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Phacoemulsification tip

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(56) Related Art
US 5653724 A
US 6423074 B1
US 6494868 B2
US 4526571 A
US 2001/027601 A1
US 5213569 A

Abstract of the Disclosure

A phacoemulsification tip having an arched or curved shaft. Such a feature serves to produce more efficient cutting during torsional vibration of the tip while maintaining a greater space between the distal end of the tip and the posterior capsule.

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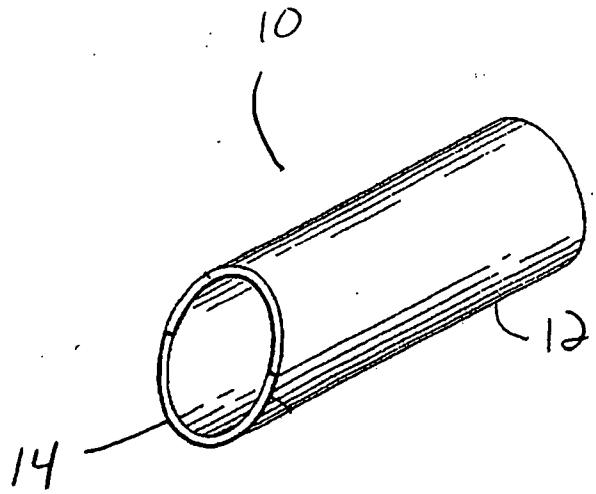

FIG. 1
(Prior Art)

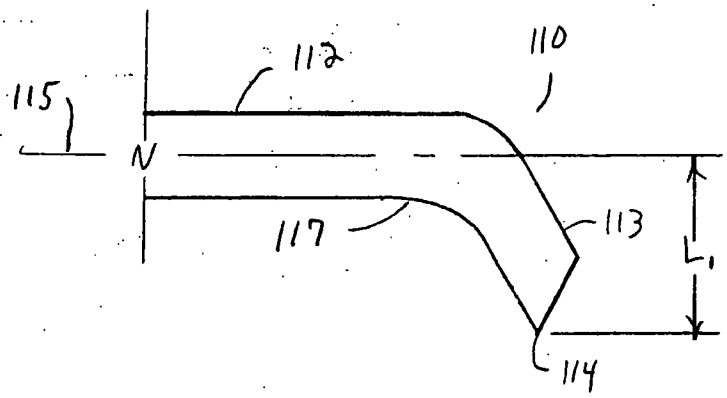

FIG. 2
(Prior Art)

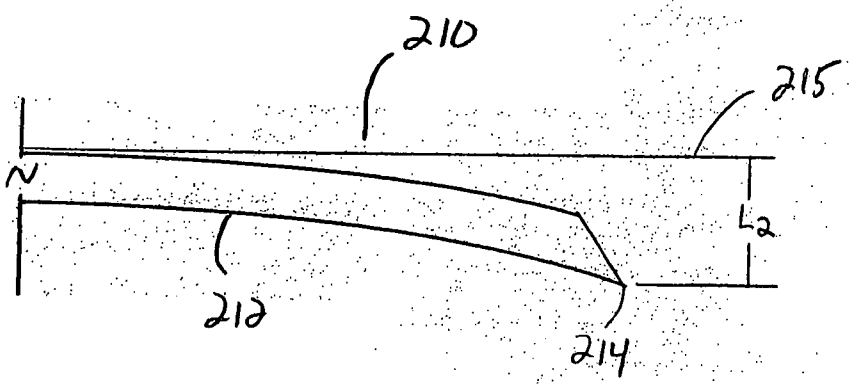

FIG. 3

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Invention Title:

PHACOEMULSIFICATION TIP

Our Ref : 764349
POF Code: 230590/459561

The following statement is a full description of this invention, including the best method of performing it known to applicant(s):

PHACOEMULSIFICATION TIP

This application claims priority from US Application No.11/060,827 filed 18 February 2005, and from US Application No. 11/232,205 filed 21 September 2005, the contents of which are to be taken as incorporated herein by this reference.

Background of the Invention

This invention relates generally to the field of phacoemulsification and more particularly to torsional phacoemulsification cutting tips.

