US011285448B1

(12) **United States Patent**
Lund

(10) **Patent No.: US 11,285,448 B1**
(45) **Date of Patent: Mar. 29, 2022**

(54) **STATIC MIXER INSERTS AND STATIC MIXERS INCORPORATING SAME**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **17/227,567**

(22) Filed: **Apr. 12, 2021**

(51) **Int. Cl.**
B01F 5/06 (2006.01)

(52) **U.S. Cl.**
CPC ***B01F 5/0657*** (2013.01); ***B01F 5/0656*** (2013.01); ***B01F 5/0658*** (2013.01); ***B01F 5/0665*** (2013.01); *B01F 5/0663* (2013.01); *B01F 2005/062* (2013.01)

(58) **Field of Classification Search**
CPC B01F 5/0657; B01F 5/0658; B01F 5/0635; B01F 5/0636; B01F 5/0656; B01F 5/0665; B01F 5/0663; B01F 2005/062
USPC 366/336–340
See application file for complete search history.

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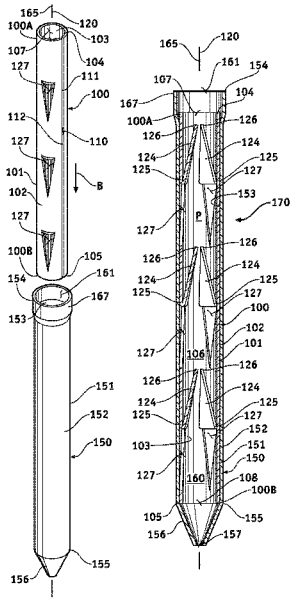
(57) **ABSTRACT**

A static mixer for liquids or gases includes a housing having a continuous inner surface defining a fluid flow path for liquids or gases, an inlet to the fluid flow path, and an outlet from the fluid flow path, and an insert extending longitudinally through the fluid flow path between the inlet and the outlet. The insert is elastically expansive to exert outwardly directed pressure against the continuous inner surface of the housing. In one embodiment, the insert is hollow and has deflectors dispersed therethroughout and each projecting inwardly into the fluid flow path. In another embodiment, the insert includes a helical deflector extending inwardly into the fluid flow path from the continuous inner surface, and helically about a longitudinal axis of the housing.

8 Claims, 17 Drawing Sheets



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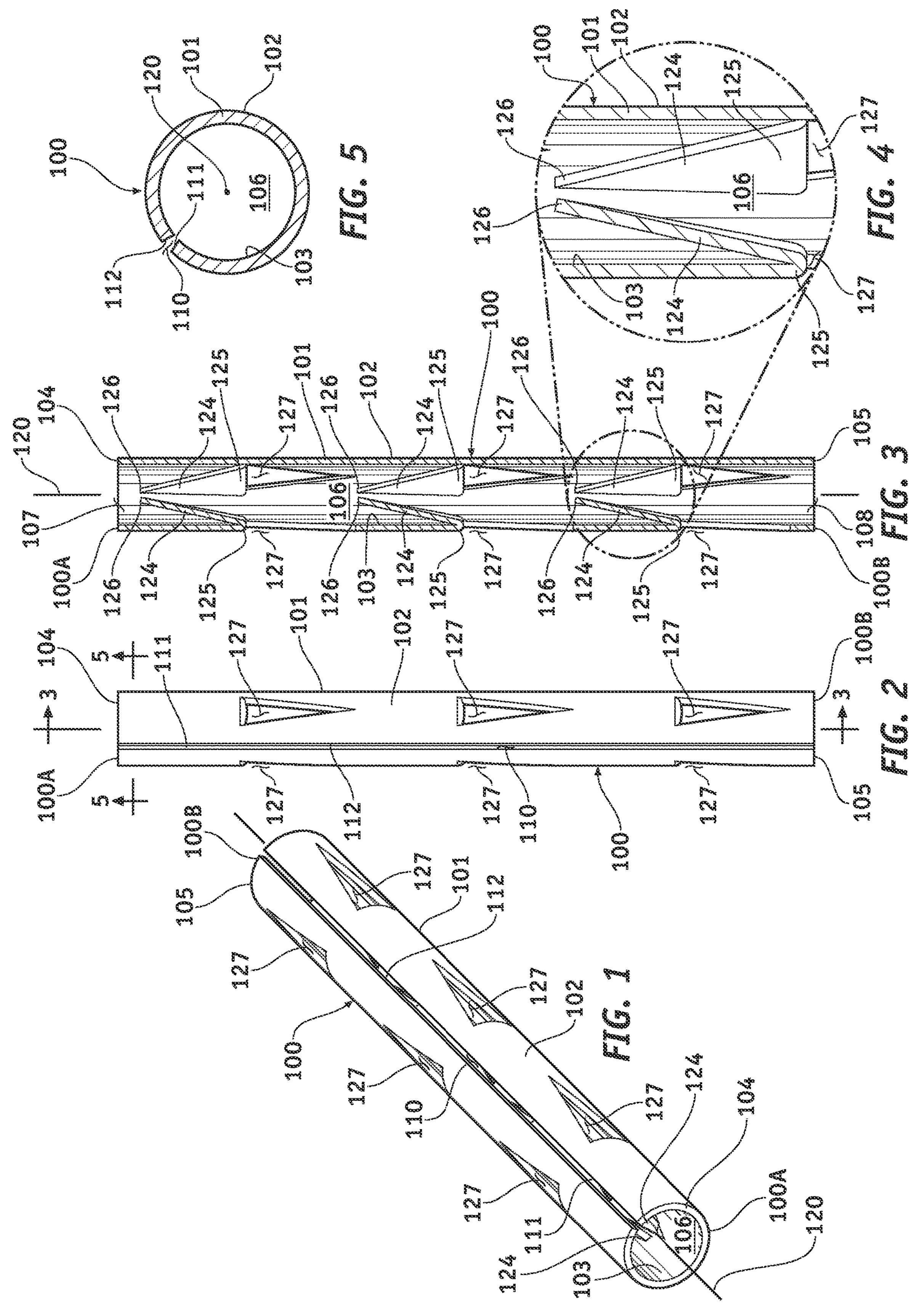
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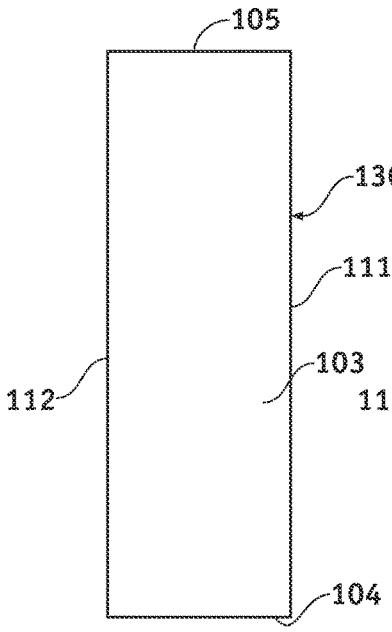

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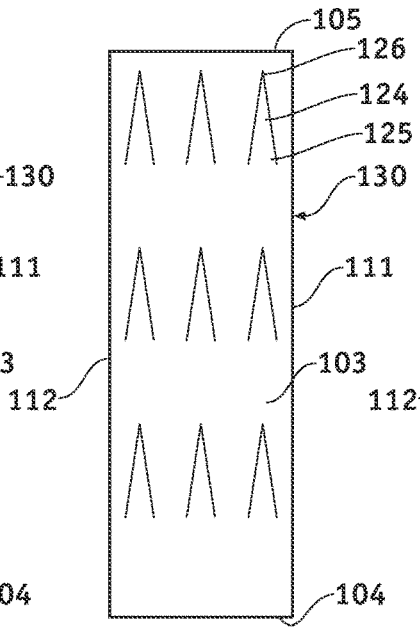

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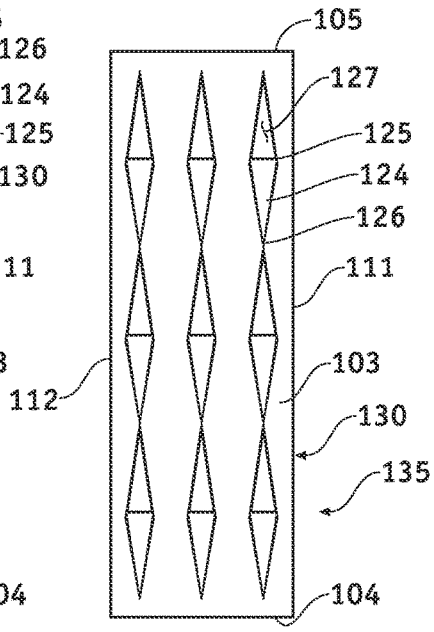

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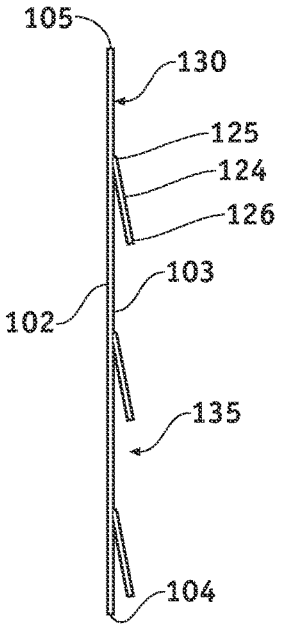

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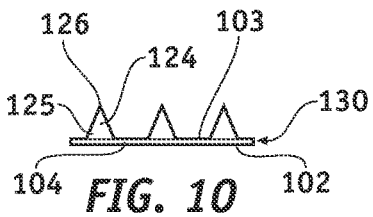

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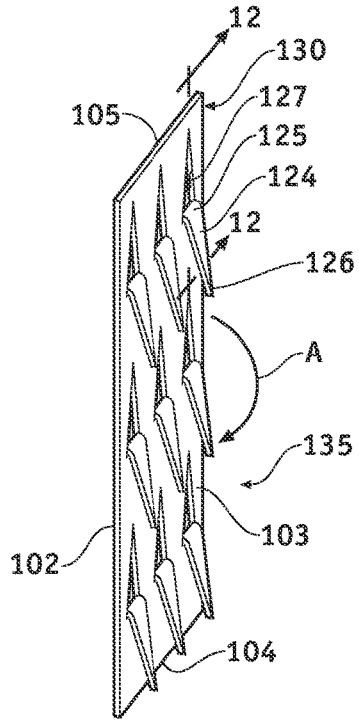

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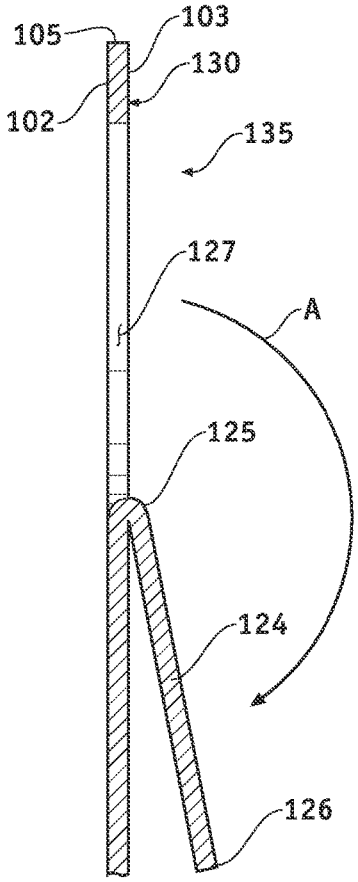
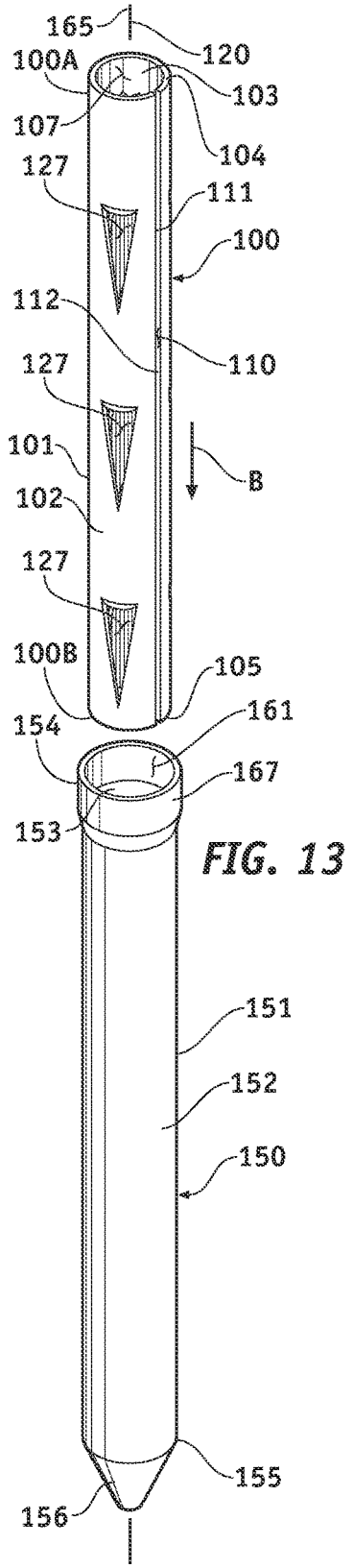


FIG. 12



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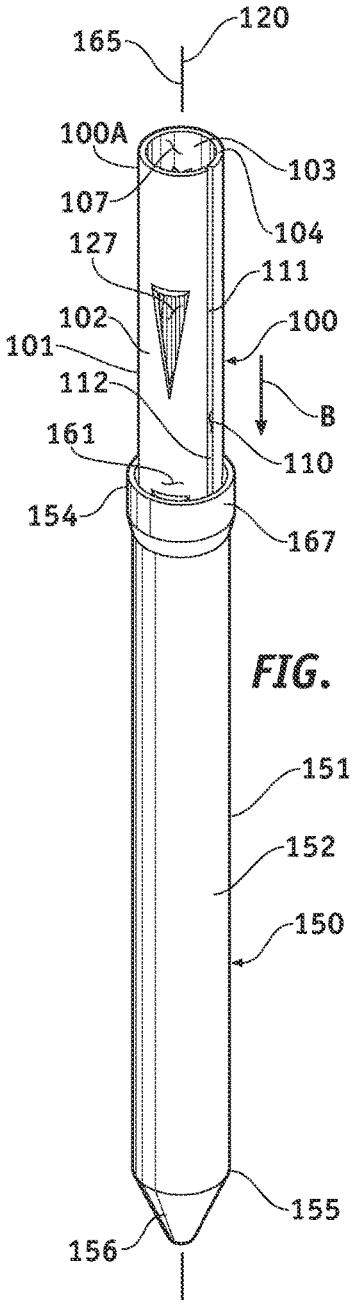

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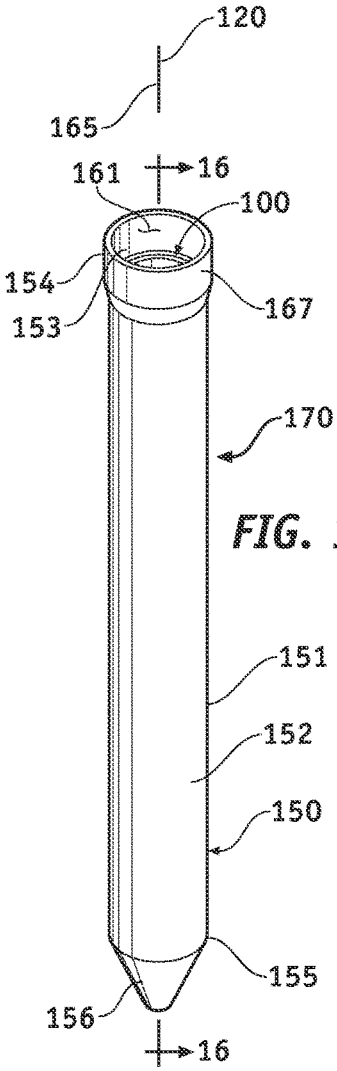

