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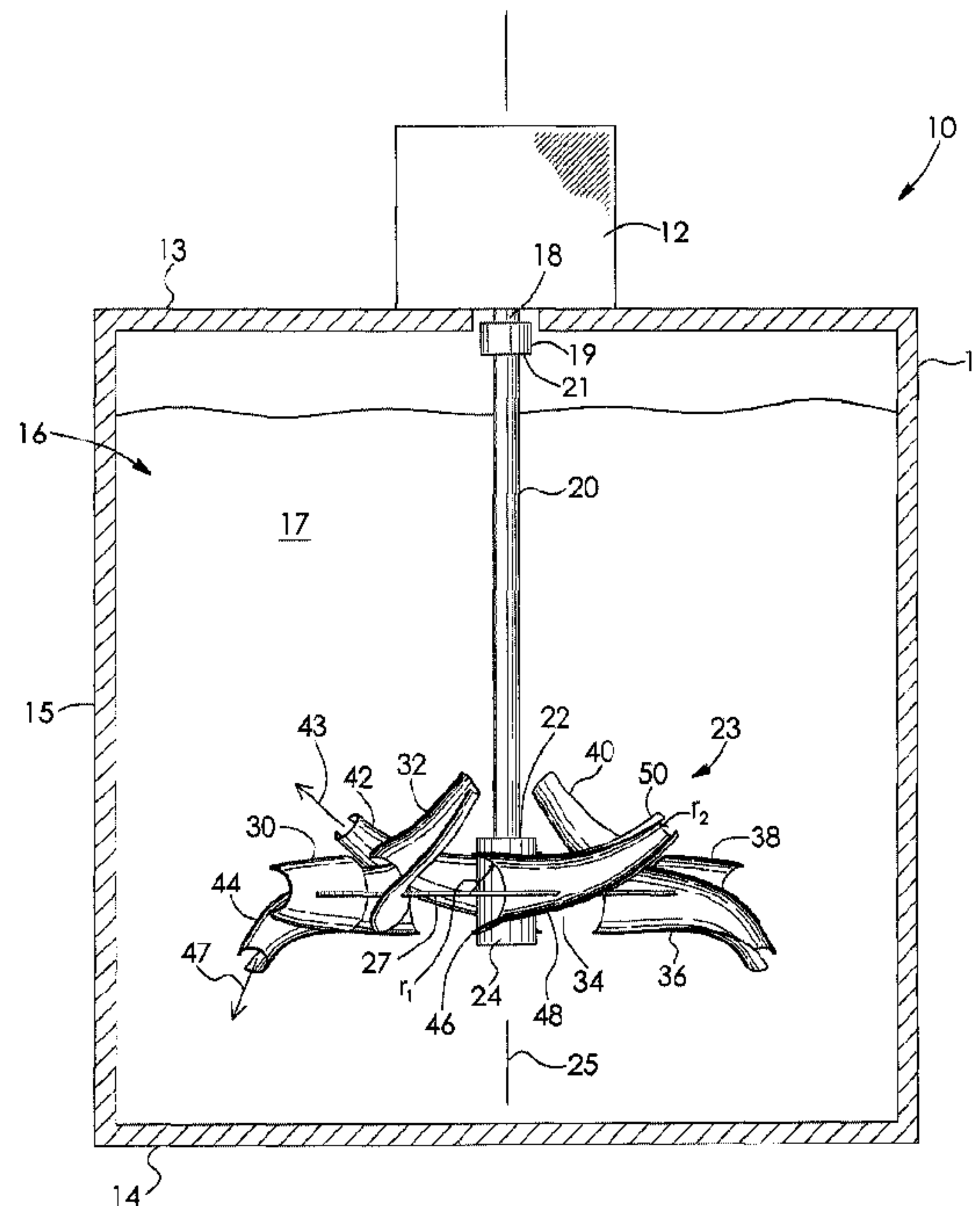
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(54) Titre : ROTOR DE MELANGE AYANT DES AUBES EN FORME DE CANAL

(54) Title: MIXING IMPELLER HAVING CHANNEL-SHAPED VANES



(57) **Abrégé/Abstract:**

The present invention relates to a mixing impeller for an agitator. The impeller has a body that may be disc-shape. The impeller has a plurality of radially spaced-apart, longitudinally curved, channel-shaped vanes connected to and extending outwards from the body in a plurality of different directions. At least one of the vanes has a distal end at least partially facing above the body. At least one of the vanes has a distal end at least partially facing below the body. At least one of the vanes has a distal end at least partially facing tangential to the body.

ABSTRACT OF THE DISCLOSURE

The present invention relates to a mixing impeller for an agitator. The impeller has a body that may be disc-shape. The impeller has a plurality of radially spaced-apart, longitudinally curved, channel-shaped vanes connected to and extending outwards from the body in a plurality of different directions. At least one of the vanes has a distal end at least partially facing above the body. At least one of the vanes has a distal end at least partially facing below the body. At least one of the vanes has a distal end at least partially facing tangential to the body.

MIXING IMPELLER HAVING CHANNEL-SHAPED VANES

Field of the Invention

[0001] The present invention relates to a mixing impeller. In particular, the invention relates to a mixing impeller having longitudinally curved, channel-shaped vanes.

Description of the Related Art

[0002] United States Patent No. 5,791,780 to Bakker shows an impeller assembly for agitating a fluid contained in a vessel and dispersing a gas introduced therein. The impeller assembly includes an impeller having a plurality of generally radially extending blades. Each of the blades includes diverging upper and lower sheet-like portions having generally radially extending leading edges. The upper and lower portions are joined to form a generally V-shaped cross-section with a trailing vertex. The width of the upper portion of each blade is greater than the width of the lower portion of the blade such that the upper portion leading edge extends forwardly of the lower portion leading edge, thus producing an upper portion overhang to capture and disperse rising gas bubbles. The impeller assembly further comprises a drive assembly for rotating the impeller assembly.

[0003] United States Patent No. 5,246,289 to Middleton et al. shows an agitator assembly for use in effecting dispersion of a fluid such as a gas in a liquid. The assembly comprises a rotor having a rotatably driven shaft mounting a series of scoop-shaped blades which are oriented with the mouths of the scoops presented in the direction of rotation of the shaft. Each blade is mounted at an angle of attack such that one end of the blade leads the other in the direction of rotation. To eliminate gas cavity formation, each blade is of a generally streamlined configuration in section and the ends thereof are generally transverse to the axis of rotation of the rotor.

[0004] United States Patent No. 5,037,209 to Wyss shows a stirring mechanism, with a plurality of hollow, at least partially conically shaped stirring elements. These elements are provided with two openings, are symmetrically offset and are fixed on the stirring shaft at least approximately tangential to an imaginary circular cylinder coaxial to the stirring shaft. In the starting phase, the stirred substance flows laminarly through the stirring elements. However, as soon as they have reached a predetermined minimum velocity of about 1.3 m/s, the flow inside the stirring elements is forced to reverse by dynamic pressure.

[0005] US 2009/0110559 A1 shows an aerating propeller for attaching to the end of a drive shaft includes blades having a chamber to receive a flow of fluids from a conduit in a drive shaft. A trailing face of the blade includes a first opening into the chamber to permit the flow of fluids in the chamber to exit the propeller and a tip of the blade includes a second opening extending into the chamber to permit the flow of fluids in the chamber to exit the propeller. The first opening of the first blade is aligned generally in the same plane with the leading face of the second blade which follows the first blade when the propeller is rotated.

BRIEF SUMMARY OF INVENTION

[0006] The present invention provides, and it is an object of the present invention to provide, an improved mixing impeller.

[0007] There is accordingly provided a mixing impeller for an agitator. The impeller has a body. The impeller has a plurality of radially spaced-apart, longitudinally curved, channel-shaped vanes connected to and extending outwards from the body in a plurality of different directions.

[0008] There is also provided a mixing impeller for an agitator. The impeller has an axis of rotation and includes an annular body having a top and a bottom. The impeller has a plurality of radially spaced-apart, channel-shaped vanes connected to and extending outwards from the top and the bottom of the body. Each of the vanes has a proximal end

connected to the body and a distal end radially spaced-apart from the proximal end. At least one of the vanes is configured to extend axially outwards relative to the axis of rotation. At least another of the vanes is configured to extend radially outwards. At least a further of the vanes is configured to be at least partially bisected by the body. The distal end of a first one of the vanes at least partially faces above the body. The distal end of a second one of the vanes at least partially faces below the body. The distal end of a third one of the vanes at least partially faces tangential to the body.

BRIEF DESCRIPTION OF DRAWINGS

[0009] The invention will be more readily understood from the following description of preferred embodiments thereof given, by way of example only, with reference to the accompanying drawings, in which:

- 5 Figure 1 is a side elevation view of an agitator assembly, showing a tank in section, a motor and gear box assembly mounted to the tank, and an impeller according to a first embodiment, the impeller being connected to the motor;

Figure 2 is a top perspective view of the impeller shown in Figure 1;

Figure 3 is a top plan view of the impeller shown in Figure 1;

- 10 Figure 4 is a bottom perspective view of the impeller shown in Figure 1;

Figure 5 is a side elevation fragmented view of the impeller shown in Figure 1, with a plurality of vanes being shown angularly spaced-apart from the body of the impeller;

- Figure 6 is a top plan view of an impeller according to a second embodiment; together
15 with part of an agitator shaft connected thereto, the impeller having a pair of conical deflectors, only one of which being shown in Figure 6;

Figure 7 is a side elevation view of the impeller shown in Figure 6, both conical deflectors are shown;

Figure 8 is a top plan view of an impeller according to a third embodiment;

- 20 Figure 9 is a side elevation view of the impeller shown in Figure 8;

Figure 10 is a top plan view of an impeller according to a fourth embodiment;

Figure 11 is a top perspective view of an impeller according to a fourth embodiment.

Figure 12 is a top perspective view of an impeller according to a fifth embodiment;

Figure 13 is a bottom plan view of the impeller shown in Figure 12;

Figure 14 is a side elevation view of the impeller shown in Figure 12;

Figure 15 to Figure 22 are different shapes of the distal ends of the vanes, and

5 Figure 23 to Figure 27 are shapes of the different vanes.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

10 [00010] Referring to the drawings and first to Figure 1, there is shown an agitator assembly 10. The assembly has a housing, in this example a tank 11. The assembly 10 has an actuator, in this example an electric motor and gear box assembly 12 mounted to the tank. The motor and gear box assembly is conventional and well known to those skilled in the art. Its parts and operation per se will therefore not be described in detail.

15 The tank 11 is cylindrically-shaped in this example, and has a top 13, a bottom 14 opposite the top, and a curved, peripheral side 15 in this example extending between the top and bottom. The tank 11 has an interior 16 within which is disposed a substance to be mixed, in this example a liquid 17. In another embodiment, the tank may contain solid materials or a liquid-solid mixture to be mixed. The agitator assembly 10 may be

20 used, for example, in the chemical industry or in a waste management system.

[0011] The motor and gear box assembly 12 has a stub shaft 18. The assembly 10 includes a coupling member 19 and an agitator shaft 20. The agitator shaft has a first end 21 and a second end 22 opposite the first end. The coupling member 19 couples the first end of the agitator shaft 20 to the stub shaft 18 of the motor. Shaft 20 is thus

25 rotatably connected to the motor and gear box assembly 12.

[0012] The agitator assembly 10 has a mixing impeller 23 mounted to the second end 22 of the shaft 20. The impeller includes a centrally disposed hub 24, in this example. The hub has an aperture 26, best shown in Figure 3, configured to receive the

second end of the shaft. Referring back to Figure 1, the shaft 20 may be keyed to the hub 24 for connecting to the hub and shaft together. The impeller 23 has an axis of rotation 25 around which shaft 20 and impeller 23 rotate.

5 [0013] As seen in Figure 3, the impeller 23 has disc-shaped body 27. The body has a top 28 shown in Figures 2 and 3 facing the top 13 of the tank 11 shown in Figure 1. Referring to Figure 4, the body 27 has a bottom 29 opposite its top. The bottom of the body faces the bottom 14 of the tank shown in Figure 1.

10 [0014] Referring to Figure 2, the impeller 23 has a plurality of radially spaced-apart, longitudinally curved, channel-shaped vanes 30, 32, 34, 36, 38, 40, 42, and 44. While eight vanes are shown in this example, this number of vanes is not strictly required and there may be a different number of vanes in other embodiments.

15 [0015] The vanes 30, 32, 34, 36, 38, 40, 42, and 44 extend outwards from the body 28 in a plurality of different directions. Vanes 30, 32, 34 and 36 are radially spaced-apart by 180 degrees relative to vanes 38, 40, 42 and 44, respectively. The vanes 30, 32, 34, 36, 38, 40, 42, and 44 are channel-shaped and c-shaped in section with a convex side and a concave side, as shown in Figure 2 by concave side 33 and convex side 35 for vane 30.

20 [0016] Each of the vanes has a proximal end connected to the body. This is shown in Figure 4 for vane 34 by its proximal end 46. The proximal ends of the vanes connect to both the top 28 and the bottom 29 of the body 27, with the body bisecting the proximal ends of the vanes in this example and the vanes disposed through radially extending and spaced-apart, curved slots of the body. This is shown by slot 37 for vane 32 in Figure 2. Each of the vanes tapers towards a distal end which is radially spaced-apart from the proximal end, in this embodiment. This is shown by distal end 50 for vane 34. In this embodiment, the channel-shaped distal ends 50 are smaller in cross-section relative to the channel-shaped proximal ends 46. Each vane has a radius of curvature r . The radius of curvature r_1 at the proximal ends 46 of the vanes is

25

greater than the radius of curvature r_2 at the distal ends 50 of the vanes in this example.

[0017] Referring to Figures 1 and 2, vanes 32, 34, 40 and 42 are configured to extend axially outwards from the top 28 of the body 27 and relative to the axis of rotation shown in Figure 1. These vanes also extend radially outwards with their distal ends at least partially facing the top 13 of the tank 11. These vanes so configured thus promote upward movement of the liquid, as shown by arrow of numeral 43 for vane 42 in Figure 1. Vanes 32 and 40 extend outwards from the top of the body at a greater angle relative to vanes 34 and 42. In this example, vanes 32 and 40, as shown by vane 40 in Figure 5, are angularly spaced-apart from the top 28 of the body 27 at an angle α_1 equal to 60 degrees. Vanes 34 and 42 are angularly spaced-apart from the top of the body at an angle α_2 equal to 30 degrees, in this example.

[0018] As seen in Figures 1 and 4, vanes 36 and 44 are configured to extend axially outwards from bottom 29 of the body 27 and relative to the axis of rotation 25 shown in Figure 1. These vanes extend radially outwards with their distal ends at least partially facing the bottom 14 of the tank 11. These vanes so configured promote downward movement of the liquid, as shown by arrow of numeral 47 for vane 44 in Figure 1. Referring to Figure 5, these vanes, as shown by vane 36, are angularly spaced-apart from the bottom 29 of the body 27 at an angle α_3 equal to 30 degrees. Angles α_1 , α_2 and α_3 are provided by way of example only. Alternatively, one or more of the vanes may be angularly spaced-apart from the body 27 by an angle α_4 equal to 45 degrees or an angle α_5 equal to 80 degrees, for example.

[0019] Referring to Figures 1 and 2, vanes 30 and 38 are configured to extend radially outwards from the body 27, with their distal ends facing the side 15 of the tank 11. Each of the vanes, with vanes 30 and 38 in particular, are configured to promote centrifugal movement of the liquid, as shown by arrow of numeral 39 for vane 38 in Figure 3.