The human eye in its simplest terms functions to provide vision by transmitting light through a clear outer portion called the cornea, and focusing the image by way of the lens onto the retina. The quality of the focused image depends on many factors including the size and shape of the eye, and the transparency of the cornea and lens.

When age or disease causes the lens to become less transparent, vision deteriorates because of the diminished light which can be transmitted to the retina. This deficiency in the lens of the eye is medically known as a cataract. An accepted treatment for this condition is surgical removal of the lens and replacement of the lens function by an IOL.

In the United States, the majority of cataractous lenses are removed by a surgical technique called phacoemulsification. During this procedure, a thin phacoemulsification cutting tip is inserted into the diseased lens and vibrated ultrasonically. The vibrating cutting tip liquifies or emulsifies the lens so that the lens may be aspirated out of the eye. The diseased lens, once removed, is replaced by an artificial lens.

A typical ultrasonic surgical device suitable for ophthalmic procedures consists of an ultrasonically driven handpiece, an attached cutting tip, and irrigating sleeve and an electronic control console. The handpiece assembly is attached to the control console by an electric cable and flexible tubings. Through the electric cable, the console varies the power level transmitted by the handpiece to the attached cutting tip and the flexible tubings supply irrigation fluid to and draw aspiration fluid from the eye through the handpiece assembly.

The operative part of the handpiece is a centrally located, hollow resonating bar or horn directly attached to a set of piezoelectric crystals. The crystals supply the required ultrasonic vibration needed to drive both the horn and the attached cutting tip during phacoemulsification and are controlled by the console. The crystal/horn assembly is suspended within the hollow body or shell of the handpiece by flexible mountings. The handpiece body terminates in a reduced diameter portion or nosecone at the body's distal end. The nosecone is externally threaded to accept the irrigation sleeve. Likewise, the horn bore is internally threaded at its distal end to receive the external threads of the cutting tip. The irrigation sleeve also has an internally threaded bore that is screwed onto the external threads of the nosecone. The cutting tip is adjusted so that the tip projects only a predetermined amount past the open end of the irrigating sleeve. Ultrasonic handpieces and cutting tips are more fully described in U.S. Pat. Nos. 3,589,363; 4,223,676; 4, 246, 902; 4,493,694;

4,515,583; 4,589,415; 4,609,368; 4,869,715; 4,922,902; 4,989,583; 5,154,694 and 5,359,996, the entire contents of which are incorporated herein by reference.

In use, the ends of the cutting tip and irrigating sleeve are inserted into a small incision of predetermined width in the cornea, sclera, or other location. The cutting tip is ultrasonically vibrated along its longitudinal axis within the irrigating sleeve by the crystal-driven ultrasonic horn, thereby emulsifying the selected tissue in situ. The hollow bore of the cutting tip communicates with the bore in the horn that in turn communicates with the aspiration line from the handpiece to the console. A reduced pressure or vacuum source in the console draws or aspirates the emulsified tissue from the eye through the open end of the cutting tip, the cutting tip and horn bores and the aspiration line and into a collection device. The aspiration of emulsified tissue is aided by a saline flushing solution or irrigant that is injected into the surgical site through the small annular gap between the inside surface of the irrigating sleeve and the cutting tip.

One phacoemulsification tip that has gained widespread acceptance has a belled or flared distal end. Such a tip is described in U.S. Patent No. 4,816,018 (Parisi). Such a design allows for larger lens material purchase as well as increased holding force when vacuum is applied to the tip while maintaining a smaller bore in the shaft of the tip. This combination of features increases anterior chamber stability, by reducing sudden outflow from the anterior chamber when the distal end becomes occluded and this occlusion breaks.

Another phacoemulsification tip is an angled or "bent" tip with or without a flared distal end. These tips are described in U.S. Patent No. 6,039,715 (Mackool), U.S. Patent No. 5,653,724 (Imonti) and U.S. Patent No. 5,154,694 (Kelman). These tips have a predominantly straight shaft with the far distal portion of the shaft being bent on an angle. Bent tips are used by a great many surgeons, and are particularly useful when used in conjunction with a oscillatory phacoemulsification handpiece, such as those described in U.S. Patent No. 6,352,519 (Anis, et al.) and U.S. Patent No. 6,602,193 (Chon) and commercially available as the NeoSoniX® handpiece from Alcon Laboratories, Inc., Fort Worth, Texas, however; some surgeons are reluctant they feel that due to the proximal location of the bend it is more difficult to judge the position of the proximal cutting edge based on the extrapolation of the sleeved portion of the tip.

