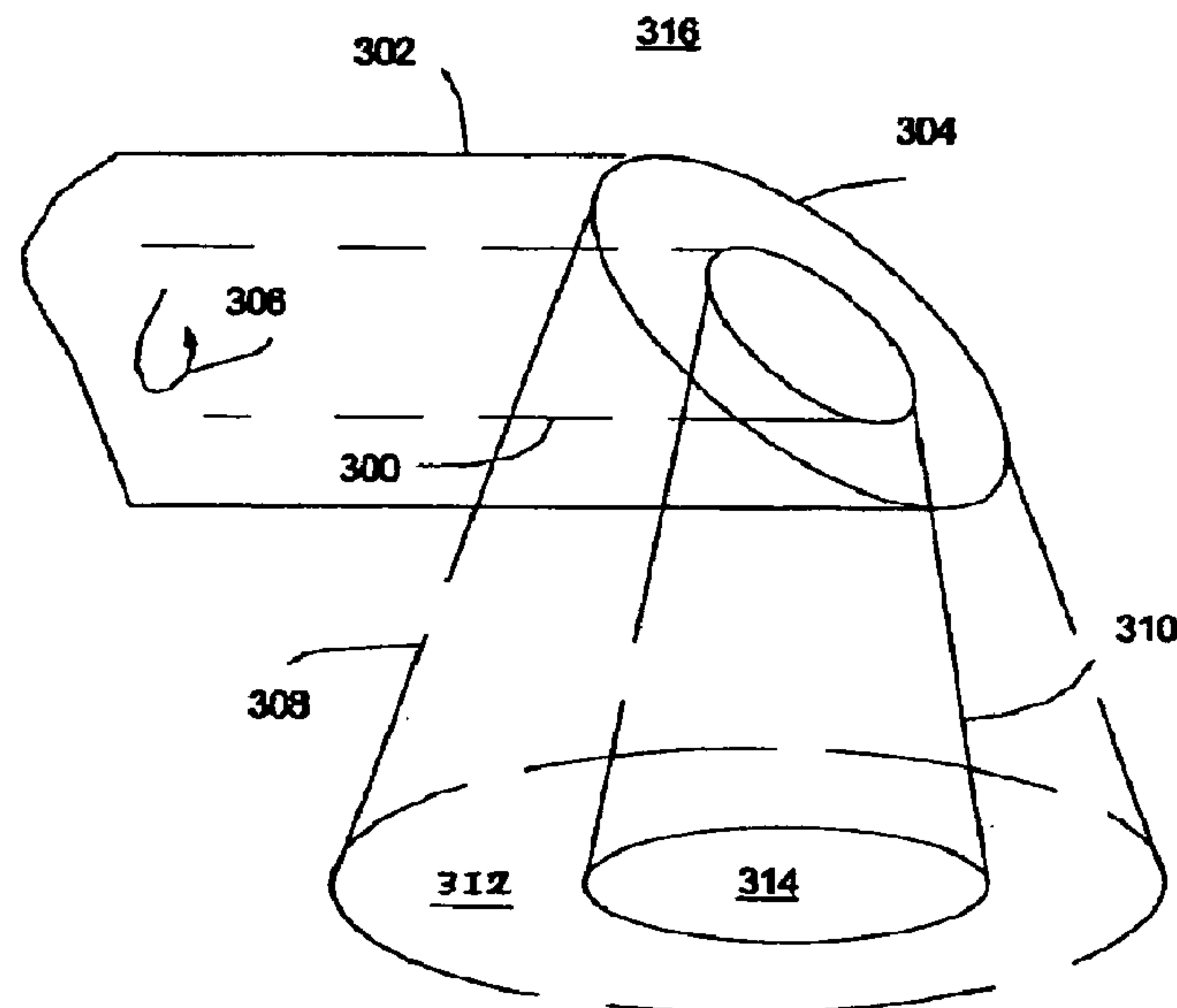




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(54) **Titre : DISPOSITIF ET METHODE DESTINES AU TRAITEMENT DE L'HYPERPLASIE BENIGNE DE LA PROSTATE**  
(54) **Title: BENIGN PROSTATIC HYPERPLASIA TREATMENT DEVICE AND METHOD**



(57) **Abrégé/Abstract:**

A device and method are provided which achieve tissue ablation as well as tissue coagulation substantially simultaneously during the treatment of BPH by utilizing at least two wavelengths of light. The device and method improve urinary flow and minimize post-



**(57) Abrégé(suite)/Abstract(continued):**

treatment blood loss and edema while maintaining a nearly blood-free operating field during treatment by irradiating substantially simultaneously with at least two different wavelengths of light. The present device and method uses optical fibers including in preferred embodiments special side emitting optical fibers to provide a practical, minimally invasive treatment of enlarged prostates. According to the present invention, tissue ablation is affected by having one wavelength that is highly absorbed in the prostatic tissue while another less highly absorbed wavelength coagulates surrounding hyperplastic tissues while maintaining minimal thermal damage to normal tissue, surrounding the hyperplasia. In a preferred embodiment the highly absorbed wavelength is about 1460 nm and the less absorbed by water but with some significant hemoglobin absorption is about 980 nm. This combination aids the patient by reducing blood loss and edema. It can aid the practitioner, especially where imaging is employed, by maintaining a substantially blood-free area during treatment.