[0020] Impeller 23 as herein described, with its channel-shaped, tapered vanes

extending in a plurality of directions, may thus enable liquid or other substances within the tank 11 to be mixed in a more enhanced and efficient manner.

[0021] Figures 6 and 7 show an impeller 23.1 for the agitator assembly 10 shown in Figures 1 to 5 according to a second embodiment. Like parts have like numbers and function as the embodiment shown in Figures 1 to 5 with the addition of ".1". Impeller 23.1 is substantially the same as impeller 23 shown in Figures 1 to 5 with the following exceptions.

[0022] Impeller 23.1 is particularly suited for mixing primarily liquid substances. The impeller has 12 vanes 30.1, 32.1, 34.1, 36.1, 38.1, 40.1, 42.1, 52, 53, 54, 55 and 56 in this example. Each of the vanes is substantially similar in shape. Vanes 30.1, 34.1, 38.1, 42.1, 53 and 55 extend radially and axially outwards from top 28.1 of the body 27.1 relative to the axis of rotation, with their distal ends, as shown by distal end 63 for vane 30.1, facing towards the bottom 14 of the tank 11 shown in Figure 1. These vanes thus promote downward movement of the liquid.

[0023] Referring to Figure 6 and 7, vanes 32.1, 36.1, 40.1, 52, 54 and 56 extend radially and axially outwards from the bottom 29.1 of the body 27.1 relative to the axis of rotation, with their distal ends, as shown by distal end 59 for vane 32.1 in Figure 7, facing towards the top 13 of the tank 11 shown in Figure 1. These vanes thus promote upward movement of the liquid.

[0024] Each vane is longitudinally curved and channel-shaped with a flat, quadrilateral top and bottom and a curved side which is longitudinally convex on the side facing the top and the bottom and longitudinally concave on the side facing away from its top and bottom. For vane 32.1, this is shown in Figure 6 with vane 32.1 having a side 60, top 62 and bottom 64.

[0025] Referring to Figures 6 and 7, the impeller has a pair of centrally disposed deflectors 86 and 88, mounted to the top 28.1 and bottom 29.1 of body 27.1, respectively.

Each deflector is substantially the same as the other and therefore only deflector 86 will be described in detail. As seen in Figure 7, deflector 86 is generally conical in shape and, in particular, has a concave frustoconical outer surface 90 in this example. Referring to Figure 6, the deflector's proximal end 92 abuts top 28.1 of body 27.1, and is larger in radius relative to its distal end 94. As seen in Figure 7, the deflector 86 has a central aperture 96 extending from end 92 to end 94 and configured to receive agitator shaft 20.1, as shown in Figure 7, with the deflector snugly receiving the shaft at end 92 of the deflector.

[0026] Referring to Figures 6 and 7, the deflector 86 is curved and continuous in profile and provides a smooth path for the liquid to be agitated to pass therealong from the top 28.1 of the body 27.1, along the surface 90 and to the outer surface of the shaft 20.1. In a like manner, deflector 88 is also curved in profile and provides a smooth path in profile between the bottom 29.1 of the body and the deflector's corresponding concave, conical surface 100. Deflector 86 is configured to direct liquid in an axially downward and radially outward direction, as shown by arrow of numeral 101 in Figure 7. Put another way, deflector 86 is configured to direct liquid downward and outward towards portions of the proximal ends 53 of the vanes disposed above the body 27.1, driving the flow of liquid out through the distal ends 53 of the vanes. Referring to Figure 7, deflector 88 is configured to direct liquid an axially upward and radially outward direction, as shown by arrow of numeral 103, towards portions of the proximal ends of the vanes disposed below the body 27.1, driving the flow of liquid out through the distal ends of the vanes. The deflectors may be welded to the body 27.1 or frictionally engage with the shaft 20.1.

[0027] Figures 8 and 9 show an impeller 23.2 for the agitator assembly 10 shown in Figures 1 to 5 according to a third embodiment. Like parts have like numbers and function as the embodiment shown in Figures 1 to 5 with the addition of ".2". Impeller 23.1 is substantially the same as impeller 23 shown in Figures 1 to 5 with the following exceptions.

[0028] Each vane has a straight section at its proximal end and has a smooth transformation to the c-shaped distal end.

5 [0029] As seen in Figure 8, shaft 20.2 has a flange 102 connected to its second end 22.2, by welding in this example. The flange has a plurality of radially spaced-apart apertures 104. The body 27.2 has a plurality of corresponding apertures, and the flange 102 is connectable to the impeller 23.2 by way of a plurality of connectors passing through said apertures. In this example the connectors are in the form of bolts and nuts 106, though they may be rivets, for example, according to another embodiment.

10 [0030] Figures 10 to 11 show an impeller 23.3 for the agitator assembly 10 shown in Figures 1 to 5 according to a fourth embodiment. Like parts have like numbers and function as the embodiment shown in Figures 1 to 5 with the addition of “.3”. Impeller 23.3 is substantially the same as impeller 23 shown in Figures 6 to 7 with the following exceptions.

15 [0031] All impeller vanes are attached to the bottom 29.3 of the body 28.3 and configured both to extend axially outwards relative to the axis of rotation and to extend radially outwards to below the body.

20 [0032] Figures 12 to 14 show an impeller 23.4 for the agitator assembly 10 shown in Figures 1 to 5 according to a fifth embodiment. Like parts have like numbers and function as the embodiment shown in Figures 1 to 5 with the addition of “.4”. Impeller 23.4 is substantially the same as impeller 23 shown in Figures 1 to 5 with the following exceptions.

25 [0033] Impeller 23.4 has a plurality of radially spaced-apart, vertically-aligned connector plates, as shown by plate 108 in Figure 14, connected to and extending radially outwards from the hub 24.4. Body 27.4 is also centrally connected to and extends around hub 24.4. The body is relatively small compared to the embodiments shown in Figures 1 to 13. Referring to Figure 13, each of the plates has a first portion 110

that extends through a respective one of the radially spaced-apart slots 37.4 of the body. Each of the plates 108 also has a second portion 112 that extends tangential to the circular outer edge 109 of the body 27.4. The second portions are bent relative to the first portions and both the first and second portions are generally rectangular in shape in this example. The connector plates 108 may function to reinforce body 27.4 and impeller 23.4 generally.

[0034] Each of the vanes 30.4, 32.4, 36.4, 38.4, 40.4 and 44.4 has a proximal end that is flat, as shown by end 114 for vane 32.4 in Figure 12. The connector plates 108 connect the proximal ends of the vanes to the body 27.4. This connection may be by way of welding, for example, though this is not strictly required and other ways of connecting the vanes to the connector plates are possible. Each of the vanes 30.4, 32.4, 36.4, 38.4, 40.4 and 44.4 has a distal end that is c-shaped in cross-section, as seen in Figure 14 by distal end 116 for vane 32.4. The vanes fully extend outwards from the body 27.4 and do not directly connect with the body.

[0035] Figure 15 to Figure 20 show different shaped channels at the distal ends. Figure 15, 17, 19, 21 show closed channels at the vane distal ends, as examples, including round, rectangular, polygon, or elliptical. Figure 16, 18, 20, 22 show partially opened channels at the vane distal ends.

[0036] Figure 23 to Figure 27 shows different configurations of the impeller vanes. Figure 23 shows an impeller vane similar to those shown in Figure 1 to Figure 4 with the exception that the vane is not-tapered, the proximal end 46 and the distal end 50 has same size and shape. The radius of curvature r_1 of the vane proximal end is equal in size to the radius of curvature r_2 of the vane distal end.

[0037] Figure 24 shows a vane substantially identical to those vanes shown in Figures 1 to 5. Figure 25 shows a vane substantially identical to those vanes shown in Figures 8 to 9. The vane is configured to have a straight section at its proximal end and transformed to c-shaped distal end.

[0038] Figure 26 shows a vane configured to have a straight plate section at its proximal end and a closed channel at its distal end. The edge 46 has an angle of 30 to 60 degree to the body surface.

5 [0039] Figure 27 shows a vane similar to Figure 26 with the exception that its distal end is tapered.

[0040] It will be appreciated that yet further variations are possible within the scope of the invention described herein. For example, as mentioned above, the number of vanes may vary. Also, the angular positioning of the vanes may vary. The vanes may connect at their proximal ends to the top, the bottom, or both the top and bottom of the body of the impeller. The vanes may be fully curved or partially curved. The vanes may be formed with a plurality of plates welded together.

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[0041] It also will be understood by someone skilled in the art that many of the details provided above are by way of example only and are not intended to limit the scope of the invention which is to be determined with reference to the following claims.

15

WHAT IS CLAIMED IS:

1. A mixing impeller for an agitator, the impeller comprising:

a body; and

a plurality of radially spaced-apart, longitudinally curved, channel-shaped vanes connected to and extending outwards from the body in a plurality of different directions,

wherein the impeller has an axis of rotation, wherein at least one of the outer vanes is configured to extend axially and radially outwards, and has a distal end at least partially facing above or below the body.
2. The impeller as claimed in claim 1 wherein each of the longitudinally curved vanes has a proximal end operatively connected to the body and a distal end radially spaced-apart from the proximal end.
3. The impeller as claimed in claim 1, wherein the body is annular and has a top and a bottom opposite the top and wherein the impeller further includes a central hub that connects with an agitator shaft.
4. The impeller as claimed in claim 1, wherein the body is annular and has a top and a bottom opposite the top, a plurality of apertures to connect to a flange that connects with an agitator shaft.

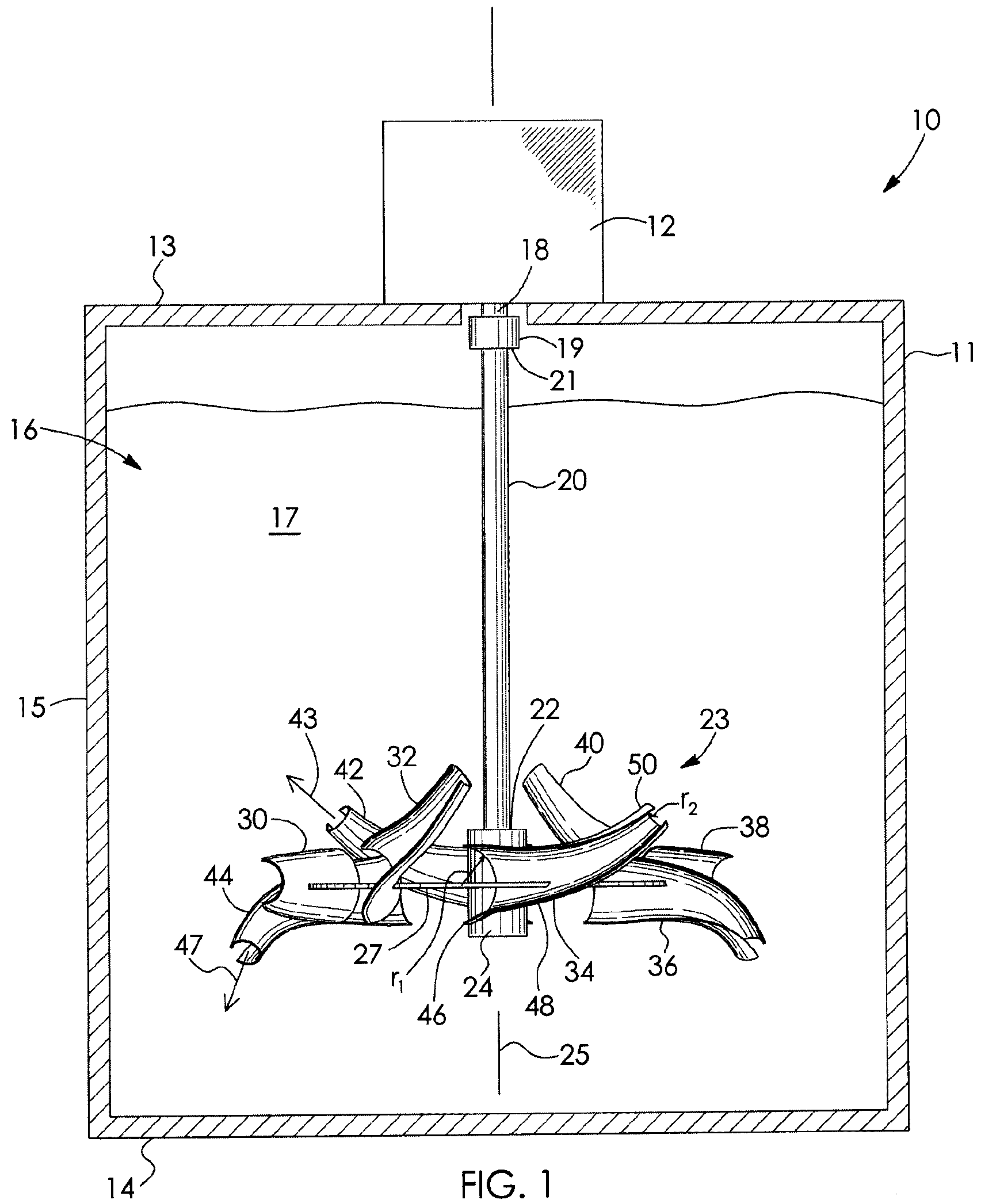
5. The impeller as claimed in claim 1, wherein at least one of the vanes has a distal end at least partially facing above the body.
6. The impeller as claimed in claim 1, wherein at least one of the vanes has a distal end at least partially facing below the body.
7. The impeller as claimed in claim 1, wherein at least one of the vanes is at least partially bisected by the body.
8. The impeller as claimed in claim 2 wherein the impeller has an axis of rotation, and wherein each vane has a distal end that is c-shaped in section, a convex side and a concave side.
9. The impeller as claimed in claim 2 wherein each vane has a straight side that extends outwards and perpendicular from the body, a top and a bottom that forms a u-shaped channel space for directing liquid therethrough.
10. The impeller as claimed in claim 2 wherein the impeller has an axis of rotation, and wherein each vane has a distal end that is o-shaped in section, a convex side and a concave side.
11. The impeller as claimed in claim 2 wherein the impeller has an axis of rotation, and wherein each vane has a distal end that is polygon-shaped in section, has interior sides and exterior sides.

