviously an advantage is realized by this stream shape over merely alternating flat streams in that a longer line of demarcation between layers is created and thus, an increase in the chance that a spinnerette orifice will intercept such a line and create a bi-component filament is realized.

In order to understand how the combination of full and half width streams takes place, attention is again directed to FIGURES 1 and 7. There it is seen that full width slot 36 is aligned with half-width slot 48 from passageway 84 to passageway 80, while half-width slot 48 is aligned with full width slot 64 from passageway 82 to passageway 80. Similarly, half-width slot 72 is aligned with full width slot 66 from passageway 84 to passageway 80. Furthermore, half-width slots 48 and 72 empty into neck slots 50 and 50' which are aligned with a portion of full-width slots 36 and 66 respectively.

The same effect is created when full width slots as illustrated in FIGURE 6 are substituted for half-width slots 72 and 48 in plates 68 and 46 respectively due to the fact that solution streams A and B are under the same pressure and will impress themselves or one another with equal force. Less congestion at the point of entry into passageway 80 is created when half-width slots are utilized however, due to the fact that only a half as much solution is directed to that point and the fact that the spinning fluid must travel down into the channel formed by slots 48 and 72 and then turn around a corner and up or down into the passageway 80. During the travel up or down the fluid turbulence caused by moving around a corner is dissipated resulting in a smooth flow.

From an inspection of FIGURE 1 it is obvious that the invention contemplates the use of a plurality of plates. As described above the plates are arranged in sets of 4 to produce the flow pattern illustrated in FIGURES 8 and 9. The number of plates can, however, be varied to obtain a desired pattern. Preferably, though, at least one set 26 of plates are utilized in the mixer plus a terminating set of three plates 28 in which the first aperture after the inlet plate has the shape shown in FIGURE 2 and the last aperture before the outlet plate 20 has the shape illustrated in FIGURE 4. By this arrangement, a single stream is created in which the uppermost layer and lowermost layer are full width.

An alternate embodiment is illustrated in FIGURE 10. Rather than sets of four plates, the sets of three plates utilized contain the first 30 and third 62 plates of set 26 as illustrated in FIGURES 1, 2, and 4 separately by a second plate 86. Three square apertures 88 extend through the plate 86 and correspond to, and are in alignment with the squared apertures 42–42'', 38–38'', and 40–40'', in plates 30 and 62. Thus, as in the embodiment illustrated in FIGURE 1, passageways corresponding to passageways 80, 82, and 84 as shown in FIGURE 7 will be formed and a flow pattern, as illustrated in FIGURE 11, containing alternating layers of A and B spinning solutions will be produced.

In both embodiments inlet tubes 16 and 18 communicate through inlet plate 14 with passageways 82 and 84. At outlet plate 20, the tube 22 communicates with passageway 80 and directs the spinning fluid to the spinnerette 24. Thus, a plurality of spinning fluids entering through the tubes 16 and 18 are combined into a single stream exiting through tube 22 and composed of stacked alternating layers of fluid having lines of demarcation therebetween which, when intercepted by a spinnerette orifice, results in a conjugate filament.

Clear lines of demarcation are maintained between the various layers due to their high viscosity and, hence, aversion towards any significant degree of intermixing. Furthermore, the fluids exist as contiguous layers only a short period of time before being extruded through a spin-

nerette 24 as conjugate filaments. After extrusion, the solvent is immediately removed in a coagulating bath if wet spun, or by evaporation of dry spun, removing all tendency of the diverse solutions to mix.

The plate mixer is assembled by stacking the various plates in the correct order between the inlet plate 14 and the outlet plate 20. Appropriate holes 90 are provided in each of the plates for receiving fastening means such as threaded bolts 92 extending from end to end through the laminate formed by placing the various plates in face to face contiguous relationship. When tightly in place, the bolts 92 cause the assembly to form a sturdy, leak-free unit. Alternate holding means, such as external clamps, may of course be used in place of the bolts.

It is apparent that by utilizing the teaching of this invention a novel plate mixing device which is simple, efficient, and inexpensive may be produced. The mode of construction results in less back pressure than any plate mixture heretofore utilized and requires one-third to one-half fewer plates. Due to the unique arrangement of channels within the mixer, it, in one embodiment, produces stacked layers having relatively long lines of demarcation therebetween.