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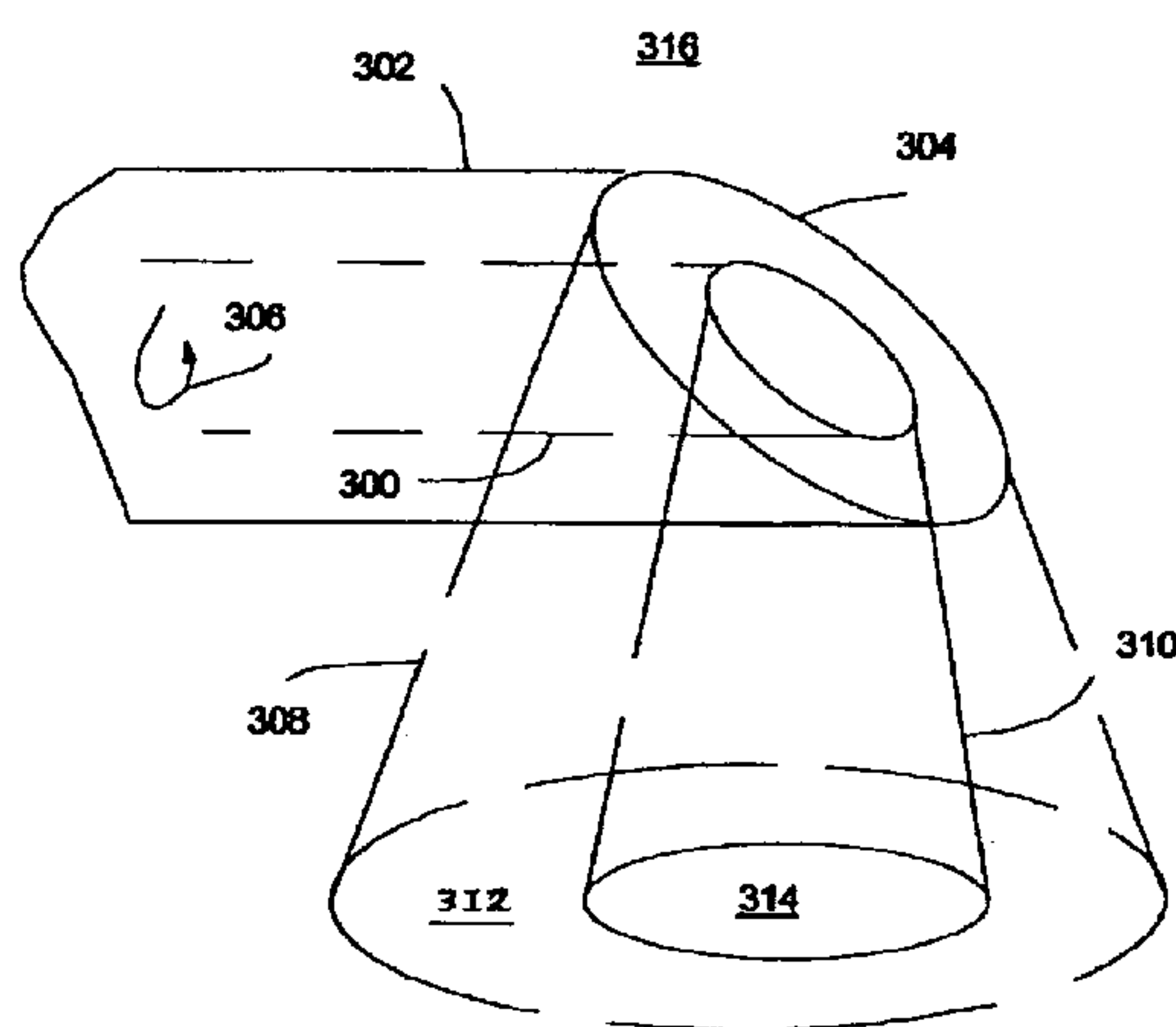
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(54) Title: BENIGN PROSTATIC HYPERPLASIA TREATMENT DEVICE AND METHOD



(57) Abstract: A device and method are provided which achieve tissue ablation as well as tissue coagulation substantially simultaneously during the treatment of BPH by utilizing at least two wavelengths of light. The device and method improve urinary flow and minimize post-treatment blood loss and edema while maintaining a nearly blood-free operating field during treatment by irradiating substantially simultaneously with at least two different wavelengths of light. The present device and method uses optical fibers including in preferred embodiments special side emitting optical fibers to provide a practical, minimally invasive treatment of enlarged prostates. According to the present invention, tissue ablation is affected by having one wavelength that is highly absorbed in the prostatic tissue while another less highly absorbed wavelength coagulates surrounding hyperplastic tissues while maintaining minimal thermal damage to normal tissue, surrounding the hyperplasia. In a preferred embodiment the highly absorbed wavelength is about 1460 nm and the less absorbed by water but with some significant hemoglobin absorption is about 980 nm. This combination aids the patient by reducing blood loss and edema. It can aid the practitioner, especially where imaging is employed, by maintaining a substantially blood-free area during treatment.



WO 2008/002340 A2

## BENIGN PROSTATIC HYPERPLASIA TREATMENT DEVICE AND METHOD

### BACKGROUND OF THE INVENTION

5

#### Field of the invention

The present invention relates generally to devices for treatment of hyperproliferative tissues, and more particularly to a system and method for the treatment of benign prostate hyperplasia that substantially simultaneously ablates excess tissue and coagulates tissue just  
10 beyond the ablation, providing a near blood-free treatment, by utilizing at least two or more separate wavelengths of light.

#### Information Disclosure Statement

Benign prostatic hyperplasia (BPH) or "enlarged prostate" refers to the noncancerous  
15 (benign) growth of the prostate gland. While BPH is the most common prostate problem in men over 50 years of age, benign growth of the prostate begins with microscopic nodules around 25 years of age but rarely produces symptoms before a man reaches 40. It is estimated that 6.3 million men in the United States have BPH and the disease is responsible for 6.4 million doctor visits and more than 400,000 hospitalizations per year.

20 The exact cause of BPH is unknown but it is generally thought to involve hormonal changes associated with the aging process. Testosterone likely has a role in BPH as it is continually produced throughout a man's lifetime and is a precursor to dihydrotestosterone (DHT) which induces rapid growth of the prostate gland during puberty and early adulthood. When fully developed, the prostate gland is approximately the size of a walnut and remains  
25 at this size until a man reaches his mid-forties. At this point the prostate begins a second period of growth which for many men often leads to BPH later in life.

In contrast to the overall enlargement of the gland during early adulthood, benign prostate growth occurs only in the central area of the gland called the transition zone, which wraps around the urethra. As this area of the prostate grows, the gland presses against the urethra and causes a number of lower urinary tract symptoms (LUTS) such as difficult urination (obstructive symptoms) and painful urination (storage symptoms).  
Eventually, the bladder itself weakens and loses the ability to empty itself.

