(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 4 371 657 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
22.05.2024 Bulletin 2024/21

(21) Application number: **22208228.1**

(22) Date of filing: **18.11.2022**

(51) International Patent Classification (IPC):
B01F 25/432 *(2022.01)*

(52) Cooperative Patent Classification (CPC):
B01F 25/4321

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

(71) Applicant: **medmix Switzerland AG**
9469 Haag (Rheintal) (CH)

(72) Inventors:
- **Carsten, Degendorfer**
8032 Zürich (CH)
- **Jim, Giger**
9469 Haag (CH)
- **Joachim, Schoeck**
8404 Winterhur (CH)

(74) Representative: **Manitz Finsterwald**
Patent- und Rechtsanwaltspartnerschaft mbB
Martin-Greif-Strasse 1
80336 München (DE)

(54) STATIC MIXER

(57) The invention relates to a static mixer for mixing at least two components with one another comprising a plurality of mixing elements (9) with each mixing element configured to divide each component to be mixed in at least two, preferably more than two, strands of material and further configured to merge said strands of material in layers, with said plurality mixing elements being arranged along a longitudinal axis (2) of the mixer (8) behind one another, wherein the mixer further comprises a central bar (21) being arranged parallel to said longitudinal axis, with the plurality of mixing elements being arranged at an outer surface of the bar such that the mixing elements surround the central bar, wherein the central bar extends along at least 60% of a total longitudinal length of the mixer.

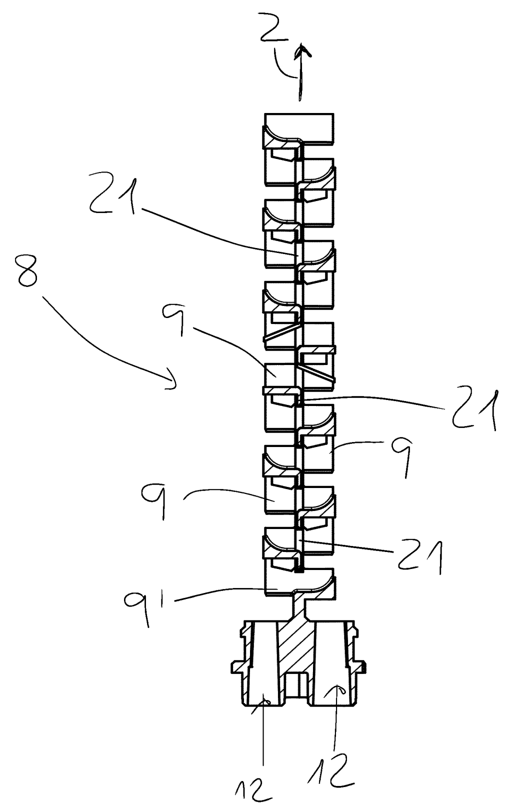


Fig. 9

EP 4 371 657 A1

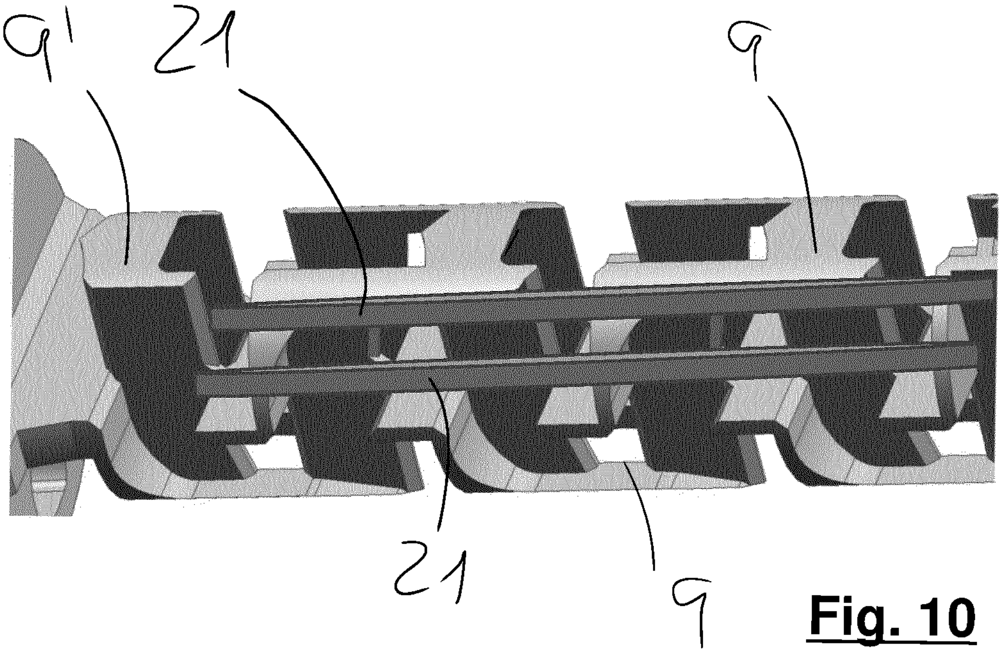


Fig. 10

Description

[0001] The invention relates to a static mixer for mixing at least two components with one another comprising a plurality of mixing elements with each mixing element configured to divide each component to be mixed in at least two, preferably more than two, strands of material and further configured to merge said strands of material in layers.

[0002] Static mixers for mixing at least two components with one another are commonly known.

[0003] With such known static mixers, different components, such as a matrix material and an associated hardener, are mixed with one another. Such two-component materials can be used, for example, as impression materials in the dental field, as cement material for prosthetic restorations, as building materials for temporary devices or for the attachment of temporary dentures, for example temporary crowns. Other areas of application are in the industrial sector, where such two-component materials are used, for example, as high-strength adhesives as a substitute for mechanical fasteners. Coatings can also be produced using such two-component materials, in particular for vapor barriers, anti-corrosion coatings and anti-slip coatings.

[0004] The components can be distributed equally, i.e. mixed in a ratio of 1:1, or unequally, i.e. in different ratios, for example in ratios of 2:1, 4:1 or 10:1. Due to the different mixing ratios, a very large range of applications can be implemented, since some applications, for example, require a larger proportion of hardener, while other applications require a lower proportion of hardener.

[0005] The static mixers, which are often also referred to as mixer tips, are usually attached to a cartridge in which the two components are stored in separate chambers. The components are forced out of the cartridge via pistons, which may be mechanically, electrically or pneumatically driven, for example, and enter the static mixer via the mixer inlet section. When flowing through the mixing elements arranged one behind the other, the components are repeatedly divided into partial flows and then connected to one another again until the components are sufficiently mixed at the downstream end of the static mixer. The components mixed in this way ultimately emerge from a discharge opening in the mixer housing at the downstream end of the static mixer and are applied to the desired application site.

[0006] Usually such mixers can be attached to mixing assemblies comprising one or two cartridges. Upon use of such assemblies and mixers, the two materials stored inside the one respectively the two cartridges are urged towards the outlets of said cartridges such that they are dispensed into the static mixer. Inside said static mixers, the two materials are then mixed with one another before the resulting mixed material is dispensed via a dispensing outlet at a front end of the mixer.

[0007] In particular with relatively small mixing tube diameters, the diameter of the mixing elements is also relatively small. In order to be able to push a sufficient amount of material to be mixed through the mixing tube, the mixing elements must occupy a relatively small volume proportion of the tubular mixer housing, so that the wall thickness of the individual sections of the mixing elements is usually relatively thin.

[0008] In order to increase the stability of the mixing elements, it is known to connect the individual mixing elements to one another by radially external web elements. However, these external web elements restrict the free volume within the mixing tube that is available for the components to be mixed, which can be disadvantageous.