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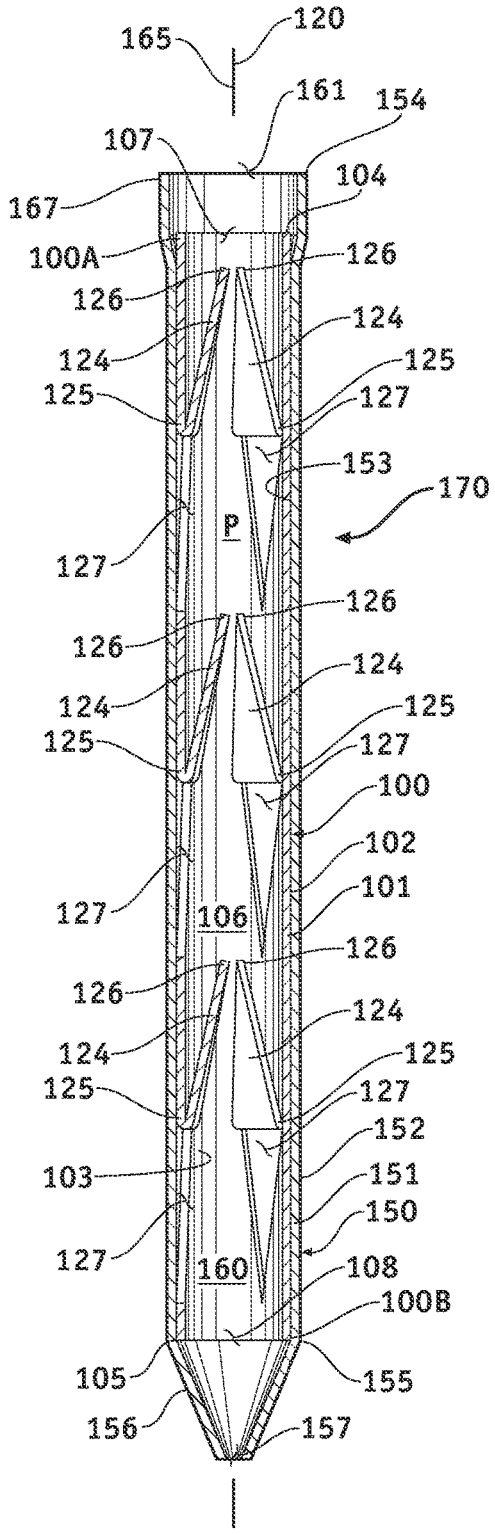
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FIG. 16

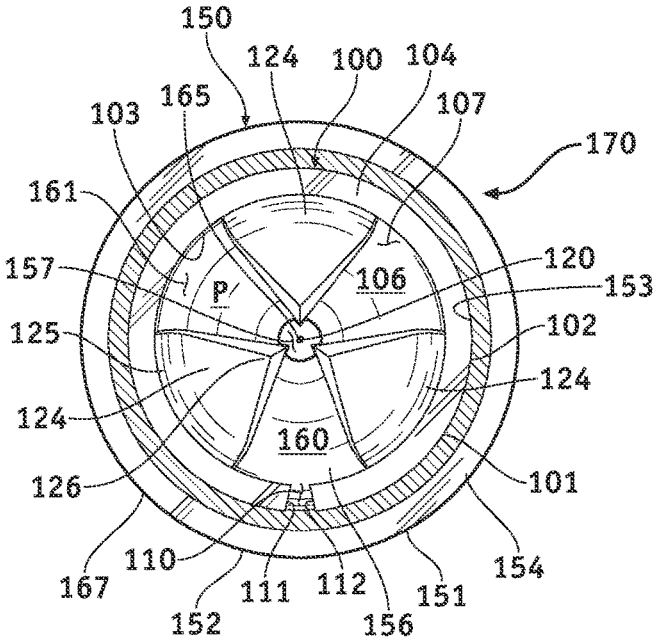
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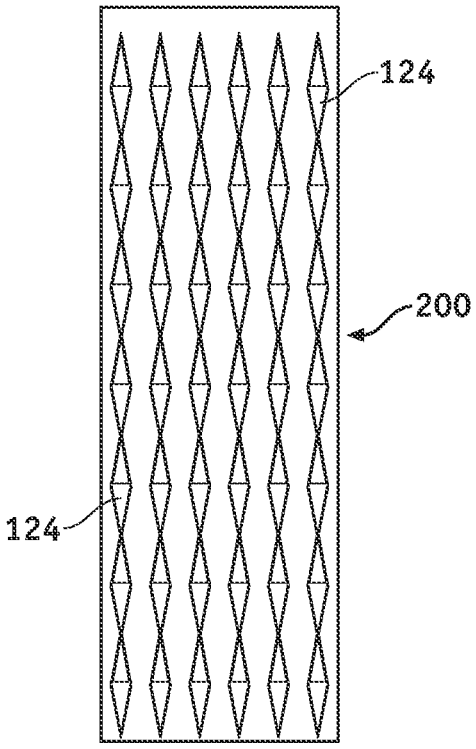
FIG. 17



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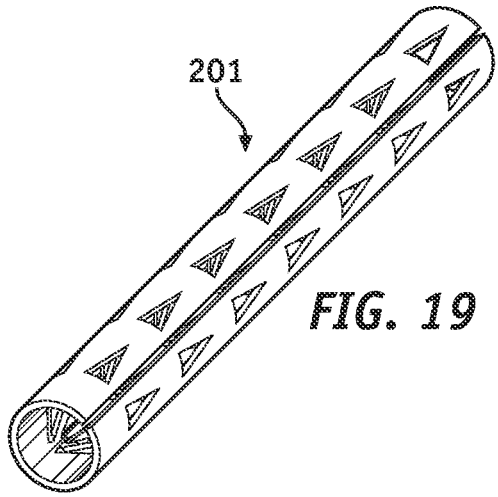

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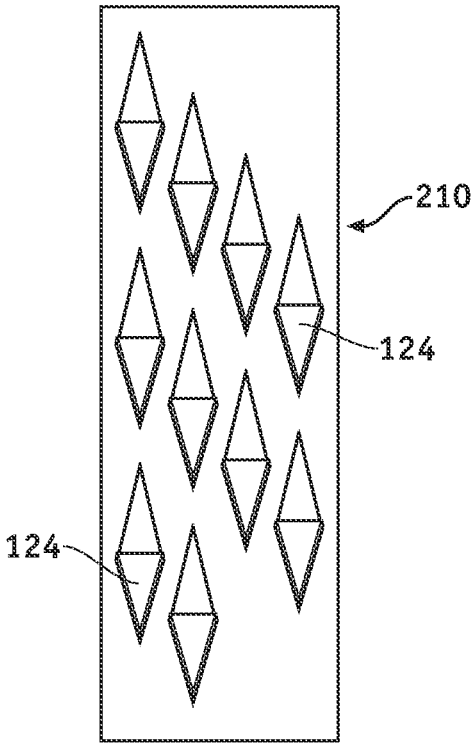

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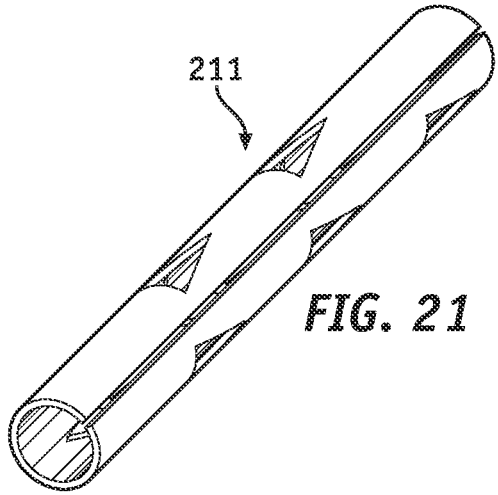


FIG. 21

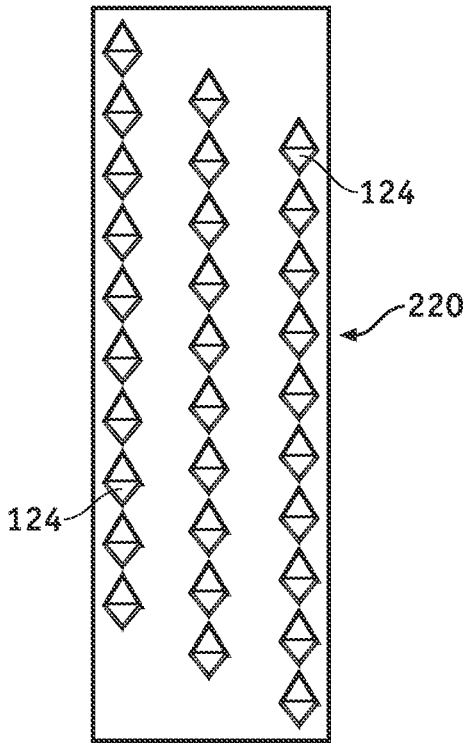
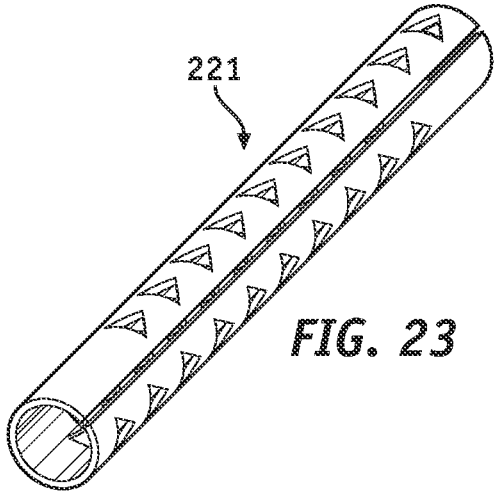


FIG. 22



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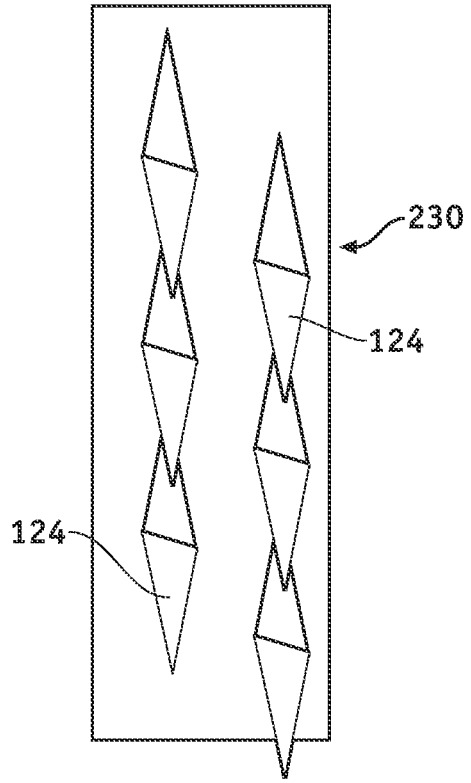

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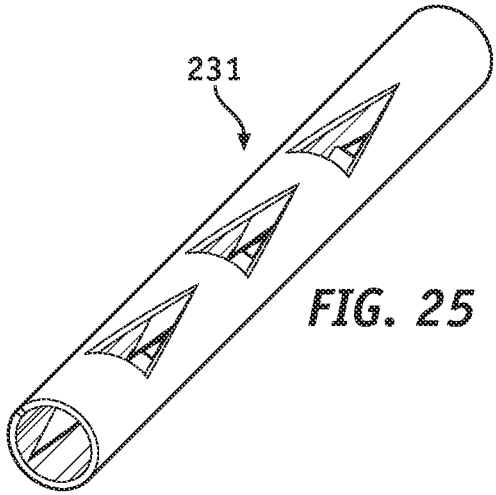

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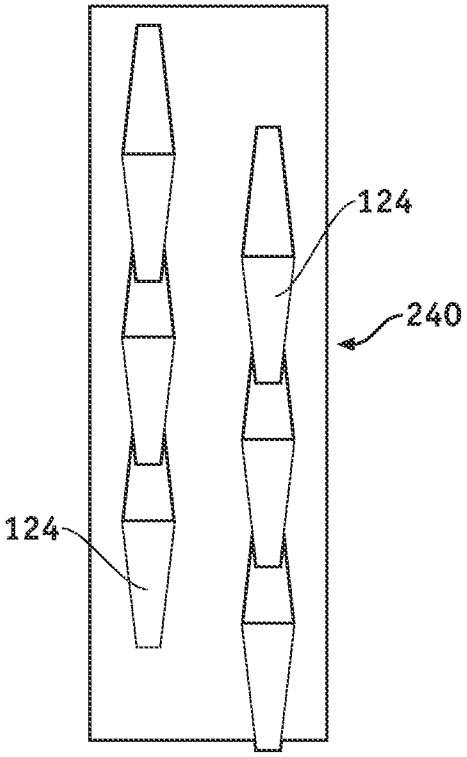

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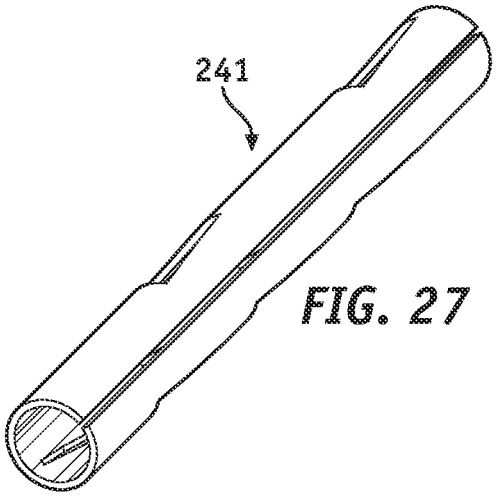

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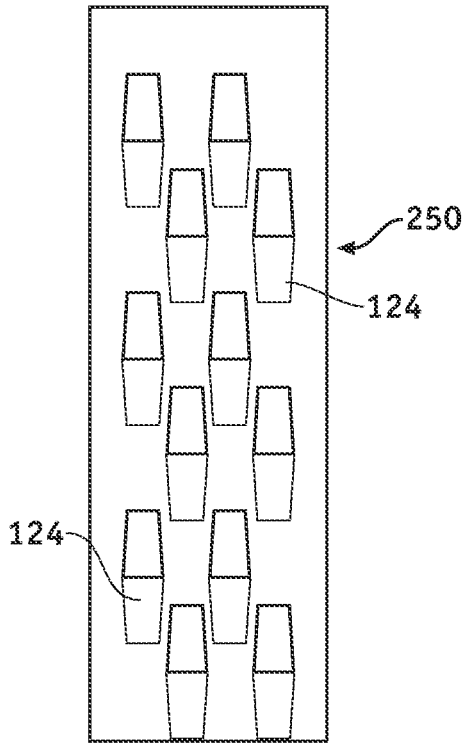

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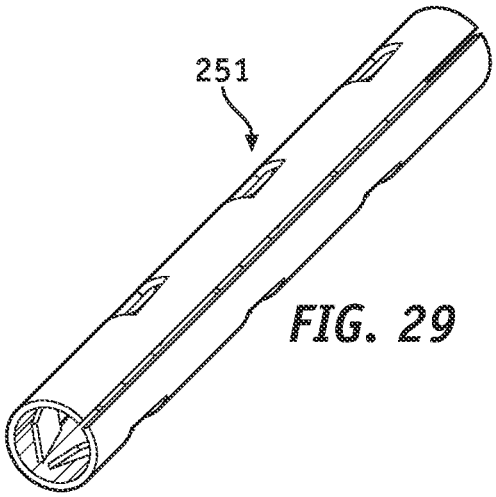

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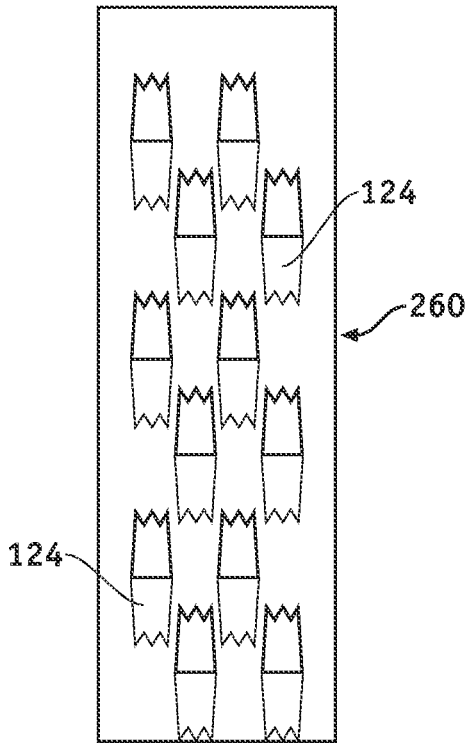
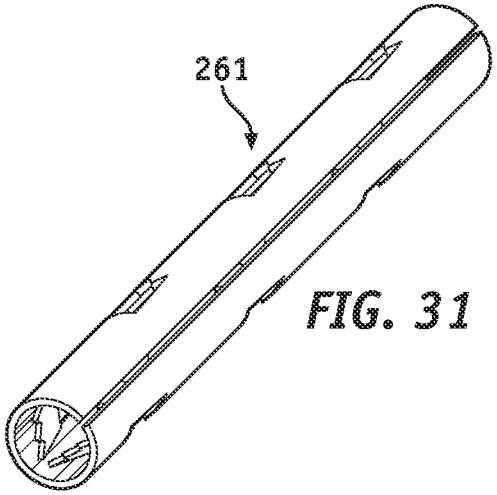