The invention may be embodied in other specific forms without departing from the spirit of essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims is therefore intended to be embraced therein.

I claim:

1. Apparatus for combining a plurality of spinning fluids into a single, multi-component stream to be spun into conjugate filaments comprising:
- (a) a plurality of plates joined together in face to face relationship forming a laminate;
- (b) a single, shaped aperture through each of said plates;
- (c) the apertures in every other of said plates being mirror images of one another;
- (d) the apertures in contiguous plates having different shapes;
- (e) said apertures in combination defining a plurality of angularly related passageways through said laminate whereby a plurality of spinning fluids introduced into said passageways will emerge as a single stream having stacked, alternating layers of said plural fluids.

2. Apparatus for combining a plurality of spinning fluids into a single, multi-component stream to be spun into conjugate filaments comprising:
- (a) at least four plates joined together in face to face relationship forming a laminate;
- (b) a single, shaped aperture through each of said plates with
  - (1) the apertures in contiguous pairs of plates having different shapes, and
  - (2) the apertures in every other plate being mirror images of one another;
- (c) said apertures in combination defining a plurality of angularly related passageways through said laminate whereby a plurality of fluid spinning fluids introduced into said passageways will emerge as a single, fluid stream having stacked, alternating layers of said plural fluids.

3. Apparatus for combining a plurality of spinning fluids into a single, multi-component stream to be spun into conjugate filaments comprising:
- (a) a laminate comprised of at least four plates joined in face to face relationship;
- (b) a single, shaped aperture through each of said plates;
- (c) said aperture in at least one of said plates including
  - (1) three spaced openings the centers of which lie on a common line on the surface of said plate with one of said openings disposed between the other two,
  - (2) a first slot through said plate connecting said one of said openings with another of said openings and lying to one side of said common line, and
  - (3) a second slot through said plate connecting said one of said openings to the remaining said opening and lying to the other side of said common line;
- (d) said aperture in at least another of said plates including
  - (1) three openings the centers of which lie on a common line on the surface of said plate with one of said openings disposed between the other two, and
  - (2) a slot lying to one side of said common line and connecting all three of said openings;
- (e) at least one of the remaining plates being a mirror image of said one of said plates and at least one other of the remaining plates being a mirror image of said another of said plates;
- (f) said apertures in combination defining a plurality of angularly related passageways through said laminate; and
- (g) means for separately introducing a plurality of spinning fluids into said passageways whereby said plurality of fluids will emerge as stacked, alternating layers of a single fluid stream.

4. Apparatus for combining a plurality of spinning fluids into a single, multi-component stream to be spun into conjugate filaments comprising:
- (a) a laminate composed of at least one set of four plates joined in face to face relationship;
- (b) a single, shaped aperture through each of said plates including
  - (1) three spaced symmetrical openings having their centers connected by a common line with
  - (2) two of said openings disposed outwardly off and on opposite sides of a central opening;
- (c) said openings in said plates being aligned with the openings in each of the other plates to form three, spaced, parallel, continuous passageways from end to end through said laminate, two being outer passageways and one being a central passageway;
- (d) means at one end of said laminate for separately supplying a spinning fluid to each of said outer passageways;
- (e) said aperture in the first of said plates at said one end of said laminate also including
  - (1) a first slot through said plate connecting one of said outer openings to said central opening and positioned on a first side of said common line,
  - (2) a second slot through said plate connecting the other of said outer openings to said central opening and positioned on the other side of said common line,
  - (3) said slots defining channels oppositely exiting into said central passageway whereby a portion of each of said fluids is carried to opposed segments of said central pasageway;
- (f) said aperture in the second of said plates also including
  - (1) a slot through said plate connecting all three of said openings and positioned on one side of said common line,
  - (2) said slot defining a channel from said outer passageways exiting into said central passageway whereby a portion of each of said fluids will

be directed coincidentally into said central passageway

(g) said slot in said second plate and one of said slots in said first plate being in alignment;

(h) said aperture in the third of said plates from said end of said laminate also including