[0009] Another known option to enhance the stability of such static mixers is to provide them with up to four longitudinal bars that are arranged at an outer surface of the mixing elements such that the bars surround the mixing elements from a radially outer side to provide them with an adequate stability. However, also this option has shown to have the same disadvantages as the web-option discussed above.

[0010] Therefore, it is an object of the invention to provide a static mixer with which the above mentioned drawbacks can be overcome. This object is solved by the subject matter of independent claim 1.

[0011] The static mixer according to the invention comprises a plurality of mixing elements with each mixing element configured to divide each component to be mixed in at least two, preferably more than two, strands of material and further configured to merge said strands of material in layers. Furthermore, said plurality mixing elements is arranged along a longitudinal axis of the mixer behind one another.

[0012] The invention is further characterized in that the mixer further comprises a central bar being arranged parallel to said longitudinal axis, with the plurality of mixing elements being arranged at an outer surface of the bar such that the mixing elements surround the central bar, and in that said central bar extends along at least 60% of a total longitudinal length of the mixer.

[0013] That is, contrary to conventionally known static mixers the mixer according to the invention comprises only one bar that is arranged at the center of the mixer and not at an outer surface thereof. By arranging the bar at the center of the mixer with the mixing elements being arranged around said central bar. This arrangement has the advantage that the mixing capability of the mixer can be enhanced while simultaneously keeping the mechanical stability of the mixer.

[0014] By arranging the central bar at the center of the mixer, i.e. by arranging the mixing elements at an outer surface of the central bar, the two components that are supposed to be mixed with one another can move freely through the plurality of mixing elements without encountering any obstacles and/or obstructions along their way as it is the case with the longitudinal bars of the prior art mixers that are arranged at the outer surfaces of the mixing elements.

[0015] Another advantage compared to the prior art mixers is that by arranging a central bar instead of two or more bars at the outer surface of the mixing element, material, i.e. plastic, can be reduced as only one stability bar is needed with the mixer according to the invention. A reduction of material is advantageous both in view of sustainability reasons as well as cost reasons.

[0016] In this connection it should also be noted that the central bar can either be formed as one single bar or also as two or more separate bars of smaller dimension, which each bar being arranged in the center of the mixer, i.e. such that the mixing elements surround the two or more central bars.

[0017] The central bar according to the invention further extends along at least 60% of a total longitudinal length of the mixer. That is, it is possible that said central bar extends along the complete longitudinal length or only along a part of its longitudinal length which is at least 60% of its total length. The precise length of the central bar can be chosen according to the application field of the mixer and/or according to its overall dimensions and/or according to the materials that are supposed to be mixed with one another, for instance.

[0018] According to an embodiment of the invention the central bar extends along at least 75% of the total longitudinal length of the mixer. Hence, said central bar can extend along at least ¾ of the total length of the mixer. This can, for example, be advantageous if the overall dimensions of the mixer are not chosen to be too small such that the mixing elements themselves comprise an inherent stability.

[0019] According to a further embodiment the central bar extends along at least 90% of the total longitudinal length of the mixer. That is, the central bar can extend along almost the complete the complete length of the mixer. This can for example be advantageous when the overall dimensions of the mixer are chosen to be rather small such that the mixing elements need more additional stability.

[0020] According to another embodiment of the invention the central bar can also extend along the complete longitudinal length of the mixer, i.e. along all of the plurality of mixing elements.

[0021] Thus, it can be seen from the above embodiments that the precise longitudinal length of the central bar can be chosen freely with the only limitation being the minimum of length of at least 60% of the complete longitudinal length of the mixer.

[0022] According to a further embodiment the static mixer comprises a housing that covers at least some of the plurality of mixing elements. Said housing can for example serve as an outer wall of the mixer that encloses the mixing elements such that when the two materials to be mixed flow through said mixing elements they also flow along an inner surface of the housing. Therefore, the dimensions as well as the materials of the housing can be chosen such that the materials that flow through the mixer can easily flow along the inner surface of the mixer without sticking to it and/or without being hindered by any obstructions such as ribs or projections or the like.

[0023] In this connection it is also noted that the housing can cover at least 60% of the total longitudinal length of the mixer. According to a further embodiment the housing can cover at least 75%, preferably more than 90%, of the total longitudinal length of the mixer. That is, the longitudinal length of the housing can for example be chosen in accordance with the length of the central bar such that for example the length of the housing corresponds with the length of the central bar. In other cases the length of the housing can be chosen inversely proportional to the length of the central bar. In yet other cases the length of the housing and the length of the central bar do not stand in any correspondence with one another. Hence, it can be seen that also the length of the housing can be chosen freely.

[0024] According to still another embodiment the static mixer further comprises alignment means configured to align the mixer centrally with respect to the housing. A precise alignment of the mixer with respect to the housing can be needed to allow an even mixing of the materials as then the housing surrounds the mixing elements evenly at each side and/or at along their circumference at an even distance.

[0025] In this connection it should also be noted that the alignment means can be configured to alter at least an inner shape of the housing such that mixer is aligned centrally with respect to the housing. Hence, the alignment means can for example be a part of the inner surface of the housing or can be arranged at the inner surface of the housing. The alignment means can further be configured to guide the housing along the mixing elements upon attachment of the housing to allow an even covering of the mixing elements.

[0026] Alternatively or additionally the alignment means can be configured to press-fit and/or spring-fit the mixer into the housing. Such a press-fit and/or spring-it connection can be advantageous to allow for a safe fixation of the housing.

[0027] According to a further embodiment of the invention a most downstream mixing element does not comprise a central bar, in order to centrally dispense the mixed material from the static mixer. This can ensure that the mixed material can be dispensed centrally out of the mixer without needing any additional centering elements. In this connection it can also be possible that said most downstream mixing element comprises an opening instead of said central bar through which the mixed material can be dispensed.

[0028] According to a further embodiment the static mixer comprises a transverse edge and at an angle to the transverse edge extending guide walls and at an angle to the longitudinal axis arranged guide elements with openings, wherein each mixing element has a transverse edge with an adjoining transverse guide wall and at least two guide walls which open into separating edges with lateral ones - end sections and at least one bottom section arranged between the guide walls, which has at least one opening on one side of the transverse edge and at least two openings on the other side of the transverse edge.

[0029] According to another embodiment each mixing element comprises: first and second guide walls with a common transversal edge, a separating edge at an end opposite the common transversal edge, wherein the guide walls form a curved and continuous transition between the separating edges and the common transverse edge, wherein the transversal edge divides the material to be mixed, and wherein the first and second guide walls and common transversal edge of a mixing element divide the components into six flow paths.

[0030] It is further also possible that each mixing element is configured to merge said strands of material in layers at an outlet side of the respective mixing element. This way the materials to be mixed with one another are merged after passing each mixing element thereby enhancing the mixing quality of the mixer. This can also lead to a reduction of mixing elements and therefore also to a reduction of the length of the mixer as less mixing elements may be needed to provide a reliably good mixing quality.

[0031] According to yet another embodiment the mixing element is configured to divide each component to be mixed at an inlet side of the respective mixing element. This way each component, i.e. each material, can be split up into two or more strands which are then mixed with the second component. This can be advantageous as several rather small strands of material can be mixed better with one anther as only two rather thick strands of material.

[0032] According to a further embodiment a cross section of the central bar is different from a cross section of a guide wall of the mixing element, in particular the guide wall as defined above, for example the cross-section of the central bar can be selected from the group of members consisting of a square cross-section, a triangular cross-section, a rectangular cross-section, a round cross-section, an oval cross-section, a polygonal cross-section and combinations of the foregoing. Similarly the guide wall can have a cross-section selected from the group of members consisting of a square cross-section, a triangular cross-section, a rectangular cross-section, a round cross-section, an oval cross-section, a polygonal cross-section and combinations of the foregoing, the only difference is that the cross-section has to be different from that of the central bar. This means that if the central bar is selected with e.g. a round or square cross-section, then the guide wall should have a rectangular cross-section or any of the other cross-sections.