Obstructive symptoms such as intermittent flow or hesitancy before urinating can severely reduce the volume of urine being eliminated from the body. If left untreated, acute urine retention can lead to other serious complications such as bladder stones, urinary tract infections, incontinence, and, in rare cases, bladder damage, kidney damage. These complications are more prevalent in older men who are also taking anti-arrhythmic drugs or anti-hypertensive (non-diuretic) medications. In addition to the physical problems associated with BPH, many men also experience anxiety and a reduced quality of life.

Mild symptoms of BPH are most often treated with medication such as alpha-blockers and anti-androgens. Men suffering with moderate to severe BPH symptoms typically must undergo surgery. Transurethral resection of the prostate (TURP) is the standard surgical procedure, although there are a number of other surgical approaches available as well. Other less invasive surgical methods include: transurethral incision of the prostate (TUIP), transurethral microwave thermotherapy (TUMT), transurethral electrovaporization (TUVP), transurethral needle ablation (TUNA), and laser surgery.

There are a number of different laser techniques in which light is used to eliminate excess prostate tissue either by ablation (vaporization) or thermal coagulation mechanisms. The observed clinical effects are due to the absorption of light (by the target tissue itself and/or surrounding fluids) and subsequent heat transfer, the extent of which largely depends on the power and wavelength of the laser beam. In general, wavelength determines the depth of tissue penetration while power has a direct influence on the temperature created within the tissue. However, it is temperature that determines the ultimate impact at the treatment area since tissue must be heated to greater than 50 C to induce coagulation whereas vaporization occurs at temperatures over 100 C. Temperature also impacts morbidity, namely inflammation, dysuria, bleeding, and the need and duration of post-treatment catheterization.

Laser approaches currently in use for the treatment of BPH utilize a single wavelength of light to eliminate excess prostate tissue via ablation or by inducing coagulation necrosis. Initially, however, laser surgeries for BPH used the holmium: YAG laser in combination with the Nd:YAG laser in a treatment method called Combination Endoscopic Laser Prostatectomy (CELAP) being a two step process where the holmium laser was used to create the channel through the prostate and the Nd laser was used for coagulation. It was further determined that the Nd laser was unnecessary if the holmium laser was defocused for coagulation purposes. See A.H.H. Tan and P.J. Gilling, *Holmium Laser Prostatectomy*, BJU International, 92, 527-530 (2003). For the CELAP procedure, the holmium laser was used to create a channel in the prostate by vaporizing the tissue after which, the Nd:YAG laser was used to further eliminate tissue via coagulation. CELAP has been replaced by newer, single-wavelength laser methods which are still being evaluated for long-term efficacy.

Holmium Laser Enucleation of the Prostate or HoLEP is a laser ablation technique in which a 2140 nm Ho:YAG laser is used to remove whole lobes from the prostate. Specifically, HoLEP uses a bare optical fiber which is brought into direct contact with the target tissue. Enucleation occurs when the vapor bubbles that form in front of the fiber bombard the target tissue and tear it apart. Special morcellators or other extraction techniques are needed to remove tissue debris from the area. The efficacy of the HoLEP procedure depends upon maintaining very close contact between the fiber and the tissue to be removed. As a result, it is possible to perforate the prostate during the procedure and many surgeons avoid using HoLEP because of the difficulty in learning and maintaining proficiency in the technique.

Another laser technique to eliminate prostate overgrowth features a frequency-doubled Nd:YAG laser as a pulsed, 532 nm high-power potassium-titanyl-phosphate laser (KTP) that vaporizes target tissue as well as induces thin layers of coagulation in the surrounding tissues as described by Davenport *et al.* in US 6,554,824. The 532 nm radiation used in KTP is selectively absorbed by hemoglobin and penetrates tissues only to a depth of 1-2 mm. Moreover, this method requires continuous irrigation of the treatment site to cool the tissue during the procedure to help reduce unwanted coagulation necrosis in deeper tissue layers.

Interstitial laser coagulation (ILC) is a minimally invasive method that uses a Nd:YAG laser to reduce the volume of the prostate by inducing coagulation necrosis in the interior of the prostate, as opposed to eliminating tissue via ablation. As a result, ILC does not require the removal of tissue debris during treatment and avoids subsequent sloughing (and associated bleeding) of necrotic tissue post-treatment. However, this wavelength has a relatively long penetration depth and thus has the capacity to produce deeper and broader zones of thermal damage there as necessary. As such, ILC treatment methods require precise, well-controlled positioning and monitoring of the laser fiber tip during the procedure and may only be appropriate for a select group of patients (i.e. patients having a specified pre-operative prostate volume).

Much like TURP, most types of laser surgeries are able to provide an immediate improvement in the urinary stream. Laser surgery for BPH has other potential advantages such as reduced blood loss as well as shorter treatment times, faster patient recovery, and a lower risk of post-treatment incontinence. However, many patients still require catheterization for 1-2 weeks post-treatment after undergoing some forms of laser surgery. Despite the obvious benefits of laser procedures for BPH, long-term follow-up studies on the clinical results of many laser techniques are not yet widely available.

To date, none of the less invasive procedures have proven to be more effective than TURP nor are they generally appropriate across all patient groups including: younger men, debilitated elderly patients, patients with severe medical conditions including uncontrolled diabetes, cirrhosis, active alcoholism, obesity, and heart disease, as well as men taking blood thinning medications. As such, there remains a need for a device and treatment method for the effective alleviation of BPH symptoms that can be used across all patient groups with a minimum of adverse complications post-treatment. The present invention is directed towards this need.

### **Objectives and Brief Summary of the Invention**

It is an object of the present invention to provide a device and treatment method that will eliminate a sufficient amount of prostate tissue to improve urinary flow while also minimizing blood loss and edema.

It is another object to provide a fiber optic device and irradiation method utilizing at least two wavelengths of light so as to achieve ablation as well as coagulation in the target tissue.

