



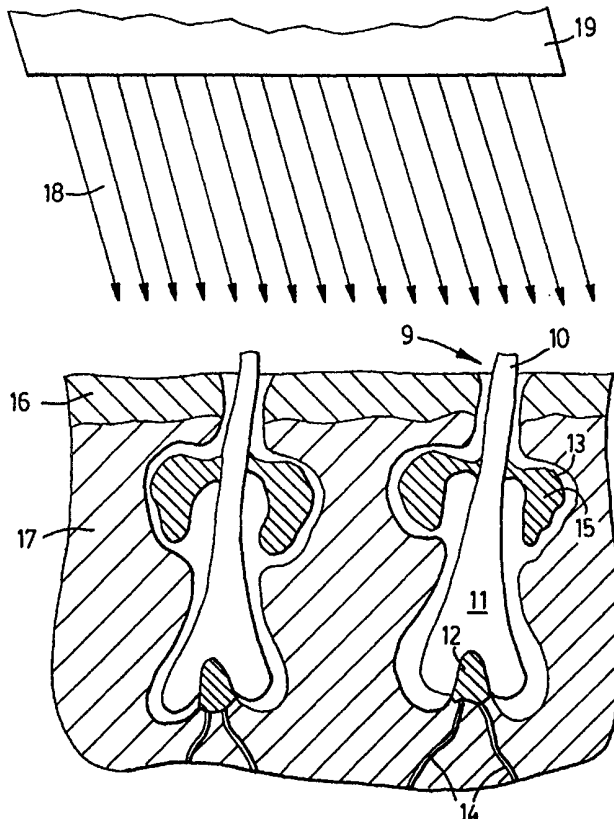
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<p>(21) International Application Number: PCT/CA98/01005                  (22) International Filing Date: 28 October 1998 (28.10.98)                   (71) Applicant: KERALASE LTD. [CA/CA]; Suite 204, 822-11th Avenue, S.W., Calgary, Alberta T4R OE5 (CA).                  (72) Inventors: STEWART, Bob, W.; 5745 Pandora Avenue, Cincinnati, OH 45213 (US). JOCHUM, Frances, R.; 712 Knickerbacker, Ballwin, MO 63021 (US).                  (74) Agent: BLAKE CASSELS &amp; GRAYDON; World Exchange Plaza, 20th Floor, 45 O'Connor Street, Ottawa, Ontario K1P 1A4 (CA).</p>	<p>(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).</p> <p><b>Published</b> <i>With international search report.</i></p>	

(54) Title: METHOD OF HAIR REMOVAL BY TRANSCUTANEOUS APPLICATION OF LASER LIGHT

(57) Abstract

A method of hair removal, used primarily for cosmetic purposes, comprising the transcutaneous use of laser light having a wavelength which targets the keratin component of hair, thus destroying the hair by photothermolysis without damage to surrounding skin or tissue; this primary method may be supplemented by the use of intrafollicular hair removal methods utilizing a second wavelength of light produced by the same source used to generate the primary light wavelength.



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Method of Hair Removal by Transcutaneous  
Application of Laser Light

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BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates generally to a method of permanent hair removal using laser light. More specifically, the invention relates to the transcutaneous use of laser light to target the keratin component of hair, thus destroying the hair by photothermolysis without damage to surrounding skin or tissue.

2. Description of the Prior Art

Currently available laser hair removal methods may be classified as either intrafollicular or transcutaneous in nature. Intrafollicular methods comprise the delivery of laser light thru a small probe tip to the hair follicle. The light utilized is of a wavelength which is readily absorbed by either the melanin in the hair or the hemoglobin in the blood vessels surrounding the papilla. This absorption of light energy produces heat, resulting in damage to the hair shaft, photocoagulation of the tissue surrounding the papilla, and subsequent destruction of the hair. Because the light energy employed in this method is absorbed by either blood or melanin in the skin, it requires the use of a very narrow beam of light to target a single hair at a time and prevent damage to the surrounding tissue. This results in a painstaking, time-consuming process which must be administered by a skilled operator. When targeting melanin, this method losses effectiveness when used on lighter haired or darker skinned patients. In addition, some methods in this category

require that the needle-like probe tip be inserted into the hair follicle, a painful process which must be repeated for every hair.