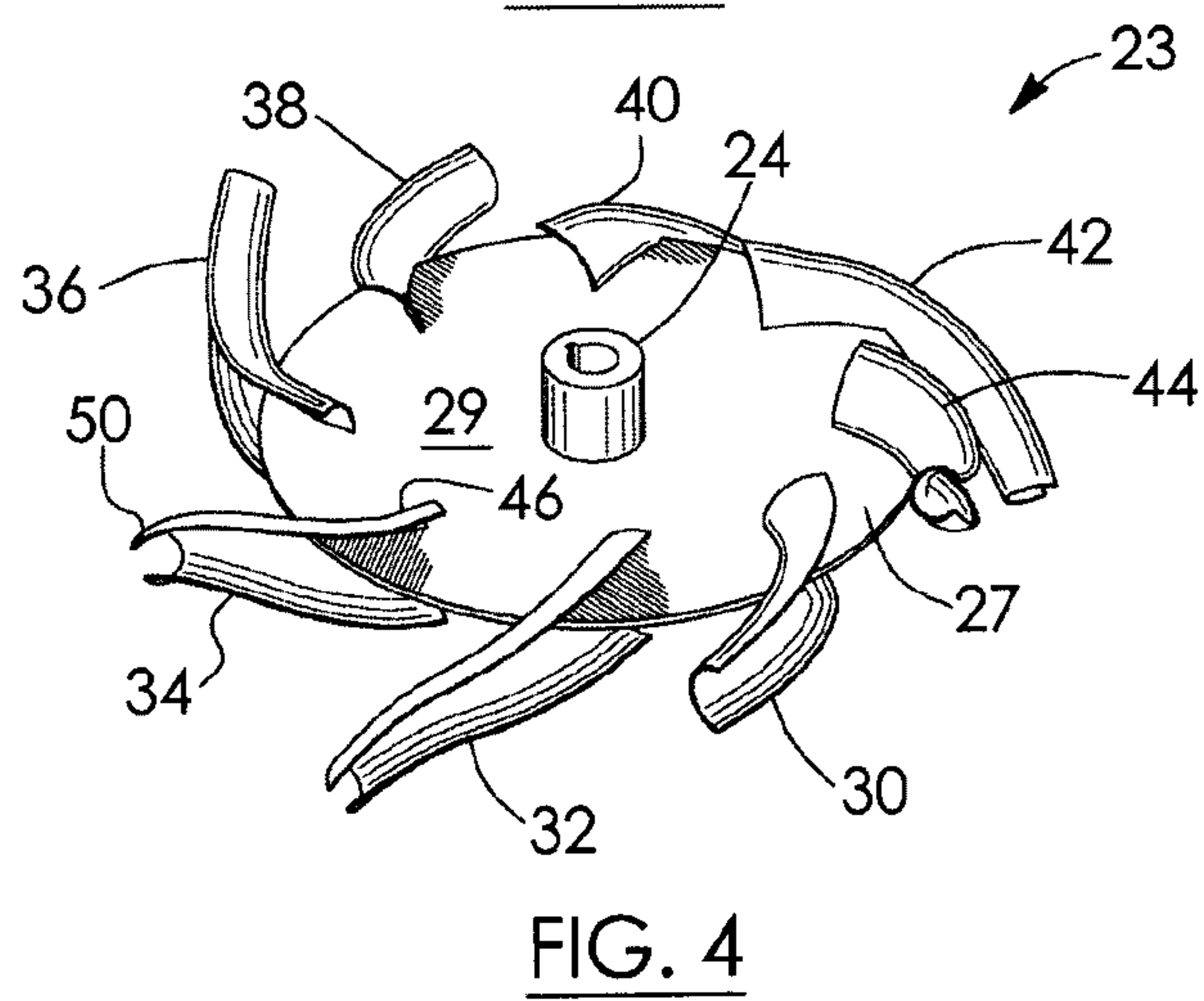
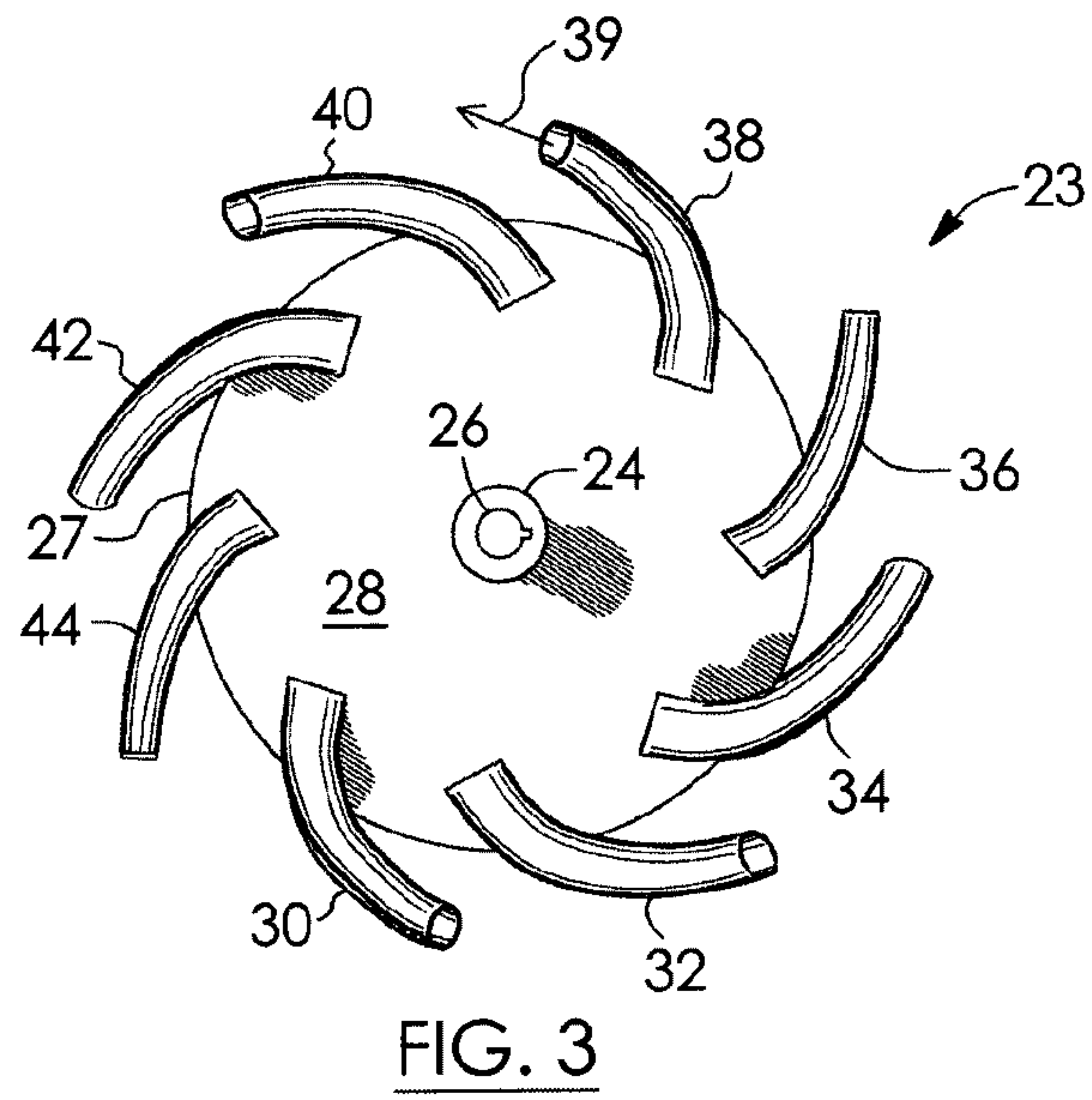
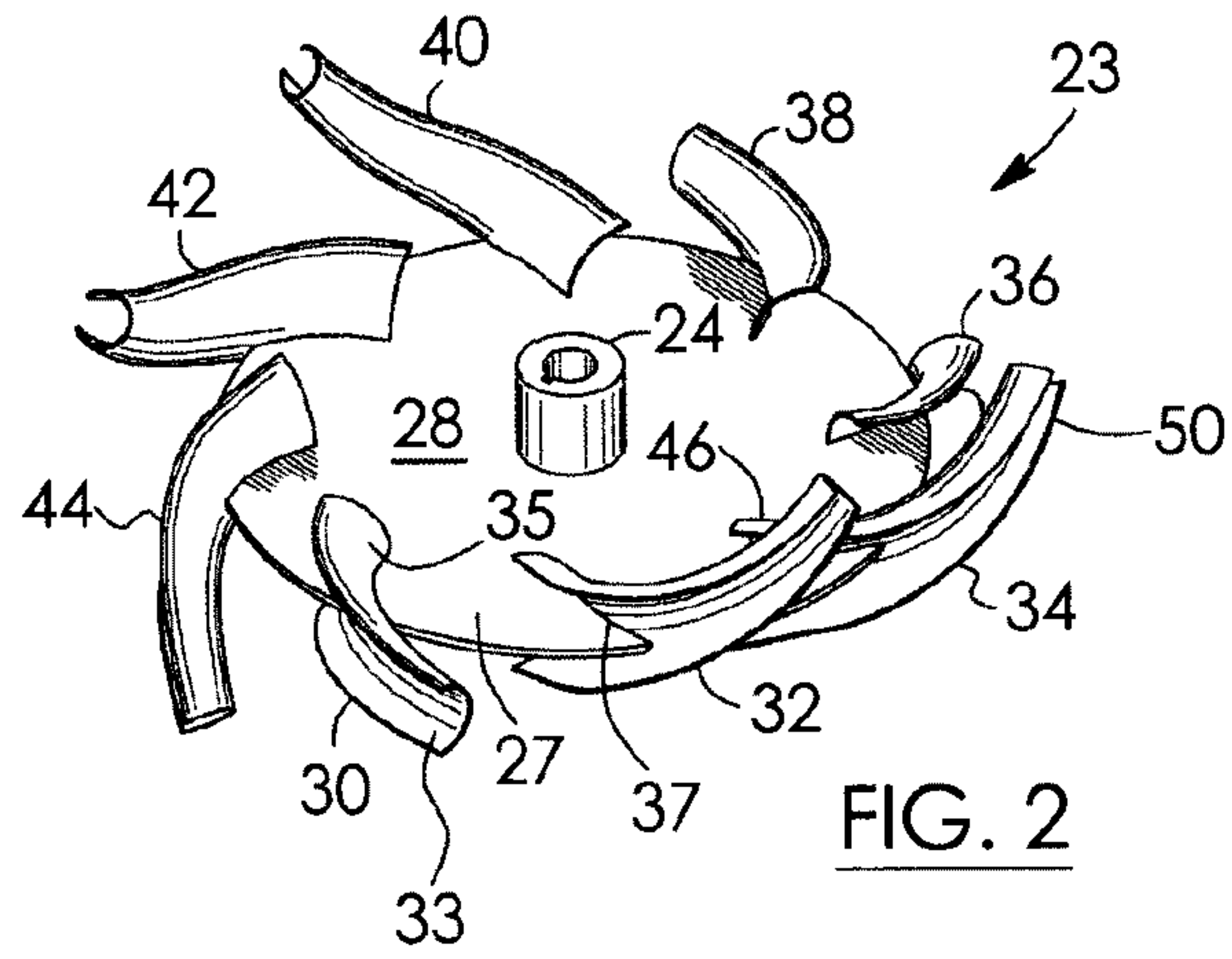
12. The impeller as claimed in claim 2 wherein each vane has a proximal end that has same geometric shape as its distal end.
13. The impeller as claimed in claim 2 wherein each vane has a proximal end that has straight edge with an angle to the body surface of 30 to 60 degree, and transits to the channel shaped distal end as the vanes extend outwards.
14. The impeller as claimed in claim 2 wherein each vane has a tapered distal end.
15. The impeller as claimed in claim 1, further including a centrally disposed deflector connected to the body, the deflector having a concave frustoconical outer surface.
16. The impeller as claimed in claim 15, wherein the impeller has an axis of rotation, wherein the body has a top and a bottom opposite the top, the deflector connecting to the top of the body and being configured to direct liquid in an axially downward and radially outward direction relative to the axis of rotation, and wherein the impeller has a further deflector having a concave frustoconical outer surface, the further deflector connecting to the bottom of the body and being configured to direct liquid in an axially upward and radially outward direction relative to the axis of rotation.
17. An agitator having a housing, an actuator mounted to the housing, a shaft rotatably connected to the actuator and the impeller as claimed in claim 1, the impeller being rotatably mounted to the shaft.
18. A mixing impeller for an agitator, the impeller having an axis of rotation and

comprising:

an annular body having a top and a bottom;

a plurality of radially spaced-apart, longitudinally-curved, channel-shaped vanes extending outwards from the top and the bottom of the body, each vane having a proximal end connected to the body and a distal end radially spaced-apart from the proximal end, the distal ends being channel-shaped in cross-section at least one vane being configured to extend axially outwards relative to the axis of rotation, at least another vane being configured to extend radially outwards, at least a further vane being configured to be at least partially bisected by the body, the distal end of a first vane at least partially facing above the body, the distal end of a second vane at least partially facing below the body and the distal end of a third vane at least partially facing tangential to the body.