(1) first and second slots connecting the outer openings to the central opening and positioned relative to said common line to be a mirror image of said first and second slots in said first plate,

(2) one of said slots being aligned with said slot in said second plate,

(3) said slots defining channels oppositely exiting into said central passageway defined by said central openings whereby a portion of each of said fluids is carried to opposed segments of said central passageway;

(i) said aperture in the fourth of said plates from said end of said laminate also including

(1) a slot through said plate connecting all three of said openings and positioned to be a mirror image relative to said common line of said slot through said second plate,

(2) said slot defining a channel from said outer passagways exiting into said central passageway whereby a portion of each of said fluids will be coincidentally directed into said central passageway;

(j) said slot in said fourth plate and one of said first and second slots in said third plate being in alignment; and

(k) said apertures in combination defining a plurality of angularly related passageways and channels in said laminate whereby a plurality of fluid spinning fluids introduced into said outer passageways will emerge as a single fluid stream having stacked, alternating layers of said plural fluids.

5. Apparatus for combining a plurality of spinning fluids into a single, multi-component stream to be spun into conjugate filaments comprising:

(a) a laminate composed of at least one set of four plates joined in face to face relationship;

(b) a single, shaped aperture through each of said plates including

(1) three spaced, symmetrical square openings having their centers positioned along a common line with

(2) two of said openings disposed outwardly off and on opposite sides of a central opening,

(3) said common line dividing each of said plates into first and second sections;

(c) said openings in said plates being aligned with the openings in each of the other plates to form three spaced, parallel, square, continuous passageways from end to end through said laminate, two being outer passageways and one being a central passageway;

(d) means at one end of said laminate for separately supplying a spinning fluid to each of said outer passageways,

(e) said aperture in the first of said plates at said one end of said laminate also including

(1) a first slot through said plate connecting one of said outer openings to said central opening and positioned in said first section of said plate,

(2) a second slot through said plate connecting the other of said outer openings to said central opening and positioned in said second section of said plate,

(3) said first slot defining a channel exiting into said central passageway in that segment of said central opening in said first plate lying in said first section, and

(4) said second slot defining a channel exiting into said central passageway in that segment of said central opening lying in said second section whereby a portion of each of said fluids is carried into opposed segments of said central passageway;

(f) said aperture in the second of said plates also including

(1) a slot through said plate positioned in said second section of said plate and connecting all three of said openings at those segments of said openings lying in said second section,

(2) said slot defining a channel from said outer passageways exiting into said central passageway in that segment of said central opening of said second plate lying in said second section of said second plate;

(g) said slot in said second plate and said second slot in said first plate being in alignment;

(h) said aperture in the third of said plates from said end of said laminate also including

(1) a first slot through said plate connecting said outer opening aligned with said one of said outer openings in said first plate to said central opening and positioned in said second section of said third plate,

(2) said first slot being aligned with said slot in in said second plate,

(3) a second slot through said plate connecting said outer opening aligned with said other of said outer openings in said first plate and positioned in said first section of said third plate,

(4) said first slot defining a channel exiting into said central passageway in that segment of said central opening in said third plate lying in said second section, and

(5) said second slot defining a channel exiting into said central passageway in that segment of said central opening lying in said first section whereby a portion of each of said fluids is carried into opposed segments of said central passageway;

(i) said aperture in the fourth of said plates from said end of said laminate also including

(1) a slot through said plate positioned in said first section of said plate and connecting all three of said openings at those segments of said openings lying in said first section of said fourth plate,

(2) said slot defining a channel from said outer passageways exiting into said central passageway in that segment of said central opening of said fourth plate lying in said first section of said fourth plate;

(j) said slot in said fourth plate and said second slot in said third plate being in alignment;

(k) said apertures in combination defining a plurality of angularly related passageways and channels in said laminate whereby a plurality of fluid spinning fluids introduced into said passageways will emerge as a single fluid stream having stacked, alternating layers of said plural fluids with clear lines of demarcation therebetween.

6. Apparatus according to claim 5 including means at the other end of said laminate communicating with said central passageway for directing said single fluid stream to a spinnerette having a plurality of openings therein whereby said multi-component stream is converted to a plurality of multi-component filaments.

