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(54) MULTI-PORTION MIXING ELEMENT

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Publication Classification

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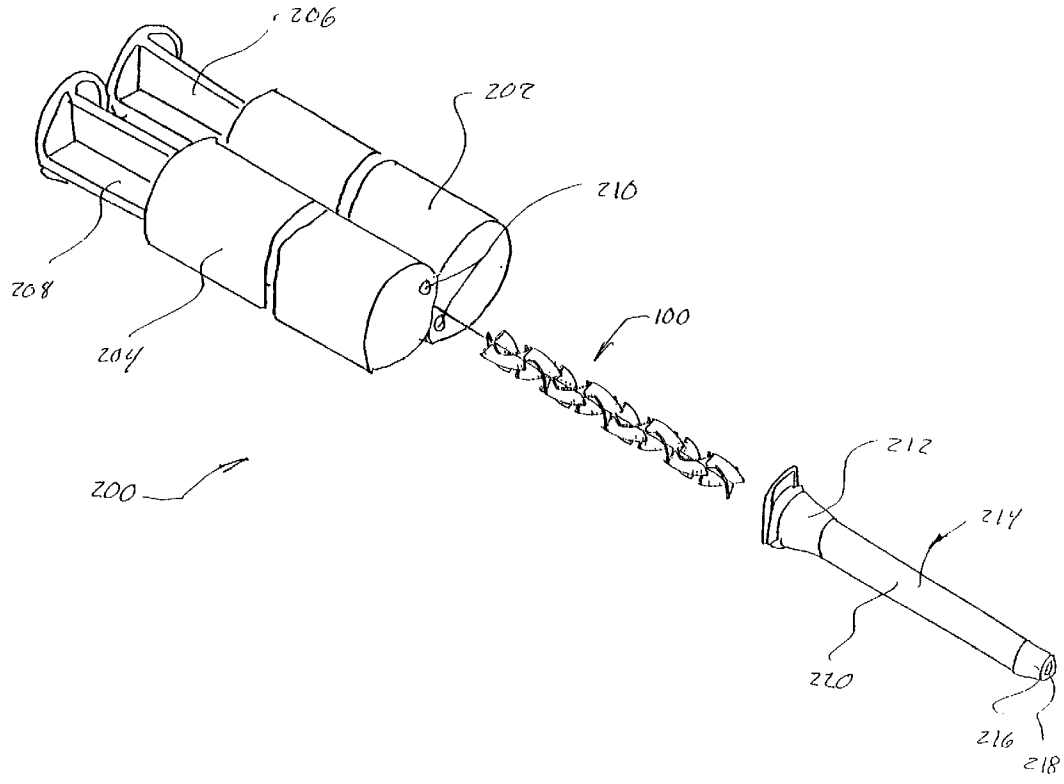
(52) **U.S. Cl.** **222/137**

(57) **ABSTRACT**

A device for mixing and dispensing at least two separate components, comprising: at least two containers for separately containing one component of the at least two separate components to be mixed, each container of the at least two containers having an opening; a nozzle assembly having an inlet portion communicating with each opening of each container, the nozzle assembly defining a mixing chamber communicating with the inlet portion, and a discharge outlet communicating with the mixing chamber; a mixing element disposed in the mixing chamber, the mixing element having a shank defining a longitudinal axis thereof, the mixing element having a plurality of mixing portions along the longitudinal axis of the shank, each mixing portion of the plurality of mixing portions being separated by a space, each mixing portion having at least two extensions, each extension extending radially outwardly from the shank and extending along a length of each mixing portion in spiral form relative to the longitudinal axis, the at least two extensions of one mixing portion varying in angular position from the at least two extensions of mixing portions contiguous to the one mixing portion relative to said longitudinal axis; and a discharging device for discharging the at least two separate components from the at least two containers into the nozzle assembly.



