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(54) **INFUSION NOZZLE**

INFUSIONS DÜSE

BUSE D'INJECTION

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Description

Field of the Invention

[0001] An infusion nozzle to infuse treated water into a body of water to provide optimum dispersion of the treated water and its contents into the water of the body.

Background of the Invention

[0002] During the treatment of the water in bodies of water such as aquariums, ponds, pools and spas, it is standard practice to treat a smaller amount of water and inject it into the larger body so that the larger body becomes infused with the treatment substances that are carried by the treatment water. Ozone, oxygen, air, and chlorine are frequently injected into the treatment water, and are carried by it to the larger body where it can serve to control odor and bacteria, for example. There are many other examples, all of which rely on infusing the treatment substances so they are thoroughly dispersed throughout the larger body of water.

[0003] Apparatus to inject treatment substances, which may be liquids as well as gases, into treatment water, is well developed. One suitable device is an aspirating injector of the type shown in Mazzei patent No. US-4,123,800, for injection of treatment substances into a treatment water, and an injector for doing so. The objective is to provide a high concentration of treatment gas or liquid which, when dispersed through the larger body will control whatever nuisance or risk is involved.

[0004] Of course the effectiveness of this procedure is dependent on thorough dispersal of the treatment material. Quite frequently the treatment material will be present at the infusion nozzle both in saturated solution in the treatment water and as bubbles. If bubbles of gas are large and merely float to the surface and burst, the gas is lost, and may even be a hazard. For example, discharge of ozone into the air is strictly regulated, and often systems must be operated with less than optimum ozone throughput in order that undissolved ozone will not escape from the water. It is an object of the present invention to provide an infusion nozzle from which treatment water is injected into a body of water with an improved flow pattern that provides a flow into the larger body in which the bubbles are not only small and well-distributed, but are in a flow stream that, as it infuses into the larger body, incorporates in itself a large region of previously-untreated water. The bubbles are thereby more fully distributed and dissolved in the water to be treated.

[0005] These objects are attained with only minor energy loss, so that the force and "range" of the plume of treated and directly affected water is not appreciably shortened. This advantage is so pronounced that the output from this infusion nozzle can be used to sweep the bottom of a tank, providing a wider swath, and a vigorous mixing action as well.

Brief Description of the Invention

[0006] An infusion nozzle according to this invention includes a nozzle body having a flow passage there-through. The flow passage has an entry port, an exit port and a circularly-sectioned wall extending along a central axis between the two ports.

[0007] The wall includes an entry portion that extends from the entry port and is substantially cylindrical with a diameter. It further includes a constricting portion which is preferably frusto-conical, with a diameter which lessens as it extends away from the entry portion. It extends to the exit port, at the smaller end of the constricting portion.

[0008] A plurality of vanes projects into the passage from the wall. Each vane extends partway into the entry portion and partway into the constricting portion. These vanes have a dimension of length, a thickness, and a deflection face which faces the oncoming stream of water from the entry port. Their ends closer to the exit port are spaced from the exit port. Each includes a crest which extends into the entry portion and in the constricting portion. The deflection surface terminates at the crest and forms a small angle relative to a plane that includes the central axis and passes through the vane where the vane intersects the junction between the entry portion and the constricting portion.

[0009] The vanes are symmetrically spaced apart from one another. Their crests do not cross the central axis.

[0010] As a consequence, a substantial outer portion of the flowing liquid is deflected to receive a rotational component of motion while a central "core" of the flowing stream continues on a straight-through axial path.

[0011] The resulting fluid stream exiting the nozzle exhibits both axial and radial velocities greater than the velocity of the fluid into which the stream is infused. Therefore, due to this relatively higher velocity of the stream along its entire length, its pressure is lower than that of the water or fluid into which it is infused (as explained by Bernoulli's principle). This results in an active entrainment of untreated water or fluid into the stream along the entire length of the stream in volumetric ratios many times the volume of the entering stream from the nozzle.