FIG. 30



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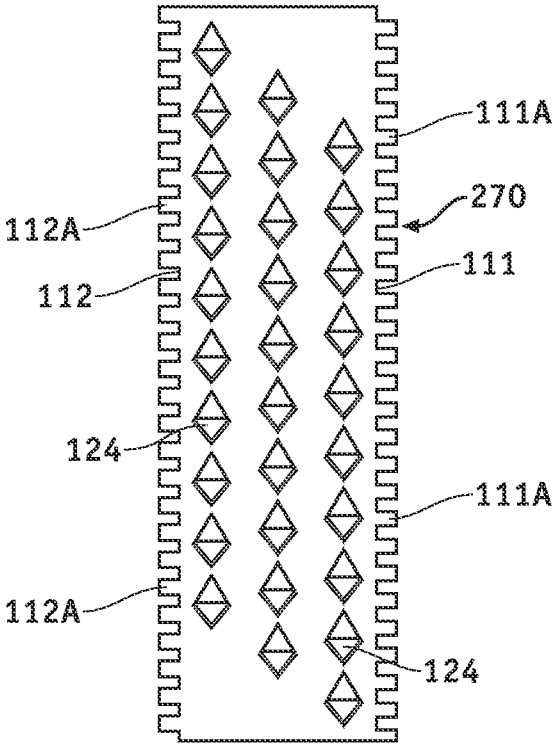

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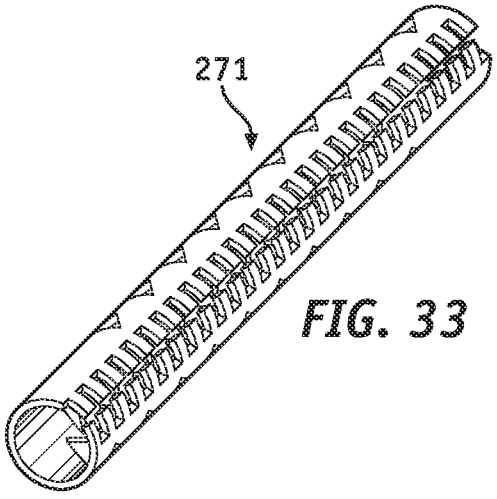

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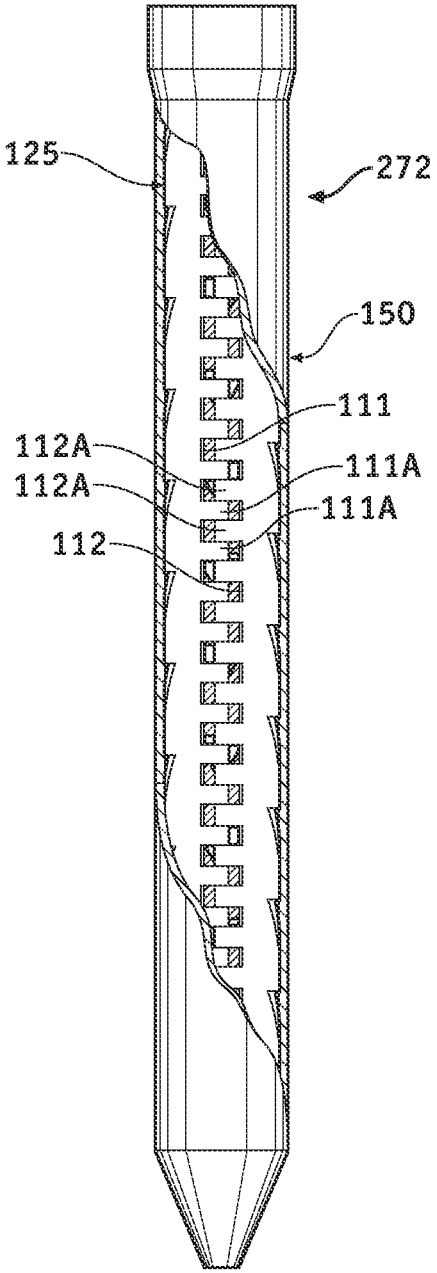
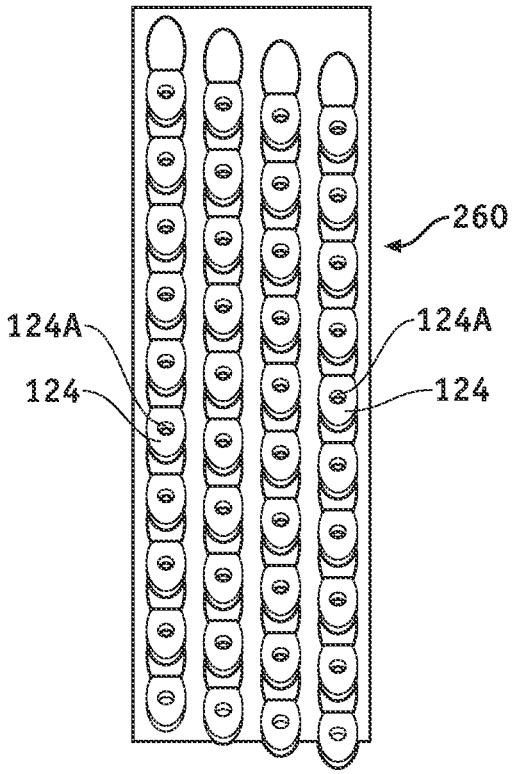


FIG. 34



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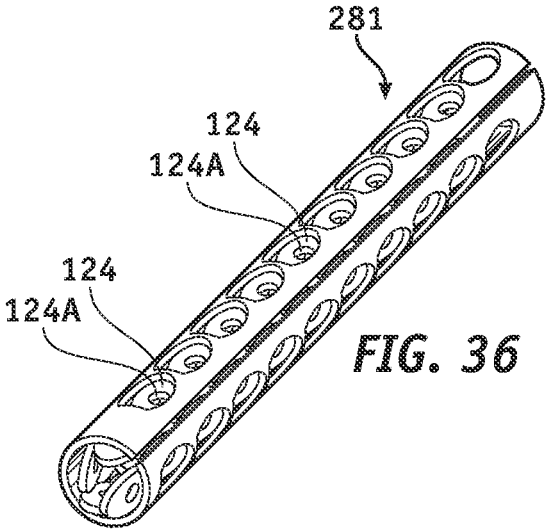

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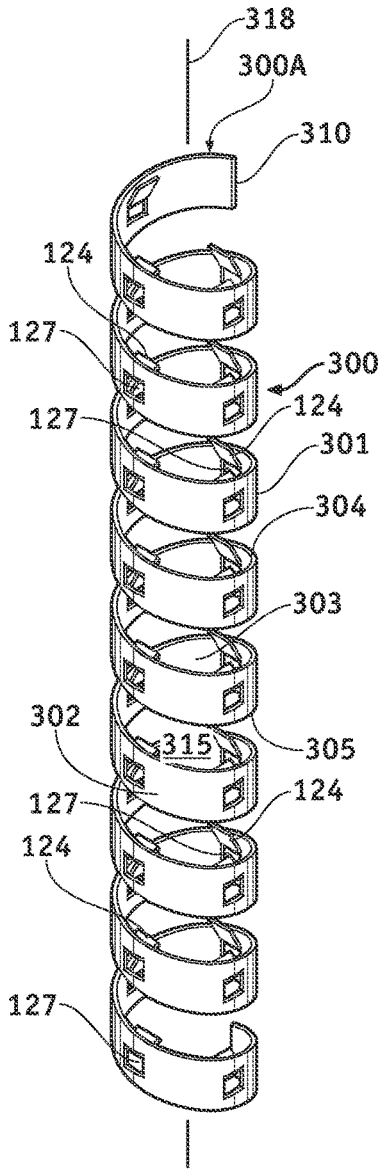

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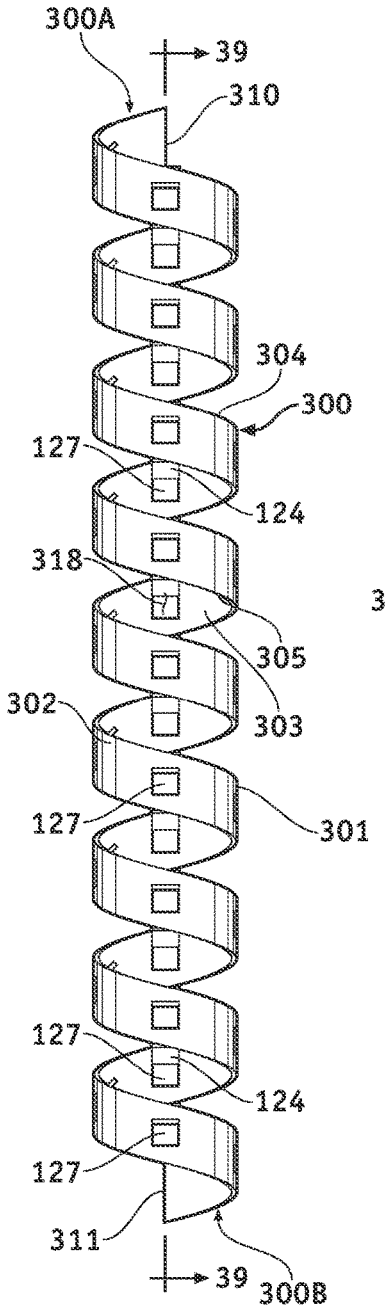

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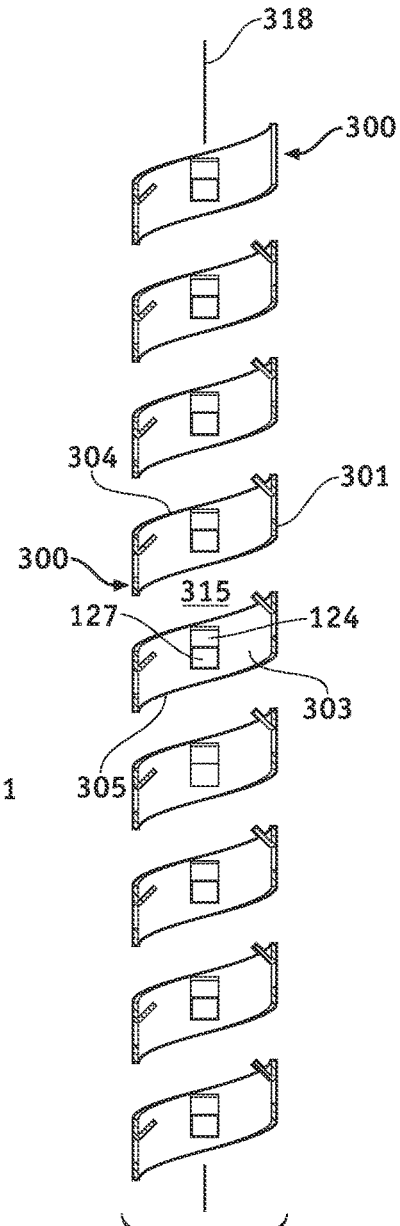

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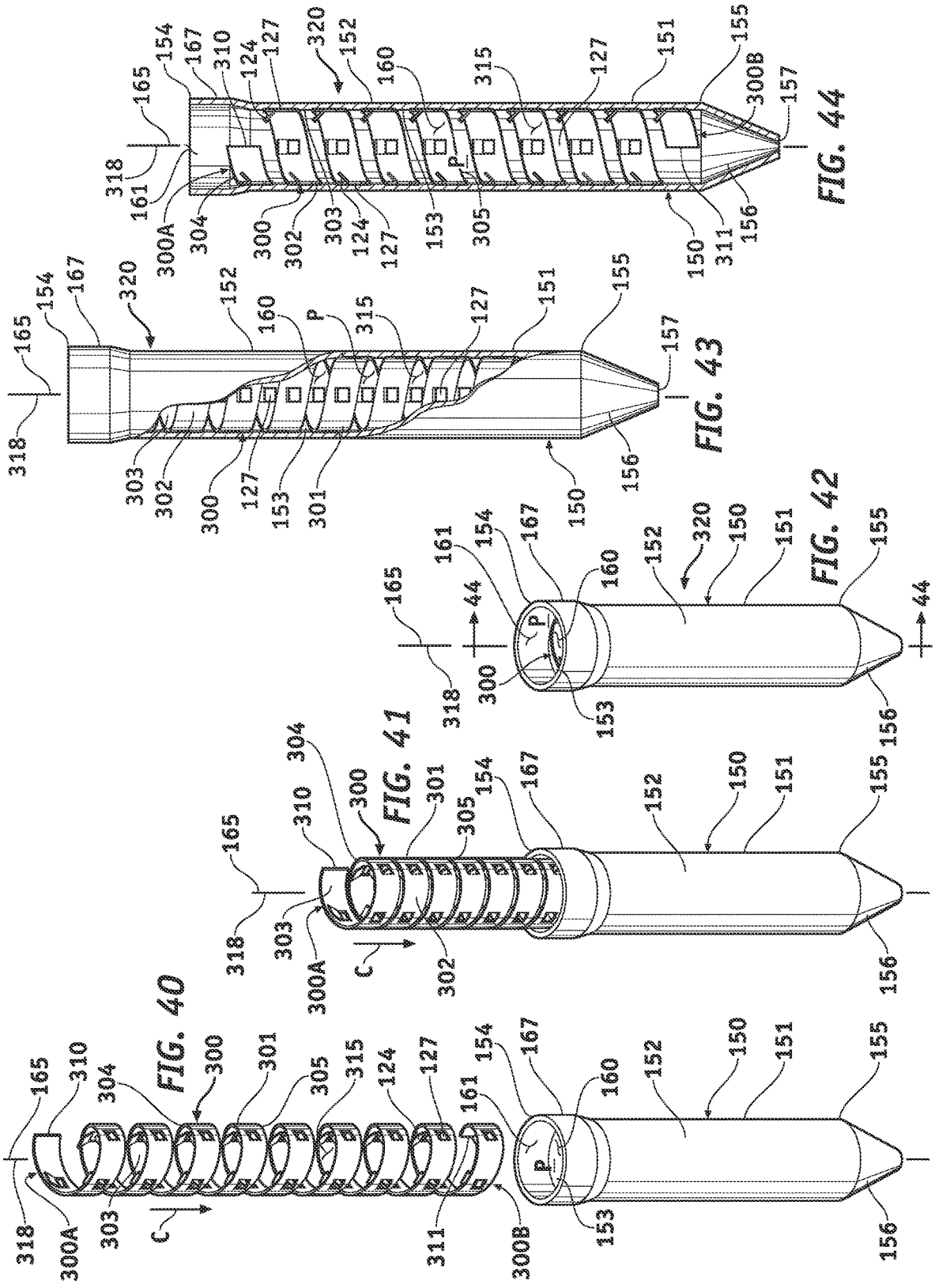
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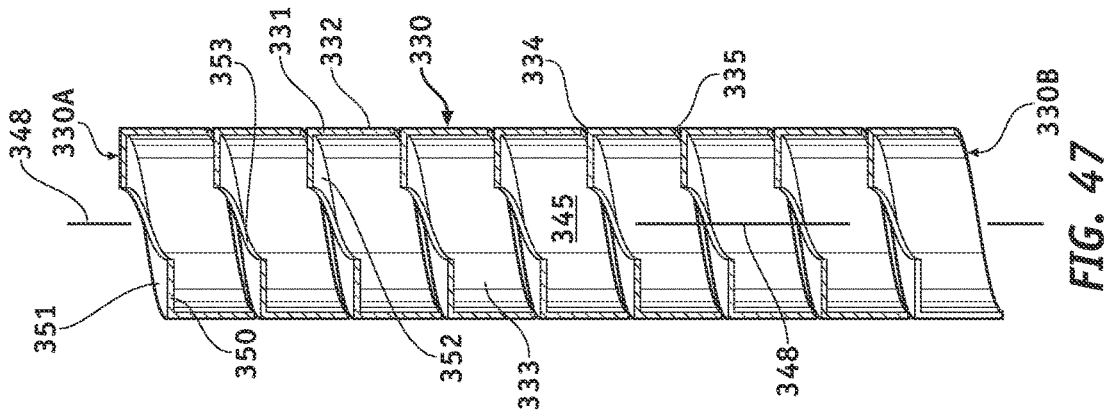