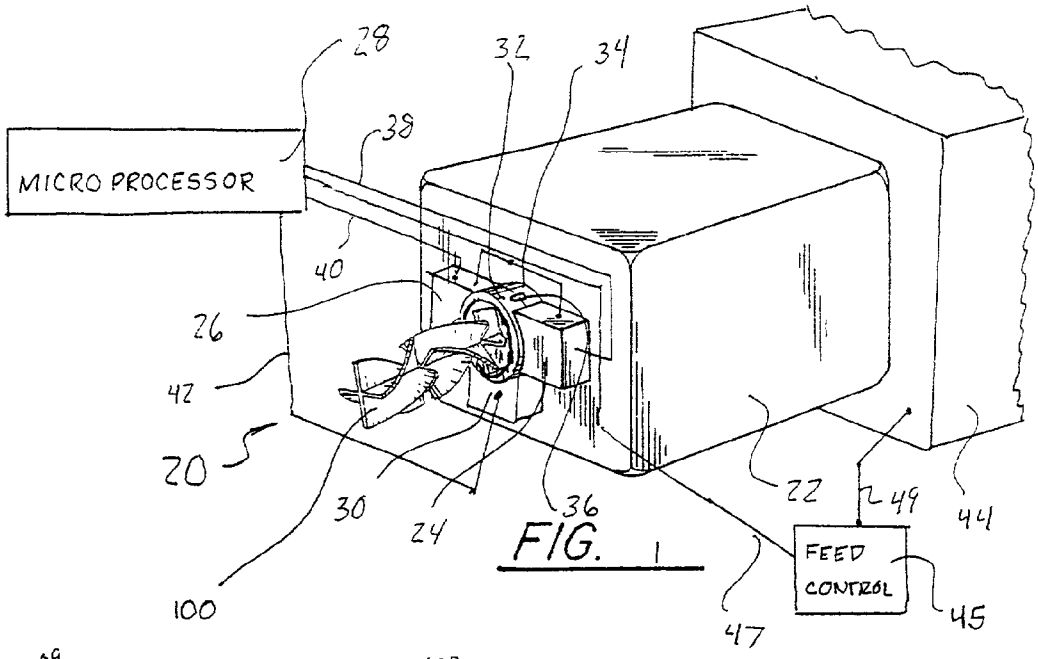


FIG. 1

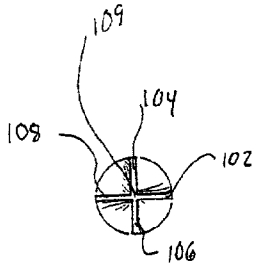


FIG. 3

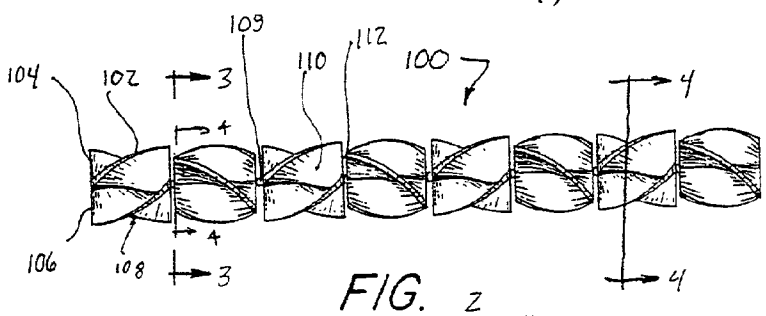


FIG. 2

FIG. 4

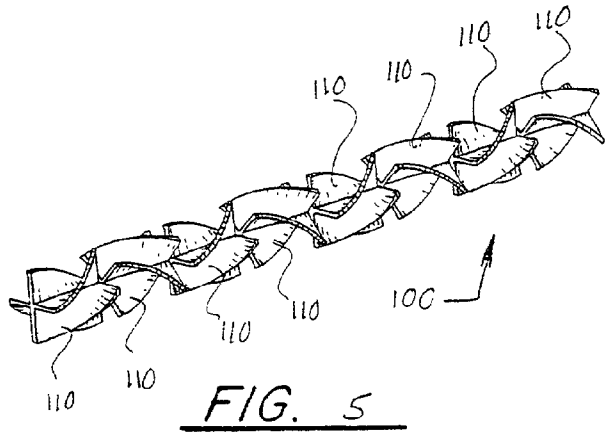


FIG. 5

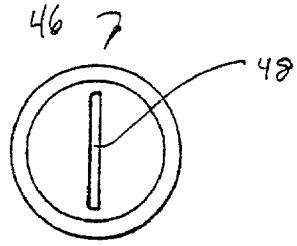


FIG. 6

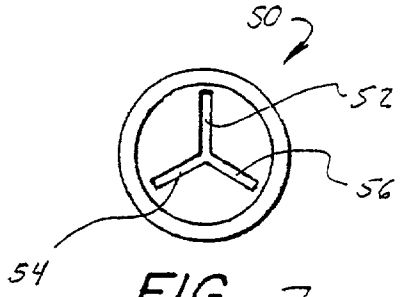


FIG. 7

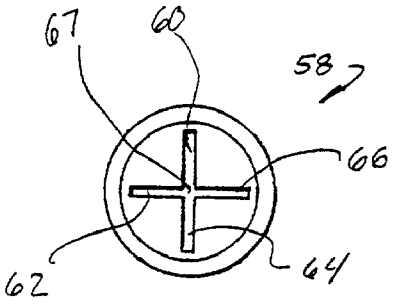


FIG. 8

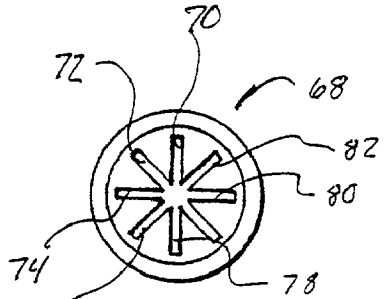


FIG. 9

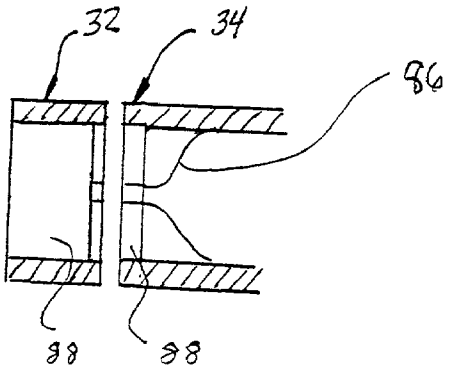


FIG. 10

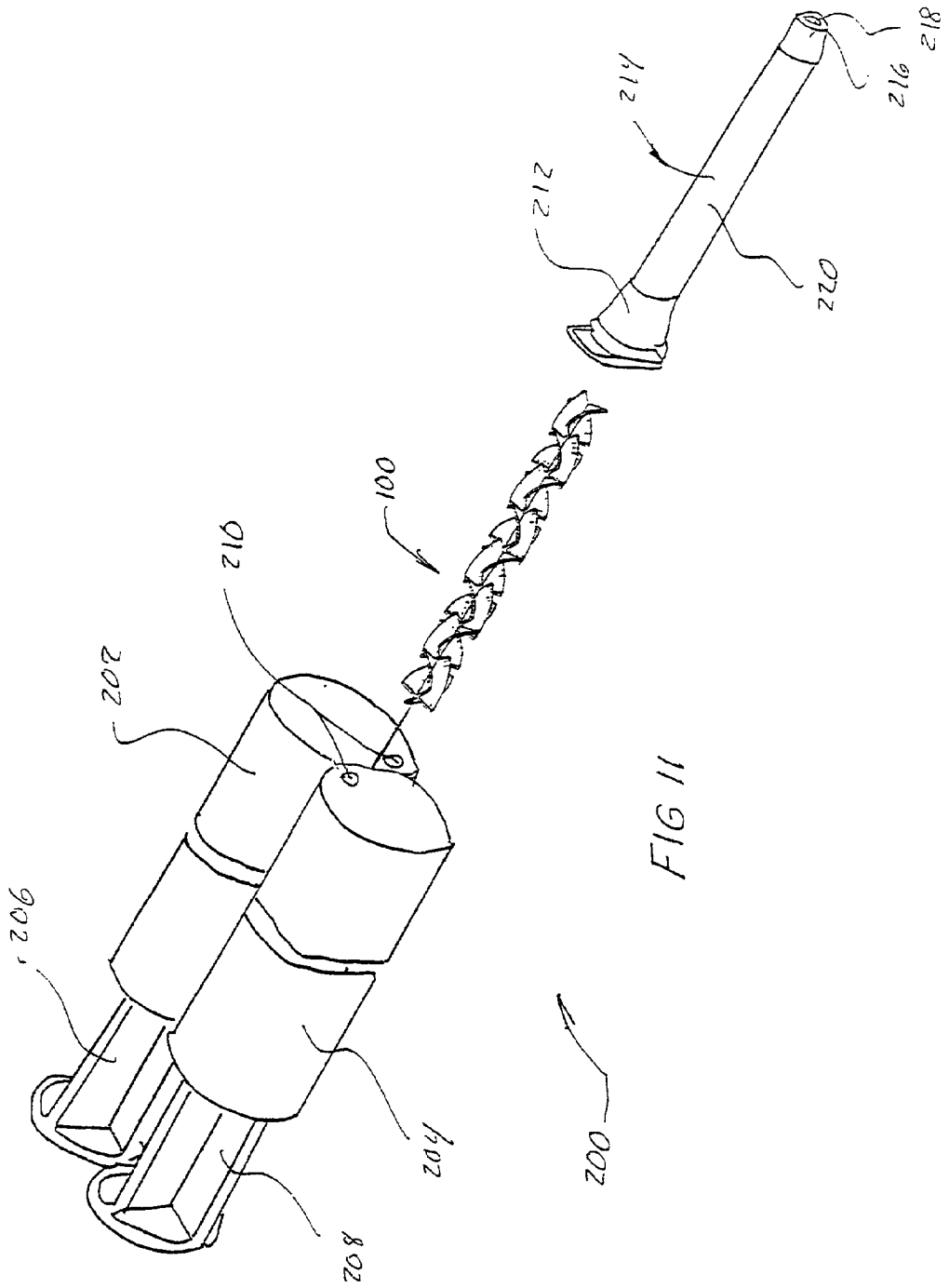


FIG 11

MULTI-PORTION MIXING ELEMENT

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is a divisional application and claims the benefit of U.S. patent application Ser. No. 09/329,038, filed Jun. 9, 1999, all of which is hereby incorporated by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] This invention relates to mixing devices. More particularly, this invention relates to a multi-portion mixing element for a static mixer, and a static mixer including a multi-portion mixing element.

[0004] 2. Prior Art

[0005] Many polymerizable resins are used in multi-component dispensers where final mixing of the resin takes place in the disposable tip called a static mixer. One of the more common static mixer designs utilized today is the twisted ribbon or the two-paddle mixer. These stationary mixers rotate the fluid resin components 180°, then split each component in half. The fluid components go through