It is yet another object of the present invention to effectively treat the symptoms of BPH using a fiber optic device and at least two wavelengths of light.

It is still another object to provide a fiber optic device and irradiation method utilizing at least two wavelengths of light to achieve ablation as well as coagulation in the target tissue with a pattern of pulses and energy densities.

Briefly stated, the present invention provides a device and method which achieve tissue ablation as well as tissue coagulation substantially simultaneously during the treatment of BPH by utilizing at least two wavelengths of light. The device and method improve urinary flow and minimize post-treatment blood loss and edema while maintaining a nearly blood-free operating field during treatment by irradiating substantially simultaneously with at least two different wavelengths of light. The present device and method use optical fibers including in preferred embodiments special side emitting optical fibers to provide a practical, minimally invasive treatment of enlarged prostates. According to the present invention, tissue ablation is affected by having one wavelength that is highly absorbed in the prostatic tissue while another less highly absorbed wavelength coagulates surrounding hyperplastic tissues while maintaining minimal thermal damage to normal tissue, surrounding the hyperplasia. In a preferred embodiment the highly absorbed wavelength is about 1460 nm and the less absorbed by water but with some significant hemoglobin absorption is about 980 nm. This combination aids the patient by reducing blood loss and edema. It can aid the practitioner, especially where imaging is employed, by maintaining a substantially blood-free area during treatment. The present device and method is used in conjunction with optical fibers including side emitting optical fibers to provide a practical, minimally invasive treatment of enlarged prostates.

According to a broad aspect of the present invention there is provided a medical laser device for applying radiation to an area of treatment by means of at least one optical fiber capable of transmitting laser radiation at, at least two wavelengths to the area of treatment. The medical laser device comprises at least two laser sources capable of emitting at least two wavelengths of laser radiation, each having a different effect in tissue at the area of treatment

and wherein a combination of the wavelengths are selected to effect a desired treatment of selected prostatic tissue, a first wavelength selected for its coagulating effect, coagulating laser radiation, and a second wavelength selected for its ablative effect, ablative laser radiation. The first wavelength is 980 ( $\pm 20$ ) nm and the second wavelength is between 1300  
 5 and 1600 nm. A single optical fiber transmits the at least two wavelengths of the laser radiation therein. A tip on a distal end of the single optical fiber emits the at least two wavelengths of the laser radiation. The laser radiation is irradiated through a smaller cross-section of the optical fiber and the coagulating laser radiation is irradiated through a larger cross-section of the optical fiber.

10 According to another broad aspect of the present invention there is provided the use of a laser device capable of transmitting at least two wavelengths of radiation, a first wavelength having a coagulating effect on a selected designated site and a second wavelength having an ablative effect on the selected designated site. The laser device includes a single optical fiber having a distal end locatable at the selected site to deliver the at least two wavelengths of laser  
 15 radiation to the selected site. The at least two wavelengths of radiation are further characterized by a pattern of pulses and energy densities that achieve the ablative as well as the coagulating effect on the selected site.

According to another broad aspect of the present invention there is provided a medical laser device for applying radiation to an area of treatment by means of at least one optical  
 20 fiber capable of transmitting laser radiation at, at least two wavelengths to said area of treatment, said medical laser device comprising: at least two laser sources capable of emitting at least two wavelengths of laser radiation, wherein said at least two wavelengths of laser radiation include a first wavelength of 980 ( $\pm 20$ ) nm and a second wavelength of between 1300 and 1600 nm; at least one optical fiber capable of transmitting said at least two  
 25 wavelengths of said laser radiation therein; and a tip on a distal end of said at least one optical fiber for emitting said at least two wavelengths of said laser radiation.

According to another broad aspect of the present invention there is provided a medical laser device for treating benign prostatic hyperplasia of a prostate comprising first and second laser sources respectively emitting first and second wavelengths of radiation, the first  
 30 wavelength being selected for a coagulating effect in prostatic tissue and the second wavelength being selected for ablation of the prostatic tissue, said first wavelength being

shorter than said second wavelength, and an optical fiber having a fiber core and at least one cladding layer, the at least one cladding layer being in communication with the first laser source for transmission of the first wavelength therethrough, and the fiber core being in communication with the second laser source for transmission of the second wavelength  
5 therethrough.

The above and other objects, features and advantages of the present invention will become apparent from the following description read in conjunction with the accompanying drawings.

### Brief Description of Figures

Figures 1A and 1B illustrate by block diagrams medical laser devices of the present invention.

Figures 2A and 2B illustrate by perspective views optical fibers of the present invention.

Figure 3 illustrates by perspective view the application of the optical fiber of Figure 2 in the medical laser device of Figure 1.

### Detailed Description of Preferred Embodiments

Figure 1A is a block diagram depicting one embodiment of medical laser device **100** in accord with the present invention. Device **100** includes two laser sources **102** and **104** for the generation of at least two different wavelengths of light. Laser source **102** emits radiation into first optical fiber **114** and laser source **104** emits radiation into second optical fiber **112**. A combiner **108** takes the inputs from optical fibers **112** and **114** and forms a single optical fiber **106** that transmits the two different wavelengths of radiation into optical fiber probe **110**. According to the present invention, device **100** emits light of at least two different wavelengths, preferably one wavelength is between  $980 \pm 20$  nm and the other is between 1300 nm and 1600 nm. Device **100** further includes a control device **116** where the operational parameters are input. These operational parameters would include power, duration, repetition rate, and continuous or pulse mode, energy density, etc., for each of the lasers therein. Figure 1B illustrates device **100** having another laser source **120**. It is therefore seen that device **100** may have multiple laser sources for performing multiple medical functions necessary to properly treat the illness or condition of concern. These laser sources may be operating at the same time, at different times, in different sequences, with different powers, at different waves, and in different modes.

Probe **110** with attached optical fiber **106** is inserted into the urethra up to the area of the surrounding prostate tissue of concern by conventional means including catheter. Further other devices may be included in the catheter such as viewing means, irrigating means. Probe **110** would include at least one optical fiber output end for emitting the laser radiation and would have a termination selected from the group consisting of a bare fiber, a capped fiber, and preferably a fiber output end having a side-firing output as well be discussed hereafter.