[0033] According to further embodiment of the invention a cross section of the central bar is larger than a cross section of a guide wall of the mixing element, in particular in particular 1.01 to 3 times larger, especially 1.02 to 1.5 times larger. That is, according to the invention the central bar is not only an imaginary line that connects the mixing elements with one another but rather an independent component that may either be formed as a separate component or that may be formed integrally with the mixing elements.

[0034] The invention is further described in connection with the following embodiments depicted in the Figures, which show:

Fig. 1:	a static mixer according to prior art;
Fig. 2:	the static mixer of Fig. 1;
Fig. 3:	a detailed view of a mixer according to prior art;
Fig. 4:	another detailed view of the mixer of Fig. 4;
Fig. 5:	the mixer of Fig. 3;
Fig. 6:	a cross section of the mixer of Fig. 5;
Fig. 7:	another cross section of the mixer of Fig. 5;
Fig. 8:	a side view of the mixer according to prior art;
Fig. 9:	a static mixer according to the invention;
Fig. 10:	another embodiment of the static mixer according to the invention.

[0035] Fig. 1 shows a static mixer 1 according to the prior art which comprises a mixer housing 3 extending along a longitudinal axis 2. The mixer housing 3 has a tubular section 4 and an enlarged section 5 adjoining the tubular section 4 upstream thereof. The mixer 1 can be attached in a known manner to a cartridge containing components to be mixed by means of attachment means 7.

[0036] A mixer 8 is arranged inside the tubular section 4 of the mixer housing 3, which comprises a multiplicity of mixing elements 9 arranged one behind the other along the longitudinal axis 2. A first mixing element 9' arranged at the upstream end of the mixer 8 is connected via a connecting web 10 to a mixer inlet section 11, which has two inlets 12 and two outlets 13 in fluid communication with the inlets 12 (see Fig. 2). The outlets 13 are in fluid communication with the first mixing element 9', so that when the mixer 1 is attached to the cartridge, two free-flowing components contained in the cartridge enter the inlets 12 via cartridge outlets, exit from the outlets 13 of the mixer 8 and, via the first mixing element 9', enter the mixer 8. The two component streams are divided several times by the mixing elements 9, 9' of the mixer 8 and then combined again until the two components are mixed as desired and they ultimately emerge mixed with one another at an outlet opening 14 at the downstream end of the tubular section 4 of the mixer housing 3.

[0037] The mixing elements 9, 9' of the static mixer 1 each comprise at their downstream outlet ends two parallel wall elements 15, 16 extending in the direction of the longitudinal axis 2 and one at the upstream inlet end of the respective mixing element 9, 9'. A wall element 17 is also arranged running in the direction of the longitudinal axis 2, but at a 90° angle to the wall elements 15, 16, which wall element 17 forms the connecting web 10 for the first mixing element 9'. Furthermore, the mixing elements 9, 9' comprise deflection elements 18 which have a deflection surface 19 which extends transversely to the longitudinal axis 2 and in which openings are formed through which the components can flow. For further specific design of the mixing elements 9, 9' and the mixer 8 according to the prior art reference is made to the following Figures 3 to 8, in which the precise structure of the mixing elements and their contents are described in detail. In principle, the mixer and the mixing element can also be designed in a different way, for example as a conventional helical mixer with a helical mixing bodies or as a mixer, as described for example in EP 0 749 776, EP 0 815 929 or EP 1 125 626, the content of which is also explicitly included by reference in the disclosure of the present application.

[0038] The mixing elements 9, 9' are connected to one another in their radially outer regions by stiffening webs 20, only two of the stiffening webs being visible in Fig. 1 and three of the four existing stiffening webs being visible in Fig. 2. The non-visible stiffening web in Fig. 2 lies diametrically opposite the stiffening web 20 shown in Fig. 2 in the upper front area.

[0039] A stiffening of the mixer 8 is already achieved by the stiffening webs 20. In order to achieve an even further improved stability of the mixer 8, according to the prior art the material of the mixer 8 can be a stiffened plastic. For this purpose, for example, a high-molecular plastic can be used as the plastic. Additionally or alternatively, to stiffen the plastic, stiffening fillers, for example fibers, can also be embedded in the plastic. Chemical curing, curing by UV radiation or curing by electron beams is also conceivable for stiffening the plastic of the mixer 8.

[0040] Plastics stiffened in this way can be used in a mixer 8 which is designed unchanged as shown in Figs. 1 and 2. However, it is also conceivable that by using a stiffened plastic, the stability of the mixer 8 can be increased even without stiffening webs 20 or through thinner stiffening webs 20 or webs 20 that are interrupted in sections.

[0041] An example of a further mixing element for a static mixer according to the prior art - and in this connection also according to the invention - is shown in FIG. 3. The mixing element includes an installation body 201 which is installed in a tubular housing which is not shown. The tubular housing serves as a boundary of a mixing space 220 which is located in the interior of the tubular housing. A fluid to be mixed, which is as a rule made up of at least two different components, flows through the mixing space 220. In most cases, the components are present in the liquid state or as viscous materials. These include, for example, pastes, adhesives, but also fluids which are used in the medical sector which include pharmaceutical agents or fluids for cosmetic applications and foods. Such static mixers are also in particular used as disposable mixers for the mixing of a hardening mix of flowable components such as the mixing of multicomponent adhesives. Another preferred use is in the mixture of impression materials in the dental field.

[0042] The mixing element in accordance with FIG. 3 thus includes an installation body 201 for installation into a tubular mixer housing, with the installation body 201, 101 having a longitudinal axis 210 which is aligned in the direction of a fluid flowing into the installation body 201. A mixing space 220 which is bounded at the peripheral side by a mixer housing, not shown, can be spanned by the installation body 201. A cubic mixing space is indicated in FIG. 3 to facilitate understanding. The side surfaces of the cube can represent the inner walls of the mixer housing. The fluid flows from the cover surface of the cube, which forms a flow cross-sectional surface 222, in the direction of the installation body 101.

[0043] The installation body 201 and the installation body 101 have the same structure; however, the installation body 101 is rotated by 180° about the longitudinal axis 210. Like the mixing space 220, the mixing space 120 has a flow cross-sectional surface 122 in a plane 121 arranged normal to the longitudinal axis 210 which essentially corresponds to the flow cross-sectional surface of the tubular mixer housing surrounding the installation body 101. For installation bodies 201, 101 which have at least one plane of symmetry which divides the mixing space into two equal parts, the longitudinal axis is disposed in this plane of symmetry. The mixing space is bounded by the mixer housing, not shown. In this embodiment, the mixing element should be installed into a mixer housing having a rectangular or quadratic cross-section. The inner dimension of the mixer housing which is used for determining the equivalent diameter is given by reference line 236.