a series of splits and blends until the desired mixing is achieved. The dual component, single fluid resin then exits the static mixer and is deposited as required. When use of the resin applicator is complete, the static mixer tip is disposed of and the multi-component dispenser can be used another day with a new mixing tip. Examples of such devices are found in U.S. Pat. No. 4,538,920 and U.S. Pat. No. 4,753,536.

[0006] Although the twisted ribbon mixer is quite reliable and inexpensive, it does have drawbacks. Resin components with large viscosity differences are difficult to blend. Since many of the multi-component dispensers are hand operated, highly viscous fluids cannot be blended by hand because of the back pressure developed during the circuitous route the resin blend must take in the two-paddle design. Also, when many blends are required, the length of the static mixer becomes cumbersome (up to twenty centimeters long, one-quarter of an inch or three eights of an inch in diameter). This causes a considerable amount of wasted material and also reduces work efficiency.

[0007] Thus, there is a need in the industry for a mixing element for a static mixer which can provide better blending of all types of fluids, including highly viscous fluids, so that the length of the static mixer becomes less cumbersome and less material is wasted.

SUMMARY OF THE INVENTION

[0008] The above-discussed and other drawbacks and deficiencies of the prior art are overcome or alleviated by a device for mixing and dispensing at least two separate components, comprising: at least two containers for separately containing one component of the at least two separate components to be mixed, each container of the at least two containers having an opening; a nozzle assembly having an inlet portion communicating with each opening of each container, the nozzle assembly defining a mixing chamber communicating with the inlet portion, and a discharge outlet communicating with the mixing chamber; a mixing element disposed in the mixing chamber, the mixing element having a shank defining a longitudinal axis thereof, the mixing element having a plurality of mixing portions along the longitudinal axis of the shank, each mixing portion of the plurality of mixing portions being separated by a space, each mixing portion having at least two extensions, each extension extending radially outwardly from the shank and extending along a length of each mixing portion in spiral form relative to the longitudinal axis, the at least two extensions of one mixing portion varying in angular position from the at least two extensions of mixing portions contiguous to the one mixing portion relative to said longitudinal axis; and a discharging device for discharging the at least two separate components from the at least two containers into the nozzle assembly.