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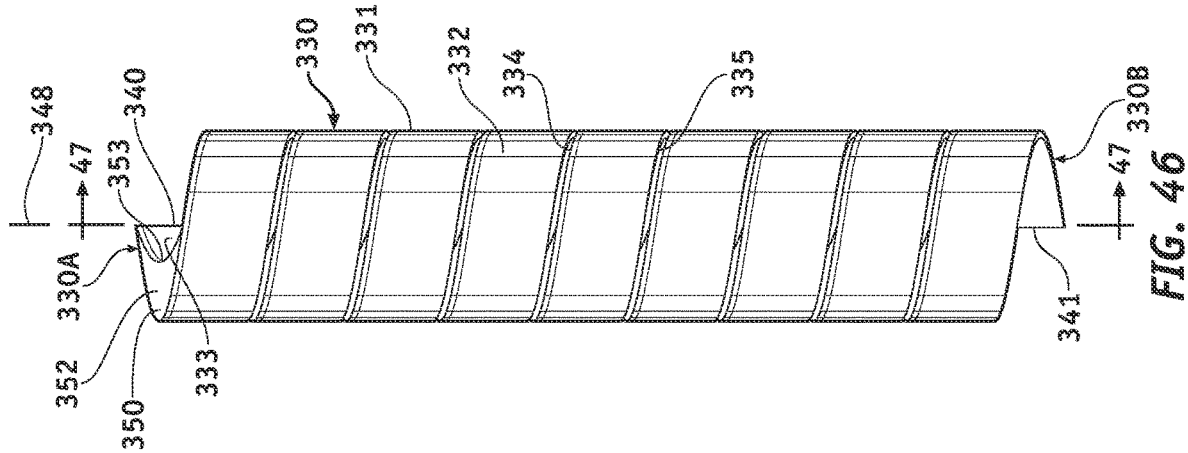

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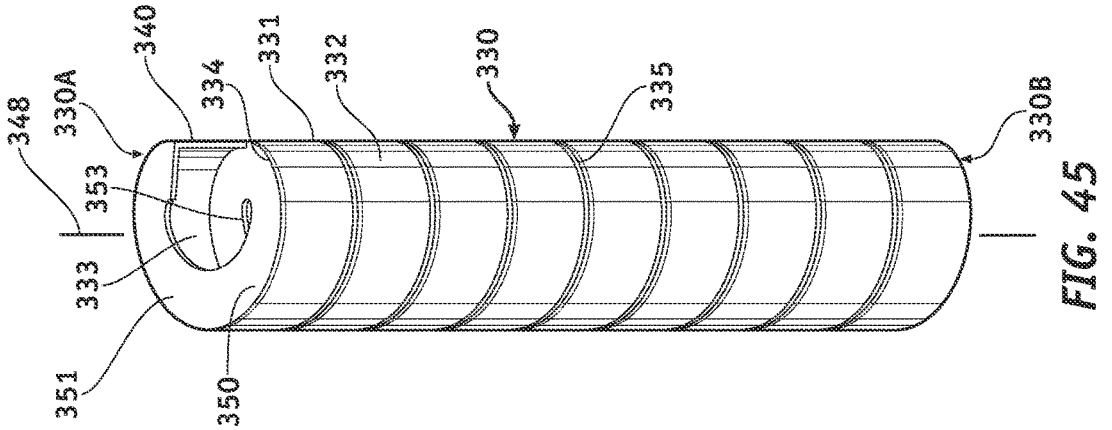

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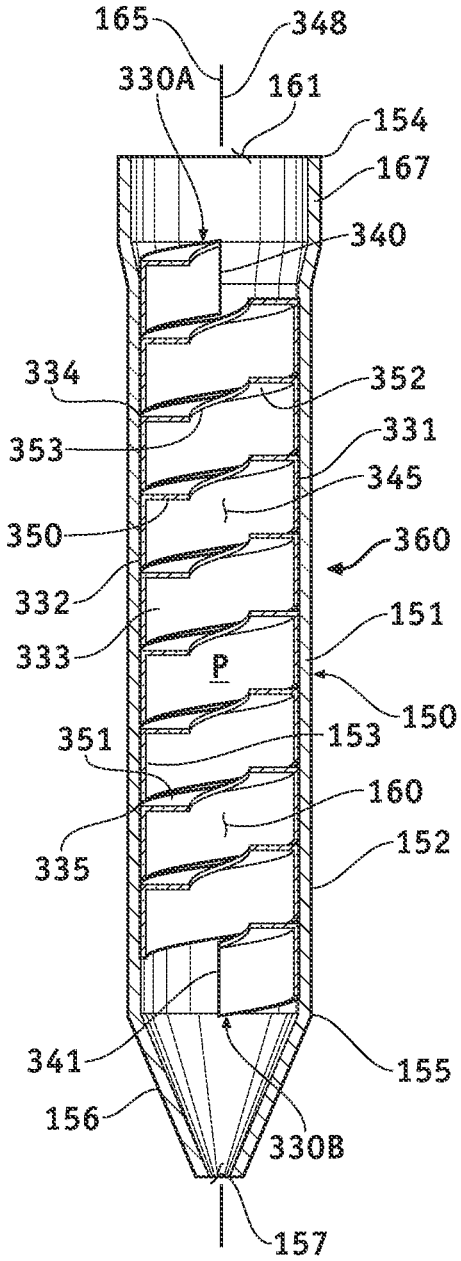
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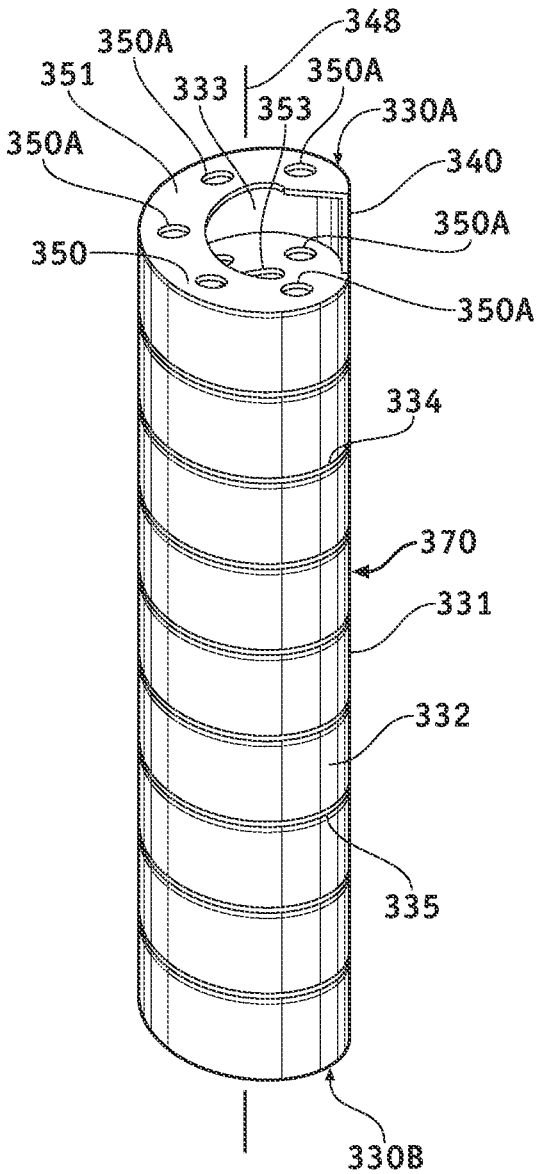
FIG. 48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335
330B

FIG. 49

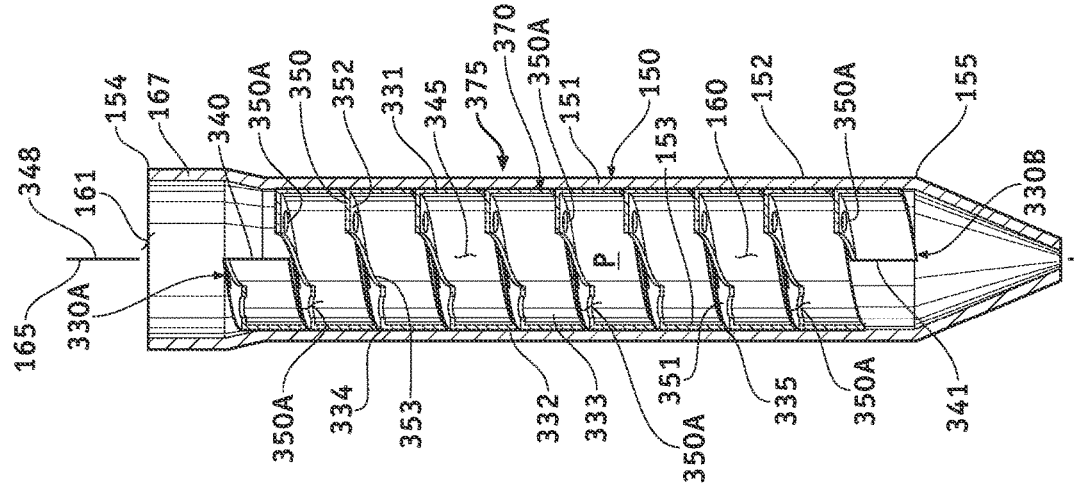

FIG. 52

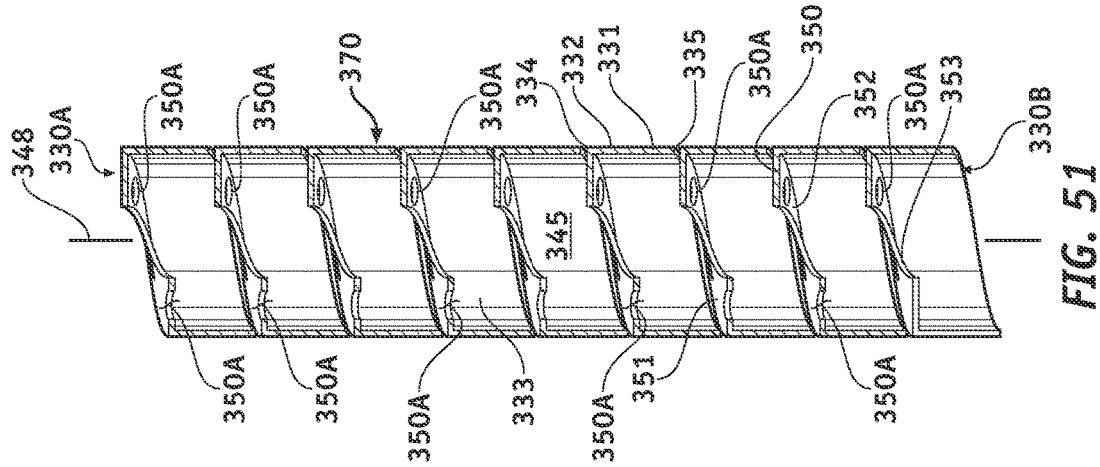

FIG. 51

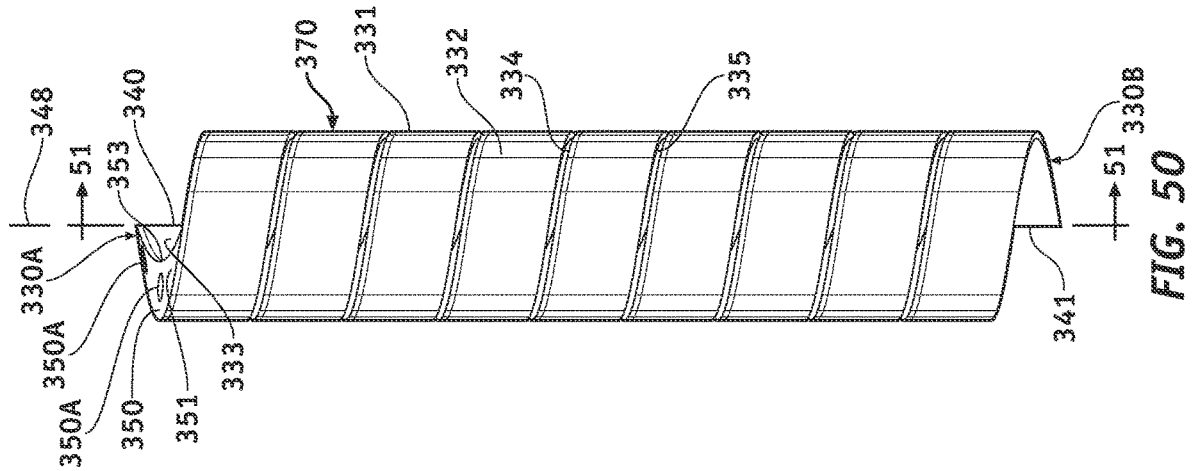

FIG. 50

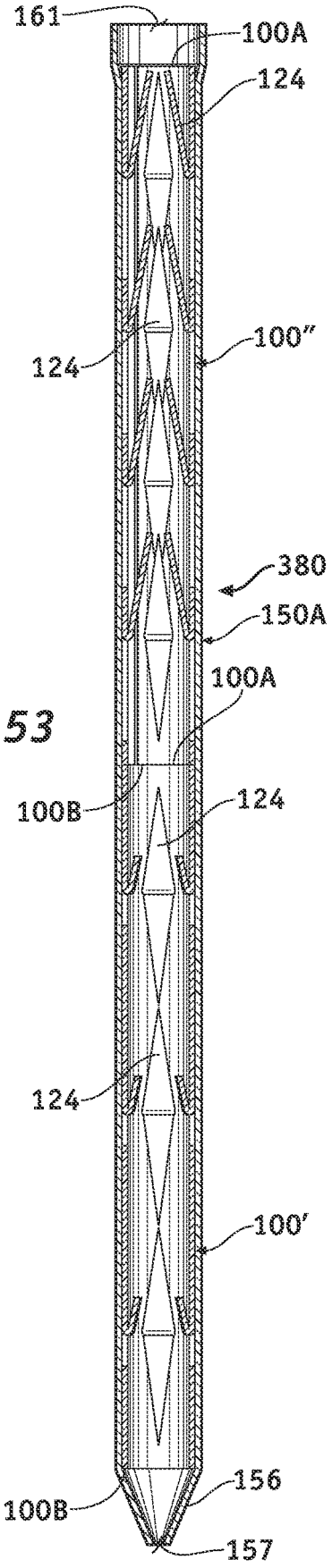
161
100A
124
124
100″
380
150A
100A
100B
124
124
100′
100B
156
157

FIG. 53

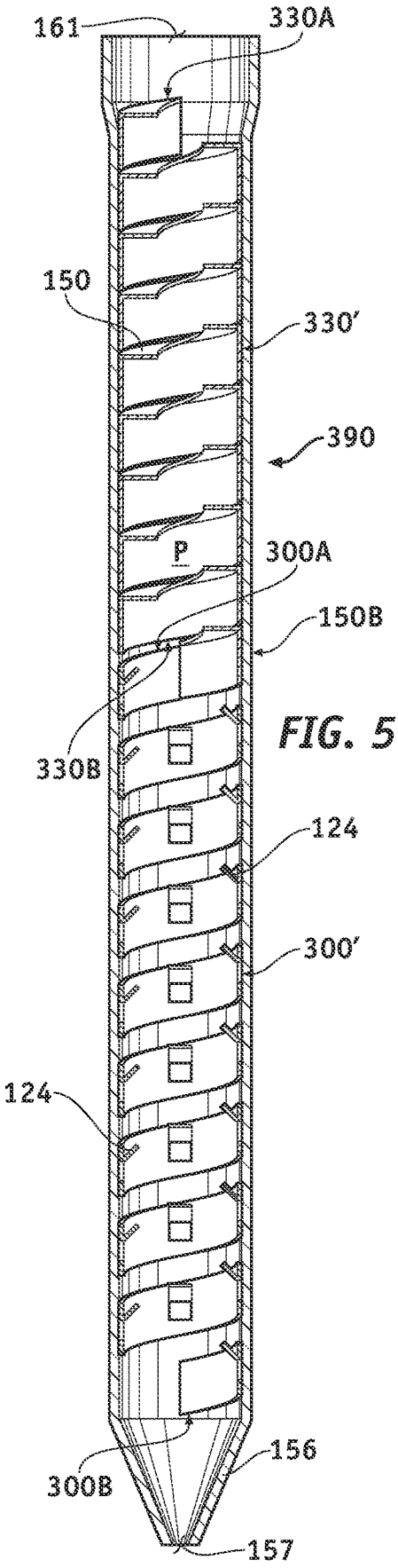
161
330A
150
330′
390
P
300A
150B
330B
124
300′
124
300B
156
157