[0044] The installation body 201 contains at least one first wall element 202 which serves a division of the fluid flow into two part flows flowing substantially parallel to the longitudinal axis 210. The wall element 202 has a first side wall 203 and a second side wall 204. The intersection of the first wall element 202 with the plane 221 produces a cross-sectional surface 223. This cross-sectional surface 223 amounts to a maximum of $\frac{1}{5}$, preferably a maximum of 1/10, particularly preferably a maximum of 1/20, of the flow cross-sectional surface 222 of the mixing space 220 without installation bodies. The fluid thus flows at both sides of the side walls 203, 204 of the wall element 202. The flow direction of the fluid is indicated by an arrow. The wall element has a substantially rectangular cross-section. The first wall element 202 has a first wide side 205, a second wide side 206 as well as a first and second long side 225, 235. The first wide side 205, the second wide side 206, the first long side 225 and the second long side 235 form the periphery of each of the side walls 203, 204. The long sides 225, 236 extend substantially in the direction of the longitudinal axis 210 and the first wide side 205 and the second wide side 206 extend transversely to the direction of the longitudinal axis. The first wall element 202 divides the mixing space into two parts. The wall element 202 has the function of a bar element which divides the fluid flow into two parts, with their deflection being negligible with the exception of the deflection at the edges of the first wide side 205. The wall thickness 207 of the wall element 202 usually amounts to less than 1 mm for a mixing element with a total length of up to 100 mm.

[0045] A deflection element 211 which serves for the deflection of the part flows in a direction differing from the longitudinal axis adjoins the first wall element 202. The deflection element has a deflection surface extending in the transverse direction to the wall element 202 at both sides of the wall element. A first opening 212 is provided in the deflection surface at the side which faces the first side wall 203 of the wall element 202.

[0046] The crossing angle between the first wall element 202 and the second or third wall element 208, 209 respectively amounts to 90° in the embodiment in accordance with FIG. 3. In accordance with FIG. 3, the first wall element 202 is connected to the second wall element 208 and to the third wall element 209 via the deflection element 211. The deflection element 211 is preferably disposed in a plane which is aligned parallel to the plane 221 or is arranged at an angle of inclination with respect to the plane, with the angle of inclination amounting to no more than 60°, preferably no more than 45°, particularly preferably no more than 30°. The smaller the angle of inclination between the surface of the deflection element 211 and the plane 221, the smaller the required construction length. Or in other words: the surface of the deflection element 211 is substantially disposed in a transverse plane which is aligned at an angle of 45° up to 90°, preferably of 60° up to 90°, particularly preferably of 75° up to 90° to the longitudinal axis 210.

[0047] The wall elements 208, 209 adjoining the deflection element 211 bound a passage which starts from the first opening 212 and extends in the direction of the longitudinal axis 210. It is meant by the expression "adjoining the deflection element" that the second and third wall elements 208, 209 are arranged opposite the first wall element 202 in the direction of the longitudinal axis, that is arranged downstream of the first wall element 202 in the direction of flow.

[0048] A second opening is provided in the deflection surface at the side which faces the second side wall 204 of the wall element 202, with the second or third wall elements 208, 209 adjoining the second opening. The second and third wall elements 208, 209 bound the same passage which also starts from the first opening 212.

[0049] A second and a third wall element 208, 209 are thus arranged adjacent to the first opening 212. The second and third wall elements 208, 209 extend in the direction of the longitudinal axis 210 and each have an inner wall 281, 291 and an outer wall 282, 292 which extend substantially in the direction of the longitudinal axis 210. The second wall element 209 has the inner wall 281 and the outer wall 282. The third wall element has the inner wall 291 and the outer wall 292. In the present embodiment, the inner walls 281, 291 and the outer walls 282, 292 extend in the direction of the longitudinal axis, that is in the vertical direction in the direction of the drawing. Each of the inner walls 281, 291 and outer walls 822, 292 can include an angle between 20° and 160° to the first or second side walls 203, 204 of the first wall element 202. The first opening 212 is arranged between the inner walls 281, 291 of the second and third wall elements 208, 209. A second opening 213 and an optional third opening 214 are arranged outside one of the outer walls 282, 292 of the second or third wall elements 208, 209. The second opening 213 and the third opening 214 are provided in the deflection surface at the side which faces the second side wall 204 of the first wall element 202. The inner wall of each wall element can in particular be parallel to its outer wall. Furthermore, the second and third wall elements can have inner walls 281, 291 and outer walls 282, 292 respectively in parallel with one another.

[0050] The first wall element 102 of the second installation body 101 adjoins the second and third wall elements 208, 209. The second installation body 101 has a first wall element 102 which extends in the direction of the longitudinal axis 210 of the mixing element and has a first side wall 103 and a second side wall 104 which is arranged opposite the first side wall 103. The first side wall 103 and the second side wall 104 are arranged substantially parallel to the longitudinal axis 210.

[0051] A deflection element 111 is arranged adjacent to the first wall element 102. The deflection element 111 has a deflection surface extending in the transverse direction to the wall element 102 at both sides thereof. A first opening 112 is provided in the deflection surface at the side which faces the second side wall 104 of the wall element 102. A second and a third wall element 108, 109 are disposed opposite the first wall element 102 in the direction of the longitudinal axis 210 adjacent to the first opening 112. That is, the second and third wall elements 108, 109 are located downstream of the first wall element 102. The second and third wall elements 108, 109 bound a passage starting from the first opening 112 and extending in the direction of the longitudinal axis 210. A second opening 113, 114 is provided in the deflection surface at the side which faces the first side wall 103 of the wall element 102. The second or third wall elements 108, 109 adjoin the second opening 113, 114.

[0052] A second wall element 108 and a third wall element 109 are arranged adjacent to the first opening 112. The second and third wall elements 108, 109 extend in the direction of the longitudinal axis 210 of the mixing element. The second wall element has an inner wall 181 and an outer wall 182 and the third wall element has an inner wall 191 and an outer wall 192. The outer walls 182, 192 and the inner walls 181, 191 extend substantially in the direction of the longitudinal axis 210 of the mixing element. They are respectively parallel to one another in the present embodiment. Each of the inner walls 181, 191 and outer walls 182, 192 include an angle between 20° and 160° to the first or second side walls 103, 104 of the first wall element 102, 90° in the present case.

The first opening 112 is arranged between the inner walls 181, 191 of the second and third wall elements 108, 109 and at least one second opening 113, 114 is arranged outside one of the outer walls 182, 192 of the second or third wall elements 108, 109. The second opening 113 and/or a third opening 114 are provided in the deflection surface at the side which faces the second side wall 104 of the first wall element 102.

[0053] The second installation body 101 containing the first wall element 102, the deflection element 111 and the second and third wall elements 108, 109 is arranged rotated about the longitudinal axis 210 by an angle of 10° up to and including 180°, in the specific example of 180°, with respect to the first installation body 201.

[0054] The first installation body 201 and the second installation body 101 have the same structure, that is they contain the same wall elements and the same deflection elements which are arranged at respectively the same angles and spacings from one another.

[0055] The first installation body 201 and the second installation body 101 are connected to one another via a plurality of common bar elements 215, 216, 217, 218.

[0056] FIG. 4 shows an example of a section of a further mixing element in accordance with the prior art and/or the invention. The structure of the mixing element does not substantially differ from the mixing element in accordance with FIG. 3; the same reference numerals as in FIG. 3 are therefore used for the same parts. Only the differences from the embodiment in accordance with FIG. 3 should also be looked at in the following. A first installation body 201 and a second installation body 101 are shown in turn of the mixing element. The installation bodies are intended for installation into a mixer housing which has a circular or elliptical cross-section. The cross-sectional extent of the inner wall of the mixer housing, not shown, is indicated by a chain-dotted line. The diameter of the mixer housing is shown by a reference line 236.

[0057] FIG. 5 shows a view of another example of a mixing element. The mixing element contains installation bodies, as shown in FIG. 4. Furthermore, the mixing element contains an inlet element which contains the feed passages for the components to be mixed. The mixing ratio of the two components can be equal to 1:1, but also be different, that is not equal to 1:1. Eleven installation bodies are shown in FIG. 5. All installation bodies are connected to one another by bar elements 215, 216, 217, 218.