[0012] The above and other features of this invention will be fully understood from the following detailed description and the accompanying drawing, in which:

Brief Description of the Drawings

[0013]

Fig. 1 is an end view of an infusion nozzle according to this invention taken at line 1-1 in Fig. 3;
Fig. 2 is an end view taken at line 2-2 in Fig. 3;
Fig. 3 is a cross-section taken at line 3-3 in Fig. 1;
Fig. 4 is a fragmentary cross-section taken at line

4-4 in Fig. 3;

Fig. 5 is a fragmentary side view of a plug useful in the manufacture of the nozzle of Fig. 3;

Fig. 6 is a fragmentary top view of Fig. 5;

Fig. 7 is a fragmentary cross-section of a cutter used to form slots in the plug of Fig. 5;

Fig. 8, 9 and 10, are schematic showings of various vanes;

Fig. 11 is a schematic showing of some properties of the stream produced by the nozzle of Fig. 3; and

Fig. 12 is a view like Fig. 6, but of a different vane shape.

Detailed Description of the Invention

[0014] The presently-preferred infusion nozzle 20 of this invention is shown in Fig. 1. It includes a body 21 having an outer wall 22 and an inner wall 23. Mounting threads 24 may be provided on the outer wall.

[0015] Inner wall 23 forms a flow passage 25 with an inlet port 26 and an exit port 27. The inner wall is circularly sectioned and extends along central axis 28 between the two ports.

[0016] Inner wall 23 includes an entry portion 30 that extends from the entry port. It is substantially cylindrical, although it may have a slight narrowing taper if desired. It further includes a constricting portion 31 which is preferably frusto-conical. Its diameter lessens as it extends away from the entry portion. The entry portion and constricting portion meet at a junction 32 which is normal to the central axis. Constricting portion 31 extends to the exit port, at its smaller end.

[0017] A plurality of vanes 35, 36, 37, 38, 39 40, 41 and 42 are symmetrically placed around the inner wall. In the illustrated example, there are eight of them. More or fewer could be provided, but eight appears to be optimum for the intended results. All are identical, so only vane 37 will be described in detail.

[0018] The vanes are linear, although they could be slightly curved if desired. However, these nozzles will usually be molded with the use of a mold cavity to form the outside wall, and a plug to form the inside wall, including the vanes. With the disclosed geometry of the inner wall, the plug can be pulled out axially without rotating it.

[0019] Vane 37 is slanted at a small deflection angle 43, between about 3 to 15 degrees, but usually about 4 degrees, relative to a plane which includes the central axis and also passes through junction 32 where it crosses the vane. While quite small, this angularity gives a sufficient rotational component to an outer portion of the stream for the purposes of this invention.

[0020] The vane is preferably formed with a wedge-like shape as shown in Fig. 4. It has a deflection face 44 facing toward the oncoming stream, and a rear face 45 facing toward the exit port. It is a convenience in molding to provide a flat surface as the crest 46 of the vane. The faces preferably form a dihedral angle 47 between pref-

erably about 20 degrees, but which can vary between about 5 degrees to about 40 degrees. This further facilitates the removal of the plug after the device is molded.

[0021] The vanes are aligned with one another. Each extends partway into the entry portion, and partway into the constricting portion. Their ends 48 are spaced from the exit port, and their ends 49 are spaced from the entry port. They extend across junction 32. Their crests extend at a crest angle 50 (see Fig. 8) relative to the central axis as to rise from the entry portion, and to fair into the constricting portion. It will be noticed that the vanes do not reach the central axis. It is not intended to rotate the entire stream, but only a limited outer portion of it.

[0022] As can best be seen in Fig. 1, there are axial regions 51 of the stream which do not encounter a vane. While more occlusion can be provided by using more vanes, or even by using steeper vanes, or vanes which approach the axis more closely, it would be at the cost of an unnecessary increase in energy loss from the stream. The illustrated arrangement, which can be scaled, provides a sufficient rotational effect.

[0023] The construction of the vanes can best be understood from an examination of the tooling plug which forms them when they are molded. Fig. 5 shows a plug 60 having an external surface 61 that forms entry portion 30, a conical portion 62 that forms the constricting portion 31, and an intersection 63 which forms junction 32.