FIG. 54

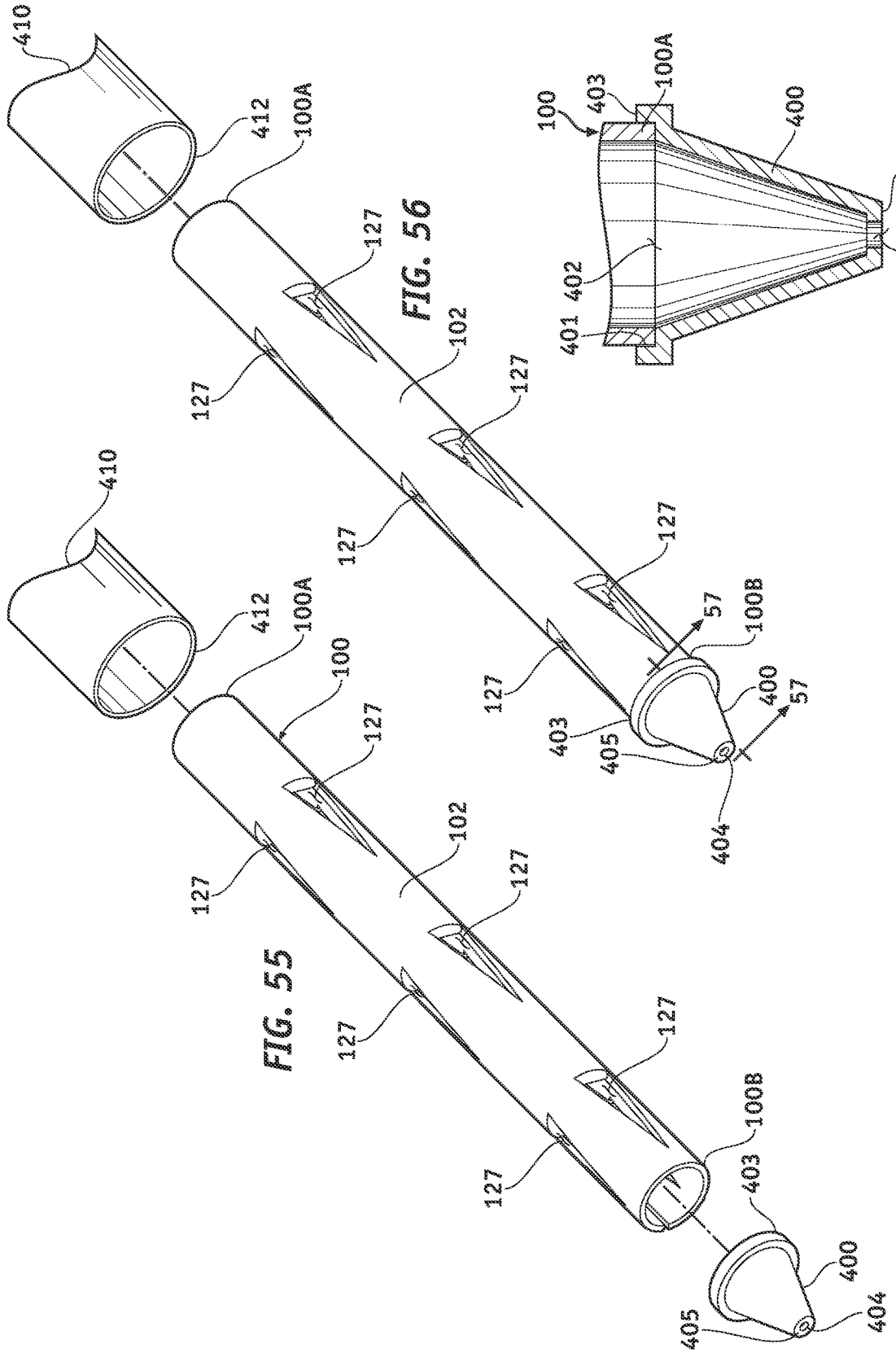

FIG. 55

FIG. 56

FIG. 57

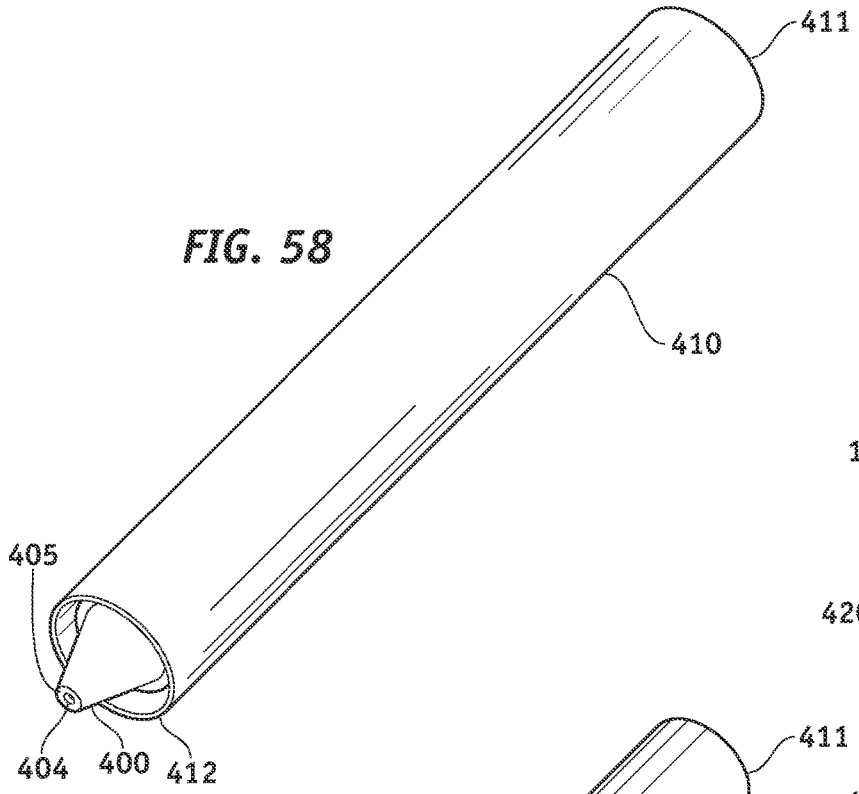

FIG. 58

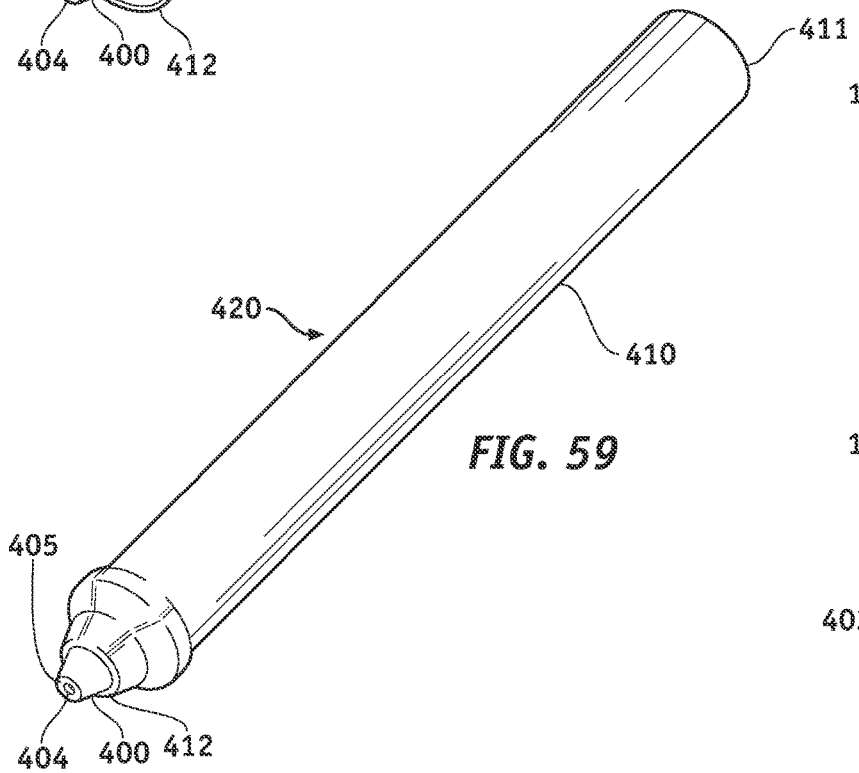

FIG. 59

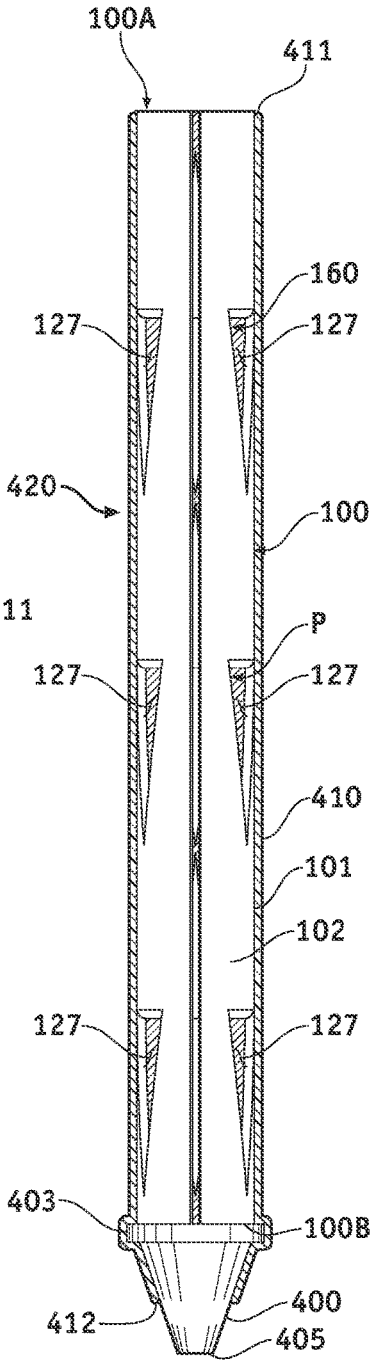

FIG. 60

STATIC MIXER INSERTS AND STATIC MIXERS INCORPORATING SAME

FIELD OF THE INVENTION

This invention relates to static mixers.

BACKGROUND OF THE INVENTION

A static mixer is a precision-engineered device without moving components for the continuous mixing of fluids. While the fluids are typically liquid, static mixers are also useful for mixing gas streams, gases and liquids, and immiscible liquids. The energy for mixing develops from a loss in pressure as fluids flow through the static mixer. There are two main static mixer designs, namely, the plate-type design and the housed-elements design. Of significance is the housed-elements design.

A housed-elements static mixer includes mixer elements in a tube or housing of metal or plastic. The mixer elements include non-moving baffles of metal or plastic, which continuously blend fluid components delivered through the housing. The mixer elements are precision engineered, notoriously expensive, and either welded in place to the housing or mechanically secured in place with separate hold-down devices, such as fasteners, brackets, or collars. Accordingly, known designs of housed-elements static mixers are expensive, require specialized skill to manufacture and assemble, and are not readily serviceable. Given these and other deficiencies, the need for continued improvement in the art is evident.

SUMMARY OF THE INVENTION

According to the invention, a static mixer for liquids or gases includes a housing and a hollow insert. The housing includes a continuous inner surface defining a fluid flow path for liquids or gases, an inlet to the fluid flow path, and an outlet from the fluid flow path. The hollow insert extends longitudinally through the fluid flow path between the inlet and the outlet, is elastically expansive to exert outwardly directed pressure against the continuous inner surface, and has deflectors dispersed therethroughout. Each deflector projects inwardly into the fluid flow path. More specifically, each deflector projects angularly upward toward the inlet. The hollow insert is formed unitarily with the deflectors. Each deflector is bent inwardly into the fluid flow path from an opening therefor through the hollow insert. The deflectors are coextensive in a particular embodiment. In another embodiment, there is at least one hole through each deflector.

According to the invention, a static mixer for liquids or gases includes a housing and a hollow insert. The housing includes a continuous inner surface defining a fluid flow path for liquids or gases, an inlet to the fluid flow path, and an outlet from the fluid flow path. The hollow insert extends longitudinally through the fluid flow path between the inlet and the outlet, is severed longitudinally and elastically expansive to exert outwardly directed pressure against the continuous inner surface, and has deflectors dispersed therethroughout. Each deflector projects inwardly into the fluid flow path. More specifically, each deflector projects angularly upward toward the inlet. The hollow insert is formed unitarily with the deflectors. Each deflector is bent inwardly into the fluid flow path from an opening therefor through the

hollow insert. The deflectors are coextensive in a particular embodiment. In another embodiment, there is at least one hole through each deflector.

According to the invention, a static mixer for liquids or gases includes a housing and a hollow insert. The housing includes a continuous inner surface defining a fluid flow path for liquids or gases, an inlet to the fluid flow path, and an outlet from the fluid flow path. The hollow insert extends longitudinally through the fluid flow path between the inlet and the outlet and has an intake end open to the inlet, a discharge end open to the outlet, a length from the intake end to the discharge end, and deflectors dispersed therethroughout. The hollow insert is severed longitudinally from the intake end to the discharge end and is elastically expansive to exert outwardly directed pressure against the continuous inner surface. Each deflector projects inwardly into the fluid flow path. In a particular embodiment, each deflector projects angularly upward toward the inlet. The hollow insert is formed unitarily with the deflectors. Each deflector is bent inwardly into the fluid flow path from an opening therefor through the hollow insert. The deflectors are coextensive in a particular embodiment. In another embodiment, there is at least one hole through each deflector.

According to the invention, a static mixer for liquids or gases includes a housing including a continuous inner surface defining a fluid flow path for liquids or gases, an inlet to the fluid flow path, and an outlet from the fluid flow path. An annular sidewall extends longitudinally through the fluid flow path between the inlet and the outlet, and includes an outer surface in frictional engagement with the continuous inner surface of the housing, an inner surface, and deflectors dispersed therethroughout and each projecting inwardly into the fluid flow path from the inner surface. Each deflector projects inwardly into the fluid flow path. More specifically, each deflector projects angularly upward toward the inlet. The annular sidewall is formed unitarily with the deflectors. Each deflector is bent inwardly into the fluid flow path from an opening therefor through the annular sidewall. The deflectors are coextensive in a particular embodiment. In another embodiment, there is at least one hole through each deflector.

According to the invention, a static mixer for liquids or gases includes a housing and a helical member. The housing is arranged about a longitudinal axis and includes a continuous inner surface defining a fluid flow path for liquids or gases, an inlet to the fluid flow path, and an outlet from the fluid flow path. The helical member extends longitudinally through the fluid flow path and helically about the longitudinal axis between the inlet and the outlet. The helical member is elastically expansive to exert outwardly directed pressure against the continuous inner surface and has deflectors dispersed therethroughout and each projecting inwardly into the fluid flow path. In a particular embodiment, each deflector projects angularly upward toward the inlet. The helical member is formed unitarily with the deflectors. Each deflector is bent inwardly into the fluid flow path from an opening therefor through the helical member. The deflectors are coextensive in a particular embodiment. The deflectors are equally spaced apart helically between respective ends of the helical member.

According to the invention, a static mixer for liquids or gases includes a housing and a helical deflector. The housing is arranged about a longitudinal axis and includes a continuous inner surface defining a fluid flow path for liquids or gases, an inlet to the fluid flow path, and an outlet from the fluid flow path. The helical deflector extends longitudinally through the fluid flow path between the inlet and the outlet,

inwardly into the fluid flow path from the continuous inner surface, and helically about the longitudinal axis. The helical deflector is elastically expansive to exert outwardly directed pressure against the continuous inner surface. Openings extend through the deflector and are equally spaced apart helically in a preferred embodiment.