The inventors have discovered that angled phacoemulsification tip are particularly advantageous when used in combination with torsional ultrasound handpiece. Torsional ultrasound handpieces are more fully disclosed in U.S. Patent No. 6,077,285 (Boukhny). Therefore, a need continues to exist for an angled phacoemulsification tip that is safer to use near the posterior capsule.

The discussion of documents, acts, materials, devices, articles and the like is included in this specification solely for the purpose of providing a context for the present invention. It is not suggested or represented that any or all of these matters formed part of the prior art base or were common general knowledge in the field relevant to the present invention as it existed before the priority date of each claim of this application.

Throughout the description and claims of this specification, the word "comprise" and variations of the word, such as "comprising" and "comprises", is not intended to exclude other additives, components, integers or steps.

Brief Summary of the Invention

According to a first aspect of the present invention there is provided a phacoemulsification tip comprising:

a rigid tubular shaft enclosing a lumen, the shaft having distal and proximal ends and a generally circular cross section, the shaft being arched from its proximal end to its distal end along an arc contained in the lumen so that the distal end of the shaft is located at one end of the arc and the proximal end of the shaft is located at the other end of the arc, the distal end of the shaft being cut at an angle between zero degrees and ninety degrees so as to form an opening at the distal end of the shaft;

wherein the shaft is progressively arched along an entire length of the shaft such that a centreline of the shaft curves continuously in one direction;

wherein the rigid tubular shaft of the phacoemulsification tip is configured to be inserted into a lens of an eye and vibrated ultrasonically to liquefy or emulsify the lens for aspiration of the lens out of the eye.

The invention further includes a phacoemulsification tip, comprising:

a rigid tubular shaft enclosing a lumen, the shaft having distal and proximal ends and a generally circular cross section, the shaft of the phacoemulsification tip being arched along an entire length of the shaft from its proximal end to its distal end along an arc contained in the lumen so that the distal end of the shaft is located at one end of the arc and the proximal end of the shaft is located at the other end of the arc, the distal end of the shaft being cut at an angle zero degrees and ninety degrees so as to form an opening at the distal end of the shaft the shaft being arched from its proximal end to its distal end along an arc contained in the lumen so that the distal end of the shaft is located at one end of the arc and the proximal end of the shaft is

located at the other end of the arc, the distal end of the shaft being cut at an angle between zero degrees and ninety degrees so as to form an opening at the distal end of the shaft;

wherein the shaft of the phacoemulsification tip is arched along an entire length of the shaft relative to a straight line, tangent to the arc of the shaft at the proximal end of the shaft, such that each point on a shaft centreline is displaced from the straight line, along a shortest distance from the point to the straight line, a distance greater than any point on the shaft centreline closer to the proximal end of the shaft;

wherein the rigid tubular shaft of the phacoemulsification tip is configured to be inserted into a lens of an eye and vibrated ultrasonically to liquefy or emulsify the lens for aspiration of the lens out of the eye.

Brief Description of the Drawings

FIG. 1 is a perspective view of the distal end of the typical prior art straight shaft phacoemulsification tip.

FIG. 2 is an elevational view of the distal end of a typical prior art angled or bent phacoemulsification tip.

FIG. 3 is an elevational view of the distal end of a phacoemulsification tip of an embodiment of the present invention.

FIG. 4 illustrates a surgical console suitable for use with an embodiment of the present invention.

Detailed Description of Preferred Embodiments of the Invention

As best seen in FIG. 1, prior art phacoemulsification tip 10 contains shaft 12 that is straight all the way to distal tip 14. As best seen in FIG. 2, prior art phacoemulsification tip 100 contains shaft 112 that is straight up to distal end 113. Distal end 113 is angled or bent on an angle relative to centerline 115 of shaft 112 from intersection 117 of shaft 112 and distal end 113 all the way to distal tip 114.