[0009] The above description and other features and advantages of the present invention will be appreciated and understood by those skilled in the art from the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] Referring now to the drawings wherein like elements are numbered alike in the several FIGURES:

[0011] **FIG. 1** is a perspective view of an apparatus for making a mixing element for a static mixer from an extrudable material;

[0012] **FIG. 2** is a side view of a static mixing element;

[0013] **FIG. 3** is a cross-sectional view of the static mixer of **FIG. 2** taken along line **3-3**;

[0014] **FIG. 4** is a cross-sectional view of the static mixer of **FIG. 2** taken along lines **4-4**;

[0015] **FIG. 5** is a perspective view of the static mixer of **FIG. 2**;

[0016] **FIG. 6** is a front view of one embodiment of an extrusion pattern;

[0017] **FIG. 7** is a front view of another embodiment of an extrusion pattern;

[0018] **FIG. 8** is a front view of yet another exemplary extrusion pattern;

[0019] **FIG. 9** is a front view of another exemplary extrusion pattern;

[0020] **FIG. 10** is a cross-sectional view of a split die set; and

[0021] **FIG. 11** is a perspective view of an exemplary embodiment of a static mixer.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT:

[0022] Referring now to **FIG. 1**, an apparatus for making a mixing element for a static mixer from an extrudable material in accordance with a preferred embodiment of the invention is generally shown at **20**. Apparatus **20** includes an extruding head **22** to which a split die set, **32** and **34**, is rotatably mounted. The split die set **32** and **34** is axially aligned and receives extrusion material from extrusion head **22**. Extruder **44** provides the extruding material as is well known in the art. As shown in **FIG. 8**, each die **32** and **34**

includes an extrusion pattern, such as the extrusion pattern generally shown at **58**. Dies **32** and **34** are capable of being rotated with the extrusion patterns aligned during extrusion so that mixing portions **110** of mixing element **100** vary in rotational position along the axis of mixing element **100**. Dies **32** and **34** are also capable of rotating to a misaligned position to prevent extruding material except for the very center of the extrusion pattern from exiting the die set to cause a break in the mixing portions **110** of mixing element **100**. Timing control **24** activates first and second motors **26** and **30** to rotate respective dies **32** and **34** and constitutes a controller for the apparatus **20**. Alignment marks **36** are provided on the split die sets **32** and **34** to indicate an aligned position and misaligned position of the die sets **32** and **34**. In a preferred embodiment, a microprocessor **28** is coupled via line **38** to timing control **24** and to motors **26** and **30** via respective lines **40** and **42**. A feed control **45** is coupled via line **49** to extruder **44** and regulates the flow of the extruded material from extruder **44**. As will be appreciated by those skilled in the art, as the rotational position of dies **32** and **34** enters into the misaligned position, the fluid forces vary significantly and feed control **45** regulates the flow of extrusion material to accommodate the reduction in need of extrusion material. Additionally, microprocessor **28** can be interfaced with feed control **45** via line **47**. Microprocessor **28** allows an operator to easily adjust the manufacturing parameters of feed and rotation to produce a variety of mixing elements **100** as set forth in more detail below.

[**0023**] In operation, extruder **44** forces the extrudable material into extrusion head **22**. Inward die **34**, as shown in greater detail in **FIG. 10**, includes an inner restriction **86** which communicates with extrusion pattern portion **88** of die **34**. Extrusion pattern portion **88** of die **34** is proportionally narrower than extrusion pattern portion **88** of outward die **32**. As the extrudable material enters die **34** it is confined by restriction **86** and forced into extrusion pattern portion **88**. During extrusion, timing control **24** rotates dies **32** and **34** simultaneously while the mixing element **100** remains stationary as it is drawn out of the extruding head **22**. The simultaneous rotation of dies **32** and **34** provides a spiral or angular variation in the extensions or paddles, as shown in **FIGS. 2, 3, 4** and **5** (which depict a four paddle static mixer having paddles **102, 104, 106** and **108**) at each mixing portion **110**. Timing control **24** activates first and second drive motors **26** and **30**. Drive motor **26** is coupled to die **32**, and drive motor **30** is coupled to die **34**. The connection of the motors to the dies is not critical and any conventional means of coupling motors **26** and **30** to dies **32** and **34** may be used (e.g., gear sets, pulleys, belts, cams, and the like). It will be appreciated to those skilled in the art that, alternatively, the mixing element **100** could be rotated as dies **32** and **34** remain stationary to provide an angular variation or spiraling effect for mixing portions **110** as mixing element **100** is extruded from extruding head **22**. After the desired length of the mixing portion **110** of mixing element **100** has been extruded, timing control **24** activates drive motors **26** and **30** to rotate respective dies **32** and **34** to a misaligned position so that alignment marks **36** are misaligned. In the misaligned position, only the very center **67** of the respective extrusion patterns (as shown in **FIG. 8**) are aligned so that only the shank **109** is extruded. It will be appreciated by those skilled in the art that the amount of time during which extrusions dies **32** and **34** are misaligned determines the length of shank **109** having no extensions **102, 104, 106, 108** extending radially outwardly therefrom. Timing control **24**, after a predetermined amount of time, activates motors **26** and **34** to rotate dies **32** and **34** back into an aligned position for continued extruding of another mixing portion **110**. Extensions **102, 104, 106** and **108** of each mixing portion **110** can vary in angular position so that there is not a constant spiral along mixing portions **110**. It will also be appreciated to those skilled in the art that one of the drive motors **26** and **30** may be eliminated if the mixing element is rotated during extrusion and the dies **32** and **34** remain aligned and stationary during extrusion.