[0058] FIG. 6 shows a section through the installation body 201 of FIG. 4. The first wall element 202 and the bar elements 215, 216, 217, 218 are sectioned. The deflection element 211 is visible in the section in accordance with FIG. 6. The deflection element 211 contains the first opening 212 which is arranged at the left side of the first wall element 202 in FIG. 6, that is on the side of its first side wall 203. The second opening 213 and the third opening 214 are arranged on the opposite side, that is on the second side wall 204. The first opening 212 is arranged offset with respect to the second and third openings 213, 214. A part element 226 of the deflection element is arranged between the second and third openings. The fluid which impacts onto the part element 226 is deflected in the direction of the second opening 213 and of the third opening 214. At the peripheral side, the second opening 213 and the third opening 214 are bounded by the mixer housing 2210.

[0059] FIG. 7 shows a section through the second and third wall elements 208, 209 of the installation body 201. The direction of gaze is in the flow direction so that the first wall element 102 of the installation body 101 is visible. The deflection element 111 adjoins the first wall element 102 of the installation body 101. The deflection element 111 contains a first opening 112 which is arranged on the side of the second side wall 104. A second opening 113 and a third opening 114 are arranged on the side of the first side wall 103. The second opening 113 and the third opening 114 are arranged offset to the first opening 112. The first, second and third openings 112, 113, 114 are arranged such that a part element is respectively arranged opposite each of the openings, that is a first part element 126 opposite the first opening 112, a second part element 127 opposite the second opening 113 and a third part element 128 opposite the third opening.

[0060] FIG. 8 shows a section through an inlet part of a static mixer and a mixing element in accordance with FIG. 5. The static mixer includes a mixer housing 2210 in which the mixing element and the inlet element are received. The mixer housing is received in a connection element 2220 which serves for connection to a cartridge.

[0061] The bar elements 215, 216, 217, 218 hold all installation bodies of the mixing element connected to one another. Each of the bar elements increases the bending stiffness of the static mixer. It can furthermore be prevented by the bar elements that a break of the mixing element occurs in the operation of the mixer, in particular when at least two mixing elements are arranged on opposite sides of the first wall elements. Furthermore, it is ensured via the bar element during the manufacture of the installation body in the injection molding process that the polymer melt can flow from the first installation body 201 to the first and all further installation bodies 101 arranged downstream. Without the bar elements, the transition from the wall element 208 or 209 to the wall element 102 disposed downstream would namely only be composed of the common sectional surface and any reinforcement thereof. That is the sectional surface in this case is composed of two squares which would have a side length corresponding to the wall thickness 207. The total polymer melt for the installation bodies disposed downstream would have to pass through these restriction points, which would result in local pressure peaks in the tool. In addition, a long dwell time of the polymer melt would result in the regions of the wall elements which would come to lie close to the tubular housing in use, which would result in variations in the polymer melt and under certain circumstances in a deterioration of the physical properties and in inhomogeneity so that such a mixing element can only be manufactured in the prior art by the use of a melt containing a foaming agent for generating a foamed structure.

[0062] For this reason, in accordance with the above examples, the bar elements for forwarding the polymer melt in the manufacturing process are provided from one installation body to each of the adjacent installation bodies.

[0063] The static mixer is usually produced from plastic by means of which even comparatively complicated geometries can be realized in the injection molding process. The totality of installation bodies 201, 101 has a length dimension 224 and each of the cross-sectional areas 223, 123 have a wall thickness 207 in particular for static mixers including a plurality of installation bodies. The ratio of length dimension 224 to wall thickness 207 amounts to at least 40, preferably at least 50, particularly preferably at least 75. For the preferred use of static mixers for small fluid quantities of filler material, the wall thickness 207 is less than 3 mm, preferably less than 2 mm, particularly preferably less than 1.5 mm. The totality of the installation bodies 201, 101 has a longitudinal dimension 224 between 5 and 500 mm, preferably between 5 and 300 mm, preferably between 50 and 100 mm.

[0064] The difference between the prior art as defined above and the mixer according to the invention can be seen in Figs. 9 and 10, in which a mixer 8 according to the invention respectively a detailed section of a mixer 8 according to the invention are depicted. The housing 3 is not shown for convenience.

[0065] It can clearly be seen that even though the general concept of the mixing elements 9, 9' as well as their design does not differ from the prior art, the mixer 8 according to the invention does not comprise webs 20, let alone a continuous web 20, at the external surface of the mixing elements 9, 9'. On the contrary, the mixer 8 according to the invention comprises one or more central bars 21 that is/are arranged at a center of the mixing elements 9, 9' thereby stiffening the mixer 8 from within.

[0066] In this connection it is also noted that the mixer 8 according to the invention could also be designed in accordance with Figs. 3 to 8 with the one or more additional central bar 21 being present at the center of the mixer 8.

[0067] Said central bar(s) 21 extend(s) along at least 60% of the total length of the mixer 8. In some cases it/they can even extend up to 100% of the total length of the mixer 8. The precise length of the central bar(s) can be chosen freely for example in accordance with the application field of the mixer 8 and/or the overall dimensions of the mixer 8 etc..

[0068] The same is true for the housing 3 (not shown) which can either cover the complete mixer 8 or only parts of the mixer 8 and/or the mixing elements 9, 9'.

[0069] It is further also possible that the most downstream mixing element 9, i.e. the mixing element 9 which is closest to the outlet 4, does not comprise the central bar 21 in order to centrally dispense the mixed material from the mixer 8. Instead of said central bar 21 said most downstream mixing element 9 can comprise an opening (not shown) that guides to mixed material towards the outlet 4 of the housing 3.

[0070] Additionally, the mixer 8 according to the invention can comprise alignment means (not shown) that are configured to align the mixer 8 with respect to the housing such that the mixer 8 can be easily aligned centrally within the housing. Such alignment means can, for example, alter the inner shape of the housing by providing corresponding protrusions or ribs or the like. Alternatively or additionally the alignment means can also be configured to press-fit and/or spring-fit the mixer 8 into the housing 3.

[0071] By providing one or more central bar(s) 21 instead of webs 10, 20 at the outer side of the mixer 8, it can be ensured that the two materials that are supposed to be mixed with one another can be mixed more evenly as there are no obstructions at the outer surface of the mixer that would hinder one or both components to flow through the mixer 8.

[0072] Additionally, as can be seen in Fig. 3, it can be possible to provide only one single central bar 21 instead of a plurality of webs 10, 20, thereby reducing the amount of plastic of the mixer 8 such the sustainability of the mixer can be improved.

Claims

1. Static mixer for mixing at least two components with one another comprising a plurality of mixing elements (9, 9') with each mixing element (9, 9') configured to divide each component to be mixed in at least two, preferably more than two, strands of material and further configured to merge said strands of material in layers,

   with said plurality mixing elements (9, 9') being arranged along a longitudinal axis (2) of the mixer (8) behind one another,
   characterized in that the mixer (8) further comprises a central bar (21) being arranged parallel to said longitudinal axis (2), with the plurality of mixing elements (9, 9') being arranged at an outer surface of the bar (21) such that the mixing elements (9, 9') surround the central bar,
   wherein the central bar (21) extends along at least 60% of a total longitudinal length of the mixer (8).

2. The static mixer according to claim 1,
   wherein the central bar (21) extends along at least 75% of the total longitudinal length of the mixer (8).

3. The static mixer according to claim 1 or 2,
   wherein the central bar (21) extends along at least 90% of the total longitudinal length of the mixer (8).

4. The static mixer according to one of the preceding claims, wherein the central bar (21) extends along the complete longitudinal length of the mixer (8).

5. The static mixer according to one of the preceding claims, further comprising a housing (3) that covers at least some of the plurality of mixing elements (9, 9').

6. The static mixer according to claim 5, wherein the housing (3) covers at least 60% of the total longitudinal length of the mixer (8).