In a typical mode of operation, probe **110** irradiates the target area with a preselected pattern of pulses and energy densities. Treatment can also involve a semi-continuous irradiation for each position to be treated, or with a turning of the side-firing fiber probe to circumferentially treat a larger section. In preferred embodiments, these patterns of pulses and energy result in the ablation of prostatic tissue as well as coagulation of underlying tissues to substantially eliminate blood loss beyond the removed tissue and with minimal thermal damage to surrounding tissue.

Figures 2A and 2B depict a side-emitting tip **210** of probe **110**, from Figure 1, that may be used in the method of the present invention. In a preferred embodiment, the present invention uses, but is not limited to, a side-emitting tip **210**. An exemplary side-emitting fiber is described in U.S. Patent No. 5,509,917. This reference further discloses means for enclosing the fiber end within a protective cover. The present invention may also employ bare fibers, capped fibers, fibers with shaped or diffusing tips.

In a typical mode of operation, optical fiber **106** delivers laser energy from each laser source and would normally be used in conjunction with a handpiece, endoscope, or similar instrument for positioning the fiber's distal end in close proximity, in direct contact with, or inside/within the target tissue. It is preferred that the handpiece, endoscope, or similar instrument have sufficient channels to accommodate the flow and removal of irrigant and/or debris from the treatment site, endoscopic instruments, aspirators, light guides, image guides, or other sensor and/or detection means.

Figure 2A illustrates optical fiber **218** having central core **200** for transmitting laser radiation. Cladding layer **206** about core **200** may further transmit laser radiation of a different or same wavelength as core **200**. Protective coating **202** being of conventional design and materials encases the cladding layer(s) and the core. In the preferred embodiment, ablative radiation may be directed into central core **200** with the coagulating radiation of a different wavelength being directed into cladding layer **206** and/or central core **200**. Additional cladding layers may be used as is conventional in the art to protect and guide the optical radiation therein. Figure 2B illustrates optical fiber **200** with tip **210** having the side-firing device therein. As seen therein, central core **200** includes two cladding layers **206** and **204** with protective coating **202** thereabout. Side-firing tip **316** is shown in greater detail in Figure 3 and has slanted face **304**. Slanted face **304** has an

optical coating thereon to reflective all or some of the transmitted radiation. For example, the ablative radiation being in core 300, presently dashed, is reflected off of slanted face 304 into an inner cone 310 of radiation having a smaller cross-section area 314 at the treatment area. The coagulating wavelength radiation is conducted in the surrounding or outer layer 302 and is also reflected off of slanted face 304 into an outer cone 308 to form larger cross-section area 312. The characteristics of the radiation emerging from core or one or more of the cladding layers are within the control of control device 116, but as seen in Figure 3, the coagulating wavelength radiation is in outer cone 308. The coagulating radiation may or may not be in inner cone 310 also.

It is therefore seen that the optical fiber may have one or more cladding layers about the core and that the laser radiation, one wavelength for the ablative effect and the other for the coagulating effect, may be input into the core and also input into the first cladding layer. In the preferred embodiment, the ablative laser radiation, of about 1460 nm, is input into the fiber core and the coagulating laser radiation, of about 980 nm, is input into not only the core but also into a first of the cladding layers. It is also certainly feasible to input the coagulating laser radiation into just the cladding layer, assuming at least two cladding layers are present. It should be understood that either laser emitting these radiations may be operated in the pulsed or continuous mode. In preferred modes the ablation wavelength will generally be pulsed and the coagulation wavelength can be semi-continuous, or pulsed before or during the ablation power pulse.

The present invention is further illustrated by the following examples, but is not limited thereby.

*Example 1:*

In accord with the present invention, a medical laser with a maximum average power of 100 W and having an output of two wavelengths of light, the first of which is 980 nm and the second of which is 1460 nm can be used in the treatment of BPH. Lasing can be performed using a 200  $\mu$ m core diameter, for example, with an all silica optical fiber, for example, with energy in a pulsed mode, for example, using a 50 W of 980 nm radiation and 50 W of 1460 nm radiation in cases where the fiber can be positioned close to the target tissues. The fiber is to be introduced and positioned via a rigid endoscope, for example, with a saline solution as an irrigant.

*Example 2:*

In another example, a medical laser with capacity to operate at about 120-150 W at each of two wavelengths of light, has a first wavelength of about 960 nm and a second wavelength of about 1370 nm. Using an all silica optical fiber with a 600  $\mu\text{m}$  core diameter and a 660  $\mu\text{m}$  clad  
5 diameter, coagulation can be achieved with a semi-continuous irradiation at 960 nm while ablation is achieved using a semi-pulsed regime for the 1370 nm wavelength. The power at each wavelength would be set at about 120 W. On/off times would be about equal in value and generally about 0.1 of a second or so.

Having described the preferred embodiments of the invention with reference to the  
10 accompanying drawings, it is to be understood that the invention is not limited to the precise embodiments, and that various changes and modifications may be effected therein by those skilled in the art without departing from the scope of the invention as defined in the appended claims.

## CLAIMS

1. A medical laser device for applying radiation to an area of treatment by means of at least one optical fiber capable of transmitting laser radiation at, at least two wavelengths to said area of treatment, said medical laser device comprising:

at least two laser sources capable of emitting at least two wavelengths of laser radiation, each having a different effect in tissue at said area of treatment and wherein a combination of said wavelengths are selected to effect a desired treatment of selected prostatic tissue, a first wavelength selected for its coagulating effect, coagulating laser radiation, and a second wavelength selected for its ablative effect, ablative laser radiation, wherein said first wavelength is of 980 ( $\pm 20$ ) nm and said second wavelength is between 1300 and 1600 nm;

a single optical fiber transmits said at least two wavelengths of said laser radiation therein; and

a tip on a distal end of said single optical fiber for emitting said at least two wavelengths of said laser radiation, said ablative laser radiation being irradiated through a smaller cross-section of said optical fiber and said coagulating laser radiation is irradiated through a larger cross-section of said optical fiber;

wherein said optical fiber has a fiber core and at least one cladding layer;

wherein said first wavelength is transmitted through the at least one cladding layer and said second wavelength is transmitted through said fiber core, wherein said first wavelength transmitted through the at least one cladding layer is shorter than said second wavelength transmitted through said fiber core.