[**0024**] Timing control **24**, and optionally microprocessor **28**, allow for variations in the degree of spiral, if any, for each mixing portion **110** as well as the length of mixing portion **110** and the space **112** between mixing portions **110**. For example, for a two paddle mixer, the rotation from start to finish for a single spiral is 180°. For a four paddle mixer, the spiral from start to finish is rotated 90°. This is beneficial because the pressure drop or loss through the static mixer is reduced due to the fluid not having to travel as far before being subdivided each time. The pressure drop of the fluid being rotated through 90° per spiral will be less than the pressure loss of the fluid having to rotate 180° per spiral, as in the two-paddle mixer. However, the amount of rotation in the spiral can be different if the manufacturer so desires. For example, the four paddle mixer can be rotated 135° or 180° from start to finish of the spiral, if so required. Furthermore, the manufacturer may opt for some, none or all of a plurality of mixing portions **110** having spirals. This technique adds great flexibility to the manufacture of the static mixing element **100**. The mixing element **100** as manufactured comprises a plurality of mixing portions **110** which can be wound on a large spool, adding to the convenience of handling. Microprocessor **28** allows quick changes in manufacturing parameters to vary the rate of rotation, alignment and feed. It will be understood that although microprocessor **28** has been described for changing the manufacturing parameters, mechanical means may be implemented in stead of microprocessor **28** for varying the rate of rotation, alignment and feed as is known. Such mechanical means are known in the pertinent art.

[**0025**] Referring now simultaneously to **FIGS. 6, 7, 8** and **9**, a discussion of extrusion patterns for first and second die sets **32** and **34** follows. **FIG. 6** depicts a double paddle extrusion pattern **46** having a single slot **48**. It will be appreciated to those skilled in the art that a center portion of slot **48** produces shank **109** when respective dies **32** and **34** are misaligned. **FIG. 7** depicts a three paddle extrusion pattern **50**. Extrusion pattern **50** has three slots **52, 54** and **56** extending outward from a center of pattern **50**. It will be appreciated to those skilled in the art that the angular variation between slots **52, 54** and **56** may be symmetrical or asymmetrical to vary mixing ratios. **FIG. 8** depicts a four paddle mixer extrusion pattern **58** having four slots **60, 62, 64** and **66** extending outward from a center **67** of pattern **58**. As with the three paddle mixing extrusion pattern **50**, the angular variation between paddles **60, 62, 64** and **66** may be symmetrically positioned from center **67** or asymmetrical. **FIG. 9** depicts an eight paddle extrusion pattern **68** having eight slots **70, 72, 74, 76, 78, 80** and **82** extending from a center of extrusion pattern **68**. In similar fashion, slots **70, 72, 74, 76, 78, 80** and **82** may be symmetrically positioned or asymmetrically positioned.

[0026] Referring now to **FIG. 2, a** discussion of the static mixing element **100** follows. Mixing element **100** has a plurality of mixing portions **110**. Each mixing portion **110** spirals independently of the other mixing portions **110**. Mixing portions have, in this embodiment, four extensions or paddles **102, 104, 106** and **108**. Each mixing portion **110** is separated by a space **112**. A shank **109** provides a central axis for mixing portions **110**. As shown in **FIGS. 3 and 4**, the angular position of the paddle ends varies along the length of contiguous mixing portions **110**, relative to the central axis provided by shank **109**. In this manner, the fluid is continually subdivided at each mixing portion for improved mixing.