7. The static mixer according to claim 5 or 6, wherein the housing (3) covers at least 75%, preferably more than 90%, of the total longitudinal length of the mixer (8).

8. The static mixer according to one of the preceding claims 5 to 7, further comprising alignment means configured to align the mixer (8) centrally with respect to the housing (3).

9. The static mixer according to claim 8, wherein the alignment means are configured to alter at least an inner shape of the housing (3) such that mixer (8) is aligned centrally with respect to the housing (3).

10. The static mixer according to claim 8 or 9, wherein the alignment means are configured to press-fit and/or spring-fit the mixer into the housing (3).

11. The static mixer according to one of the preceding claims, Wherein a most downstream mixing element does not comprise a central bar (21), in order to centrally dispense the mixed material from the static mixer (8).

12. The static mixer according to one of the preceding claims, further comprising a transverse edge and at an angle to the transverse edge extending guide walls and at an angle to the longitudinal axis (2) arranged guide elements with openings, wherein each mixing element (9) has a transverse edge with an adjoining transverse guide wall and at least two guide walls which open into separating edges with lateral ones - end sections and at least one bottom section arranged between the guide walls, which has at least one opening on one side of the transverse edge and at least two openings on the other side of the transverse edge.

13. The static mixer according to one of the preceding claims, wherein each mixing element (9, 9') comprises: first and second guide walls with a common transversal edge, a separating edge at an end opposite the common transversal edge, wherein the guide walls form a curved and continuous transition between the separating edges and the common transverse edge, wherein the transversal edge divides the material to be mixed, and wherein the first and second guide walls and common transversal edge of a mixing element divide the components into six flow paths.

14. The static mixer according to one of the preceding claims, wherein each mixing element (9, 9') is configured to merge said strands of material in layers at an outlet side of the respective mixing element (9, 9').

15. The static mixer according to one of the preceding claims, wherein each mixing element (9, 9') is configured to divide each component to be mixed at an inlet side of the respective mixing element (9, 9').

16. The static mixer according to one of the preceding claims, wherein a cross section of the central bar (21) is different from a cross section of a guide wall of the mixing element (9, 9'), in particular the guide wall as defined in clam 13, for example the cross-section of the central bar can be selected from the group of members consisting of a square cross-section, a triangular cross-section, a rectangular cross-section, a round cross-section, an oval cross-section, a polygonal cross-section and combinations of the foregoing.

17. The static mixer according to one of the preceding claims, in particular according to one of claims 13 to 16, wherein a cross section of the central bar (21) is larger than a cross section of a guide wall of the mixing element (9, 9'), in particular 1.01 to 3 times larger, especially 1.02 to 1.5 times larger.