[0024] Identical slots are cut into the plug as shown in Fig. 6. They are formed by the milling cutter whose edge is shown in Fig. 7. The milling cutter has side faces and an end face **[deletion(s)]**.

[0025] Figs. 8, 9 and 10 schematically show vanes 46, 71 and 72 formed by cutting the slots at different angles 50, 74, 75. These change the length, height, and excursion into the wall portions as shown. This is a convenient way to provide vanes for different diameters and flow rates. Generally the angle shown in Figs. 3 and 10 is preferred. Its angle 75 is about 15 degrees, but it can vary between about 5 degrees and 20 degrees.

[0026] It is an advantage in the molding process to shorten the extent to which the vanes extend into the entry portion. As shown in Fig. 3, the crest of the vane 35 has a curve 77 at its upstream end. This is optional.

[0027] Fig. 12 shows a vane 100 in all respects like vane 37 in Fig. 6, except that it is slightly curved rather than straight, to provide additional twist to the outer part of the stream, if desired.

[0028] While the actual dynamics of this infusion nozzle are not fully understood, the following description of the results it provides will be helpful. Fig. 11 shows an infusion nozzle 80 or such as nozzle 20 mounted to the wall of 81 a tank containing water 82 which requires treatment.

[0029] Fig. 11 schematically shows a stream 83 of treated water, usually containing dissolved and undissolved treatment gas, being injected at a depth 84 into water 82. While in the nozzle, the vanes have given at a rotational component of motion to least a part of a pe-

ripheral zone 85 of treatment water. The central core 86 does not have that component because it does not encounter a vane. Zone 85 is formed around core 86, almost as a cylindrical coaxial shell.

[0030] Mixing will immediately begin at the interface 87 between zone 85 and core 86. This rotary and axial mixing motion continues as the stream from the nozzle passes into the tank. In the tank, this will also occur at the interface 88 between the untreated water in the tank and zone 85. As a consequence, an increased amount of mixed waters occurs in a steadily enlarging region 90, which enlarges both the untreated water and into the cure.

[0031] Comparisons of the outputs of nozzles which are identical except that one has vanes and the other does not, are instructive. Without vanes, there is no peripheral zone 87. There is some mixing around the axial stream, but it is small, and mixing does not start until the stream is well into the tank. If one places his hand underwater around the stream next to the nozzle and moves it along the stream, he will notice that the mixing region around the stream, which he can actually feel, starts rather far into the tank, and is not particularly vigorous. Bubbles of gas will often be seen rising to the surface. If one used an infusion nozzle according to the invention and repeats this exercise, he finds very close to the exit port the start of a region of vigorous mixing-zone 90. Peripheral zone 87 has an interface 88 with the surrounding untreated water in the tank, and another interface 87 with the axially-moving core. Region 90 can be felt blooming to an increasing and substantial diameter, within which shear forces on the bubbles at both interfaces lead to their rapid disappearance as their gas is dissolved. There is a substantial absence of bubbles at the surface.

[0032] Region 90 is active, and tends to draw nearby water and particulates to it. For this reason, the stream is quite effective for sweeping the bottom of a tank, for example.

[0033] A set of dimensions suitable for a nozzle according to this invention is as follows:

Included conical angle of the constricting portion:

40 degrees

Diameter of the entry portion: 1.60 inches (41mm)

Exit port diameter: .75 inches (19mm)

Angle of the vanes relative to the plane through the central axis: 4 degrees

Distance from the exit port to the nearest end of the vanes: .25 inches (6.35mm)

[0034] This invention is not to be limited by the embodiments shown in the drawings and described in the description, which are given by way of example and not of limitation, but only in accordance with the scope of the appended claims.