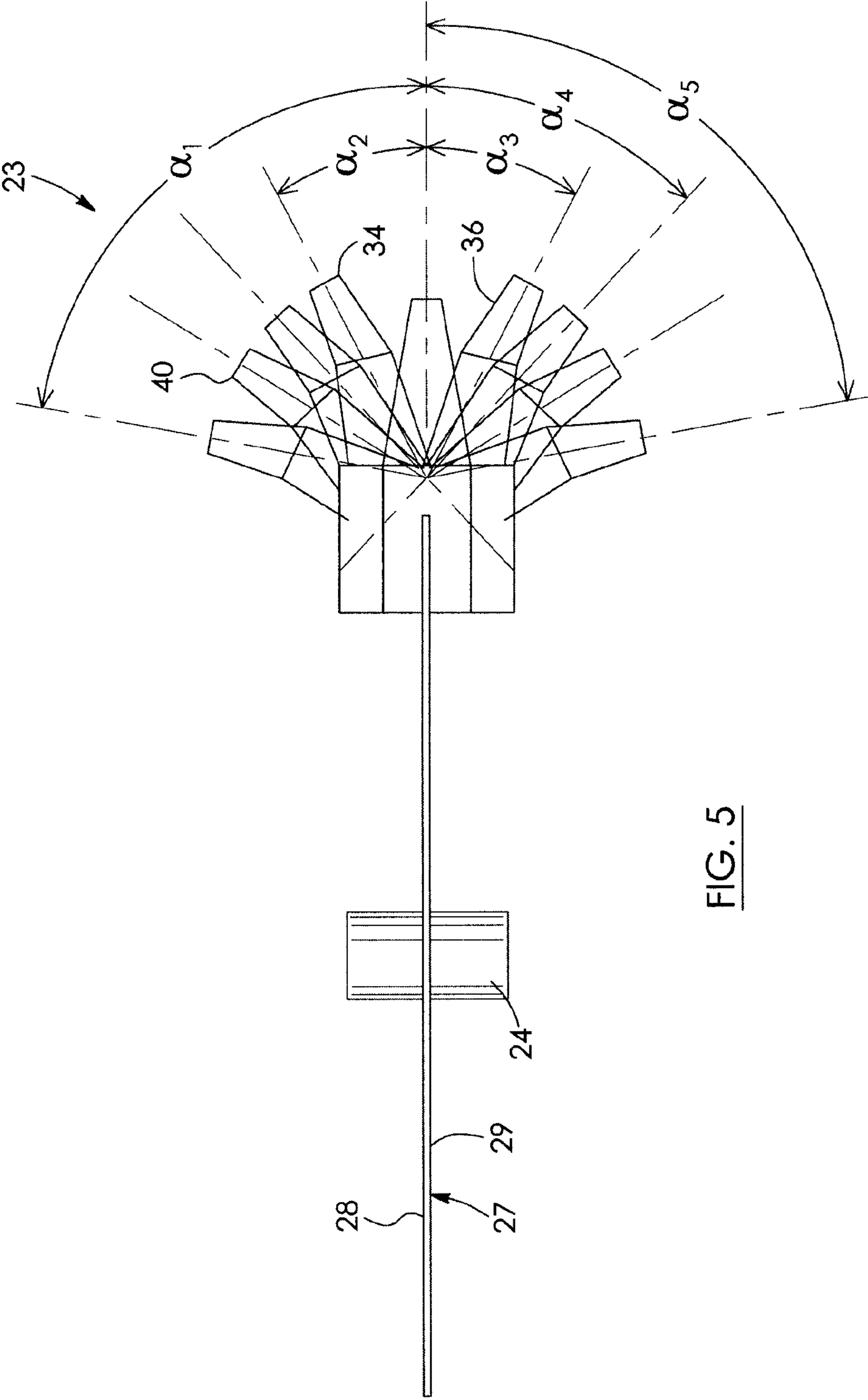


FIG. 5

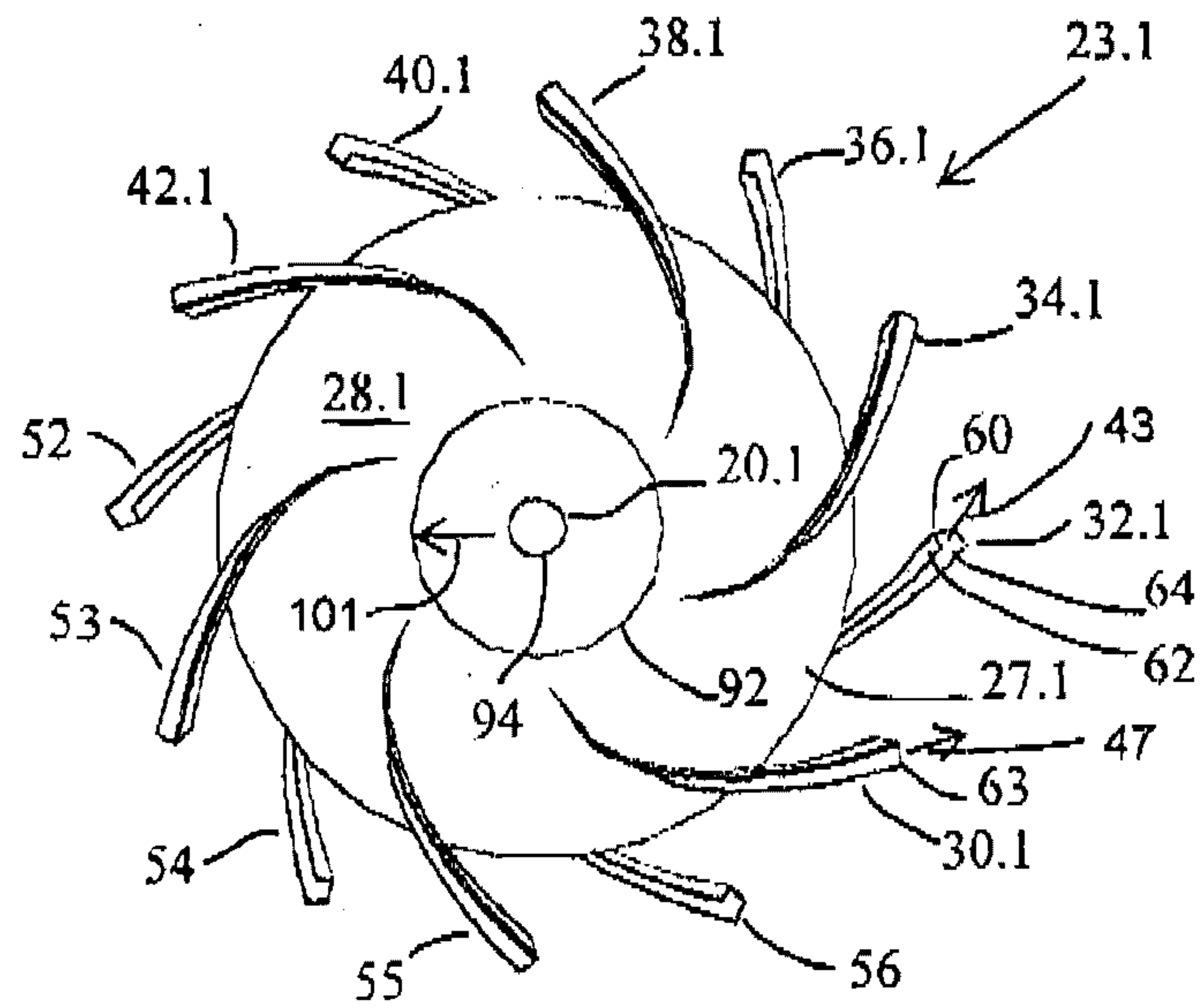


FIG. 6

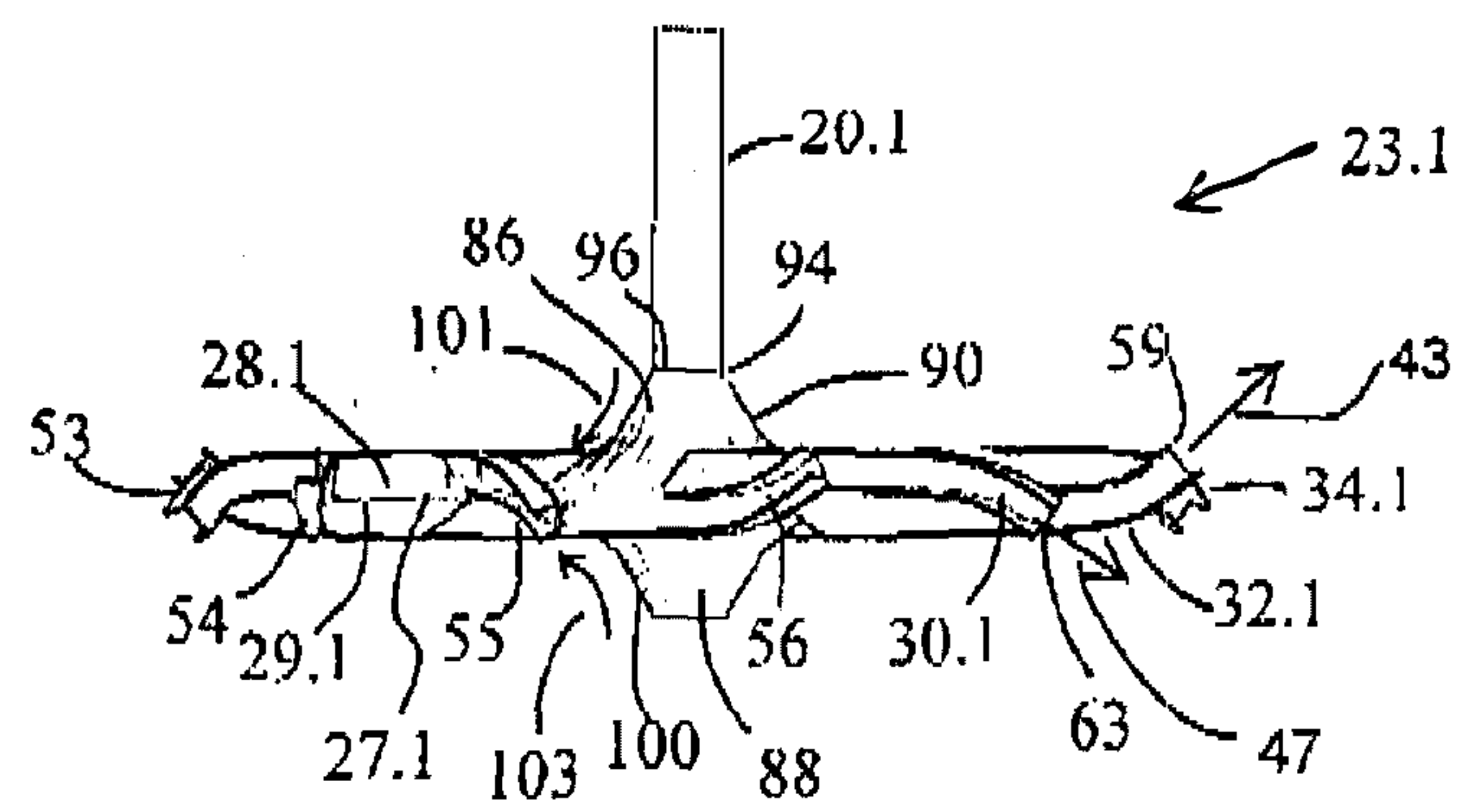


FIG. 7

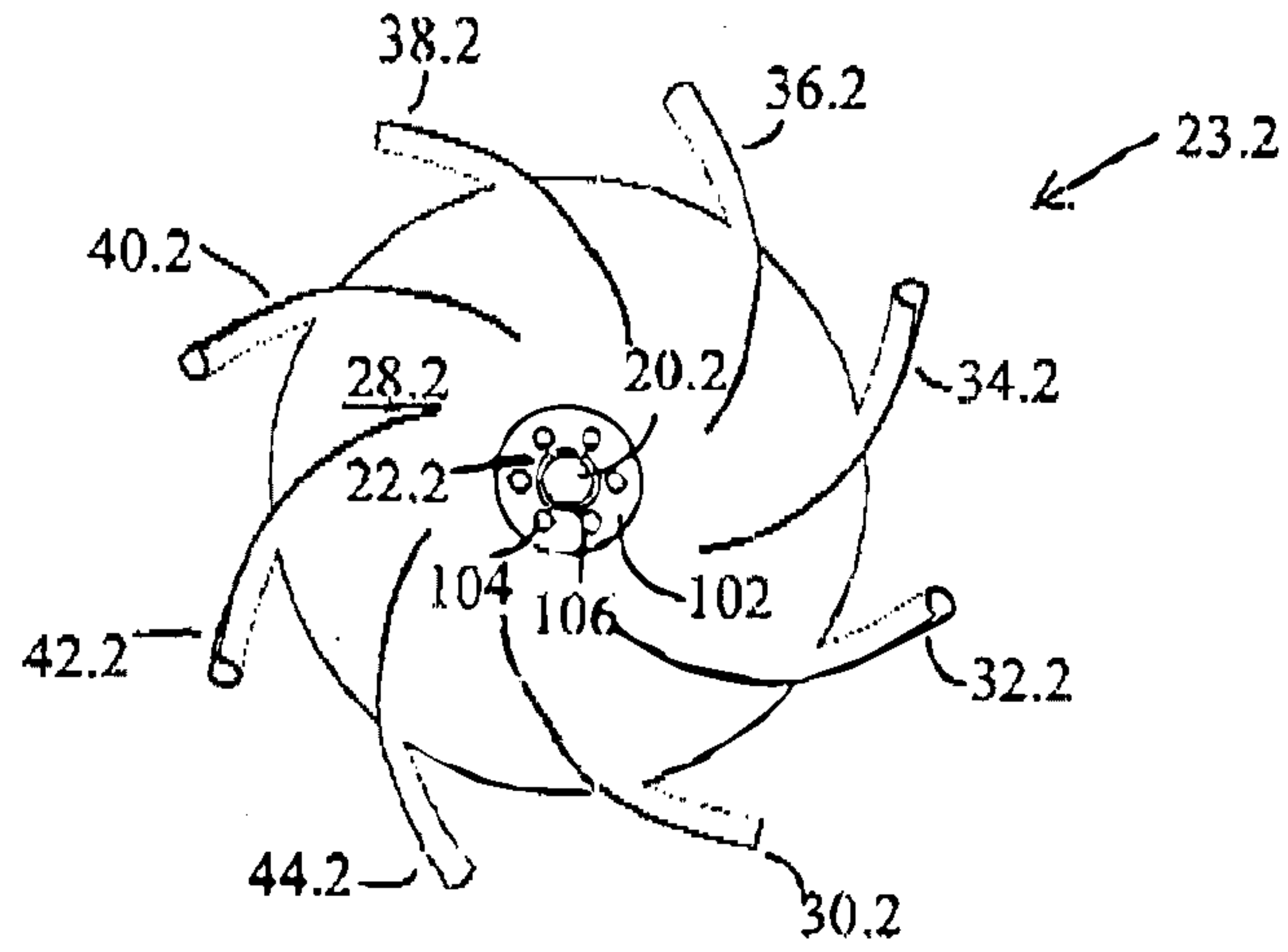


FIG. 8

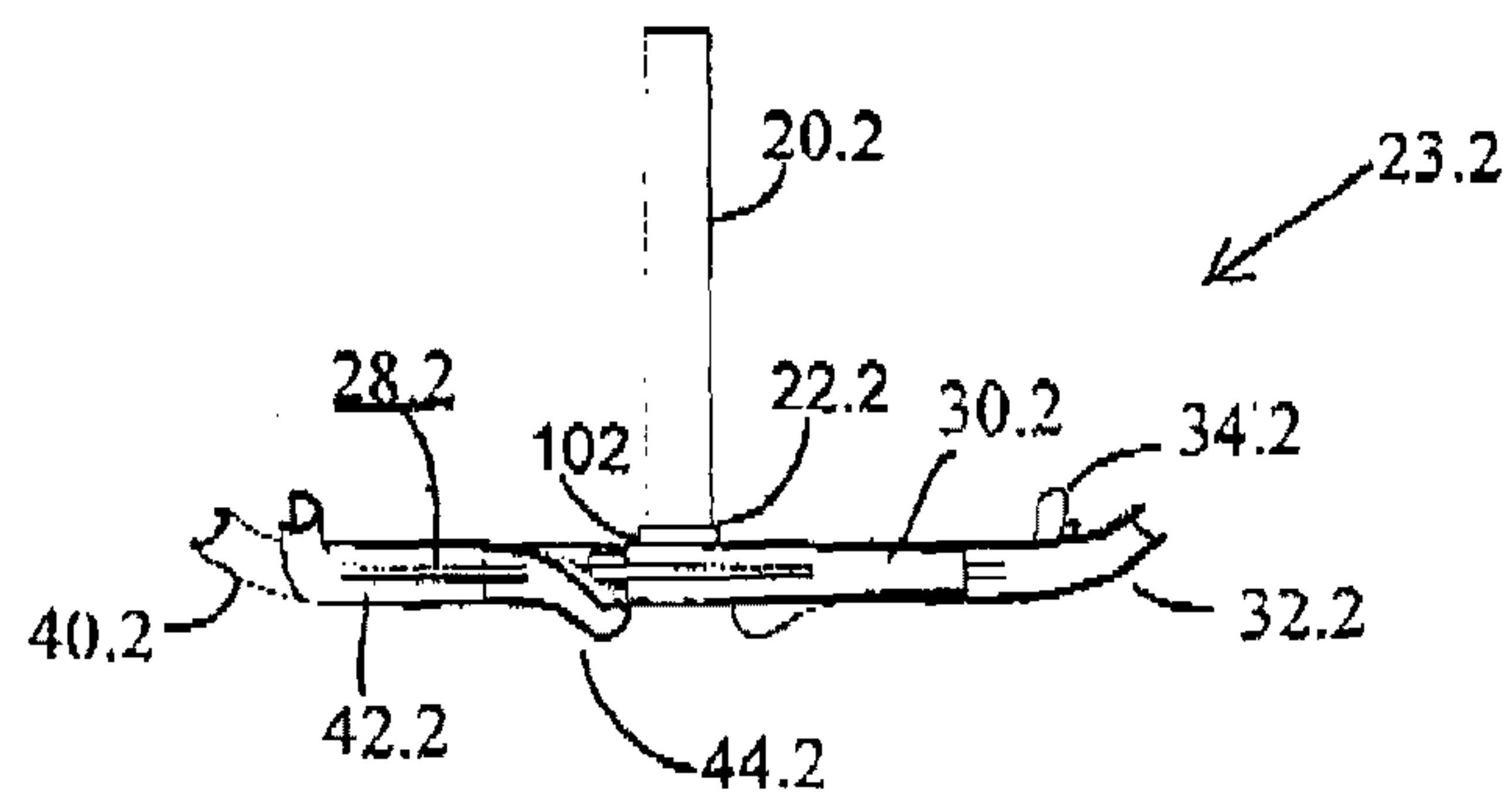