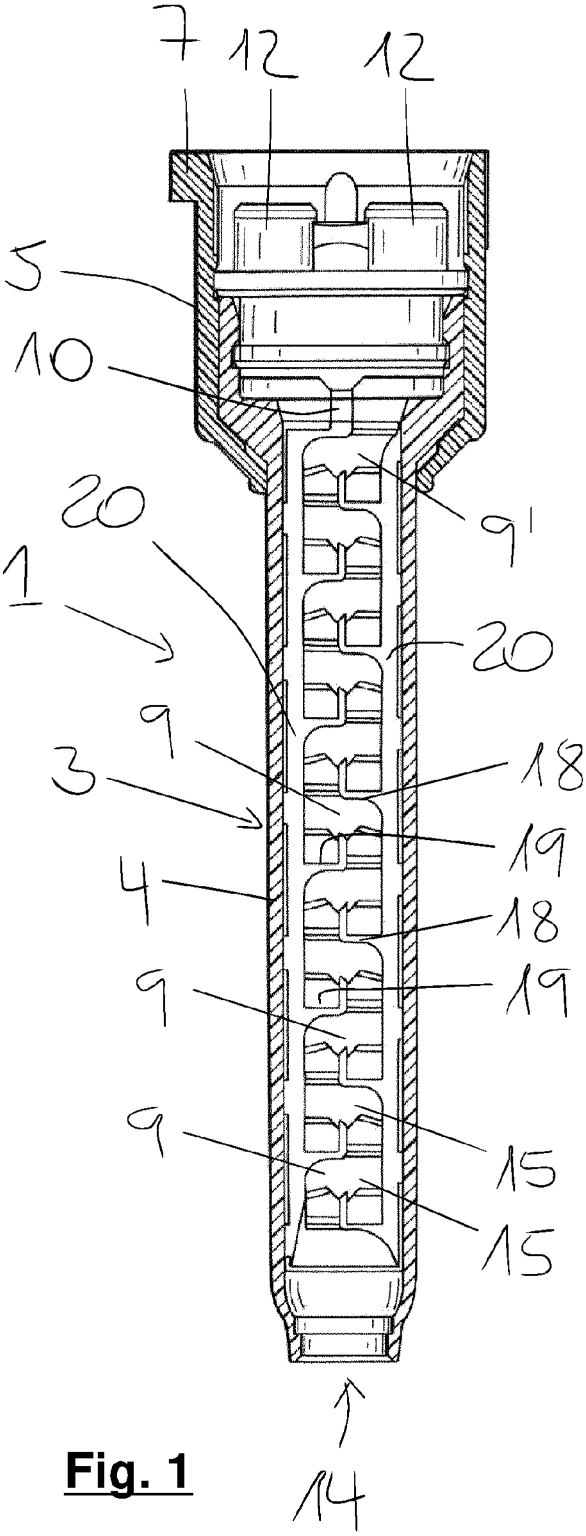

7
12
12
5
10
9'
20
1
20
9
18
3
19
4
18
9
19
9
15
9
15
14

Fig. 1

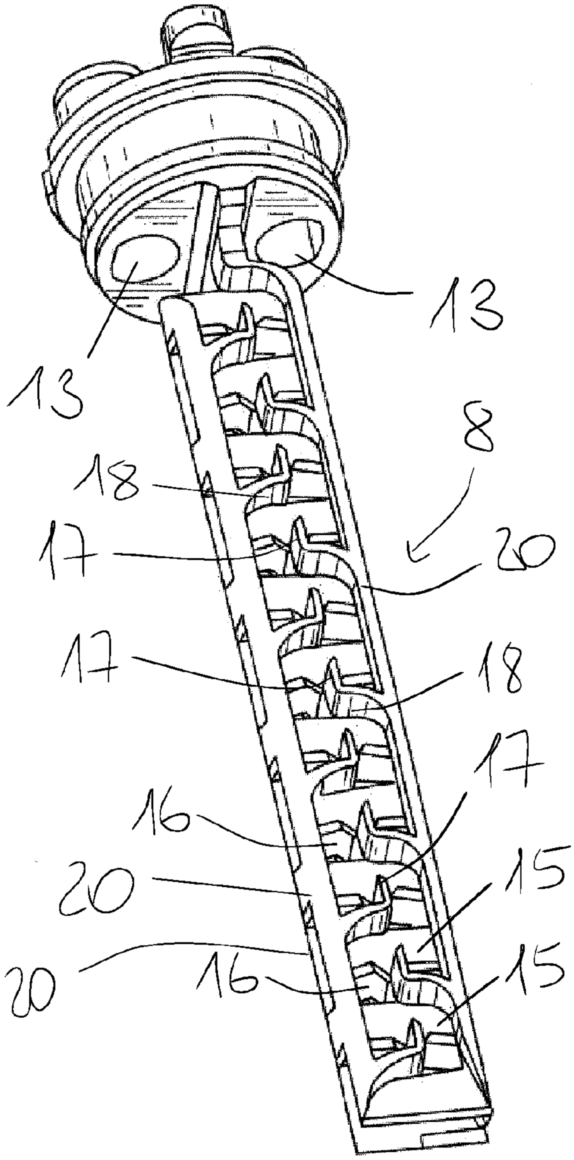

13
13
8
18
17
20
17
18
17
16
15
20
20
16
15

Fig. 2

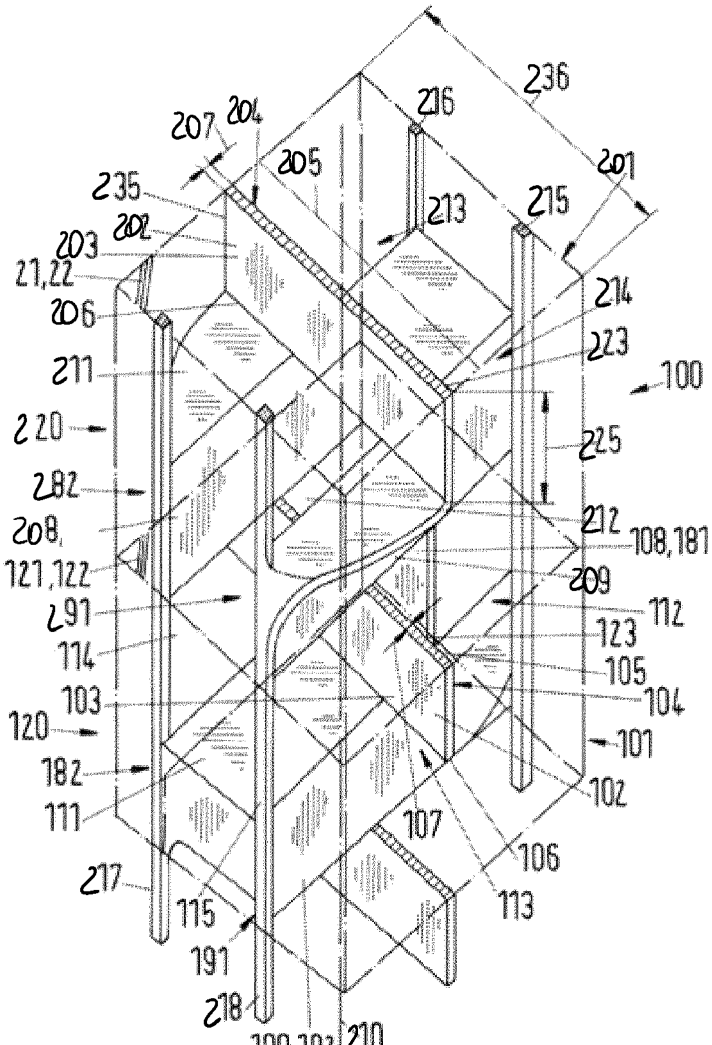

236
216
201
207
204
205
213
215
235
202
203
21,22
206
214
223
100
211
220
225
282
212
108,181
208,
121,122
209
291
112
123
114
105
104
103
120
101
182
102
111
107
106
113
217
115
191
218
109,192
210

Fig. 3

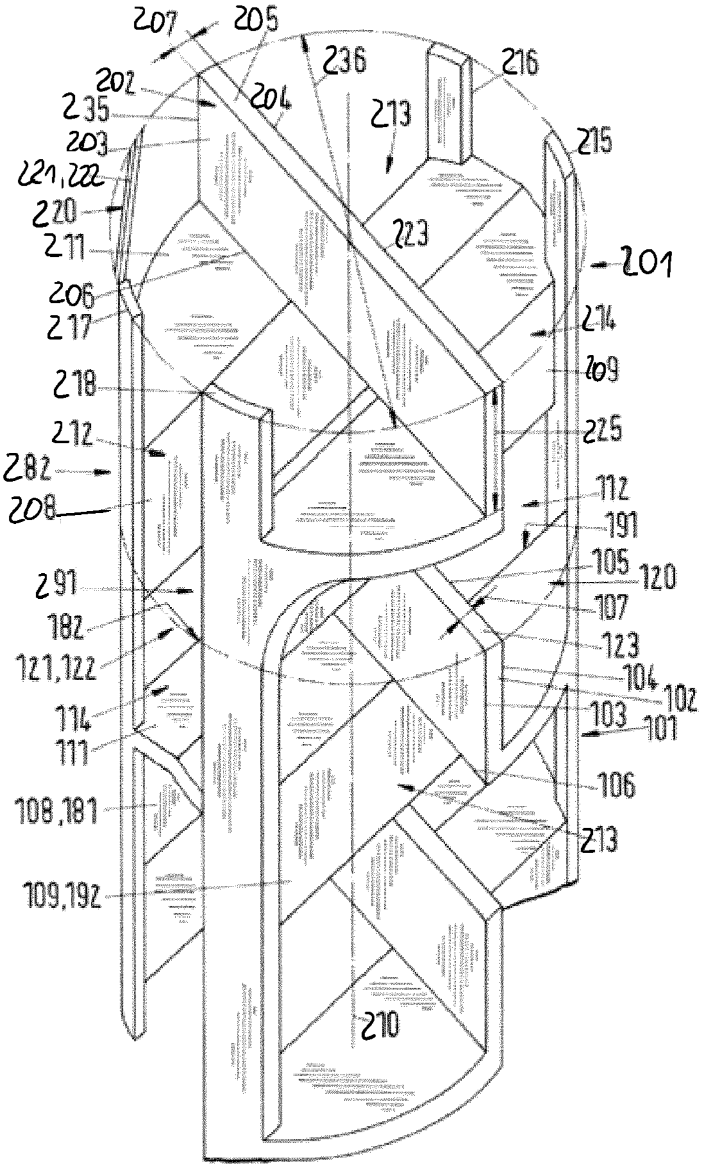

207
205
236
216
202
204
213
235
215
203
221,222
220
223
211
201
206
217
214
209
218
225
212
282
208
112
191
105
120
291
107
182
123
121,122
104
102
103
114
101
111
106
108,181
213
109,192
210

Fig. 4

Fig. 5

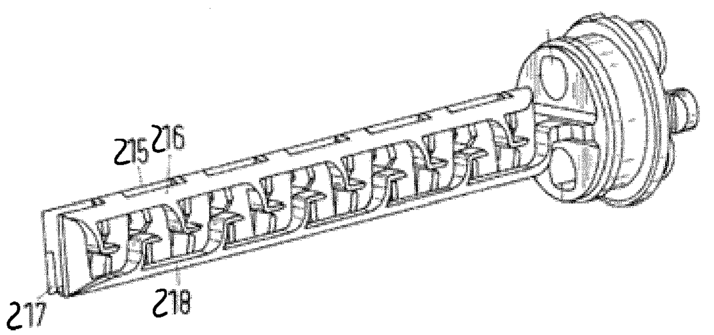


Fig. 6

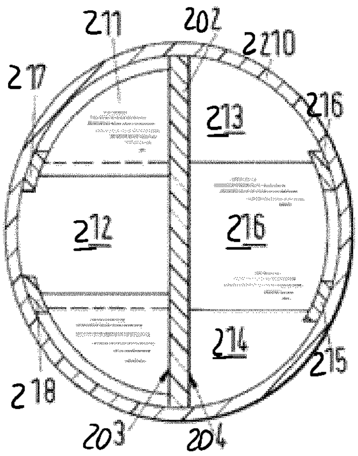
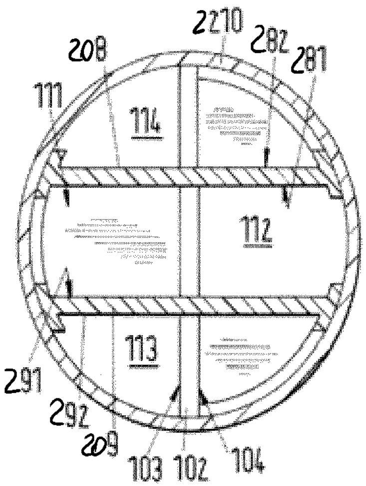