Transcutaneous laser hair removal methods currently available utilizes a substance which is massaged into the skin to penetrate the hair ducts. After cleaning the substance from the skin's surface, light of a wavelength which passes through the skin, but which is absorbed by the substance, is directed onto the treated area. The absorption of energy by the substance applied to the hair duct causes photocoagulation of the tissue surrounding the papilla and results in destruction of the hair. Although this method allows for treatment of a sizable area of skin, it requires the inconvenient, time consuming application of the light-absorbing substance. In addition, great care must be taken to completely remove the substance from the skin's surface prior to the laser treatment to avoid damage to the skin.

Because of the disadvantages associated with both methods of hair removal in use today, a new method is needed which provides faster, more convenient, and less painful permanent hair removal without damage to the patient's skin.

#### SUMMARY OF THE INVENTION

The invention relates to a method of permanent hair removal used primarily for cosmetic purposes. This method comprises the transcutaneous use of laser light having wavelength in the 880-930 nanometer range wherein the light is directed onto an area of skin on which hair removal is desired. Light of this wavelength passes through the skin with only minimal absorption by blood, blood components, and melanin. This wavelength is, however, readily absorbed by the protein keratin, the main component of hair of all colors. Absorption of the light energy by the keratin produces heat, which damages the

hair shaft and root and photocoagulates the blood vessels and tissue surrounding the papilla, resulting in destruction of the hair and preventing its re-growth.

In its preferred embodiment, the method also includes the use of a second wavelength of laser light produced by known means, such as second harmonic generation or 3-mixing plus second harmonic generation, from the same laser source which generates the primary 880-930nm wavelength. This second wavelength of light, which will be in the 440-465 nanometer range, is readily absorbed by both blood components and melanin. An intrafollicular probe is used to deliver the second wavelength of light to the hair follicle, in the manner described in the prior art, to treat the small percentage of hairs having papillas at a skin depth beyond the effective range of the primary wavelength of light. In this fashion, a single laser light source can be used to treat all types of hair in the least painful and most efficient, cost effective, and convenient manner possible.

There are numerous problems associated with the hair removal methods in the field of prior art. Some of these methods are painful for the patient. Others have varying effectiveness depending on the skin and hair color of the patient. Most must be administered by highly skilled operators to reduce the risk to the patient. All of these methods involve expensive, painstaking, and time-consuming processes. In addition, all carry substantial risk of skin damage if not performed properly.

It is an object of the invention to provide a hair removal method which: 1) is fast and convenient; 2) is less painful; 3) is effective on hair of all types; 4) has reduced risk for skin damage; and 5) utilizes a low cost, low maintenance, and low power consumption laser source. Further objects and advantages of the invention will become apparent from a consideration of the drawings and description.

**BRIEF DESCRIPTION OF THE DRAWING**

Figure 1 is a sectional view of an area of skin showing the structure of hair and skin and the transcutaneous application of laser light.

Figure 2 is a graph showing the absorption spectrum of hemoglobin, melanin, and keratin in the visible and near infra-red light range.

Figure 3 is a sectional view of an area of skin showing the structure of hair and skin and the intrafollicular application of laser light.

**DRAWING REFERENCE NUMERALS**

9	hair
10	shaft
11	root
12	papilla
13	follicle
14	blood vessels
15	sebaceous glands
16	epidermis
17	dermis
18	laser light
19	fiber optic cable probe tip
20	intrafollicular probe

## DESCRIPTION OF THE PREFERRED EMBODIMENT

### Description:

Figure 1 illustrates the preferred embodiment of the invention. As shown, laser light 18 emanates from the probe tip 19 of a fiber optic cable, not shown, and is directed onto the surface of the skin. The other end of the fiber optic cable is connected to a laser light source, also not shown. The size and shape of the light beam may be customized to meet the requirements of any individual application. Figure 1 also illustrates the structure of hairs 9 and the surrounding upper and lower skin layers, known as the epidermis 16 and the dermis 17, respectively. Hair 9 comprises shaft 10, shown shaved near the surface of the skin, and root 11. Follicle 13 is a sac which encloses shaft 10, root 11 and adjacent sebaceous glands 15. Located at the lower end of follicle 13 is the papilla 12, which is fed by blood vessels 14 and provides nourishment to root 11. In order to prevent regrowth of hair 9, it is the papilla 12 and blood vessels 14 which must be damaged sufficiently to prevent continued nourishment of root 11.