FIG. 9

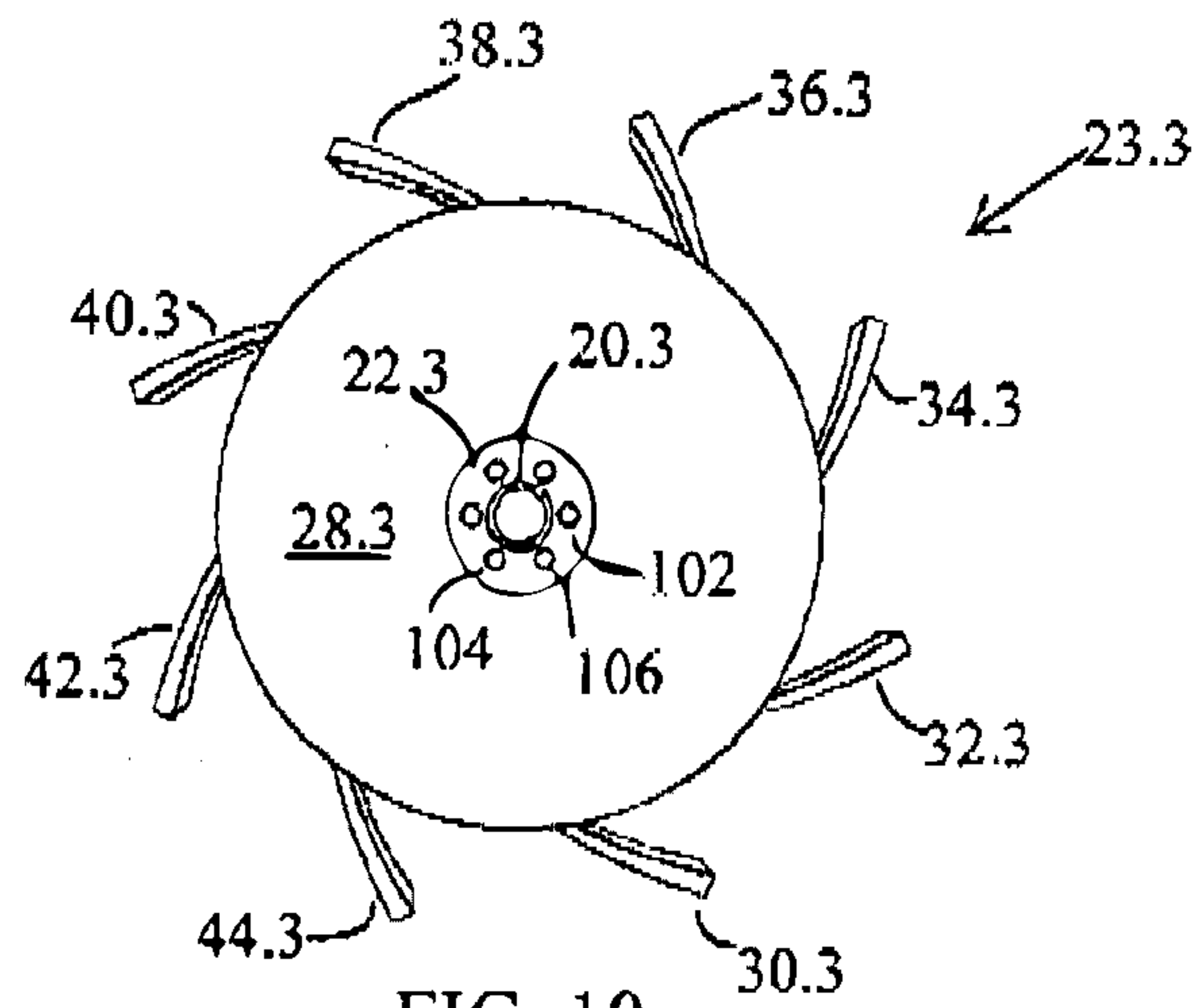


FIG. 10

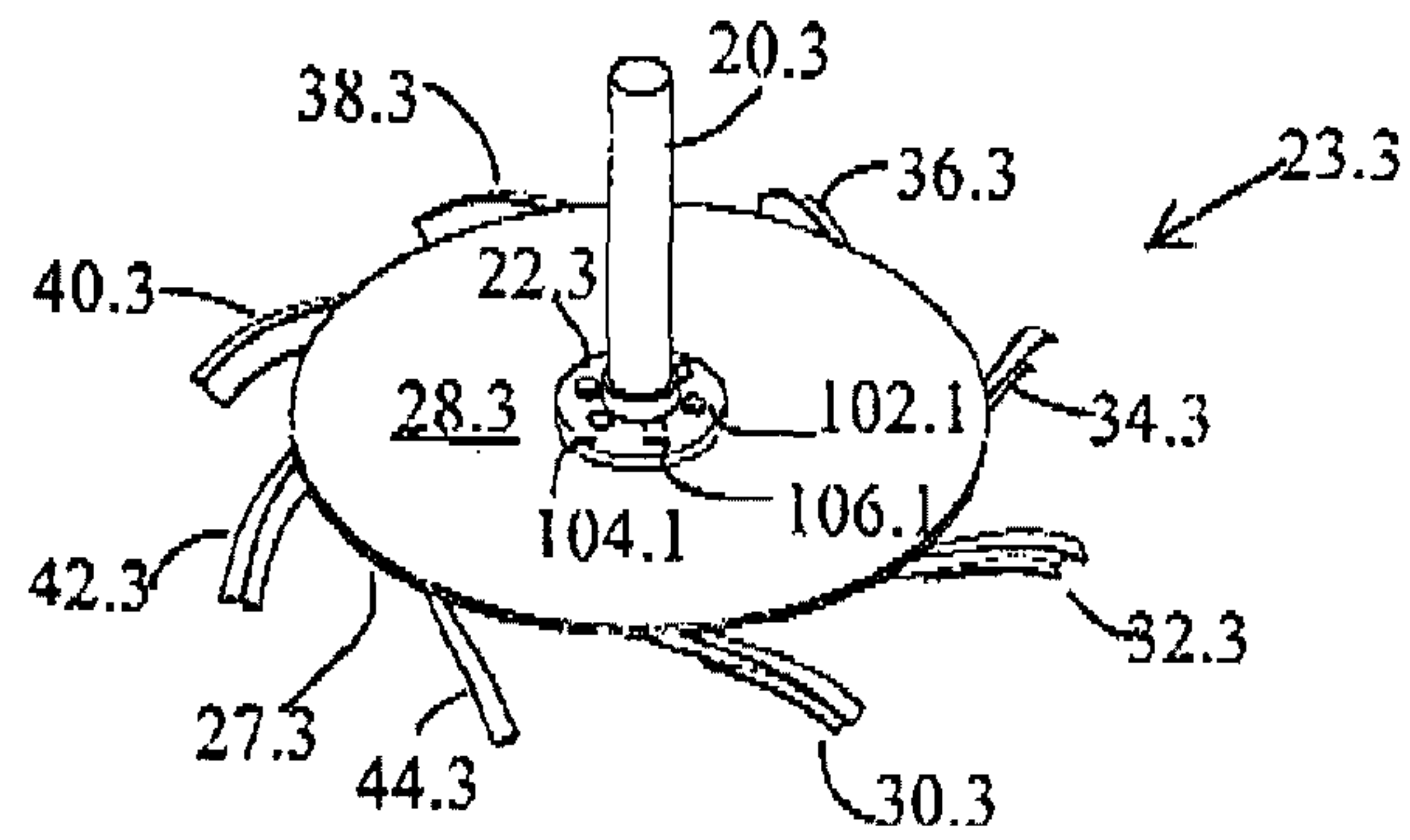


FIG. 11

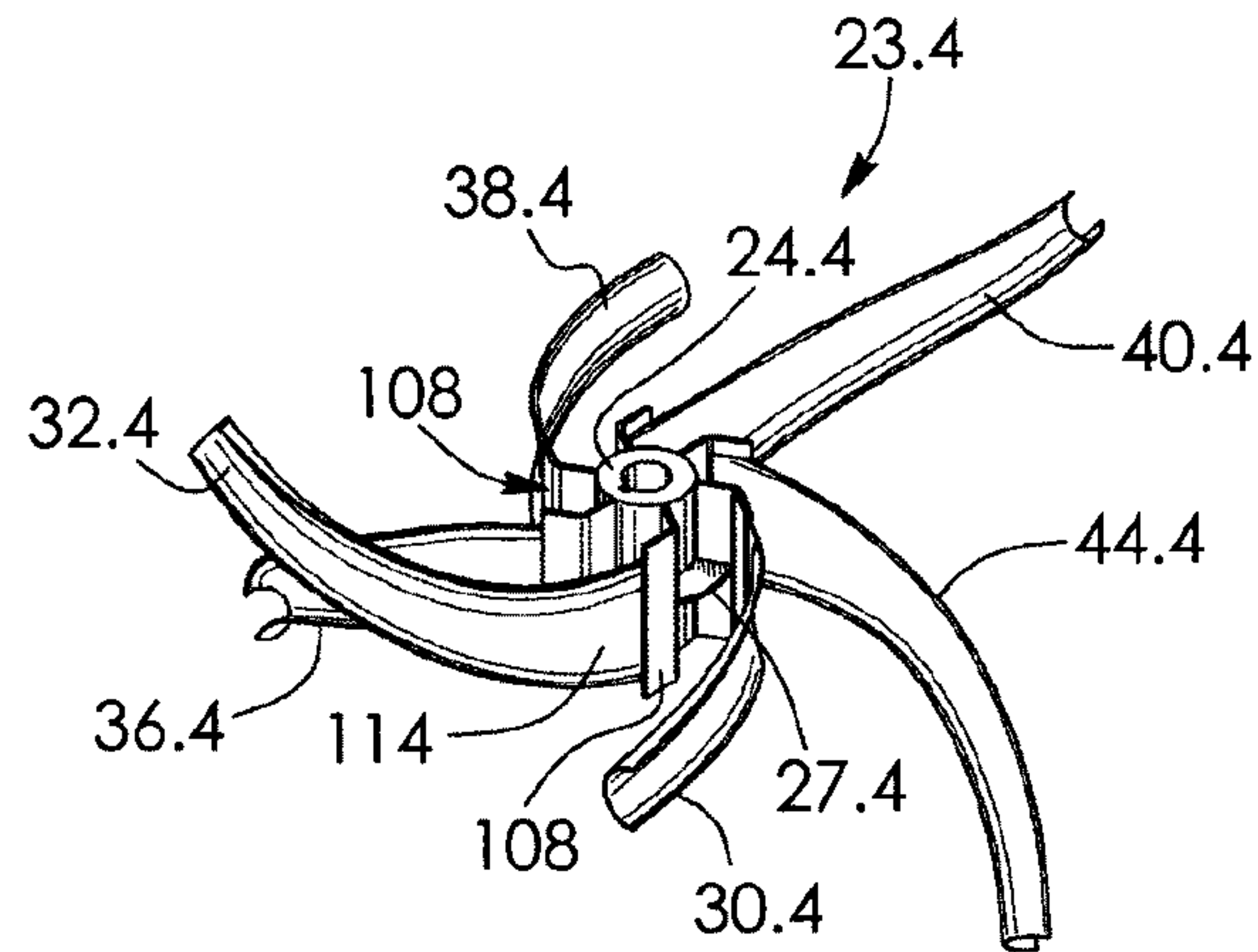


FIG. 12

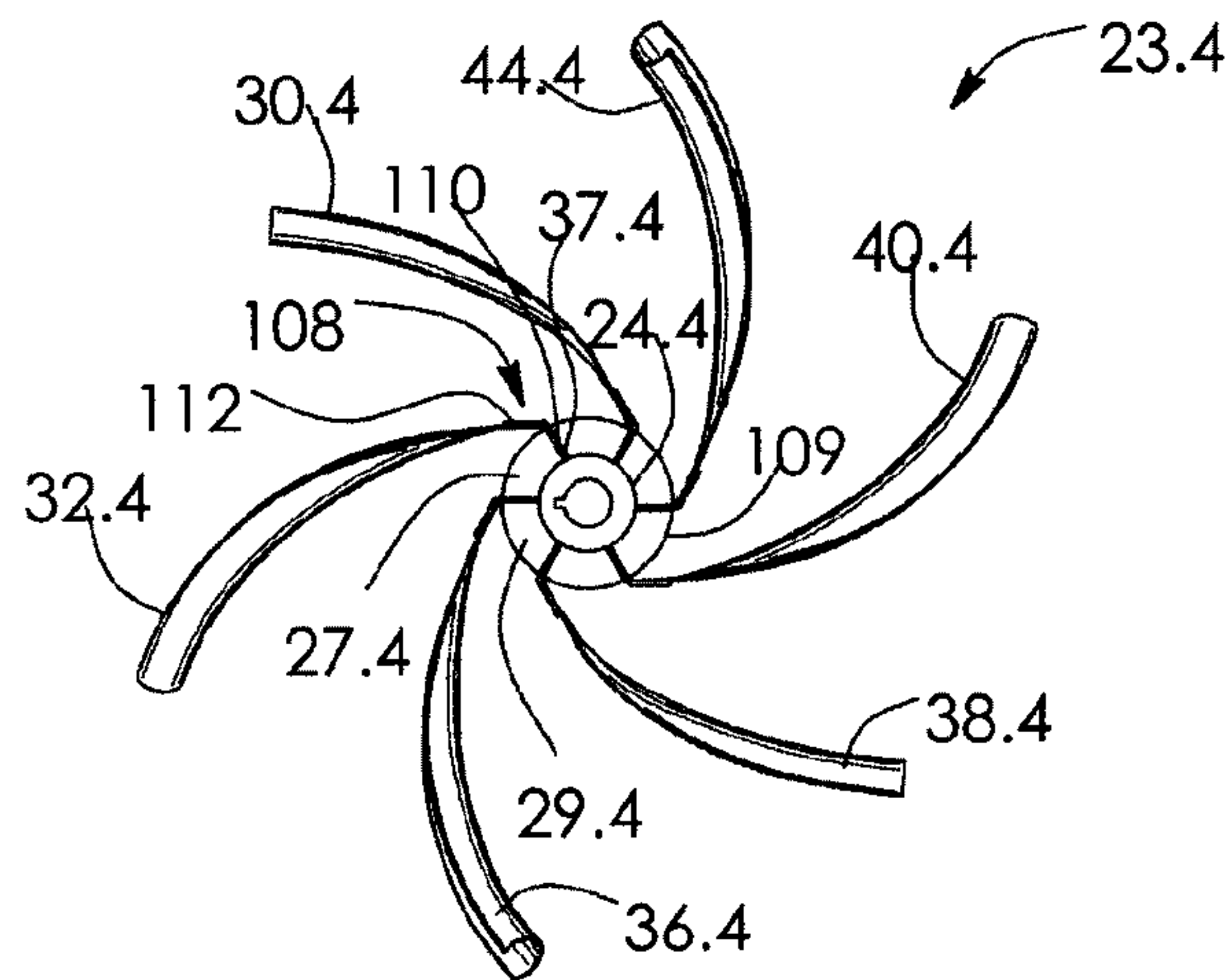


FIG. 13