7. Apparatus according to claim 5 wherein said laminate includes a plurality of said sets of four plates.

8. Apparatus for combining a plurality of spinning fluids into a single, multi-component stream to be spun into conjugate filaments comprising:

(a) a laminate composed of at least one set of three plates joined in face to face relationship;

(b) apertures through each of said plates including
(1) three, spaced, symmetrical openings having their centers connected by a common line with
(2) two of said openings disposed outwardly off and on opposite sides of a central opening;
(c) said openings in said plates being aligned with the openings in each of the other plates to form three, spaced, parallel, continuous passageways from end to end through said laminate, two being outer passageways and one being a central passageway;
(d) means at one end of said laminate for separately supplying a spinning fluid to each of said outer passageways;
(e) said aperture in the first of said plates at said one end of said laminate also including
(1) a first slot through said plate connecting one of said outer openings to said central opening and positioned on a first side of said common line,
(2) a second slot through said plate connecting the other of said outer openings to said central opening and positioned on the other side of said common line,
(3) said slots defining channels oppositely exiting into said central passageway whereby a portion of each of said fluids is carried to opposite segments of said central passageway;
(f) said aperture in the third of said plates from said end of said laminate also including
(1) first and second slots connecting the outer openings to the central opening and positioned relative to said common line to be a mirror image of said first and said second slots in said first plate,
(2) said slots defining channels oppositely exiting into said central passageway defined by said central openings whereby a portion of each of said fluids is carried to opposed segments of said central passageway; and
(g) said apertures in combination defining a plurality of angularly related passageways and channels in said laminate whereby a plurality of spinning fluids introduced into said passageways will emerge as a single fluid stream having stacked, alternating layers of said plural fluids.

9. Apparatus for combining a plurality of spinning fluids into a single multi-component stream to be spun into conjugate filaments comprising:
(a) a laminate composed of at least one set of three plates joined in face to face relationship;
(b) apertures through each of said plates including
(1) three, spaced symmetrical, square openings having their centers positioned along a common line with
(2) two of said openings disposed outwardly off and on opposite sides of a central opening,
(3) said common line dividing each of said plates into first and second sections;
(c) said openings in said plates being aligned with the openings in each of the other plates to form three, spaced, parallel, square continuous passageways from end to end through said laminate, two being outer passageways and one being a central passageway;
(d) means at one end of said laminate for separately supplying a spinning fluid to each of said outer passageways;

(e) said aperture in the first of said plates at said one end of said laminate also including
(1) a first slot through said plate connecting one of said outer openings to said central opening and positioned in said first section of said plate,
(2) a second slot through said plate connecting the other of said outer openings to said central opening and positioned in said second section of said plate,
(3) said first slot defining a channel exiting into said central passageway in that segment of said central opening in said first plate lying in said first section, and
(4) said second slot defining a channel exiting into said central passageway in that segment of said central opening lying in said second section whereby a portion of each of said fluids is carried into opposed segments of said central passageway;
(f) said aperture in the third of said plates from said end of said laminate also including
(1) a first slot through said plate connecting said outer opening aligned with said one opening in said first plate to said central opening and positioned in said second section of said third plate,
(2) a second slot through said plate connecting said outer opening aligned with said other opening in said first plate to said central opening and positioned in said first section of said third plate,
(3) said first slot in said third plate defining a channel exiting into said central passageway in that segment of said central opening in said third plate lying in said second section, and
(4) said second slot in said third plate defining a channel exiting into said central passageway in that segment of said central opening lying in said first section whereby a portion of each of said fluids is carried into opposed segments of said central passageway;
(g) said apertures in combination defining a plurality of angularly related passageways and channels in said laminate whereby a plurality of fluid spinning fluids introduced into said passageway will emerge as a single, fluid stream having stacked, alternating layers of said plural fluids with clear lines of demarcation therebetween.

10. Apparatus according to claim **9** including means at the other end of said laminate communicating with said central passageway for directing said single fluid stream to a spinnerette having a plurality of openings therein whereby said multi-component stream is converted to a plurality of multi-component filaments.

11. Apparatus according to claim **9** wherein said laminate is composed of a plurality of said sets of three plates.

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