Figure 2 illustrates the relatively high absorption of light in the 880-930 nm wavelength range by the protein keratin. Figure 2 also shows the relatively low absorption of light in the same range by the hemoglobin and melanin present in the tissue surrounding the hair. These absorption characteristics of keratin, hemoglobin, and melanin allow the transcutaneous use of light of the chosen wavelength to target the keratin in the hair shaft and subsequently destroy the papilla without damage to the surrounding tissue.

The preferred embodiment of the invention primarily utilizes laser light 18 having wavelength in the 880-930 nanometer range. As indicated in Figure 2, light of this wavelength passes through the dermis 17 and the epidermis 16 with only minimal absorption by blood, blood components, and melanin. This wavelength is, however,

readily absorbed by the protein keratin, which is the main component of hair of all colors. Absorption of the light energy by the keratin produces heat, which damages the hair shaft 10 and root 11. This heat may also photocoagulate the blood vessels 14 feeding the papilla 12, resulting in destruction of the hair 9 and increasing the probability of permanent removal.

Power level and duration of the laser pulse directed onto the skin must be carefully chosen to optimize the conduction of heat from the hair shaft and root to the papilla. As an example, a 0.1 second pulse from a laser delivering a power level of approximately 6 milliwatts per hair to the root would deliver sufficient energy to the hair shaft and root to result in significant damage to the papilla and a high probability of permanent hair removal. Use of a shorter, higher energy laser pulse will rapidly vaporize the hair, resulting in hair removal below the surface with little probability of permanent hair destruction. Pulses of less than 0.0001 seconds in duration having sufficient energy to damage hair can lead to very explosive, i.e. photoacoustic, absorption and to hyper- or hypo-pigmentation. Conversely, a pulse longer than 0.2 seconds can result in damage to the surrounding tissue and possible scarring.

Although highly effective on hairs having papillas at a skin depth of 1.0 cm or less, scattering and absorption of the laser light make the transcutaneous method less effective on the small percentage of hairs which exceed this limit. To effectively remove these hairs, the preferred embodiment of the invention further comprises the intrafollicular application of laser light 18 having a second wavelength, as shown in Figure 3. This second wavelength is produced by known means, such as second harmonic generation or 3-mixing plus second harmonic generation, from the same laser source which generates the primary 880-930 nm wavelength. In the manner described in the prior art, the

intrafollicular probe 20 is used to deliver laser light 18 of the second wavelength directly into the follicle 13 and of a hair 9 having papilla 12 at skin depth beyond the effective range of the transcutaneous method. This second wavelength of light, in the 440-465 nanometer range, is readily absorbed by either the melanin in the hair 9 or the hemoglobin in the blood vessels 14 surrounding the papilla 12, resulting in damage to the hair shaft 10, photocoagulation of the tissue surrounding the papilla, and subsequent destruction of the hair. In this fashion, a single, inexpensive, laser light source can be used to treat all types of hair in the least painful and most efficient, cost effective, and convenient manner possible.

Although the above description contains specificities pertaining to laser light wavelength, pulse duration, and power level, these specificities should not be construed as limitations on the scope of the invention, but rather as an exemplification of one preferred embodiment thereof. Variations in primary and secondary laser wavelength, pulse duration, and power level may be possible without significantly reducing the effectiveness of the method. The invention contemplates all variations in these, and all other laser parameters, which accomplish an equivalent result.

## CLAIMS

We claim:

1. A method for permanently removing hair from skin by means of laser light having a wavelength which passes thru the skin with minimal absorption and which is substantially absorbed by the keratin component of hair, wherein said laser light is directed onto the surface of said skin for a period of time sufficient to cause photocoagulation of said hair.
2. The method of claim 1, wherein said wavelength of said laser light is 880-930 nanometers.
3. The method of claim 2, wherein:
  - a) a second wavelength of laser light which is produced by known means, such as second harmonic generation or 3-mixing plus second harmonic generation, from the same laser source which generates the 880-930 nanometer wavelength;
  - b) said second source of light is directed by intrafollicular means to said hair.
4. The method of claim 3, wherein said second wavelength of light is 440-465 nanometers.
5. The method of claim 1, wherein the duration of the pulse of said laser light is chosen to optimize the heat conducted to the papilla of said hair.