Claims

1. An infusion nozzle (20) comprising a body (21) having an internal wall (23) which forms a flow passage (25), said flow passage (25) extending between an entry port (26) into, and an exit port (27) from, said flow passage (25), said wall (23) being circularly-sectioned and extending along a central axis (28) between said ports (26, 27), said internal wall (23) including an entry portion (30) extending from said entry port (26), a constricting portion (31) extending from its junction (32) with the entry portion (30) to the exit port (27), said constricting portion (31) decreasing in diameter from said junction (32) to said exit port (27), and a plurality of vanes (35-42) extending from said junction (32) into said entry portion (30) and into said constricting portion (31), said vanes (35-42) being equally spaced around said central axis (28), and including a deflection face (44) facing toward said entry port (26) and a crest (46) rising at a crest angle (50, 74, 75) to said central axis (28) toward said central axis (28) and fairing into said constricting portion (31) at a point spaced from said exit port (27), said vanes (35-42) being disposed at a deflection angle (43) to a plane that contains said central axis (28) and the intersection of the respective vane with said junction (32).
2. An infusion nozzle according to claim 1 in which said crest angle is between about 10 degrees to about 40 degrees.
3. An infusion nozzle according to claim 1 in which said deflection angle is between about 3 degrees and about 15 degrees.
4. An infusion nozzle according to claim 3 in which said deflection angle is about 4 degrees.
5. An infusion nozzle according to claim 1 in which said constricting portion is the frustum of a cone having an included conical angle of about 40 degrees.
6. An infusion nozzle according to claim 1 in which the number of said vanes and their respective deflection angle is selected so that a region of a stream flowing from said nozzle has a central core of axially moving water with a region around the core having at least some rotational component derived from contact with said vanes.
7. An infusion nozzle according to claim 1 in which said crest is straight.
8. An infusion nozzle according to claim 1 in which said deflection surface is curved concavely facing toward said inlet port.

Patentansprüche

1. Infusionsdüse (20), die einen Körper (21) mit einer Innenwand (23) umfasst, die einen Strömungsdurchgang (25) bildet, wobei sich der genannte Strömungsdurchgang (25) zwischen einer Einlassöffnung (26) in den genannten Strömungsdurchgang (25) und einer Auslassöffnung (27) aus dem genannten Strömungsdurchgang (25) erstreckt, wobei die genannte Wand (23) einen kreisförmigen Querschnitt aufweist und sich entlang einer zentralen Achse (28) zwischen den genannten Öffnungen (26, 27) erstreckt, wobei die genannte Innenwand (23) einen Einlassabschnitt (30) aufweist, der sich von der genannten Einlassöffnung (26) erstreckt, mit einem Verengungsabschnitt (31), der sich von dessen Verbindungsstelle (32) mit dem Einlassabschnitt (30) zu der Auslassöffnung (27) erstreckt, wobei der genannte Verengungsabschnitt (31) von der genannten Verbindungsstelle (32) zu der genannten Auslassöffnung (27) im Durchmesser abnimmt, und wobei sich eine Mehrzahl von Flügeln (35-42) von der genannten Verbindungsstelle (32) in den genannten Einlassabschnitt (30) und in den genannten Verengungsabschnitt (31) erstreckt, wobei die genannten Flügel (35-42) mit einheitlichen räumlichen Abständen um die genannte zentrale Achse (28) angeordnet sind, und mit einer Ablenkfläche (44), die in Richtung der genannten Einlassöffnung (26) ausgerichtet ist, und mit einem Scheitel (46), der mit einem Scheitelwinkel (50, 74, 75) zu der genannten zentralen Achse (28) in Richtung der genannten zentralen Achse (28) ansteigt und in den genannten Verengungsabschnitt (31) an einer von dem genannten Auslassanschluss (27) räumlich getrennten Stelle ausstrahlt, wobei die genannten Flügel (35-42) in einem Richtungsänderungswinkel (43) zu einer Ebene angeordnet sind, welche die genannte zentrale Achse (28) und die Schnittstelle zwischen dem entsprechenden Flügel und der genannten Verbindungsstelle (32) aufweist.
2. Infusionsdüse nach Anspruch 1, wobei der genannte Scheitelwinkel zwischen etwa zehn Grad und etwa vierzig Grad liegt.
3. Infusionsdüse nach Anspruch 1, wobei der genannte Richtungsänderungswinkel zwischen etwa drei Grad und etwa fünfzehn Grad liegt.
4. Infusionsdüse nach Anspruch 3, wobei der genannte Richtungsänderungswinkel etwa vier Grad beträgt.
5. Infusionsdüse nach Anspruch 1, wobei es sich bei dem genannten Verengungsabschnitt um den Stumpf eines Kegels handelt, mit einem Öffnungswinkel von etwa vierzig Grad.