2. The medical laser device of claim 1, wherein said area of treatment is a selected prostatic tissue of a prostate.

3. The medical laser device of claim 1 or 2, wherein the second wavelength is of 1460 ( $\pm 60$ ) nm.

4. The medical laser device of claim 1, wherein said tip has a side-firing feature thereon.

5. The medical laser device of claim 4, wherein said single optical fiber further comprises at least two output cones of radiation, including an inner cone of radiation at a first wavelength having said ablative laser radiation in tissue in said treatment area, and an outer cone of radiation at a second wavelength having said coagulating laser radiation in tissue in said treatment area.

6. The medical laser device of claim 5, wherein the optical fiber is further characterized by a core transmitting one of the first and second wavelengths of radiation, and a cladding transmitting another of the first and second wavelengths.

7. The medical laser device of claim 1, characterized in that said first and said second wavelengths of said laser radiation are substantially simultaneously delivered.

8. The medical laser device of claim 1, further characterized by a probe for emitting said laser radiation, said probe having a termination selected from the group consisting of a bare fiber, a capped fiber, and a fiber with a shaped end.

9. A medical laser device for applying radiation to an area of treatment by means of at least one optical fiber capable of transmitting laser radiation at, at least two wavelengths to said area of treatment, said medical laser device comprising:

at least two laser sources capable of emitting at least two wavelengths of laser radiation, wherein said at least two wavelengths of laser radiation include a first wavelength of 980 ( $\pm 20$ ) nm and a second wavelength of between 1300 and 1600 nm;

at least one optical fiber capable of transmitting said at least two wavelengths of said laser radiation therein;

a tip on a distal end of said at least one optical fiber for emitting said at least two wavelengths of said laser radiation; and

said optical fiber having a fiber core and at least one cladding layer, the at least one cladding layer being in communication with the first laser source for transmission of the first wavelength therethrough, and the fiber core being in communication with the second laser source for transmission of the second wavelength therethrough.