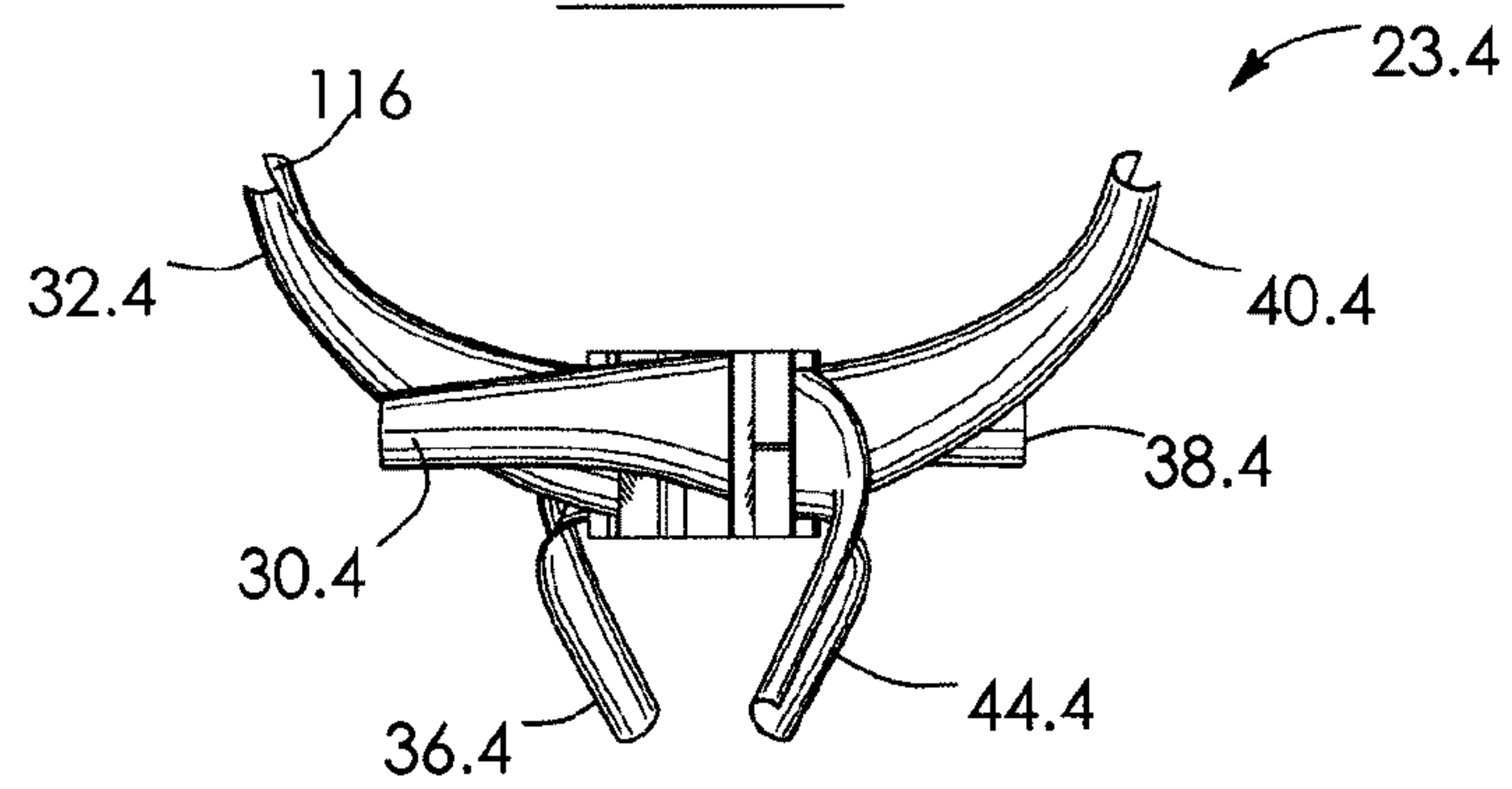


FIG. 14

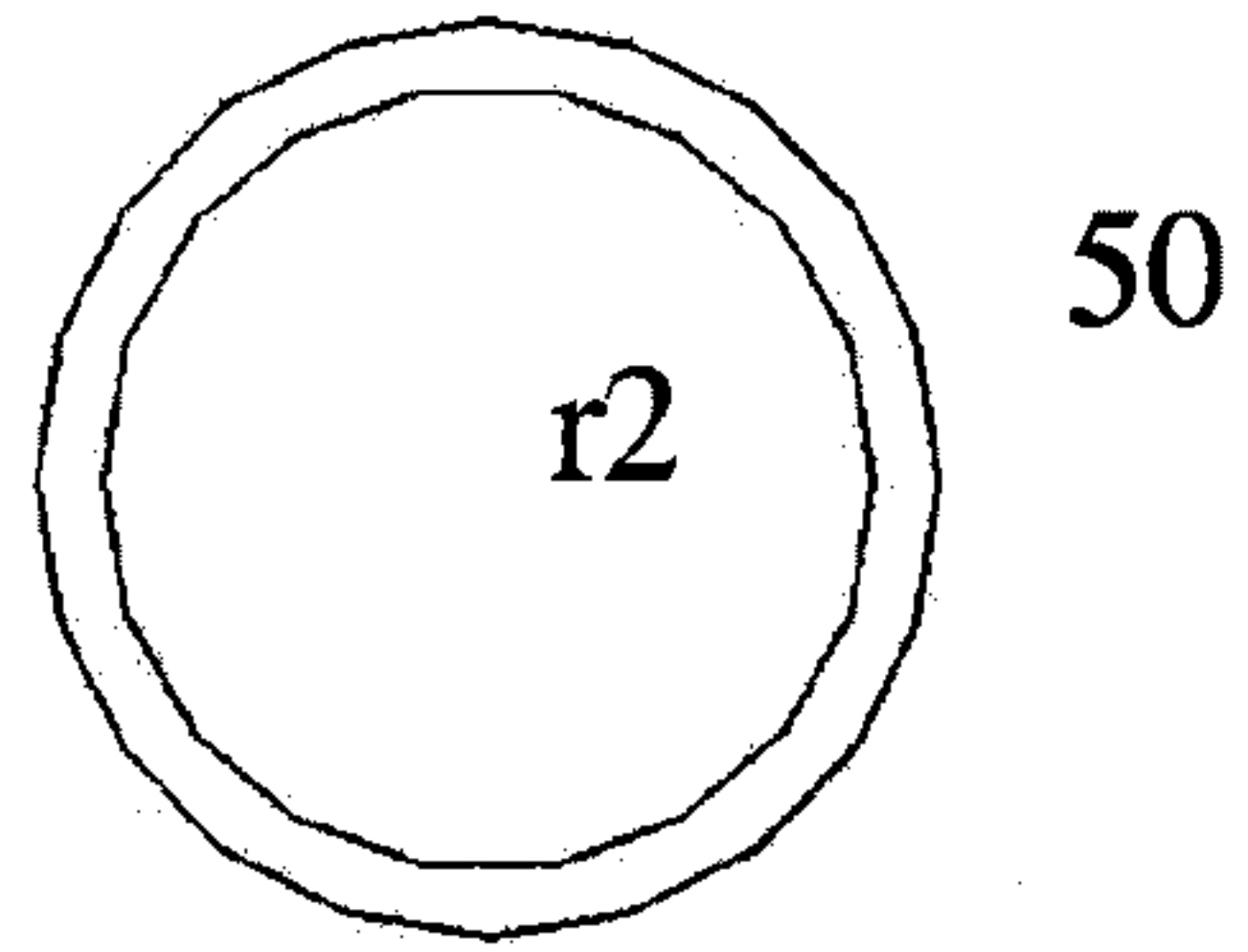


FIG. 15

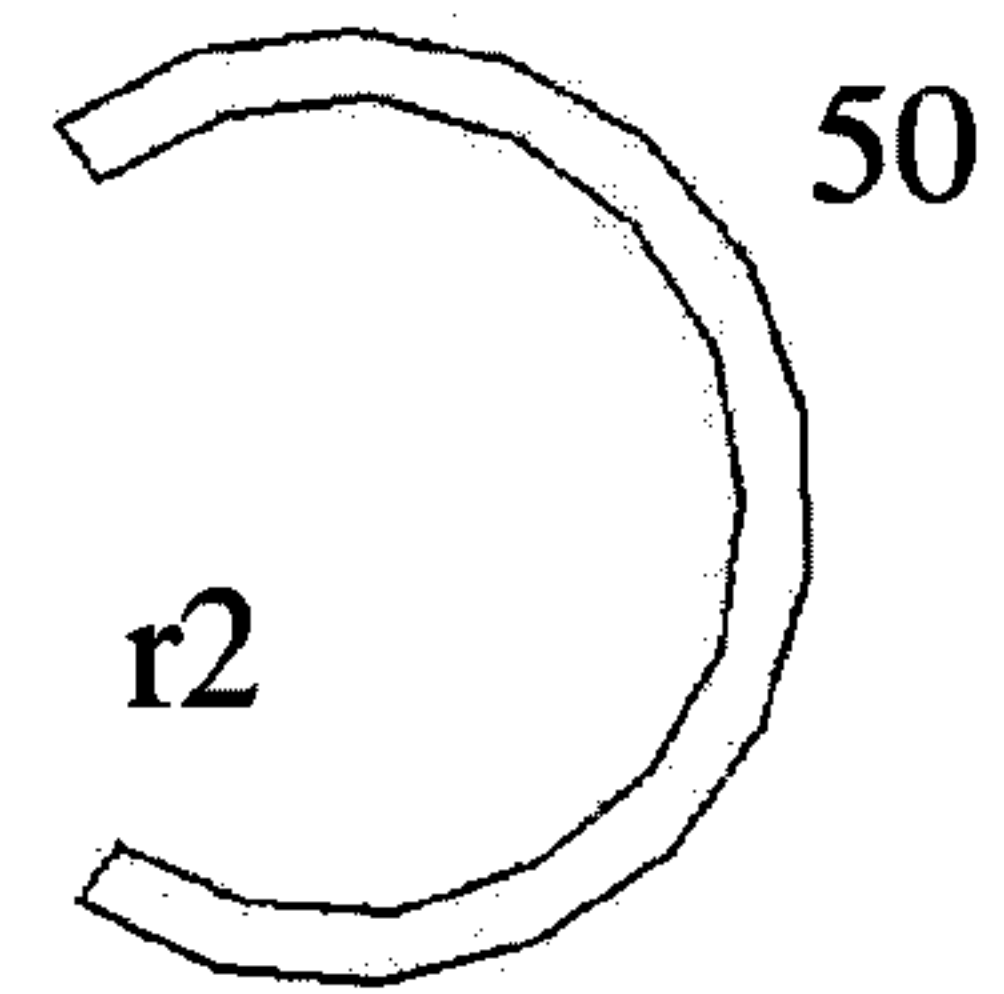


FIG. 16

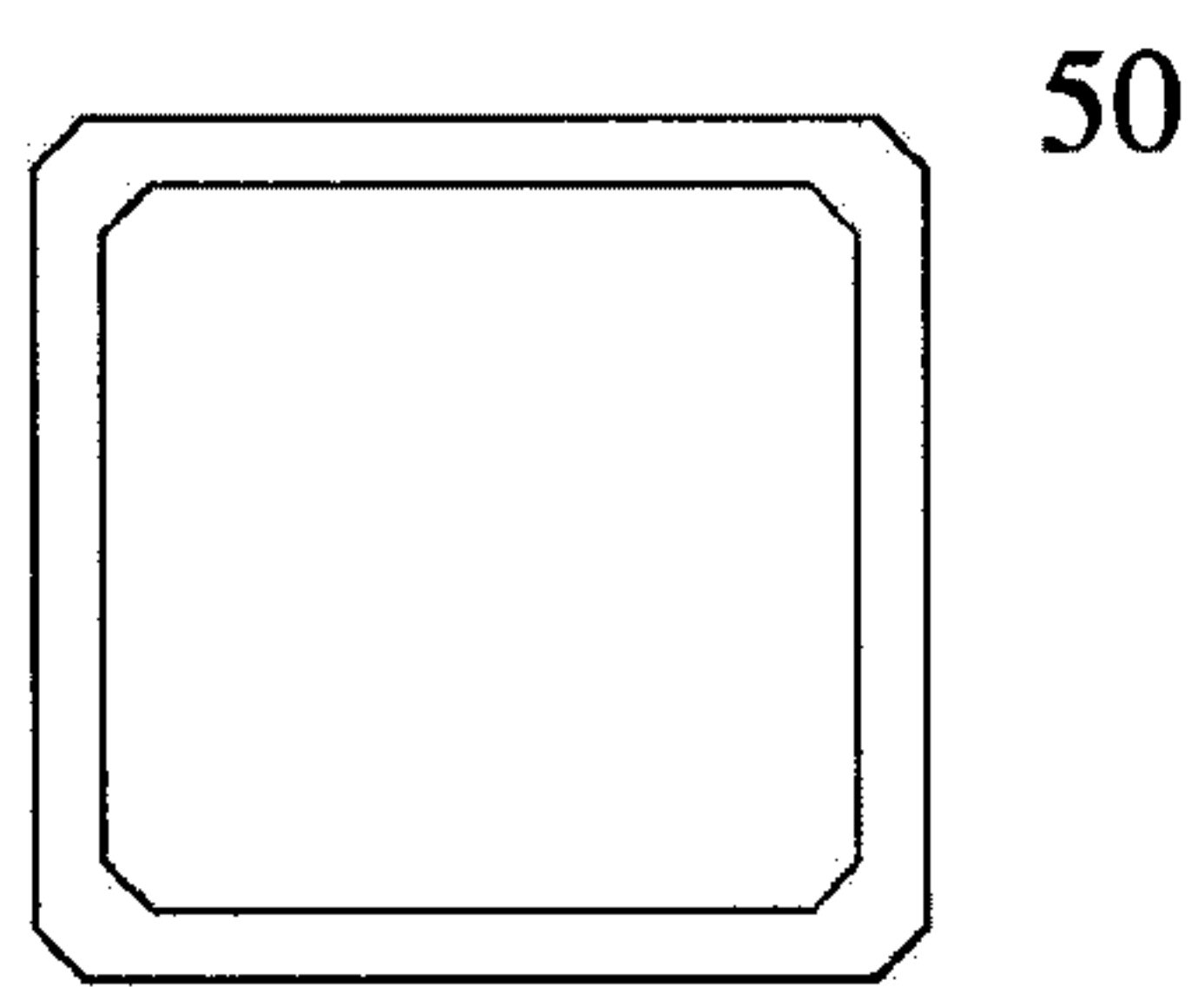


FIG. 17

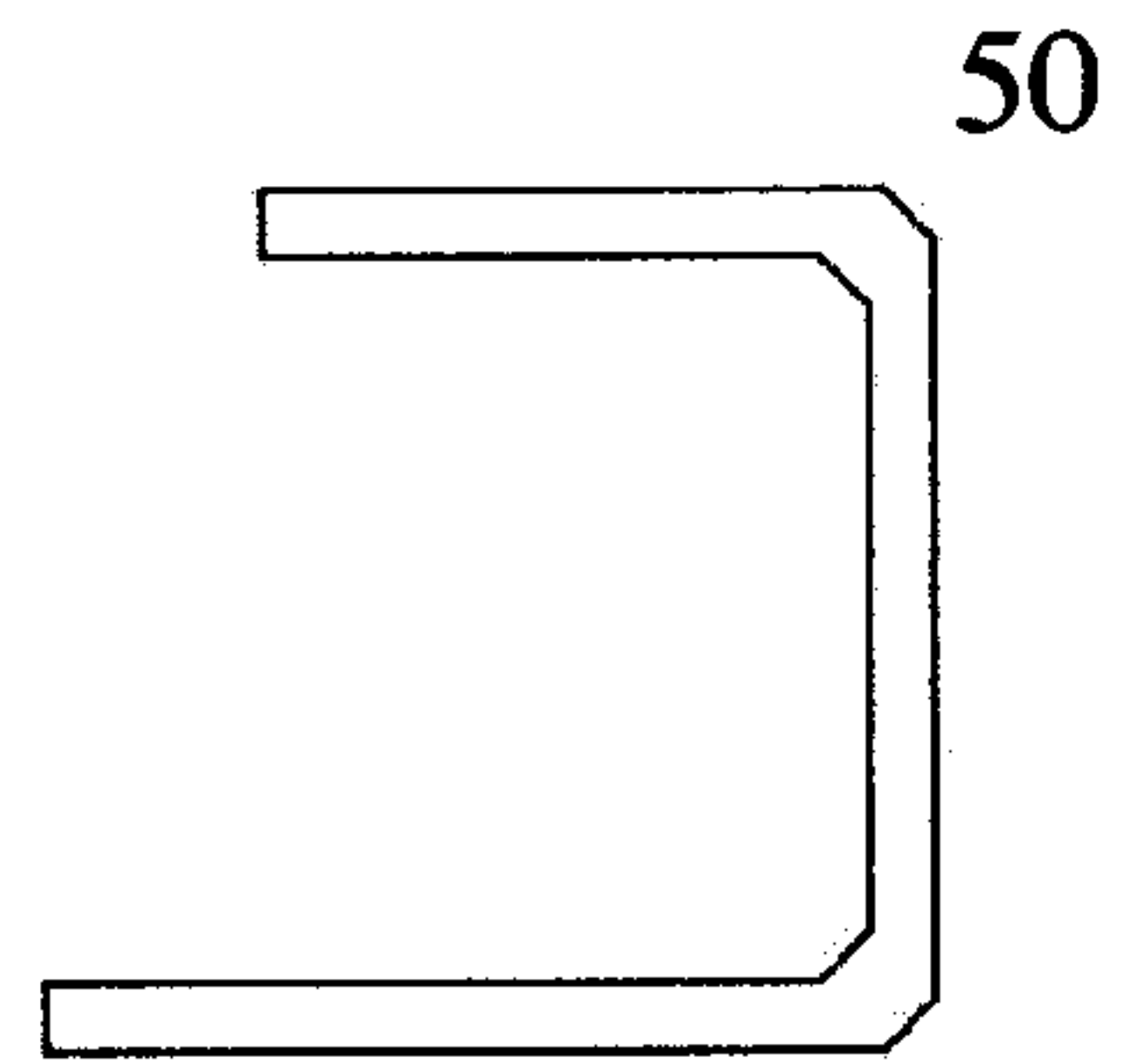