[0027] Referring now to **FIG. 11, a** static mixer and dispenser is generally shown at **200**. Static mixer **200** comprises two separate containers **202** and **204** for containing two fluid components to be mixed. Each container **202** and **204** has a respective opening **210** where the fluid components exit. Discharge elements **206** and **208** in the form of syringes force the fluid components out of respective openings **210**. Static mixing device **200** further includes a nozzle assembly **214** having an inlet portion **212** and a discharge portion **216** having a discharge orifice **218**. Mixing element **100** is positioned within mixing chamber **220** of nozzle assembly **214** and preferably positioned between respective openings **210**. When assembled, inlet portion **212** is in fluid communication with openings **210** so that fluid components enter nozzle assembly **214** with mixing element **100** symmetrically positioned between openings **210**. As fluid components are pushed through nozzle assembly **214**, the components are spiraled and subdivided along mixer **100** and eventually discharged through orifice **218**. As will be appreciated to those skilled in the art, such a static mixer using mixing element **100** can be in the form of a hand operated gun or automated mixing machine utilizing a mixing element **100** without departing from the spirit and scope of the present invention.

[0028] Thus, in use, an operator places two different fluid components to be next in respective containers **202** and **204**. At the desired time for applying the mixture of the two fluid components, syringes **206** and **208** are depressed forcing fluids out of openings **210** and into inlet **212** where the fluids travel along mixing chamber **220** and through mixing element **100** for discharge through orifice **218** for application. After use, the nozzle assembly **214** and mixing element **100** can be discarded.

[0029] Although the figures shown relate to two part fluid mixing, it is understood that one skilled in the art would recognize that the present invention is advantageously adapted to providing for the mixing of a plurality of fluids. For example, the three paddle mixer illustrated in **FIG. 7** and the four paddle mixer illustrated in **FIG. 8** are suitable for statically mixing three and four part fluid mixtures, respectfully, as described herein before for two part fluids.

[0030] While preferred embodiments have been shown and described, various modifications and substitutions may be made thereto without departing from the spirit and scope of the invention. Accordingly, it is to be understood that the present invention has been described by way of illustrations and not limitation.

What is claimed is:

1. A device for mixing and dispensing at least two separate components, comprising:

at least two containers for separately containing one component of the at least two separate components to be mixed, each container of said at least two containers having an opening;

a nozzle assembly having an inlet portion communicating with each said opening of said each container, said nozzle assembly defining a mixing chamber communicating with said inlet portion, and a discharge outlet communicating with said mixing chamber;

a mixing element disposed in said mixing chamber, said mixing element having a shank defining a longitudinal axis thereof, said mixing element having a plurality of mixing portions along said longitudinal axis of said shank, each mixing portion of said plurality of mixing portions being separated by a space, said each mixing portion having at least two extensions, each extension of said at least two extensions extending radially outwardly from said shank and extending along a length of said each mixing portion, said at least two extensions of one mixing portion varying in angular position from said at least two extensions of mixing portions contiguous to said one mixing portion relative to said longitudinal axis; and

a discharging device for discharging the at least two separate components from said at least two containers into said nozzle assembly.

2. The device according to claim 1, wherein:

said each mixing portion includes three extensions, each extension of said three extensions defining a paddle.

3. The device according to claim 2, wherein:

the angular position of each said paddle with respect to each other on said each mixing portion is asymmetrical.

4. The device according to claim 1, wherein said each mixing portion includes four extensions, each extension of said four extensions defining a paddle.

5. The device according to claim 4, wherein the angular position of each said paddle with respect to each other on each said each mixing portion is asymmetrical.

6. The device according to claim 1, wherein said each mixing portion includes a plurality of extensions, each extension of said plurality of extensions defining a paddle.

7. The device according to claim 6, wherein the angular position of each said paddle with respect to each other on said each mixing portion is asymmetrical.

8. The device according to claim 1, wherein at least one mixing portion of said plurality of mixing portions has said at least two extensions extending along said length of said at least one mixing portion in spiral form relative to said longitudinal axis.

9. The device according to claim 8, wherein said at least two extensions spiral at different initial angular positions at each said mixing portion.

10. The device according to claim 9, wherein said at least two extensions spiral form are not constant relative to said shank.

11. The device according to claim 1, wherein said each extension forms a paddle, each said paddle having two ends extending from and perpendicular to said shank, said two

ends of said each mixing portion out of alignment with said two ends of contiguous mixing portions for improved mixing.