According to the invention, a static mixer for liquids or gases includes a housing and an insert. The housing is arranged about a longitudinal axis and includes a continuous inner surface defining a fluid flow path for liquids or gases, an inlet to the fluid flow path, and an outlet from the fluid flow path. The insert includes a helical member extending longitudinally through the fluid flow path and helically about the longitudinal axis between the inlet and the outlet. The helical member is elastically expansive to exert outwardly directed pressure against the continuous inner surface. The helical member has a helical deflector extending longitudinally through the fluid flow path between the inlet and the outlet, inwardly into the fluid flow path from the helical member, and helically about the longitudinal axis. The insert includes an intake end open to the inlet, and a discharge end open to the outlet. The helical member and the helical deflector concurrently extend from the intake end to the discharge end. Openings extend through the deflector and are equally spaced apart helically in a preferred embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

Specific objects and advantages of the invention will become apparent to those skilled in the art from the following detailed description of illustrative embodiments thereof, taken in conjunction with the drawings in which:

FIG. **1** is a perspective view of static mixer insert according to the invention;

FIG. **2** is a side elevation view of the embodiment of FIG. **1**;

FIG. **3** is a section view taken along line **3-3** of FIG. **2**;

FIG. **4** is an enlarged view of a circled area of FIG. **3**;

FIG. **5** is a section view taken along line **5-5** of FIG. **3**;

FIG. **6** is a front elevation view of a sheet of material from which the static mixer insert of FIG. **1** is formed;

FIG. **7** is view corresponding to FIG. **6** illustrating deflectors cut into the sheet;

FIG. **8** is a view corresponding to FIG. **7** illustrating each deflector bent outwardly from the sheet from an opening therefor through the sheet to form a static mixer insert segment that when roll formed forms the static mixer insert of FIG. **1**;

FIG. **9** is a side elevation view of the embodiment of FIG. **8**, the opposite side elevation view being the same thereof;

FIG. **10** is an end elevation view of the embodiment of FIG. **8**;

FIG. **11** is a perspective view of the embodiment of FIG. **8**;

FIG. **12** is a section view taken along line **12-12** of FIG. **11**;

FIGS. **13-15** illustrate a sequence of steps of inserting the static mixer insert of FIG. **8** into a housing to form a static mixer in FIG. **15** according to the invention;

FIG. **16** is a section view taken along line **16-16** of FIG. **15**;

FIG. **17** is a top plan view of the embodiment of FIG. **15**;

FIG. **18** is a view like FIG. **3** illustrating another embodiment of a static mixer insert segment;

FIG. **19** is a view like FIG. **8** illustrating a static mixer insert formed from the embodiment of FIG. **18**;

FIG. **20** is a view like FIG. **3** illustrating yet another embodiment of a static mixer insert segment;

FIG. **21** is a view like FIG. **8** illustrating a static mixer insert formed from the embodiment of FIG. **20**;

FIG. **22** is a view like FIG. **3** illustrating still another embodiment of a static mixer insert segment;

FIG. **23** is a view like FIG. **8** illustrating a static mixer insert formed from the embodiment of FIG. **22**;

FIG. **24** is a view like FIG. **3** illustrating yet still another embodiment of a static mixer insert segment;

FIG. **25** is a view like FIG. **8** illustrating a static mixer insert formed from the embodiment of FIG. **24**;

FIG. **26** is a view like FIG. **3** illustrating yet another embodiment of a static mixer insert segment;

FIG. **27** is a view like FIG. **8** illustrating a static mixer insert formed from the embodiment of FIG. **26**;

FIG. **28** is a view like FIG. **3** illustrating still another embodiment of a static mixer insert segment;

FIG. **29** is a view like FIG. **8** illustrating a static mixer insert formed from the embodiment of FIG. **28**;

FIG. **30** is a view like FIG. **3** illustrating yet still another embodiment of a static mixer insert segment;

FIG. **31** is a view like FIG. **8** illustrating a static mixer insert formed from the embodiment of FIG. **30**;

FIG. **32** is a view like FIG. **3** illustrating yet another embodiment of a static mixer insert segment;

FIG. **33** is a view like FIG. **8** illustrating a static mixer insert formed from the embodiment of FIG. **32**;

FIG. **34** is a side elevation of a static mixer including an assembly of a housing and the static mixer insert of FIG. **33**, with portions of the housing being broken away for illustrative purposes;

FIG. **35** is a view like FIG. **3** illustrating still another embodiment of a static mixer insert segment;

FIG. **36** is a view like FIG. **8** illustrating a static mixer insert formed from the embodiment of FIG. **35**;

FIG. **37** is a perspective view of a helical static mixer insert constructed and arranged according to the invention;

FIG. **38** is a side elevation view of the embodiment of FIG. **37**;

FIG. **39** is a section view taken along line **39-39** of FIG. **38**;

FIGS. **40-42** illustrate a sequence of steps of inserting the helical static mixer insert first illustrated in into a housing to form a static mixer in FIG. **42** according to the invention;

FIG. **43** is a side elevation view of the embodiment of FIG. **42** with portions of the housing broken away for illustrative purposes;

FIG. **44** is a section view taken alone line **44-44** of FIG. **42**;

FIG. **45** is a perspective view of another embodiment of a helical static mixer insert constructed and arranged according to the invention;

FIG. **46** is a side elevation view of the embodiment of FIG. **45**;

FIG. **47** is a section view taken along line **47-47** of FIG. **46**;

FIG. **48** is a vertical section view of a static mixer formed with the embodiment of FIGS. **45-47**;

FIG. **49** is a perspective view of yet another embodiment of a helical static mixer insert constructed and arranged according to the invention;

FIG. **50** is a side elevation view of the embodiment of FIG. **49**;

FIG. **51** is a section view taken along line **51-51** of FIG. **50**;

FIG. **52** is a vertical section view of a static mixer formed with the embodiment of FIGS. **49-51**;

FIG. **53** is a vertical section view of an alternate embodiment of a static mixer according to the invention;

FIG. **54** is a vertical section view of yet another embodiment of a static mixer according to the invention;

FIGS. **55-59** illustrate a sequence of steps of constructing a static mixer in FIG. **59** according to yet another embodiment of the invention; and

FIG. **60** is a side elevation view of the static mixer of FIG. **59**, with portions thereof being broken away for illustrative purposes.

DETAILED DESCRIPTION

Static mixer inserts and static mixers formed therewith are disclosed.

Turning now to the drawings in which like reference characters indicate corresponding elements, attention is first directed to FIGS. **1-3** illustrating a static mixer insert **100** configured for insertion into a housing to form a static mixer for mixing fluid streams applied through the housing, whether gas streams, fluid streams, or fluid and gas streams. Insert **100** is an elongate, hollow, tubular form including elongate annular sidewall **101** having outer surface **102**, inner surface **103**, and opposed annular end edges **104** and **105**. Inner surface **103** defines volume **106** for the passage of fluid streams extending from opening **107** encircled by end edge **104** at an intake end of insert **100** denoted generally at **100**A to opening **108** encircled by end edge **105** at a discharge end of insert denoted generally at **100**B. Opening **107** for the intake of fluid streams at intake end **100**A of insert **100** and opening **108** for the discharge of mixed fluid streams at discharge end **100**B of insert **100** are aligned axially at either end of insert **100** and are each open to volume **106** extending longitudinally therebetween. End gap **110** longitudinally severs annular sidewall **101** along its length from end edge **104** to end edge **105** to define spaced-apart, parallel side edges **111** and **112** extending longitudinally from end edge **104** to end edge **105**. Annular sidewall **101**, and thus insert **100**, is arranged about axis **120** in FIGS. **1**, **3**, and **5** extending centrally through volume **106** from opening **107** to opening **108** in FIG. **3**. Annular sidewall **101** is generally cylindrical in this example and is tensionable, being fabricated of plastic, a malleable metal, such as ductile iron, or steel, a cellulosic composition, or other like or similar material or combination of materials.

Insert **100** has an array of fluid deflectors **124** dispersed therethroughout in FIG. **3**. Deflectors **124**, non-moving fluid mixing elements of insert **100**, are arranged in a predetermined pattern along the length of insert **100** between intake end **100**A and discharge end **100**B. Deflectors **124** are arranged longitudinally between intake and discharge ends **100**A and **100**B, and circumferentially between side edges **111** and **112**. Each deflector **124** is flat and extends from a base or inner end **125** connected to annular sidewall **101** to a free or outer end **126**. Each deflector **124** projects inwardly into volume **106** from inner surface **103** and angularly upward relative to inner surface **103** toward opening **107** of intake end **100**A from base **125** to free end **126** just inboard of or otherwise without reaching axis **120** about which annular sidewall **101** is arranged. Annular sidewall **101** is formed unitarily with deflectors **124**, each being of the same material as annular sidewall **101**, in which base **125** of each deflector **124** is integral with annular sidewall **101**. In this exemplary embodiment, each deflector **124** is cut into annular sidewall **101** and bent at its base **125** inwardly into volume **106** from inner surface **103** and out from an opening **127** therefor or otherwise from whence it was cut extending through annular sidewall **101** from outer surface **102** to inner surface **103**. Deflectors **124** in the present embodiment are coextensive and are each and its respective opening **127** generally triangular in shape, each deflector **124** tapering outwardly from its base **125** at inner surface **103** to its pointed free end **126**.

Insert **100** has a length from end edge **104** at intake end **100**B to end edge **105** at discharge end **100**B and has a standard or general length suitable for cutting to a correct length, or a preselected length corresponding to a specific application. Referring in relevant part to FIGS. **6-12**, insert **100** is suitably fabricated from a flat, elongate sheet **130** of material in FIG. **6** having surface **102**, surface **103** in FIGS. **9**, **10**, and **12**, end edges **104** and **105**, and side edges **111** and **112** extending from end edge **104** to end edge **105**. End edges **104** and **105** are parallel to one another as are side edges **111** and **112** and are perpendicular relative to side edges **111** and **112**. Sheet **130** is flat and rectangular, in which end edges **104** and **105** are equal in length as are side edges **111** and **112** and substantially shorter than side edges **111** and **112**. Deflectors **124** are each cut into sheet **130** in FIG. **7** with a die cutter, a stamping press, a laser or plasma cutter, a waterjet cutter, or other suitable technique. Each deflector **124** formed in sheet **130** extends toward end edge **105** from base **125** thereof left integral with sheet **130** to its corresponding free end **126**. Deflectors **124** are each bent at base **125** outwardly from surface **103** from the resulting opening **127** therefor through sheet **130** in the direction of arcuate arrow A in FIGS. **11** and **12** so as to point or otherwise project angularly upward relative to surface **103** toward end edge **104** from base **125** to free end **126** to form a static mixer insert segment **135** in FIGS. **8**, **9**, **10** and **11**. Each deflector **124** is bent by hand or with the use of a suitable bending tool. Insert **100** is formed simply by roll-forming segment **135**, namely, by rolling sheet **130** inwardly toward inner surface **103** to close side edges **111** and **112** on either side of the resulting end gap **100** to form the resulting hollow, tubular insert **100** in FIG. **1** enclosing deflectors **124** in the resulting volume **106** extending longitudinally between openings **107** and **108** of the formed intake and discharge ends **100**A and **100**B, respectively. Segment **135** is roll-formed by hand or with suitable roll-forming equipment. Deflectors **124** are bent to their angular orientation as described so that when segment **135** is roll-formed into insert **100** the free ends **126** fall short of reaching axis **120**. This prevents deflectors **124** from becoming entangled and contacting or otherwise interfering with one another in the formed insert **100** to become bent or deflected out of position.

The non-moving deflectors **124** of segment **135** are dispersed throughout sheet **130** between end edges **104** and **105** and side edges **111** and **112** in a predetermined number and pattern suitable for mixing fluid components. By way of example, the array of deflectors **124** of segment **135** includes nine deflectors **124** arranged in three parallel rows of three equally spaced-apart deflectors **124**. The rows are parallel to end edges **104** and **105**, perpendicular to side edges **111** and **112**, and equally spaced apart vertically between end edges **104** and **105**. This arrangement and number of deflectors **124** and their previously described triangular shapes are illustrated only by example. The skilled person will readily appreciate that deflectors **124** of insert **100** can have any shape, size, varying size, arrangement, and number without departing from this disclosure.

Insert **100** is for insertion into a housing **150** in FIGS. **13** and **14** to form a static mixer **170** in FIG. **15** having no moving parts and for the passage therethrough and the mixing of fluid streams. Turning to FIG. **16**, housing **150**, an elongate, hollow form of plastic or metal or other fluid impervious material or combination of materials, includes continuous sidewall **151** having outer surface **152**, inner surface **153**, upper edge **154**, and lower edge **155**. A nozzle **156** having an outlet **157** is affixed to lower edge **155** and cooperates with inner surface **153** to form volume **160**. Nozzle **156** is frustoconical and can have other standard or chosen nozzle formats in alternate embodiments. Upper edge **154** encircles inlet **161** to volume **160**. Inlet **161**, an opening, and outlet **157**, a comparatively smaller opening of nozzle **156**, are aligned axially at either end of housing **150** and are each open to volume **160** extending longitudinally therebetween. Volume **160** defines a fluid flow path P extending longitudinally through housing **150** from inlet **161** to outlet **157** and is for the passage of fluids therethrough from inlet **161** to outlet **157**. Continuous sidewall **151** is arranged about axis **165**, extending centrally through volume **160** from inlet **161** to outlet **157**. Continuous sidewall **151** is cylindrical in this example, commensurate with the cylindrical shape of insert **100**. Part of continuous sidewall **151** proximate to inlet **161** is enlarged collar forming a circumferentially widened area of volume **160**, and thus of fluid flow path P, as shown in FIG. **16**. Housing **150** is preferably of unitary construction, being one integral body.

Housing **150** and insert **100** are assembled to form a static mixer **170** in FIGS. **15**, **16**, and **17** according to the invention by aligning insert **100** inline with volume **160** and concurrently registering discharge end **100**B of insert **100** with inlet **161** of housing **150** in FIG. **13**. Insert **100** is forcibly inserted into volume **160** simply by sliding it discharge end **100**B first into and through fluid flow path P defined by volume **160** through inlet **161** in the direction of arrow B in FIGS. **13** and **14** until, as seen in FIG. **16**, discharge end **100**B of insert **100**A comes into direct contact against nozzle **156**, which arrests insert **100** from advancing into nozzle **156**. The inherent elastically expansive property of insert **100** allows it to elastically yield to housing **150** automatically when it is inserted therein, which is the case with each insert disclosed throughout this specification. Once insert **100** is installed slidably into volume **160** of housing **150** through its inlet **161**, the length of insert **100** from intake end **100**A to discharge end **100**B is sufficient so that insert **100** extends longitudinally through fluid flow path P defined by volume **160** from discharge end **100**B proximate and open to nozzle **156** and its outlet **157** to intake end **100**A at collar **167** proximate and open to inlet **161**. Part of intake end **100**A of insert **100** extends into the widened area of volume **160** defined by collar **167** in FIG. **16** inboard of inlet **161**. Insert **100** and housing **150** and their respective volumes **106** and **160** are coaxial about coincident axes **120** and **165**. Fluid flow path P extends concurrently through both housing **150** from inlet **161** to outlet **157** and insert **100** from opening **107** of intake end **100**A to opening **108** of discharge end **100**. Deflectors **124** circumferentially and longitudinally arranged in fluid flow path P each project inwardly into the coaxial volumes **106** and **160** and, thus, into fluid flow path P away from inner surface **153** of housing **150** and from inner surface **103** of annular sidewall **101** between intake end **100**B of insert **100** and discharge end **100**B of insert **100** without reaching coincident axes **120** and **165** in this example. Since annular sidewall **101** of insert **100** is elastically expansive, it is tensioned when inserted in fluid flow path P of housing **150** to exert an outward pressure or force by outer surface **102** against inner surface **153** of continuous sidewall **151** frictionally engaging outer surface **102** of insert **100** directly against inner surface **153** of housing **150**. This frictionally secures insert **100** in volume **160** to housing **150** and thereby secures deflectors **124** in fluid flow path P extending through insert **100** from intake end **100**A open to inlet **161** of housing **150** to discharge end **100**B open to outlet **157** of nozzle **156**.