FIG. 18

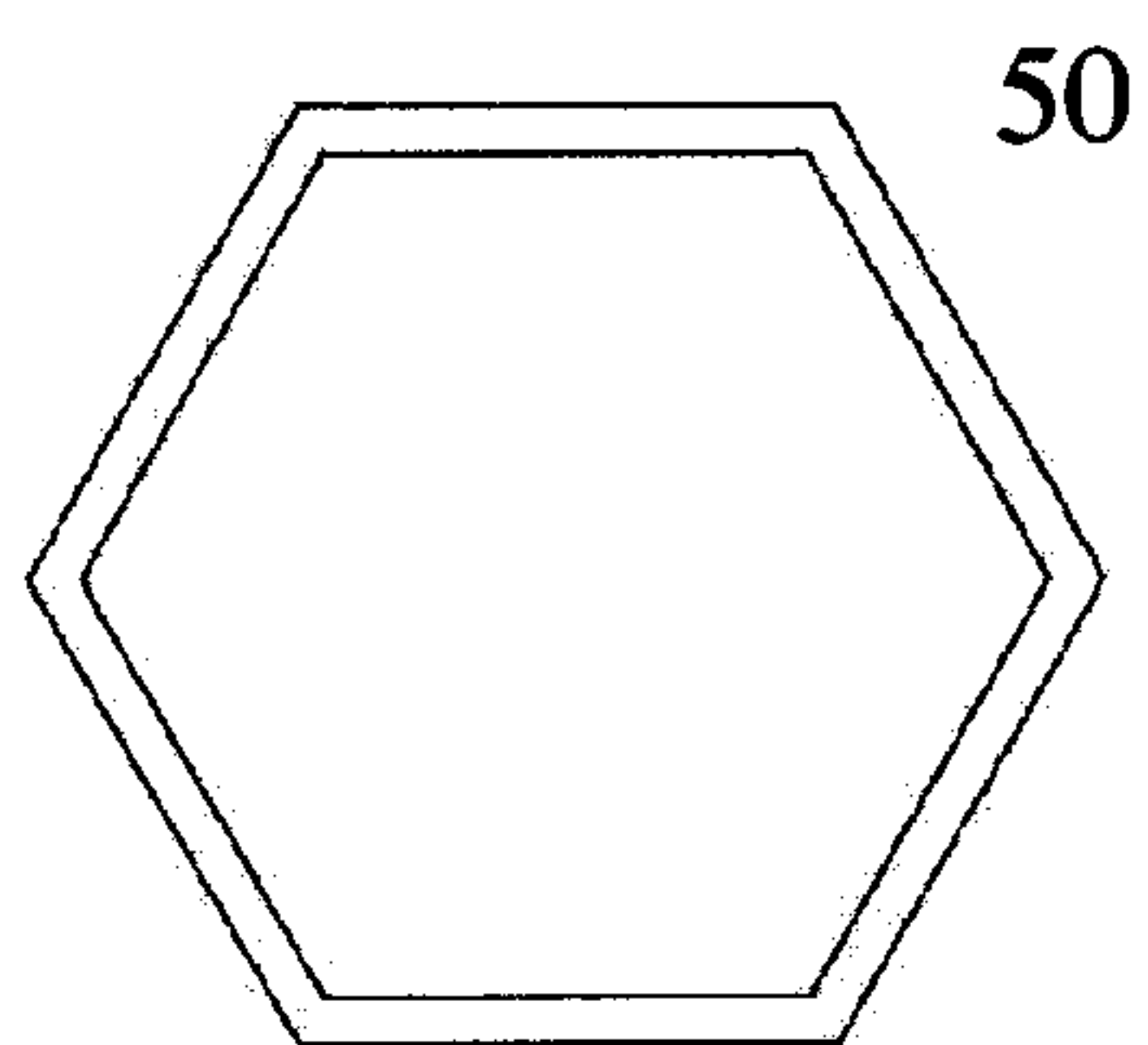


FIG. 19

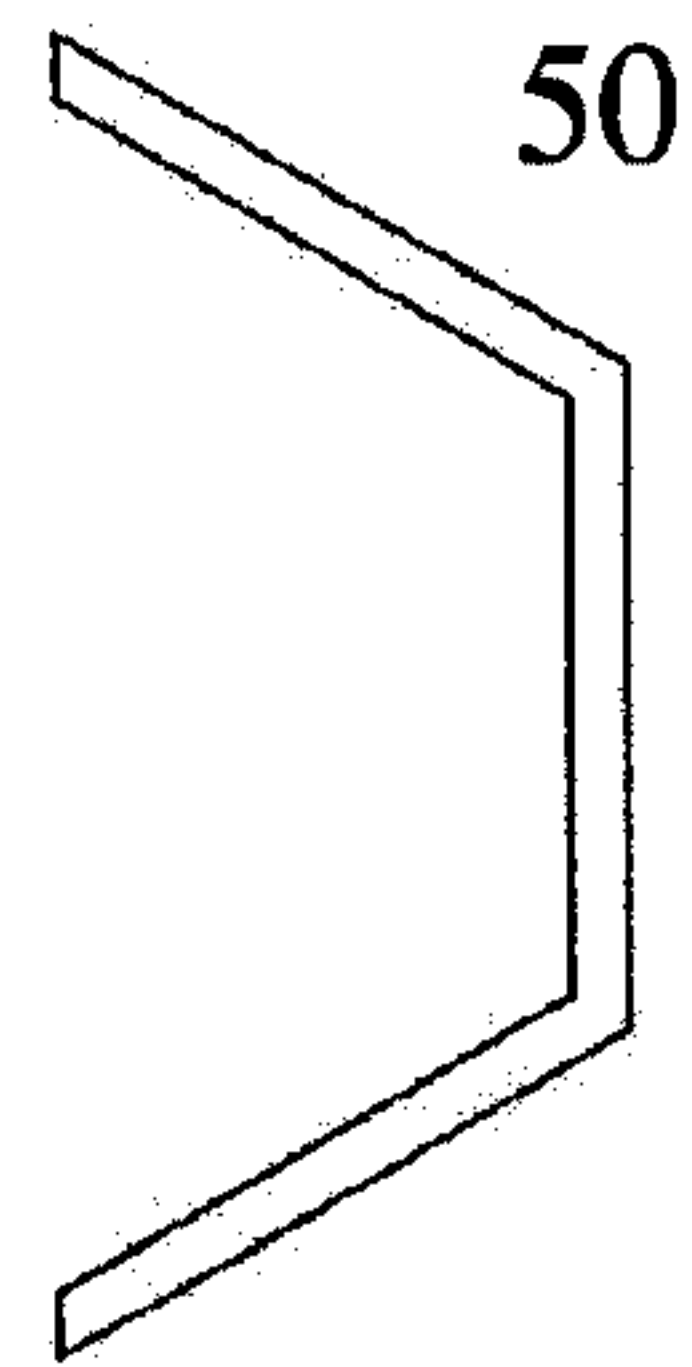


FIG. 20

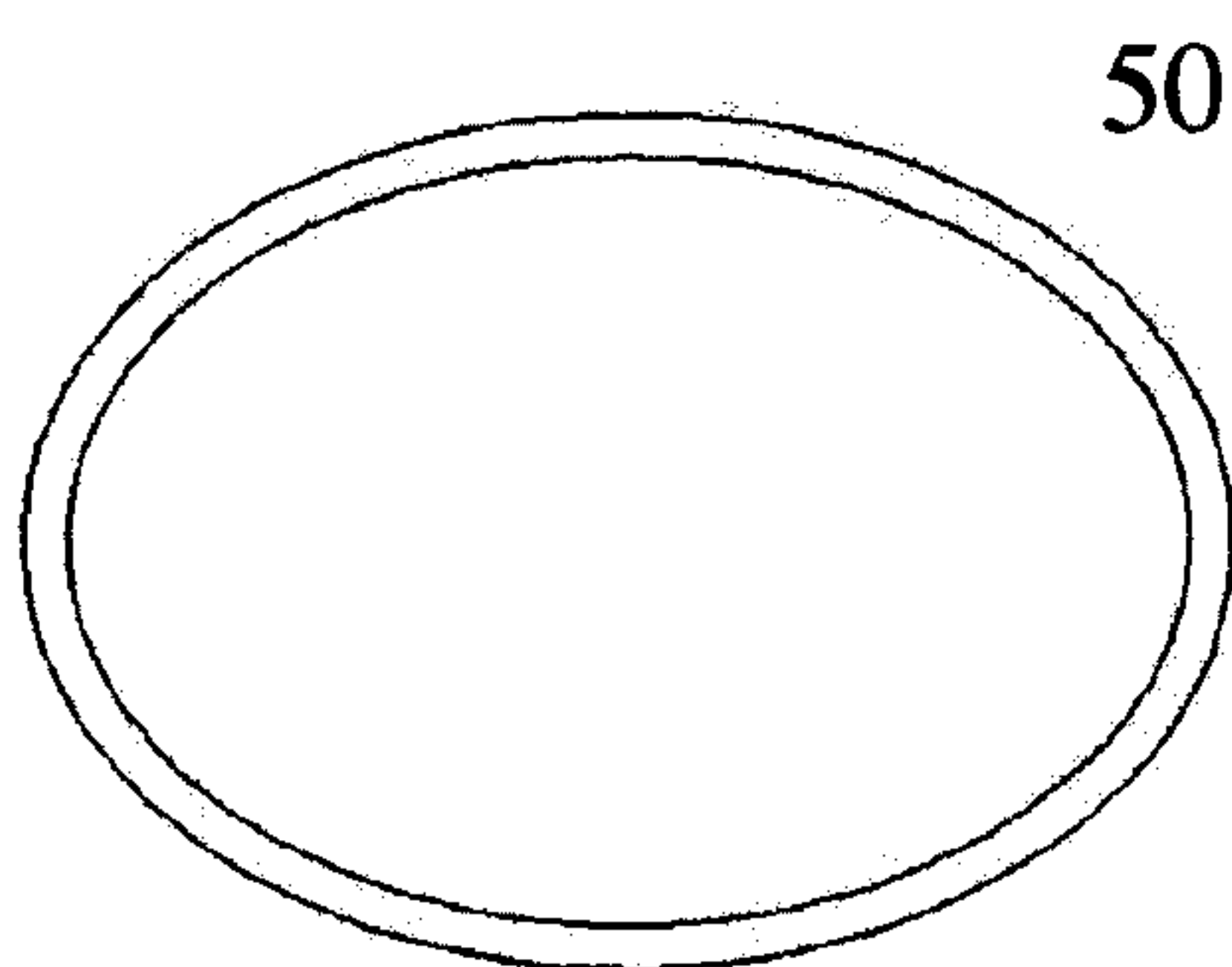


FIG. 21

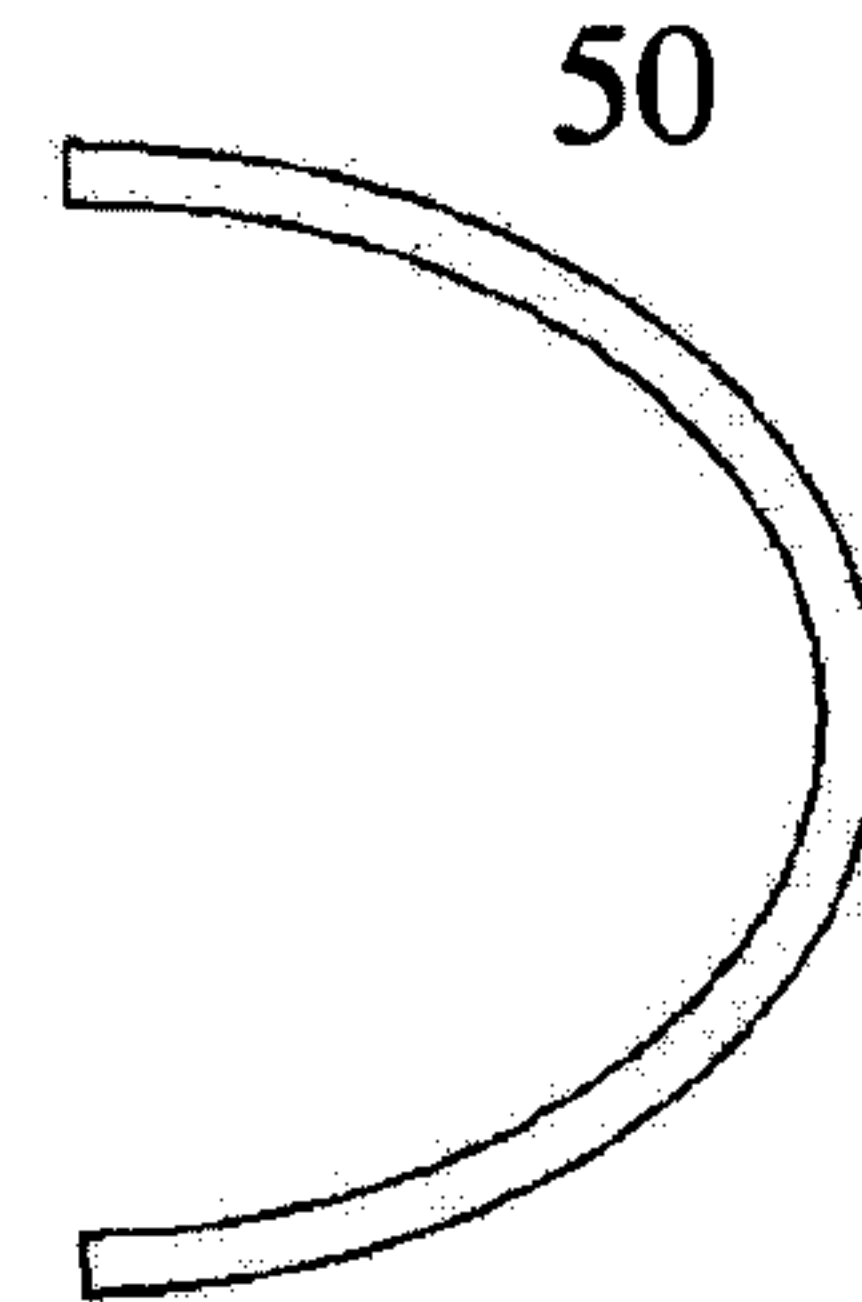


FIG. 22

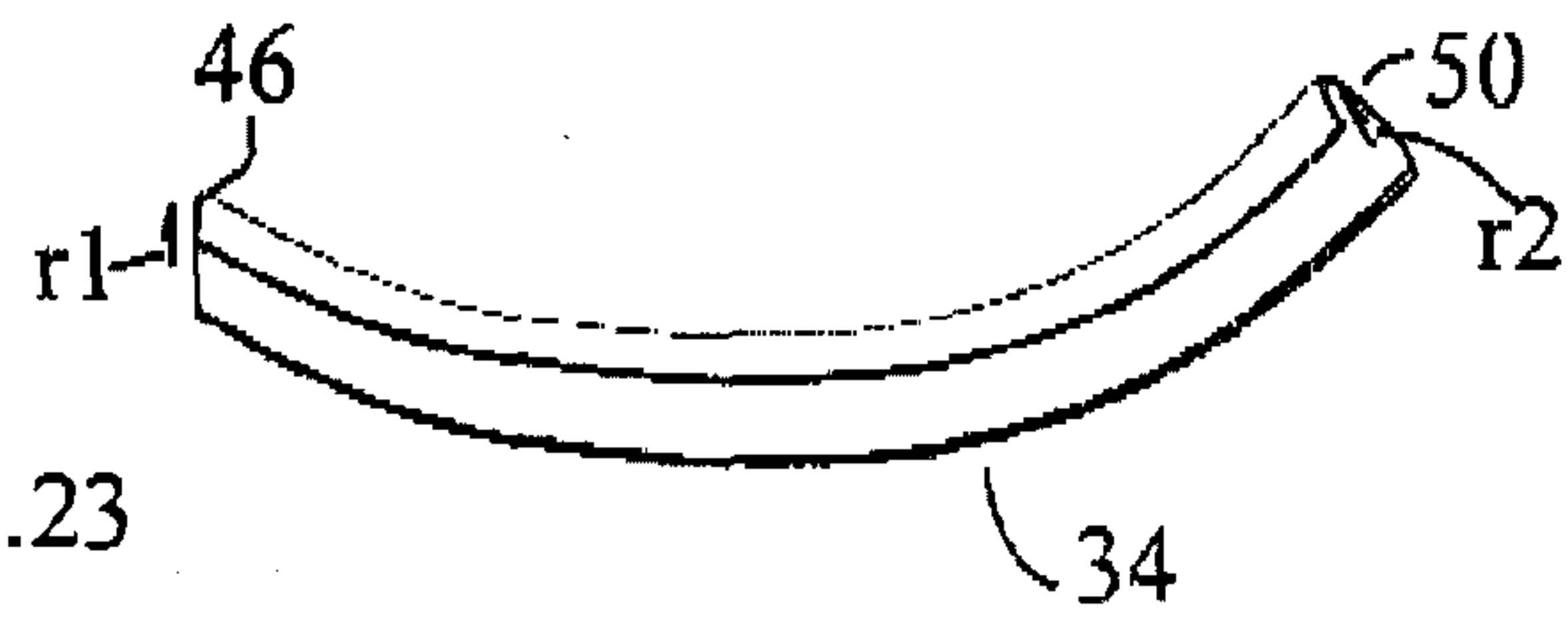