12. The device according to claim 1, wherein said discharging device comprises a syringe.

13. A device for mixing and dispensing at least two separate components, comprising:

at least two containers for separately containing one component of the at least two separate components to be mixed, each container of said at least two containers having an opening;

a nozzle assembly having an inlet portion communicating with each said opening of said each container, said nozzle assembly defining a mixing chamber communicating with said inlet portion, and a discharge outlet communicating with said mixing chamber;

a mixing element disposed in said mixing chamber, said mixing element having a shank defining a longitudinal axis thereof, said mixing element having a plurality of mixing portions along said longitudinal axis of said shank, each mixing portion of said plurality of mixing portions being separated by a space, said each mixing portion having at least two extensions, each extension of said at least two extensions extending radially outwardly from said shank and extending along a length of said each mixing portion in spiral form relative to said longitudinal axis, said at least two extensions of one mixing portion varying in angular position from said at least two extensions of mixing portions contiguous to said one mixing portion relative to said longitudinal axis; and

a discharging device for discharging the at least two separate components from said at least two containers into said nozzle assembly.

14. The device according to claim 13, wherein:

said each mixing portion includes three extensions, each extension of said three extensions defining a paddle.

15. The device according to claim 14, wherein:

the angular position of each said paddle with respect to each other on said each mixing portion is asymmetrical.

16. The device according to claim 13, wherein said each mixing portion includes four extensions, each extension of said four extensions defining a paddle.

17. The device according to claim 16, wherein the angular position of each said paddle with respect to each other on each said each mixing portion is asymmetrical.

18. The device according to claim 13, wherein said each mixing portion includes a plurality of extensions, each extension of said plurality of extensions defining a paddle.

19. The device according to claim 13, wherein the angular position of each said paddle with respect to each other on said each mixing portion is asymmetrical.

20. The device according to claim 13, wherein said at least two extensions spiral at different initial angular positions at each said mixing portion.

21. The device according to claim 20, wherein said at least two extensions spiral form are not constant.

22. The device according to claim 13, wherein said each extension forms a paddle, each said paddle having two ends extending from and perpendicular to said shank, said two ends of said each mixing portion out of alignment with said two ends of contiguous mixing portions for improved mixing.

23. The device according to claim 13, wherein said discharging device comprises a syringe.

24. A mixing element for a static mixer, comprising:

a shank defining a longitudinal axis thereof, and

a plurality of mixing portions along said longitudinal axis of said shank, each mixing portion of said plurality of mixing portions being separated by a space, said each mixing portion having at least two extensions, each extension of said at least two extensions extending radially outwardly from said shank and extending along a length of said each mixing portion, said extensions of one mixing portion varying in angular position from extensions of mixing portions contiguous to said one mixing portion relative to said longitudinal axis.

25. The mixing element according to claim 24, wherein:

said each mixing portion includes three extensions, each extension of said three extensions defining a paddle.

26. The mixing element according to claim 25, wherein:

the angular position of each said paddle with respect to each other on said each mixing portion is asymmetrical.

27. The mixing element according to claim 24, wherein said each mixing portion includes four extensions, each extension of said four extensions defining a paddle.

28. The mixing element according to claim 27, wherein the angular position of each said paddle with respect to each other on each said each mixing portion is asymmetrical.

29. The mixing element according to claim 24, wherein said each mixing portion includes a plurality of extensions, each extension of said plurality of extensions defining a paddle.

30. The mixing element according to claim 29, wherein the angular position of each said paddle with respect to each other on said each mixing portion is asymmetrical.

31. The mixing element according to claim 30, wherein at least one mixing portion of said plurality of mixing portions has said at least two extensions extending along said length of said at least one mixing portion in spiral form relative to said longitudinal axis.

32. The mixing element according to claim 31 wherein said at least two extensions spiral at different initial angular positions at each said mixing portion.

33. The mixing element according to claim 32, wherein said at least two extensions spiral form are not constant relative to said shank.

34. The mixing element according to claim 24, wherein said each extension forms a paddle, each said paddle having two ends extending from and perpendicular to said shank, said two ends of said each mixing portion out of alignment with said two ends of contiguous mixing portions for improved mixing.

35. The mixing element according to claim 24, wherein a number of said plurality of mixings portions determines a preselected length for use in a nozzle assembly having a corresponding preselected length.

36. The mixing element according to claim 35, wherein said plurality of mixing portions is disposable after use with said nozzle assembly.

* * * * *