The inventor has discovered that ultrasonic vibration of tip 110 causes a twisting of shaft 112 that is not present if tip 110 is rotarily oscillated. Such twisting causes distal tip 114 to assume a whipping motion which although less than the rotary motion generated in distal tip 114 when tip 110 is rotarily oscillated, the whipping motion greatly increases the cutting efficiency of tip 110. As discussed above, lateral displacement L_1 of distal tip 114 from longitudinal centerline 115 of shaft 112 can place distal tip 114 near the posterior capsule during surgery, and the exact location of distal tip 114 can be difficult to determine. As a result, some surgeons prefer not to use phacoemulsification tip of the design shown in FIG. 2.

As best seen in FIG. 3, phacoemulsification tip 210 of an embodiment of the present invention contains shaft 212 that is not straight but instead is bent on a slight arch along the entire length of shaft 112. So constructed, lateral displacement L_2 of distal tip 214 from reference line 215 is less than lateral displacement L_1 of distal tip 114 from centerline 115. Such a construction makes it easier for the surgeon to locate distal tip 214 and maintain a more comfortable distance from the posterior capsule during use, but still benefits from the increase cutting efficiency discussed above.

Cutting tip 210 is preferably made from stainless steel or titanium, but other materials may also be used. Cutting tip 210 preferably has an overall length of between 0.50 inches and 1.50 inches, with 1.20 inches being most preferred. Cutting tip 210 may be formed using conventional metalworking technology and preferably is electropolished to remove any burrs.

Shaft 212 is generally tubular, with an outside diameter of between 0.005 inches and 0.100 inches and an inside diameter of between 0.001 inches and 0.090 inches. Distal end 214 of shaft 212 may be cut square or cut at any suitable angle between 0° and 90°.

As best seen in FIG. 4, surgical console 320 suitable for use with an embodiment of the present invention may be any commercially available surgical control console such as the INFINITI® surgical systems available from Alcon Laboratories, Inc., Fort Worth, Texas. Console 320 is connected to handpiece 9 through irrigation line 322 and aspiration line 324, and the flow through lines 322 and 324 is controlled by the user, for example, via footswitch 326. Power is supplied to handpiece through electrical cable 400.

This description is given for purposes of illustration and explanation. It will be apparent to those skilled in the relevant art that changes and modifications may be made to the invention described above without departing from its scope or spirit.

The claims defining the invention are as follows:

1. A phacoemulsification tip, comprising:

a rigid tubular shaft enclosing a lumen, the shaft having distal and proximal ends and a generally circular cross section, the shaft being arched from its proximal end to its distal end along an arc contained in the lumen so that the distal end of the shaft is located at one end of the arc and the proximal end of the shaft is located at the other end of the arc, the distal end of the shaft being cut at an angle between zero degrees and ninety degrees so as to form an opening at the distal end of the shaft;

wherein the shaft of the phacoemulsification tip is arched along an entire length of the shaft relative to a straight line, tangent to the arc of the shaft at the proximal end of the shaft, such that each point on a shaft centreline is displaced from the straight line, along a shortest distance from the point to the straight line, a distance greater than any point on the shaft centreline closer to the proximal end of the shaft;

wherein the rigid tubular shaft of the phacoemulsification tip is configured to be inserted into a lens of an eye and vibrated ultrasonically to liquefy or emulsify the lens for aspiration of the lens out of the eye.

2. The phacoemulsification tip of claim 1 wherein the shaft is made of titanium.

3. The phacoemulsification tip of claim 1 wherein the shaft is made of stainless steel.

4. The phacoemulsification tip of claim 1 wherein the shaft has a length between 0.5 inches and 1.5 inches, an outside diameter of between 0.005 inches and 0.1 inches, and an inside diameter of between 0.001 inches and 0.09 inches.

5. The phacoemulsification tip of claim 1, wherein the shaft is arched along the entire length of the shaft relative to the straight line so that the distal end of the shaft is displaced from the straight line a distance greater than any point proximal of the distal end.