FIG. 23

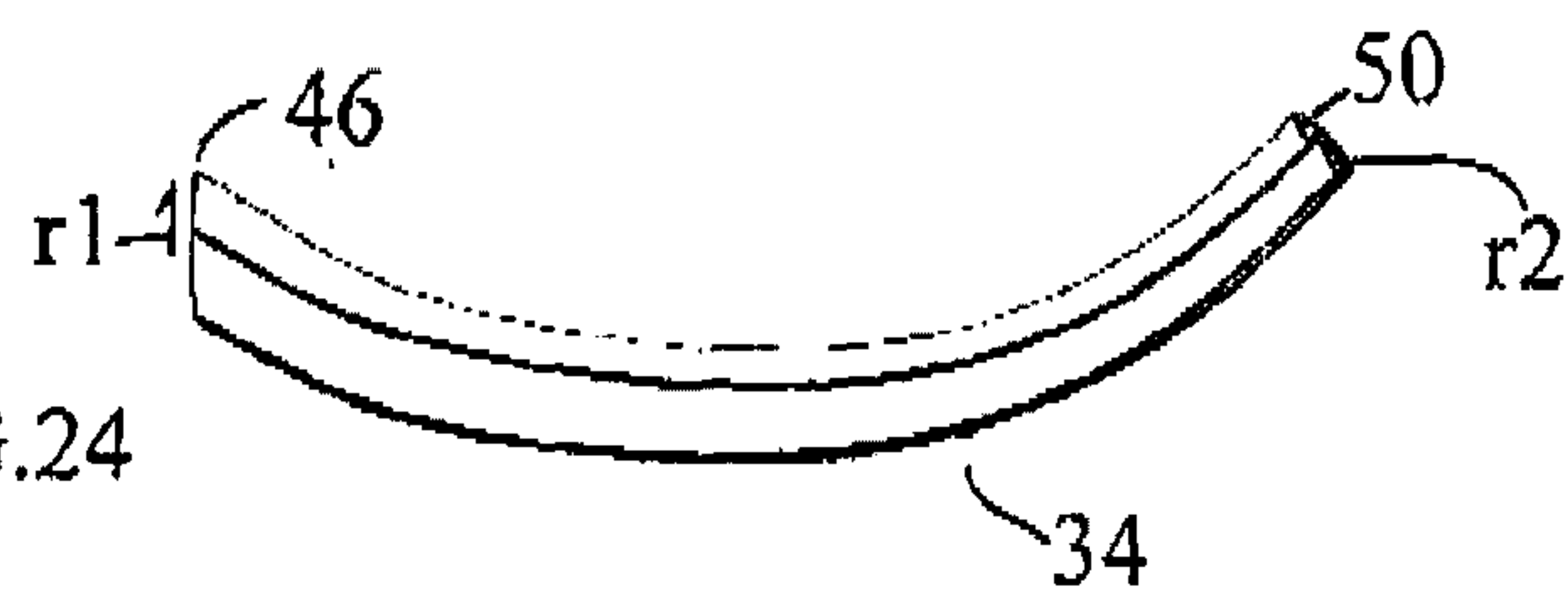


FIG. 24

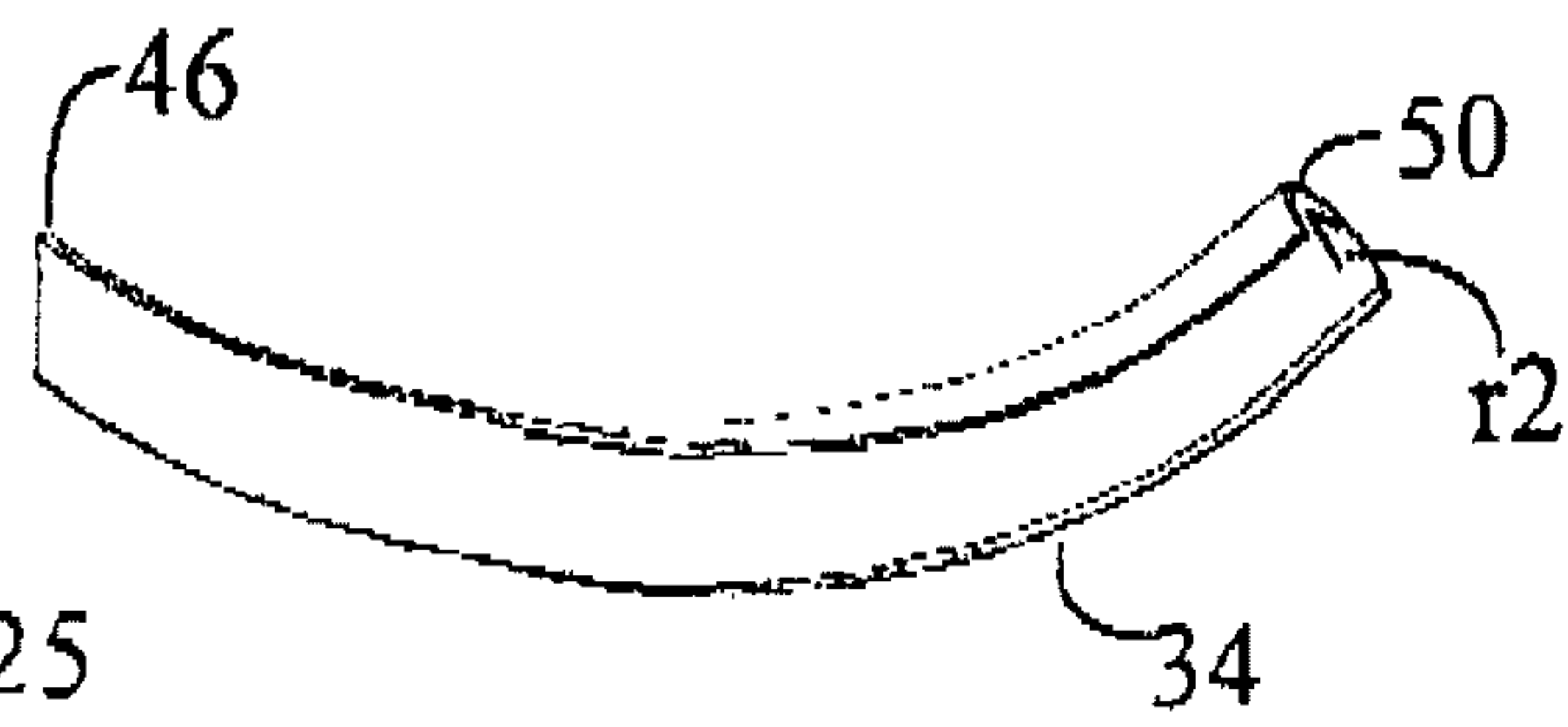


FIG. 25

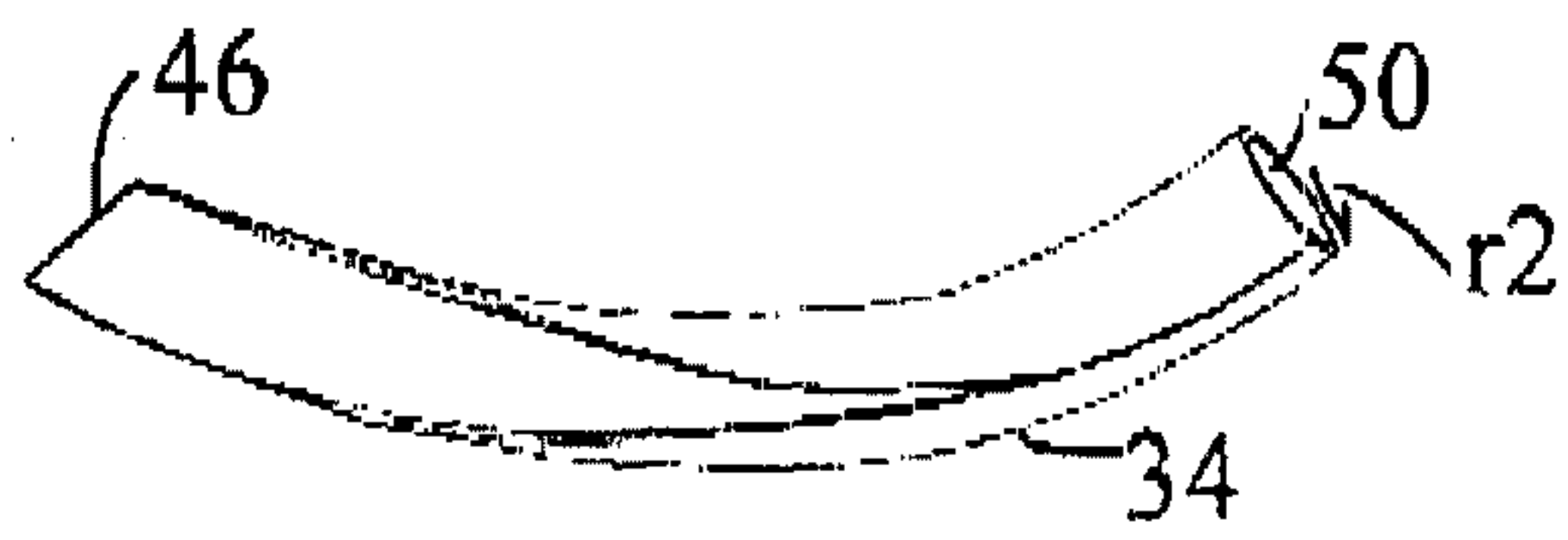


FIG. 26

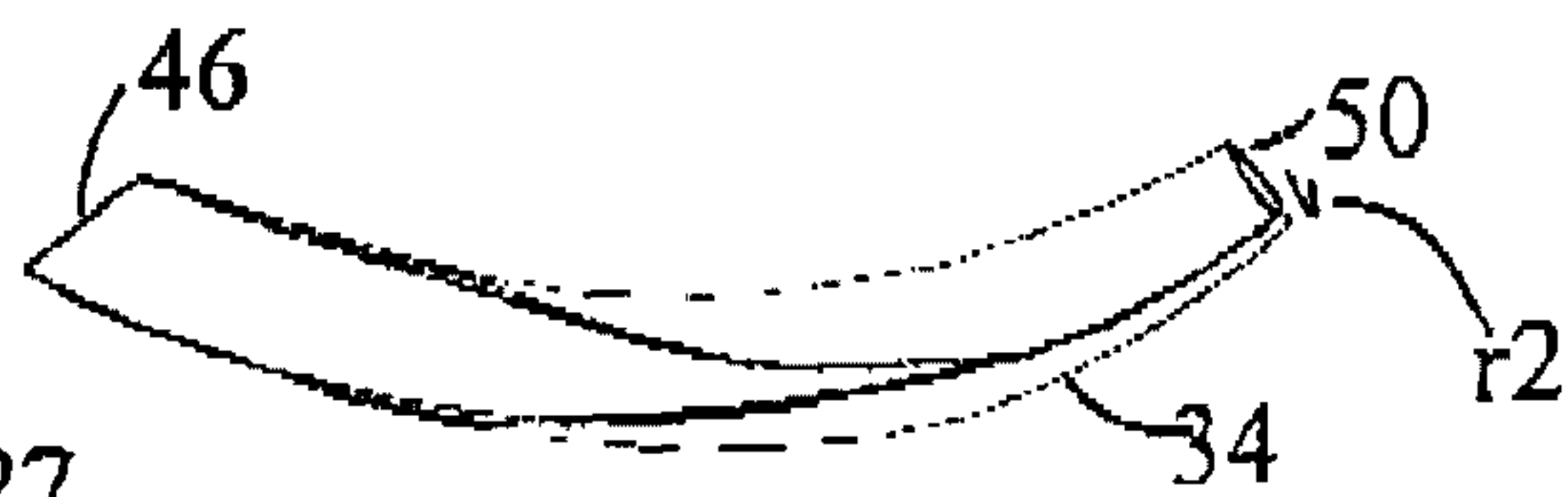


FIG. 27