And so annular sidewall **101** of insert **100** is elastically expansive, having a tendency to expand, to create a resilient frictional fit of outer surface **102** of annular sidewall **101** directly against inner surface **153** of housing **150**. Annular sidewall **101** serves as an elastically expansive carrier or frame for deflectors **124** that elastically conforms to and frictionally engages outer surface **102** directly against inner surface **153** of housing **150** when inserted therein. As installed in housing **150**, annular sidewall **101** is thereby tensioned due to its inherent tendency to expand urging outer surface **102** in direct frictional engagement against inner surface **153** of housing **150** securing insert **100** in place frictionally according to the invention thereby obviating the need for separate fasteners, welding, adhesive, end caps, or the like. The unit tension or unit pressure, which is the amount of pressure exerted by outer surface **102** of insert **100** against inner surface **153** of housing **150**, is sufficient to frictionally secure outer surface **102** of insert **100** to inner surface **153** of housing **150** to thereby secure deflectors **124** in place in fluid flow path P according to the invention. With static mixer **170** so assembled, static mixer **170** being an exemplary housed static mixer, fluid streams, whether gas streams, liquid streams, liquid and gas streams, suitably pumped through fluid pathway P according to standard techniques from inlet **161** to outlet **157** enter fluid pathway P through inlet **161**, enter insert **100** through intake end **100**A from inlet **161**, encounter and are automatically and continuously mixed by deflectors **124** suitably positioned and oriented in fluid flow path P as they flow therethrough and through insert **100** from intake end **100**A to discharge end **100**B open to outlet **157**, enter nozzle **156** from discharge end **100**B, and exit suitably mixed through nozzle **156** outlet **157**. In an alternate embodiment, side edges **111** and **112** may be secured, such as by welding, adhesive, heat bonding, or the like, to secure annular sidewall **101**. In this embodiment, insert **100** is sized accordingly so outer surface **102** directly and sufficiently frictionally engages inner surface **153** of housing **150** to frictionally secure insert **100** in place when insert **100** is inserted into housing **150** as herein described.

To withdraw insert **100** from housing **150** for repair, adjustment, cleaning, replacement, or other servicing of either component, the described method of assembling insert **100** with housing **150** to form static mixer **170** need only be reversed. Since part of intake end **100**A of insert **100** extends into the widened area of volume **160** defined by collar **167** in FIG. **16** inboard of inlet **161**, it can be taken up by a handheld pliers or other gripping tool and used to pull insert **100** outwardly from fluid flow path P through inlet **161**.

As explained above, the deflectors or fluid mixing elements of a static mixer insert segment and the static mixer insert formed therefrom according to the invention can be configured in any desired shape, size, arrangement, and number without departing from this disclosure. The shapes and sizes can be the same or different. Examples static mixer insert segments and corresponding static mixer inserts having varying deflector configurations are shown by way of example in FIGS. **18-36**. Except for the varying configurations, the structure of each segment and the corresponding

insert formed therewith in the ensuing FIGS. **18-36** and how they are each assembled with a housing to form a static mixer are identical to segment **135** and its corresponding insert **100** and its assembly with housing **150**. Accordingly, the same reference numerals are used for segment **135** and insert **100** are also used with each segment and its corresponding insert where appropriate in FIGS. **18-36**.

Turning now to FIGS. **18-36**, FIG. **18** illustrates an alternate embodiment of a static mixer insert segment **200** having an array of forty-two small triangular deflectors **124** arranged in parallel rows and upright parallel columns and shown formed into a static mixer insert **201** in FIG. **19**.

FIG. **20** illustrates yet another embodiment of a static mixer insert segment **210** having ten triangular deflectors **124** that longitudinally offset from one another larger and that are larger than deflectors **124** of segment **211**. FIG. **21** illustrates segment **210** formed into a static mixer insert **211**.

FIG. **22** illustrates still another embodiment of a static mixer insert segment **220** having thirty triangular deflectors **124** that are squattier and somewhat larger than deflectors **124** of segment **200** and smaller than deflectors **124** of segment **210**, and which are arranged in three, upright parallel rows. FIG. **23** illustrates segment **220** formed into a static mixer insert **221**.

FIG. **24** illustrates yet still another embodiment of a static mixer insert segment **230** having six, offset triangular deflectors **124** that are somewhat larger than deflectors **124** of segment **210**. FIG. **25** illustrates segment **230** formed into a static mixer insert **231**.

FIG. **26** illustrates another embodiment of a static mixer insert segment **240** having six deflectors **124** each generally shaped like an isosceles trapezoid. FIG. **27** illustrates segment **240** formed into a static mixer insert **241**.

FIG. **28** illustrates yet another embodiment of a static mixer insert segment **250** having twelve deflectors **124** each generally shaped like those of segment **240** but smaller and squattier in comparison and arranged in six, alternatively offset parallel rows. FIG. **29** illustrates segment **250** formed into a static mixer insert **251**.

FIG. **30** illustrates still embodiment of a static mixer insert segment **260** that is similar to segment **250** except that the outer end **126** of each deflector **124** is jagged. FIG. **31** illustrates segment **260** formed into a static mixer insert **261**.

FIG. **32** illustrates yet still another embodiment of a static mixer insert segment **270** that is similar to segment **220** except that the side edges **111** and **112** are configured with teeth **111**A and **112**A. FIG. **33** illustrates segment **270** formed into a static mixer insert **271**. In FIG. **34**, teeth **111**A and **112**A intermesh when insert **271** is installed in housing **150** to form static mixer **272**. The intermeshing of teeth **111**A with teeth **112**A mechanically disables side edges **111** and **112** from longitudinally displacing relative to one another in static mixer **272**.

FIG. **35** illustrates yet another embodiment of a static mixer insert segment **280** having forty deflectors **124**. An opening or hole **124**A through each deflector **124** enhances its fluid mixing property by imparting more fluid turbulence in the fluid streams. FIG. **36** illustrates segment **250** formed into a static mixer insert **281**.

Attention is now directed to FIGS. **37-39** illustrating still another embodiment of a static mixer insert **300** constructed and arranged according to the invention. Insert **300** is for insertion into a housing for mixing fluid streams applied through the housing, whether gas streams, fluid streams, or fluid and gas streams, similar to insert **100**. Insert **300** includes a helical member **301** having outer surface **302**, inner surface **303**, upper edge **303**, and lower edge **304** concurrently extending helically between a proximal end **310** at an intake end **300**A of helical member **301** and a distal end **311** at a discharge end **300**B of helical member **301**. Helical member **301** is a circular helix, i.e. one with a constant radius. In this example, helical member **301** is a helical sidewall extending vertically upright, in which inner and outer surfaces **302** and **303** are flat and parallel relative to one another. Inner surface of **302** of helical member **301** spirals about a volume **315** for the passage of fluid streams extending longitudinally through insert **300** from intake end **300**A open to volume **315** to discharge end **300**B open from volume **315**. In other words, helical member **301** spirals about and defines volume **315** extending longitudinally therethrough by inner surface **303**.

Intake end **300**A and discharge end **300**B are each open to volume **315** and are aligned axially. Helical member **301** is arranged about axis **318**, extending centrally through volume **315** from intake end **300**A to discharge end **300**B. Helical member **301** is tensionable, being fabricated of plastic, a malleable metal, such as ductile iron, or steel, a cellulosic composition, or other like or similar material or combination of materials.

Identical to the previously-described inserts, insert **300** has deflectors **124** dispersed therethroughout. The array of deflectors **124** are arranged in a predetermined pattern along the length of helical member **301** between intake end **300**A and discharge end **300**B. In this embodiment, deflectors **124** are spaced apart along the length of helical member **301** between proximal end **310** at the intake end **300**A of insert **300** and distal end **311** at the discharge end **300**B of insert **300**. Since deflectors **124** follow helical member **301**, they are spaced apart helically. Deflectors **124** are equally spaced apart in this embodiment, being equally spaced apart helically between intake end **300**A and discharge end **300**B, and are each centered between upper and lower edges **304** and **305**. The spacing between adjacent deflectors **124** and the arrangement of deflectors **124** between intake and discharge ends **300**A and **300**B can vary in alternate embodiments.

Each deflector **124** is flat and extends from base or inner end **125** connected to helical member **301** to free or outer end **126**. Each deflector **124** projects inwardly into volume **315** from inner surface **303** and angularly upward relative to inner surface **303** toward intake end **300**A from base **125** to free end **126** inboard of or otherwise without reaching axis **318** about which helical member **301** is arranged. Helical member **301** is formed unitarily with deflectors **124**, each being of the same material as helical member **301**, in which base **125** of each deflector **124** is integral with helical member **301**. Like insert **100**, each deflector **124** of insert **300** is cut into helical member **301** and bent at its base **125** inwardly into volume **315** from inner surface **303** and out from an opening **127** therefor or otherwise from whence it was cut extending through helical member **301** from outer surface **302** to inner surface **303**. Deflectors **124** in this embodiment are coextensive and are each generally square in shape, although they may be of any desired shape or relative size as required. Insert **300** has a length from intake end **300**A to discharge end **300**B and has a standard or general length suitable for cutting to a correct length, or a preselected length corresponding to a specific application.

Insert **300** is configured for insertion into the previously-described housing **150** in FIGS. **40** and **41** to form a static mixer **320** in FIGS. **42** and **44** having no moving parts and for the passage therethrough and the mixing of fluid streams. Housing **150** and insert **300** are assembled to form static mixer **320** by aligning insert **300** inline with volume **160** and concurrently registering discharge end **300**B of insert **300**

with inlet **161** of housing **150** in FIG. **40**. Insert **300** is forcibly inserted into volume **160** simply by twisting it slightly to compress it as shown in FIG. **41** to slightly reduce its outer diameter and sliding it discharge end **300**B first into and through fluid flow path P defined by volume **160** through inlet **161** in the direction of arrow C in FIGS. **40** and **41** until, as seen in FIG. **44**, discharge end **300**B of insert **300** comes into direct contact against nozzle **156**, which arrests insert **300** from advancing into nozzle **156**. The inherent elastically expansive property of insert **300** allows it to elastically yield to housing **150** automatically when it is inserted therein. Once insert **300** is installed slidably into volume **160** of housing **150** through its inlet **161**, the length of insert **300** from intake end **300**A to discharge end **300**B is sufficient so that insert **300** extends longitudinally and helically through fluid flow path P defined by volume **160** from discharge end **300**B proximate and open to nozzle **156** and its outlet **157** to intake end **300**A at collar **167** proximate and open to inlet **161**. Part of intake end **300**A of insert **300** extends into the widened area of volume **160** defined by collar **167** in FIG. **44** inboard of inlet **161**. Insert **300** and housing **150** and their respective volumes **315** and **160** are coaxial about coincident axes **318** and **165**. Fluid flow path P extends concurrently through both housing **150** from inlet **161** to outlet **157** and insert **300** from intake end **300**A to discharge end **300**B. Deflectors **124** helically arranged in fluid flow path P each project inwardly into the coaxial volumes **315** and **160** and, thus, into fluid flow path P away from inner surface **153** of housing **150** and from inner surface **303** of helical member **301** between intake end **300**A of insert **300** and discharge end **300**B of insert **300** without reaching coincident axes **318** and **165** in this example. Since helical member **301** of insert **300** is elastically expansive, it is tensioned and partially uncompressed when inserted in fluid flow path P of housing **150** in FIG. **44** to exert an outward pressure or force by outer surface **302** against inner surface **153** of continuous sidewall **151** frictionally engaging outer surface **302** of insert **300** directly against inner surface **153** of housing **150**. This frictionally secures insert **300** in volume **160** to housing **150** and thereby secures deflectors **124** in fluid flow path P extending through insert **300** from intake end **300**A open to inlet **161** of housing **150** to discharge end **300**B open to outlet **157** of nozzle **156**.

And so helical member **301** of insert **300** is elastically expansive, having a tendency to expand, to create a resilient frictional fit of outer surface **302** of helical member **301** directly against inner surface **153** of housing. Helical member **301** serves as another embodiment of an elastically expansive carrier or frame for deflectors **124** according to the invention that elastically conforms to and frictionally engages outer surface **302** direction against inner surface **153** of housing **150** when inserted therein according to the invention. As installed in housing **150**, helical member **301** is tensioned due to its inherent tendency to expand urging outer surface **302** in direct frictional engagement against inner surface **153** of housing **150** securing insert **300** in place frictionally according to the invention thereby obviating the need for separate fasteners, welding, adhesive, end caps, or the like. The unit tension or unit pressure, which is the amount of pressure exerted by outer surface **302** of insert **300** against inner surface **153** of housing **150**, is sufficient to frictionally secure outer surface **302** of insert **300** to inner surface **153** of housing **150** to thereby secure deflectors **124** in place in fluid flow path P according to the invention. With static mixer **320** so assembled, static mixer **320** being an exemplary housed static mixer, fluid streams, whether gas streams, liquid streams, liquid and gas streams, suitably pumped through fluid pathway P according to standard techniques from inlet **161** to outlet **157** enter fluid pathway P through inlet **161**, enter insert **300** through intake end **300**A from inlet **161**, encounter and are automatically and continuously mixed by deflectors **124** suitably positioned and oriented in fluid flow path P as they flow therethrough and through insert **300** from intake end **300**A to discharge end **300**B open to outlet **157**, enter nozzle **156** from discharge end **300**B, and exit suitably mixed through outlet **157** from discharge end **300**B.

To withdraw insert **300** from housing **150** for repair, adjustment, cleaning, replacement, or other servicing of either component, the described method of assembling insert **300** with housing **150** to form static mixer **320** need only be reversed. Since part of intake end **300**A of insert **300** extends into the widened area of volume **160** defined by collar **167** in FIG. **44** inboard of inlet **161**, it can be taken up by a handheld pliers or other gripping tool and used to pull insert **300** outwardly from fluid flow path P through inlet **161**.

FIGS. **45-47** illustrates still another embodiment of a static mixer insert **330** constructed and arranged according to the invention. Insert **330** is configured for insertion into a housing for mixing fluid streams applied through the housing, whether gas streams, fluid streams, or fluid and gas streams. Insert **330**, made up of helical member **331** and helical deflector **350**, is tensionable, being fabricated of plastic, a malleable metal, such as ductile iron, or steel, or other like or similar material useful for compression seating according to the invention.

Helical member **331** has outer surface **332**, inner surface **333**, upper edge **333**, and lower edge **334**, all of which concurrently extend helically between a proximal end **340** at an intake end **330**A of insert **300** and a distal end **341** at a discharge end **330**B of insert **300**. In this example, helical member **331** is a helical sidewall extending vertically upright, in which inner and outer surfaces **332** and **333** are flat and parallel relative to one another. Inner surface of **333** of helical member **301** spirals about a volume **345** for the passage of fluid streams extending longitudinally through insert **330** from intake end **330**A open to volume **345** to discharge end **330**B open from volume **345**. In other words, helical member **331** spirals about and defines volume **345** extending longitudinally therethrough by inner surface **333**. Intake end **330**A and discharge end **330**B, each of which are open to volume **345**, are aligned axially. Helical member **331** is a circular helix, i.e. one with a constant radius, arranged about axis **348** extending centrally through volume **345** from intake end **330**A to discharge end **330**B.

Helical deflector **350** has upper surface **351**, lower surface **352**, and outer edge **353**, all of which concurrently extend helically between a proximal end **350** at an intake end **330**A of insert **300** and a distal end **341** at a discharge end **330**B of insert **300**. Deflector **350**, a helical platform, extends inwardly into volume **345** from helical member **331** to outer edge **353** inboard of or otherwise without reaching axis **348** and longitudinally and helically through volume **345** along the length of insert **330** from proximal end **340** at the intake end **330**A of insert **330** to distal end **341** at the discharge end **330**B of insert **330**. Deflector **350** extends helically about axis **348** through volume **345** from proximal end **340** at the intake end **330**A of insert **330** to distal end **341** at the discharge end **330**B of insert **330**. Deflector **350** helically follows helical member **331** and extends inwardly into volume **345** in this example from upper edge **334** to outer edge **353**, being bent inwardly from upper edge **334** in this particular example. Insert **330** is formed unitarily with deflector **350**, in which deflector **350** is integral with helical

member **331**. Like helical member **331**, deflector **350** is a circular helix, i.e. one with a constant radius, arranged about axis **348** extending centrally through volume **345** from intake end **330**A to discharge end **330**B.