Fig. 7



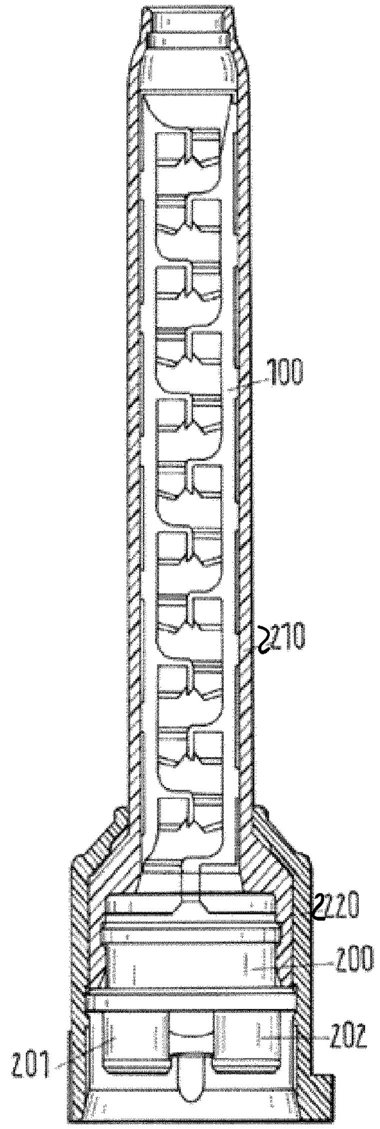


Fig. 8

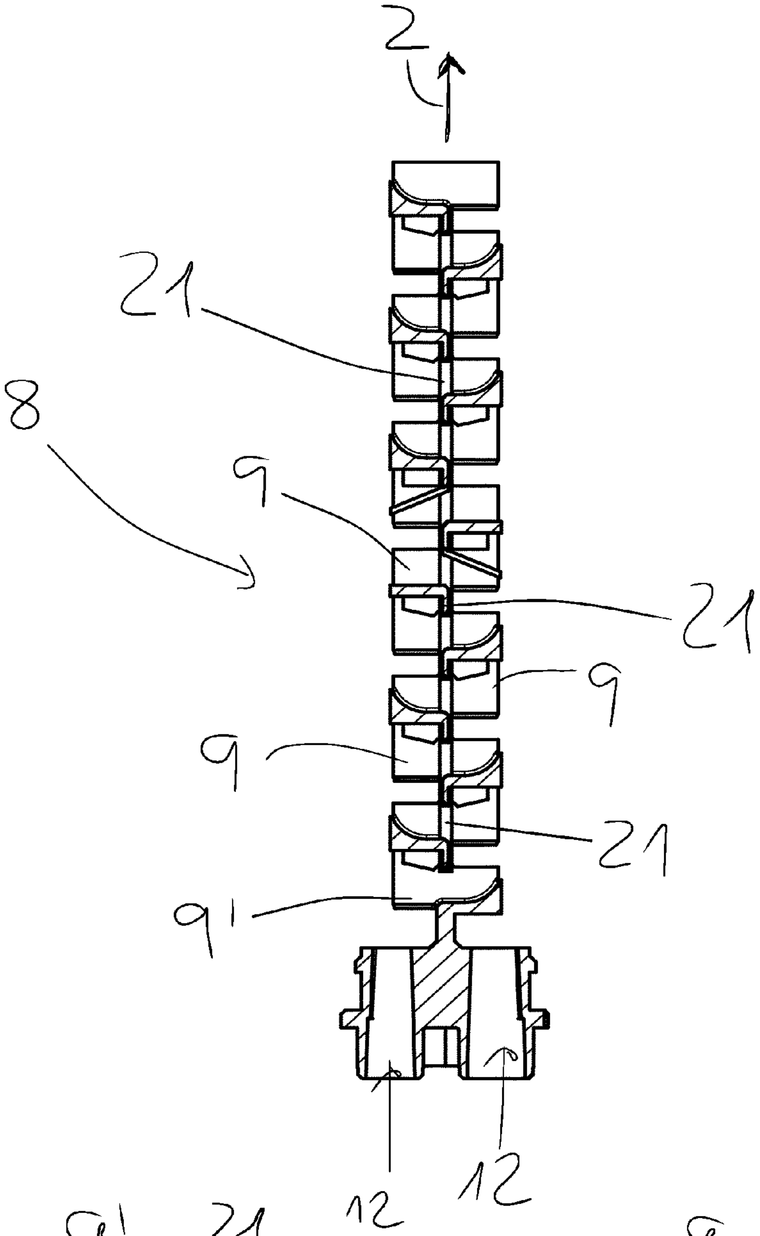


Fig. 9

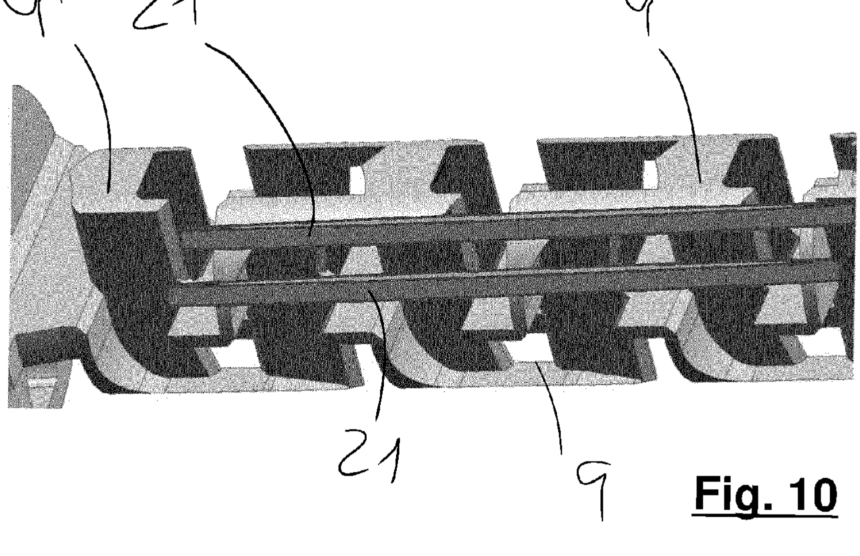


Fig. 10

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 22 20 8228

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 3 733 271 A1 (RITTER GMBH [DE]) 4 November 2020 (2020-11-04) * figures * -----	1-17	INV. B01F25/432
X	EP 3 299 082 A1 (3M INNOVATIVE PROPERTIES CO [US]) 28 March 2018 (2018-03-28)	1-3, 5-11, 14-17	
A	* figures * -----	4,12,13	

TECHNICAL FIELDS SEARCHED (IPC)
B01F

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	2 May 2023	Real Cabrera, Rafael

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
....
& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

EP 22 20 8228

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

02-05-2023

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 3733271 A1	04-11-2020	NONE	
EP 3299082 A1	28-03-2018	BR 112019005498 A2	11-06-2019
		CN 109715277 A	03-05-2019
		EP 3299082 A1	28-03-2018
		EP 3515582 A1	31-07-2019
		JP 7056822 B2	19-04-2022
		JP 2019529098 A	17-10-2019
		RU 2712586 C1	29-01-2020
		US 2019209268 A1	11-07-2019
		WO 2018057503 A1	29-03-2018

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- EP 0749776 A **[0037]**
- EP 0815929 A **[0037]**
- EP 1125626 A **[0037]**