6. Infusionsdüse nach Anspruch 1, wobei die Anzahl der genannten Flügel und deren entsprechender Richtungsänderungswinkel so ausgewählt werden, dass ein Bereich eines von der genannten Düse fließenden Stroms einen zentralen Kern sich axial bewegenden Wassers aufweist, wobei ein Bereich um den Kern mindestens eine gewisse Rotationskomponente aufweist, die aus dem Kontakt mit den genannten Flügeln abgeleitet wird.
7. Infusionsdüse nach Anspruch 1, wobei der genannte Scheitel gerade ist.
8. Infusionsdüse nach Anspruch 1, wobei die genannte Ablenkfläche konkav gekrümmt ist und in Richtung der genannten Einlassöffnung ausgerichtet ist.

Revendications

1. Buse d'infusion (20) comprenant un corps (21) présentant une paroi interne (23) qui forme un passage d'écoulement (25), ledit passage d'écoulement (25) s'étendant entre un orifice d'entrée (26) dans, et un orifice de sortie (27) dudit passage d'écoulement (25), ladite paroi (23) étant sectionnée circulairement et s'étendant le long d'un axe central (28) entre lesdits orifices (26, 27), ladite paroi interne (23) incluant une portion d'entrée (30) s'étendant à partir dudit orifice d'entrée (26), une portion de rétrécissement (31) s'étendant de sa jonction (32) avec la portion d'entrée (30) à l'orifice de sortie (27), le diamètre de ladite portion de rétrécissement (31) diminuant de ladite jonction (32) audit orifice de sortie (27), et plusieurs ailettes (35-42) s'étendant de ladite jonction (32) dans ladite portion d'entrée (30) et dans ladite portion de rétrécissement (31), lesdites ailettes (35-42) étant espacées uniformément autour dudit axe central (28), et incluant une face de déflexion (44) orientée vers ledit orifice d'entrée (26) et une crête (46) s'élevant à un angle de crête (50, 74, 75) audit axe central (28) vers ledit axe central (28) et profilé dans ladite portion de rétrécissement (31) à un point espacé dudit orifice de sortie (27), lesdites ailettes (35-42) étant disposées selon un angle de déflexion (43) à un plan qui contient ledit axe central (28) et l'intersection de l'ailette respective avec ladite jonction (32).
2. Buse d'infusion selon la revendication 1, où ledit angle de crête est entre environ 10 degrés et environ 40 degrés.
3. Buse d'infusion selon la revendication 1, où ledit angle de déflexion est entre environ 3 degrés et environ 15 degrés.
4. Buse d'infusion selon la revendication 3, où ledit an-

gle de déflexion est d'environ 4 degrés.

5. Buse d'infusion selon la revendication 1, où ladite portion de rétrécissement est le tronc d'un cône ayant un angle conique inclus d'environ 40 degrés. 5
6. Buse d'infusion selon la revendication 1, où le nombre desdites ailettes et leur angle de déflexion respectif est sélectionné de telle sorte qu'une région d'un flux s'écoulant depuis ladite buse présente un noyau central d'eau se déplaçant axialement avec une région autour du noyau ayant au moins une certaine composante de rotation résultant du contact avec lesdites ailettes. 10
15
7. Buse d'infusion selon la revendication 1, où ladite crête est rectiligne.
8. Buse d'infusion selon la revendication 1, où ladite surface de déflexion est courbée d'une manière concave en étant orientée vers ledit orifice d'entrée. 20