FIG. 1A

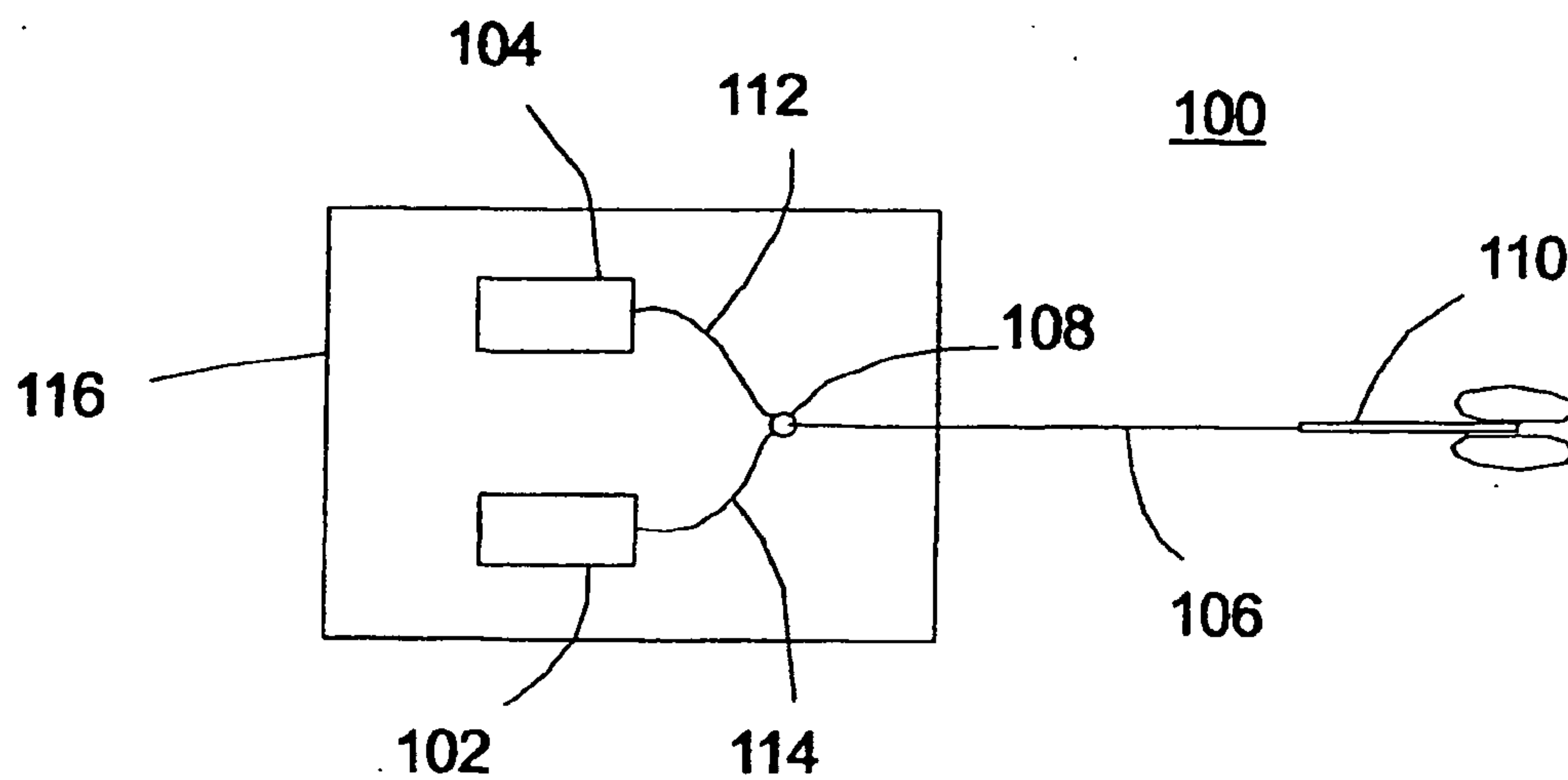
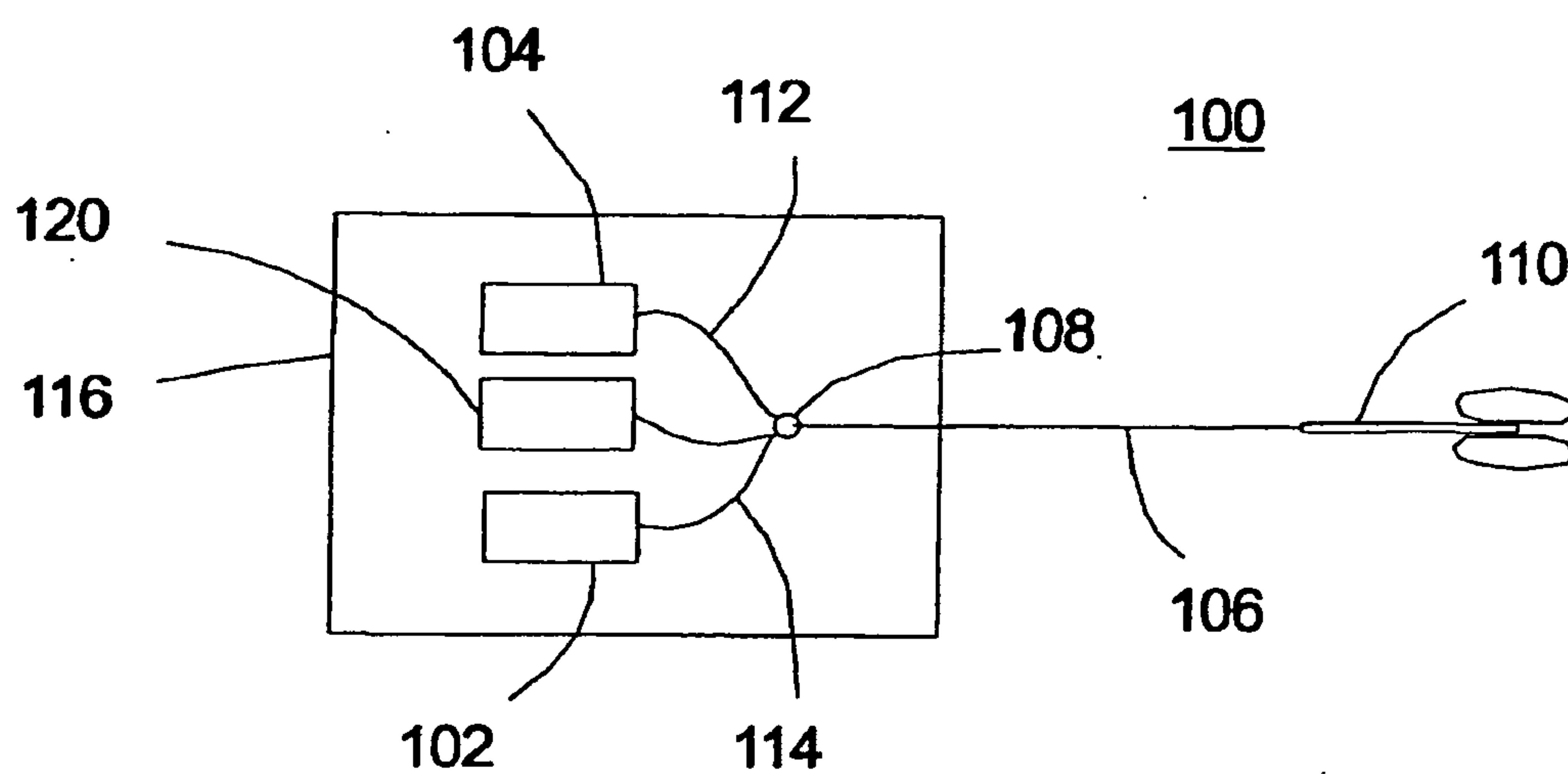