Insert **330** is configured for insertion into the previously-described housing **150** to form a static mixer **360** in FIG. **48** having no moving parts and for the passage therethrough and the mixing of fluid streams. Housing **150** and insert **330** are assembled to form static mixer **360** by aligning insert **330** inline with volume **160** and concurrently registering discharge end **330**B of insert **330** with inlet **161** of housing **150**. Insert **330** is forcibly inserted into volume **160** by sliding it discharge end **330**B first into and through fluid flow path P defined by volume **160** through inlet **161** until, as seen in FIG. **46**, discharge end **330**B of insert **330** comes into direct contact against nozzle **156**, which arrests insert **330** from advancing into nozzle **156**. The inherent elastically expansive property of insert **330** allows it to elastically yield to housing **150** automatically when it is inserted therein. Once insert **330** is installed slidably into volume **160** of housing **150** through its inlet **161**, the length of insert **330** from intake end **330**A to discharge end **330**B is sufficient so that insert **330** extends longitudinally and helically through fluid flow path P defined by volume **160** from discharge end **330**B proximate and open to nozzle **156** and its outlet **157** to intake end **330**A at collar **167** proximate and open to inlet **161**. Part of intake end **330**A of insert **330** extends into the widened area of volume **160** defined by collar **167** in FIG. **46** inboard of inlet **161**. Insert **330** and housing **150** and their respective volumes **345** and **160** are coaxial about coincident axes **348** and **165**. Fluid flow path P extends concurrently through both housing **150** from inlet **161** to outlet **157** and insert **330** from intake end **330**A to discharge end **330**B. Deflector **350** longitudinally and helically arranged in fluid flow path P about coincident axes **348** and **160** projects inwardly into the coaxial volumes **345** and **160** and, thus, into fluid flow path P away from inner surface **153** of housing **150** and from inner surface **333** of helical member **331** between intake end **330**A of insert **330** and discharge end **330**B of insert **330** without reaching coincident axes **348** and **165** in this example. Since insert **300** is elastically expansive, it is tensioned when inserted in fluid flow path P of housing **150** in FIG. **44** to exert an outward pressure or force by outer surface **332** of helical member **331** against inner surface **153** of continuous sidewall **151** frictionally engaging outer surface **332** of insert **330** directly against inner surface **153** of housing **150**. This frictionally secures insert **330** in volume **160** to housing **150** and thereby secures deflector **350** in fluid flow path P extending through insert **330** from intake end **330**A open to inlet **161** of housing **150** to discharge end **330**B open to outlet **157** of nozzle **156**.

And so insert **330** is elastically expansive, having a tendency to expand, to create a resilient frictional fit of outer surface **332** of helical member **331** directly against inner surface **153** of housing **150**. Accordingly, annular helical member **331** serves as an elastically expansive carrier that elastically conforms to and frictionally engages inner surface **153** of housing **150** when inserted therein. As installed in housing **150**, insert **300** is tensioned due to its inherent tendency to expand urging outer surface **332** in frictional engagement against inner surface **153** of housing **150** securing insert **330** in place frictionally according to the invention thereby obviating the need for separate fasteners, welding, adhesive, end caps, or the like. The unit tension or unit pressure, which is the amount of pressure exerted by outer surface **332** of insert **330** against inner surface **153** of housing **150**, is sufficient to frictionally secure outer surface **332** of insert **330** to inner surface **153** of housing **150** to thereby secure deflector **350** in place in fluid flow path P according to the invention. With static mixer **360** so assembled, static mixer **360** being an exemplary housed static mixer, fluid streams, whether gas streams, liquid streams, liquid and gas streams, suitably pumped through fluid pathway P according to standard techniques from inlet **161** to outlet **157** enter fluid pathway P through inlet **161**, enter insert **330** through intake end **330**A from inlet **161**, encounter and are automatically and continuously and helically mixed by deflector **350** suitably positioned and oriented in fluid flow path P as they flow therethrough and through insert **330** from intake end **330**A to discharge end **330**B open to outlet **157**, enter nozzle **156** from discharge end **330**B, and exit suitably mixed through outlet **157** from discharge end **330**B.

To withdraw insert **330** from housing **150** for repair, adjustment, cleaning, replacement, or other servicing of either component, the described method of assembling insert **330** with housing **150** to form static mixer **360** need only be reversed. Since part of intake end **330**A of insert **330** extends into the widened area of volume **160** defined by collar **167** in FIG. **48** inboard of inlet **161**, it can be taken up by a handheld pliers or other gripping tool and used to pull insert **330** outwardly from fluid flow path P through inlet **161**.

FIGS. **49-51** illustrate still another embodiment of a static mixer insert **370** constructed and arranged according to the invention. Insert **370** is configured for insertion into a housing for mixing fluid streams applied through the housing, whether gas streams, fluid streams, or fluid and gas streams. Insert **370** is identical in every respect to insert **330** and is assembled with housing **150** to form a static mixer **375** in FIG. **52** in the same way insert **330** and housing **150** are assembled. Accordingly, the previously discussion of insert **330** and its static mixer **360** applies in every respect to insert **370** and its static mixer **375**, and the same reference characters are used. The difference between insert **330** and insert **370** is that deflector **350** of insert **370** has openings **350**A, which enhance the mixing property of deflector **350** by imparting more fluid turbulence in the fluid streams compared to deflector **350** of insert **330**. Openings **350**A extend through deflector **350** of insert **370** between upper edge **334** of helical member **331** and outer edge **353** of deflector **350**. Openings **350**A follow deflector **350** are spaced apart along the length of deflector **350** from intake end **330**A to discharge end **330**B. Since openings **350**A follow deflector **350** of insert **370**, they are helically spaced apart along the length of deflector **350** between intake end **330**A and discharge end **330**B. Openings **350**A are equally spaced in insert **370**, although the distance between adjacent openings **350**A can vary in alternate embodiments.

Each of the static mixer inserts discussed above include a housing configured with one insert. A static mixer constructed and arranged according to the invention can be configured with more than one insert in alternate embodiments, whether two identical inserts as shown in static mixer **380** in FIG. **53** or two different inserts as shown in static mixer **390** in FIG. **54**, stacked one atop the other.

Referring briefly to FIG. **53**, static mixer **380** includes housing **150**A and two inserts **100'** and **100"**. Housing **150**A is identical to housing **150** structurally being different only in that it is comparatively longer to accommodate two inserts **150**A that are each identical to insert **100**. Accordingly, the reference characters used for insert **100** and housing **150** are also used where appropriate with inserts **100'** and **100"** and housing **150**A.

In static mixer **380**, insert **100'** extends longitudinally through fluid flow path P from its discharge end **100**B proximate and open to nozzle **156** and its outlet **157** to intake end **100**A at an intermediate location between outlet **157** and inlet **161**. Insert **100"** extends longitudinally through fluid flow path P from its discharge end **100**B proximate and open to intake end **100**A of insert **100"** to its intake end **100**A at collar **167** proximate and open to inlet **161**. Fluid streams, whether gas streams, liquid streams, liquid and gas streams, suitably pumped through fluid pathway P according to standard techniques from inlet **161** to outlet **157** enter fluid pathway P through inlet **161**, enter insert **100"** through its intake end **100**A from inlet **161**, encounter and are automatically and continuously mixed by deflectors **124** of insert **100"** suitably positioned and oriented in fluid flow path P as they flow therethrough and through insert **100"** from its intake end **100**A to its discharge end **100**B open to intake end **100**A of insert **100'**. The fluids enter insert **100'** through its intake end **100**A from discharge end **100**B of insert **100"**, encounter and are automatically and continuously mixed by deflectors **124** of insert **100'** suitably positioned and oriented in fluid flow path P as they flow therethrough and through insert **100'** from its intake end **100**A to its discharge end **100**B open to nozzle **156** and outlet **157**, enter nozzle **156** from discharge end **100**B of insert **100'**, and exit suitably mixed through nozzle **156** outlet **157**.

Referring briefly to FIG. **54**, static mixer **390** includes housing **150**B and two inserts **300'** and **330'**. Housing **150**B is identical to housing **150** structurally being different only in that it is comparatively longer to accommodate two inserts **300'** and **330'**. Inserts **300'** and **330'** are different from one another in this example, in which insert **300'** is identical to insert **300** and insert **330'** is identical to insert **330**. Accordingly, the reference characters used for housing **150**, insert **300**, and insert **330** are also used where appropriate with housing **150**B, insert **300'**, and insert **330'**, respectively.

In static mixer **390**, insert **300'** extends longitudinally through fluid flow path P from discharge end **300**B proximate and open to nozzle **156** and its outlet **157** to intake end **300**A at an intermediate location between outlet **157** and inlet **161**. Insert **330'** extends longitudinally through fluid flow path P from its discharge end **330**B proximate and open to intake end **300**A of insert **300'** to its intake end **330**A at collar **167** proximate and open to inlet **161**. Fluid streams, whether gas streams, liquid streams, liquid and gas streams, suitably pumped through fluid pathway P according to standard techniques from inlet **161** to outlet **157** enter fluid pathway P through inlet **161**, enter insert **330'** through its intake end **330**A from inlet **161**, encounter and are automatically and continuously mixed by deflector **350** of insert **330'** suitably positioned and oriented in fluid flow path P as they flow therethrough and through insert **330'** from its intake end **330**A to its discharge end **330**B open to intake end **300**A of insert **300'**. The fluids enter insert **300'** through its intake end **300**A from discharge end **330**B of insert **330**, encounter and are automatically and continuously mixed by deflectors **124** of insert **300'** suitably positioned and oriented in fluid flow path P as they flow therethrough and through insert **300'** from its intake end **300**A to its discharge end **300**B open to nozzle **156** and outlet **157**, enter nozzle **156** from discharge end **300**B of insert **300**, and exit suitably mixed through nozzle **156** outlet **157**.

It is to be emphasized that a static mixer constructed and arranged according to the invention can incorporate any combination of two or more inserts, and that the inserts can be the same or different from one another depending on specific needs.

FIGS. **55-59** illustrate a sequence of steps of constructing a static mixer **420** in FIGS. **59** and **60** from insert **100**, nozzle body **400**, and heat-shrink tube **410** according to yet another embodiment of the invention. With additional reference to FIG. **57**, nozzle body **400** includes an annular seat **401** encircling intake opening **402** at an intake end **403** and extends downwardly therefrom to an outlet **404** formed through an outlet end **405**. Intake opening **402** and comparatively smaller outlet **404** are aligned axially at either end of nozzle body **400**. Nozzle body **400** is frustoconical and can have other standard or chosen nozzle formats in alternate embodiments. Heat-shrink tube **410** is of standard construction ordinarily made of polyolefin, which shrinks radially but not longitudinally when heated to between one-half and one-sixth of its diameter. In FIG. **58**, unshrunk tube **410** has a proximal end **411**, a distal end **412**, and a length from proximal end **411** to distal end **412**.

Nozzle body **400** is fitted onto discharge end **100**B of insert **100** in FIG. **56** simply by inserting discharge end **100**B into annular seat **401** in FIG. **57**, and unshrunk tube **410** is fitted over outer surface **102** insert **100** and nozzle body **400**. Tube **410** is sufficiently long from proximal end **411** to distal end **412** to extend along over the length of insert **100** and nozzle body **410** from proximal end **411** at intake end **100**A of insert **100** to distal end **412** at nozzle body **400**. Unshrunk tube **410** is shrunk tightly around nozzle **400** and outer surface **102** of insert **100** in FIGS. **59** and **60** by the application of heat to form static mixer **420**. FIG. **60** is a side elevation view of static mixer **420** with portions of shrunk tube **410** broken away illustrating insert **100** extending therethrough to nozzle body **400**. When tube **410** is shrunk around insert **100** and nozzle body **400** in FIGS. **59** and **60**, tube **410** is wrapped tightly around both securing them together, and extends over outer surface **102** of insert **100** along the length of insert **100** from proximal end **411** at intake end **100**A to nozzle body **400** attached to discharge end **100**B, closing openings **127** through annular sidewall **101**, and beyond discharge end **100**B over nozzle body **400** in FIG. **60** to distal end **412** at an intermediate position between intake end **403** and outlet end **405**. With static mixer **420** so assembled, static mixer **420** being an exemplary housed static mixer, fluid streams, whether gas streams, liquid streams, liquid and gas streams, suitably pumped through fluid pathway P defined by volume **106** of insert **100** and nozzle body **400** according to standard techniques from intake end **100**A to outlet **404** enter fluid pathway P through intake end **100**A, encounter and are automatically and continuously mixed by its deflectors suitably positioned and oriented in fluid flow path P as they flow therethrough from intake end **100**A to discharge end **100**B open to intake opening **402** as shown in FIG. **57**, enter nozzle body **400** through intake opening **402** as shown in FIG. **57** from discharge end **100**B, and exit suitably mixed through nozzle body **400** outlet **404**. To release insert **100** and nozzle body **400** from tube **410** for repair, adjustment, cleaning, replacement, or other servicing of either component, tube **410** is simply cut away. Insert **100** and nozzle body **400** may be reassembled into a static mixer simply by shrink wrapping them in a new shrink-wrap tube.

It is to be emphasized that that any insert and any combination of two or more inserts disclosed herein may be assembled with a nozzle by the application of a shrink-wrap tube to form a static mixer according to the invention, and that the inserts of a static mixer incorporating two or more inserts can be the same or different from one another.

While the various insert and static mixer embodiments are disclosed as having generally cylindrical cross-sectional

shapes, they can have other cross-sectional shapes, such as oval, triangular, square, etc. Furthermore, the material of an insert constructed and arranged according to the invention can be fashioned with a component or combination of components designed to dissolve or otherwise mix into one or more fluid streams applied through a static mixer formed with such an insert. These one or more components can form the material of an insert, be coated onto an insert, impregnated into the material of an insert, etc. The deflectors of an insert constructed and arranged in accordance with the invention may also be configured to impart in fluid streams a desired turbulent flow mixing, laminar flow mixing, swirling mixing, etc. It is to be understood that a static mixer constructed in accordance with the invention is useful for laboratory applications, mixing two-component adhesives and sealants, wastewater treatment and chemical processing, bitumen processing, desalting crude oil, polymerization reactions, admixing of liquid additives, etc.

The present invention is described above with reference to illustrative embodiments. Those skilled in the art will recognize that changes and modifications may be made in the described embodiments without departing from the nature and scope of the present invention. Various changes and modifications to the embodiments herein chosen for purposes of illustration will readily occur to those skilled in the art. To the extent that such modifications and variations do not depart from the spirit of the invention, they are intended to be included within the scope thereof.

Having fully described the invention in such clear and concise terms as to enable those skilled in the art to understand and practice the same, the invention claimed is:

1. A static mixer for liquids or gases, comprising:

a housing including a continuous inner surface defining a fluid flow path for liquids or gases, an inlet to the fluid flow path, and an outlet from the fluid flow path; and

a hollow insert extending longitudinally through said fluid flow path between the inlet and the outlet, said hollow insert comprising an intake end open to the inlet, a discharge end open to the outlet, an outer surface between the intake end and the discharge end and facing the continuous inner surface, an inner surface between the intake end and the discharge end and facing the fluid flow path, deflectors each projecting into the fluid flow path from the inner surface, and an end gap severing the hollow insert from the intake end to the discharge end forming spaced-apart edges on either side of the end gap and extending from the intake end to the discharge end, the hollow insert elastically expansive, being tensioned outwardly toward the continuous inner surface exerting outwardly directed pressure by the outer surface directly against the continuous inner surface frictionally securing the outer surface to the continuous inner surface alone securing the hollow insert to the housing.

2. The static mixer according to claim **1**, wherein each said deflector projects angularly upward toward the inlet.

3. The static mixer according to claim **1**, wherein the hollow insert is formed unitarily with the deflectors.

4. The static mixer according to claim **3**, wherein each said deflector is bent inwardly into the fluid flow path from an opening therefor through the hollow insert.

5. A static mixer for liquids or gases, comprising:

a housing including a continuous inner surface defining a fluid flow path for liquids or gases, an inlet to the fluid flow path, and an outlet from the fluid flow path; and

an annular sidewall extending longitudinally through said fluid flow path between the inlet and the outlet, said annular sidewall comprising an intake end open to the inlet, a discharge end open to the outlet, an outer surface between the intake end and the discharge end and facing the continuous inner surface, an inner surface between the intake end and the discharge end and facing the fluid flow path, deflectors each projecting into the fluid flow path from the inner surface, and an end gap severing the annular sidewall from the intake end to the discharge end forming spaced-apart edges on either side of the end gap and extending from the intake end to the discharge end, the annular sidewall elastically expansive, being tensioned outwardly toward the continuous inner surface exerting outwardly directed pressure by the outer surface directly against the continuous inner surface frictionally securing the outer surface to the continuous inner surface alone securing the annular sidewall to the housing.

6. The static mixer according to claim **5**, wherein each said deflector projects angularly upward toward the inlet.

7. The static mixer according to claim **5**, wherein the annular sidewall is formed unitarily with the deflectors.

8. The static mixer according to claim **7**, wherein each said deflector is bent inwardly into the fluid flow path from an opening therefor through the annular sidewall.

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