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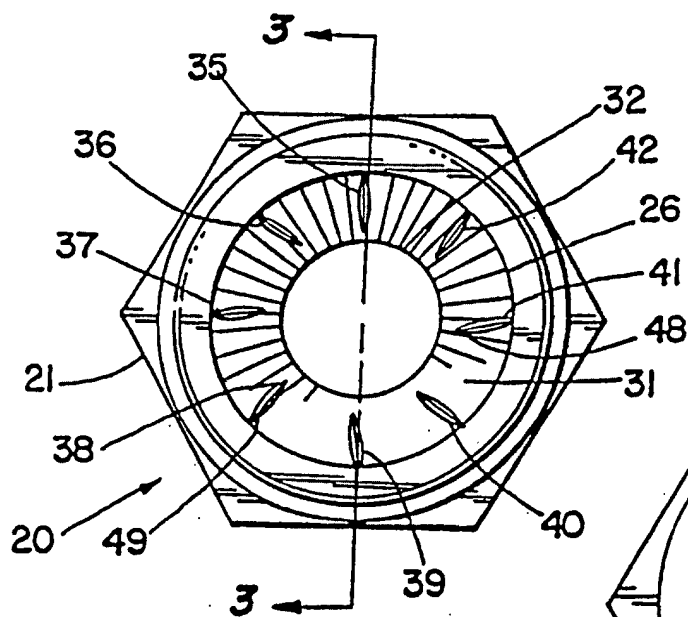


Fig. 1

Fig. 2

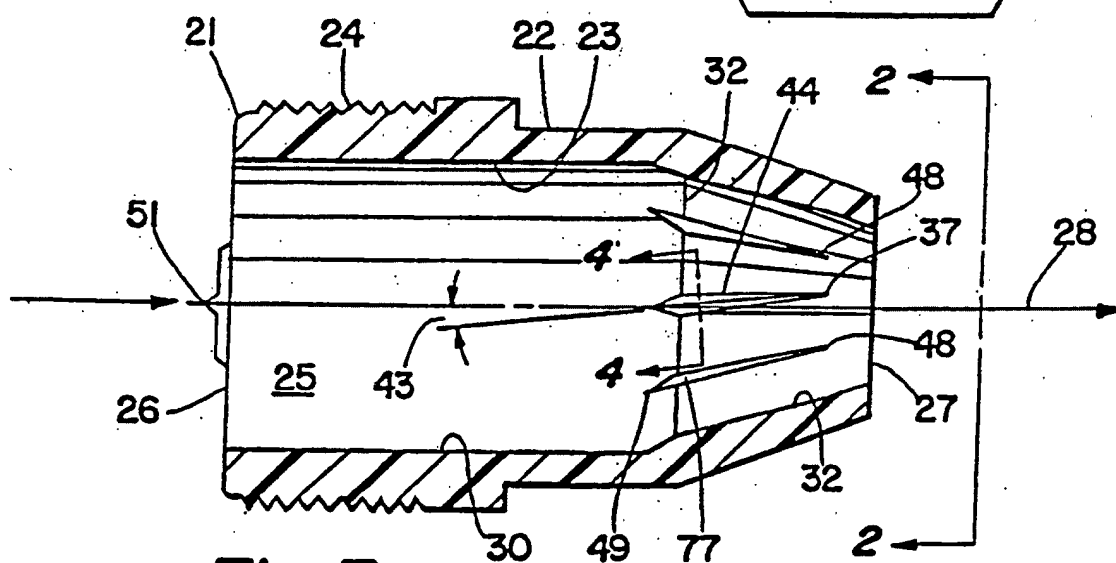
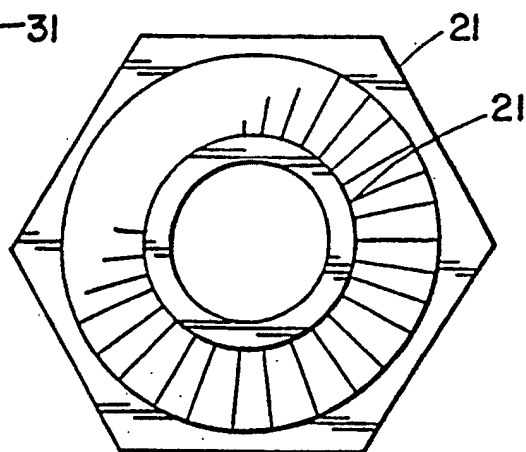