FIG. 1B



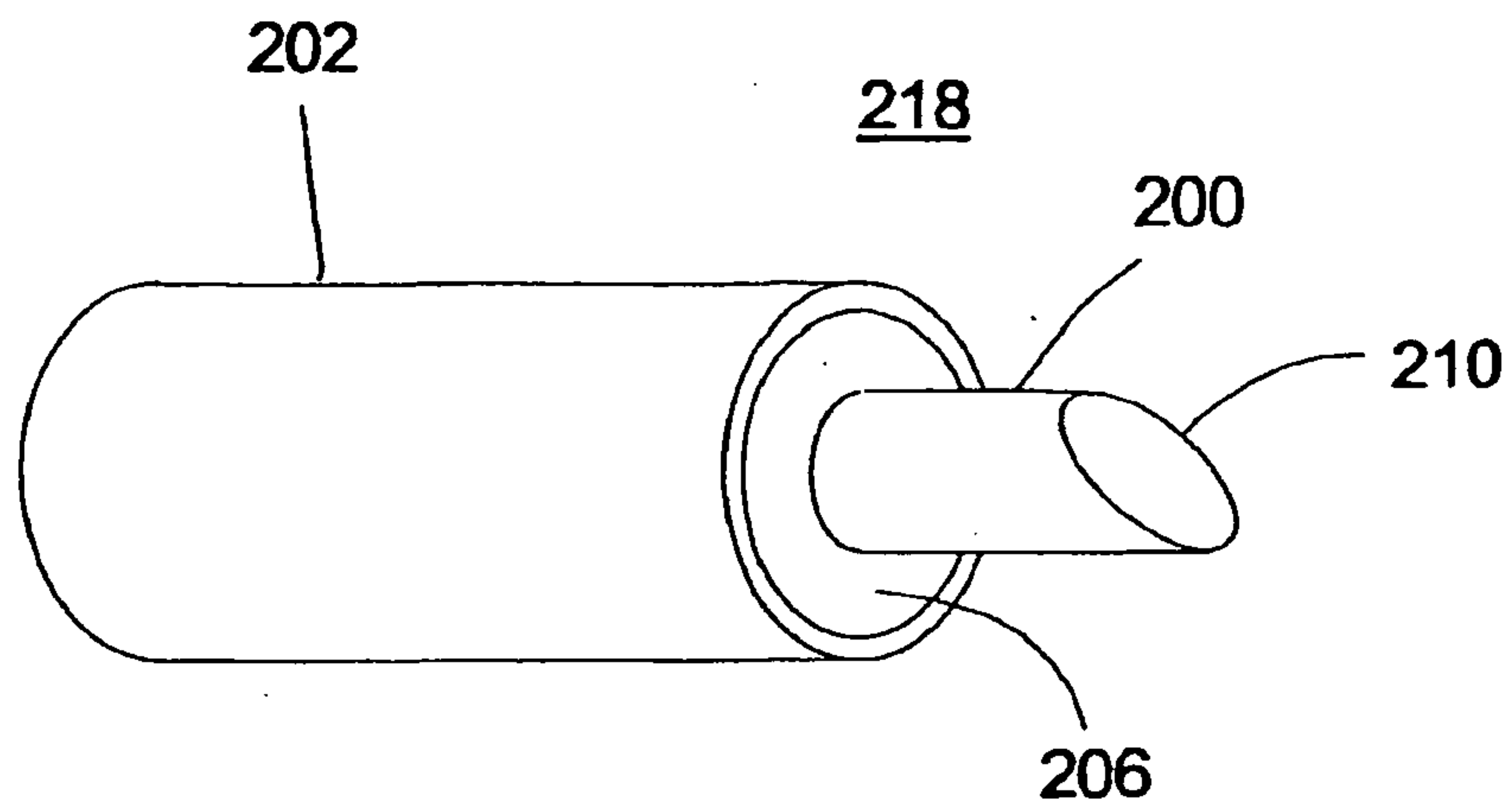
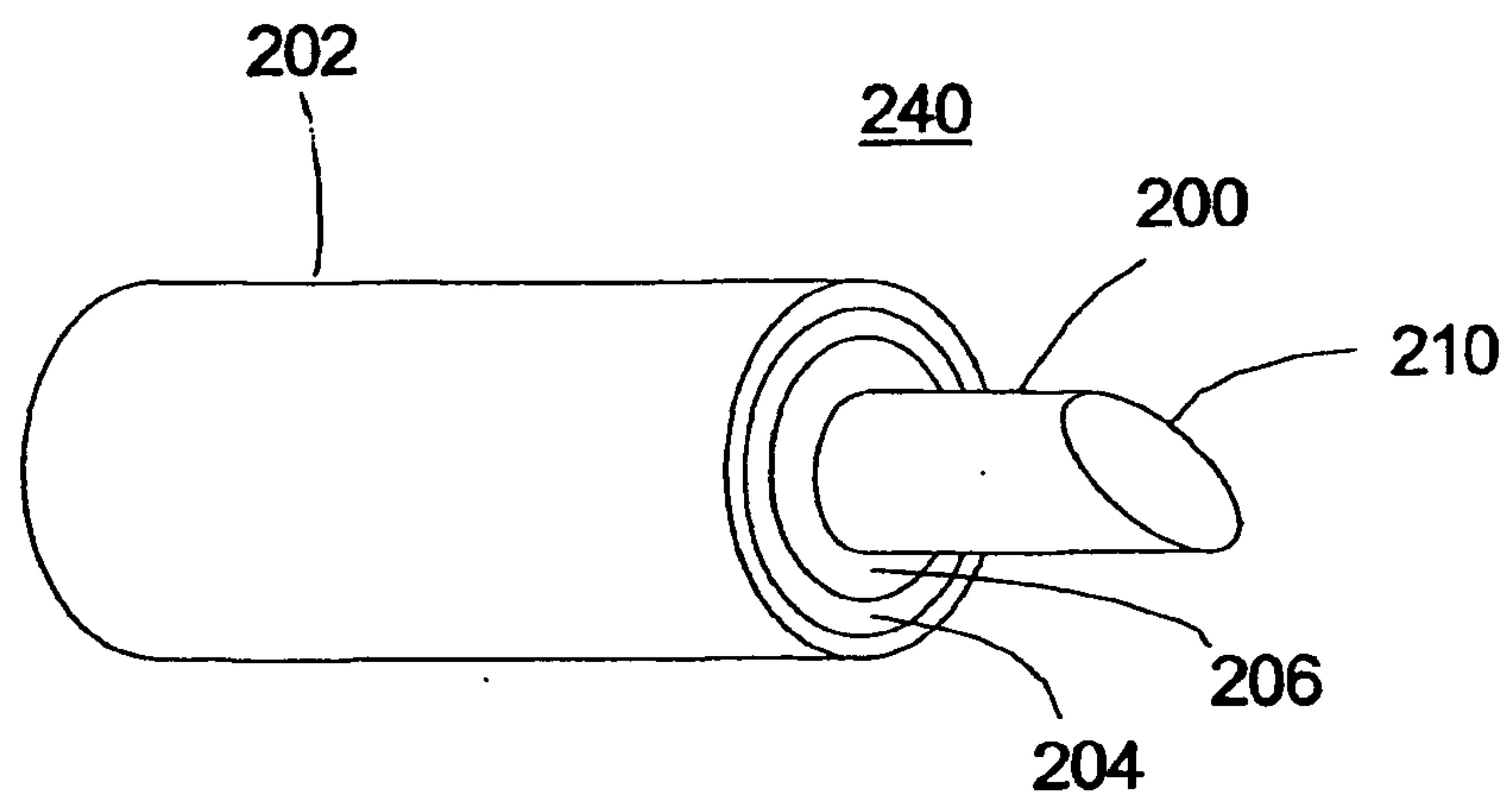
**FIG. 2A****FIG. 2B**

FIG. 3