6. The phacoemulsification tip of any one of the preceding claims, wherein the shaft is configured to be ultrasonically vibrated.

7. The phacoemulsification tip of claim 1, wherein the shaft is electropolished and has a length between 0.5 inches and 1.5 inches, an outside diameter of between 0.005 inches and 0.1 inches, and an inside diameter of between 0.001 inches and 0.09 inches.

8. A phacoemulsification tip, comprising:

a rigid tubular shaft enclosing a lumen, the shaft having distal and proximal ends and a generally circular cross section, the shaft being arched from its proximal end to its distal end along an arc contained in the lumen so that the distal end of the shaft is located at one end of the arc and the proximal end of the shaft is located at the other end of the arc, the distal end of the shaft being cut at an angle between zero degrees and ninety degrees so as to form an opening at the distal end of the shaft;

wherein the shaft is progressively arched along an entire length of the shaft such that a centreline of the shaft curves continuously in one direction;

wherein the rigid tubular shaft of the phacoemulsification tip is configured to be inserted into a lens of an eye and vibrated ultrasonically to liquefy or emulsify the lens for aspiration of the lens out of the eye.

9. The phacoemulsification tip of claim 8, wherein the shaft of the phacoemulsification tip is arched along the entire length of the shaft relative to a straight line, tangent to the arc of the shaft at the proximal end of the shaft, such that each point on the shaft centreline is displaced from the straight line, along a shortest distance from the point to the straight line, a distance greater than any point on the shaft centreline closer to the proximal end of the shaft.

10. A phacoemulsification tip substantially as hereinbefore described with reference to Figure 3 of the accompanying drawings.

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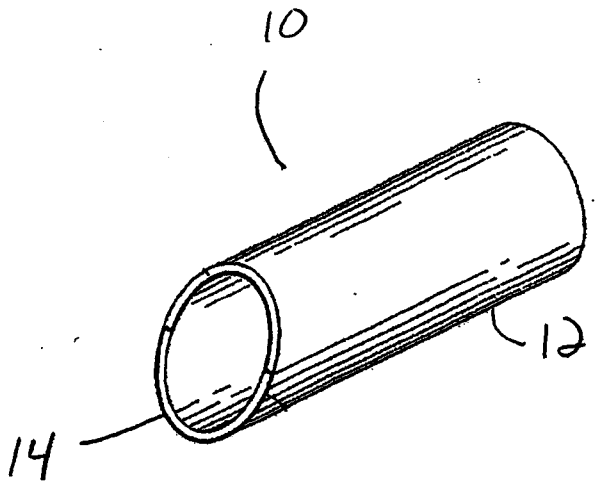

FIG. 1
(Prior Art)

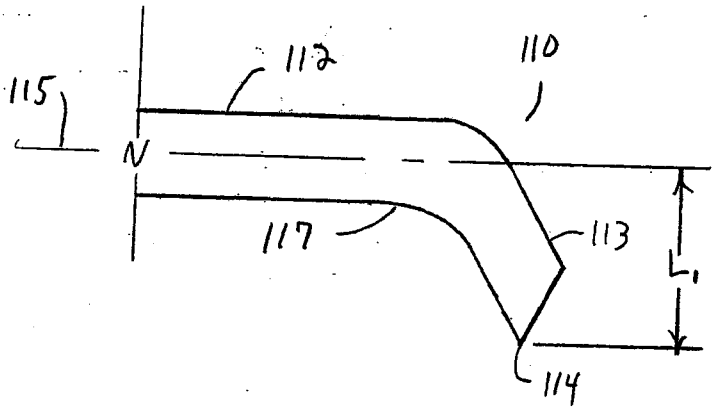

FIG. 2
(Prior Art)