Fig. 3

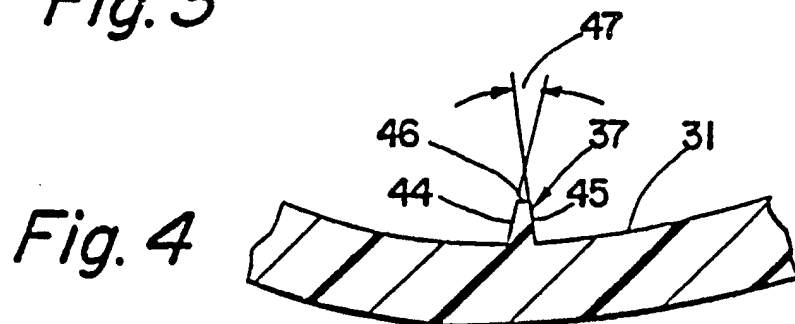


Fig. 4

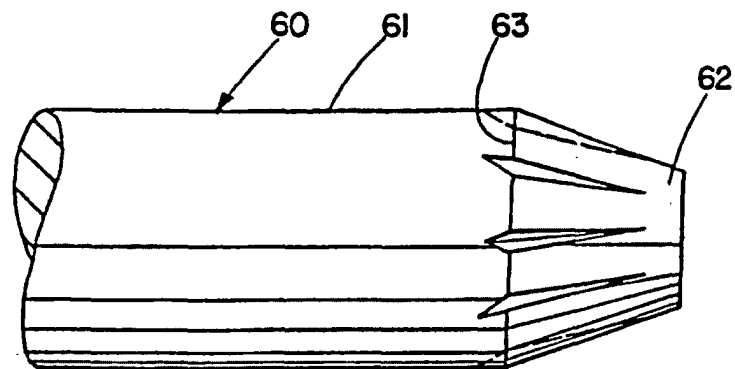


Fig. 5

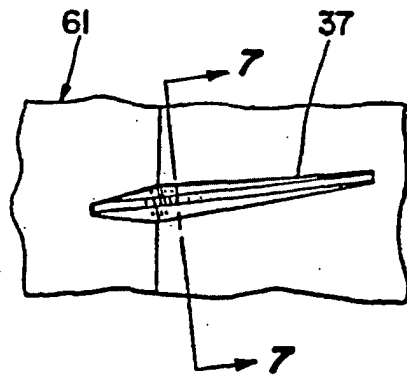


Fig. 6

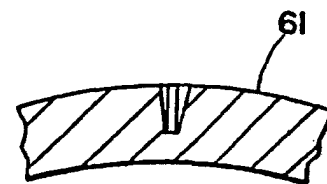


Fig. 7

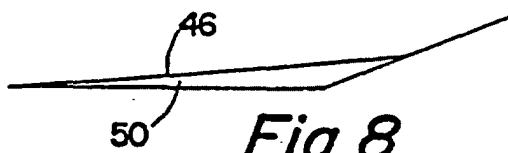


Fig. 8



Fig. 9



Fig. 10

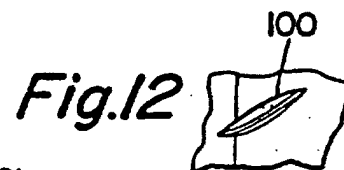


Fig. 12

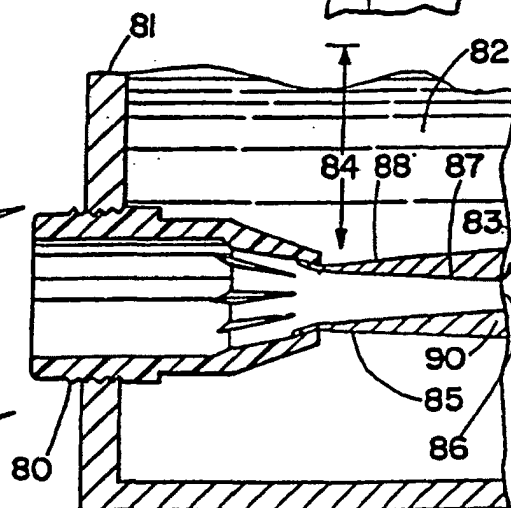


Fig. 11