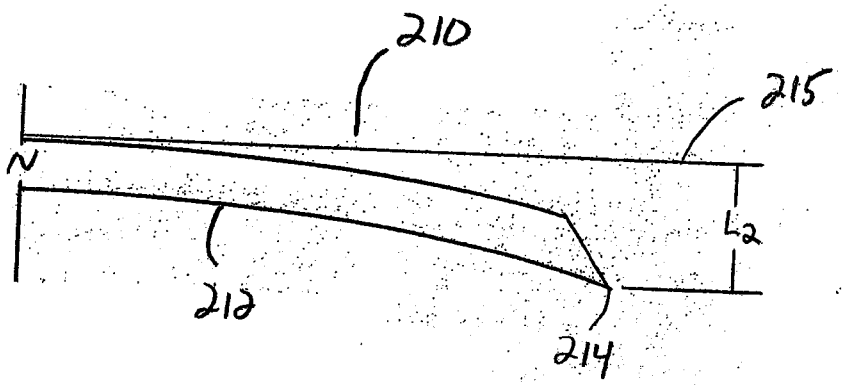

FIG. 3

2006200607 02 Sep 2009

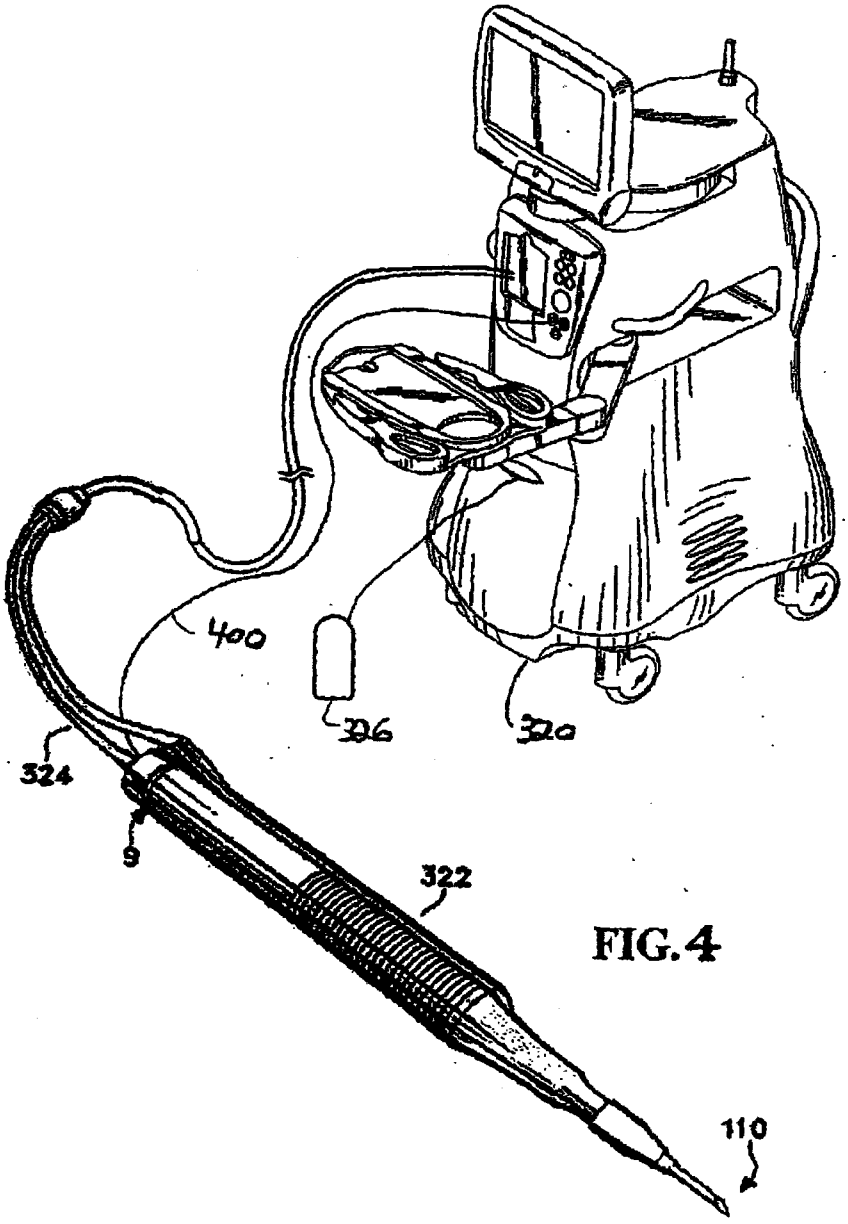

FIG. 4