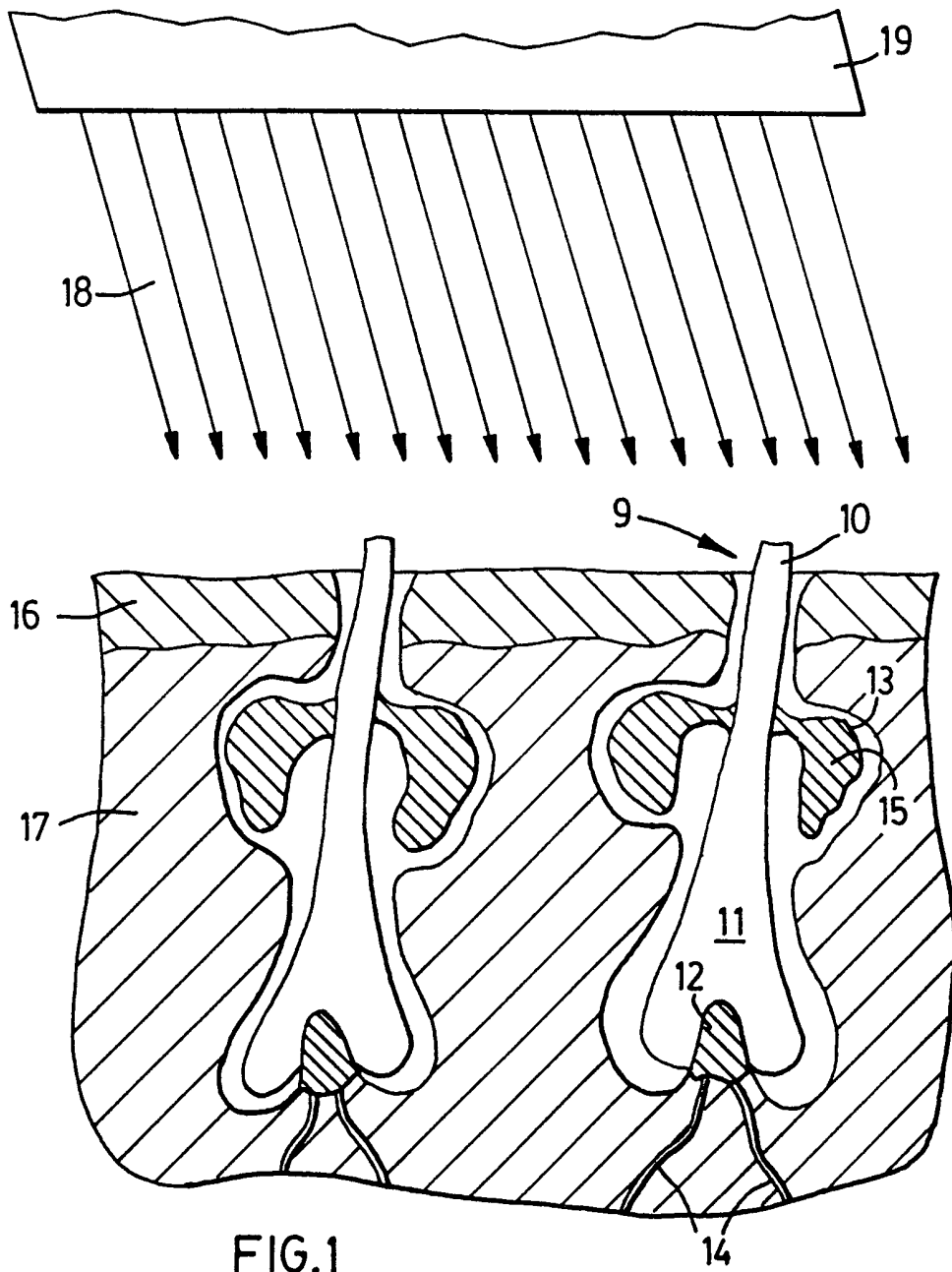


FIG.1

RELATIVE ABSORPTION SPECTRA FOR MAJOR SKIN CHROMOPHORES

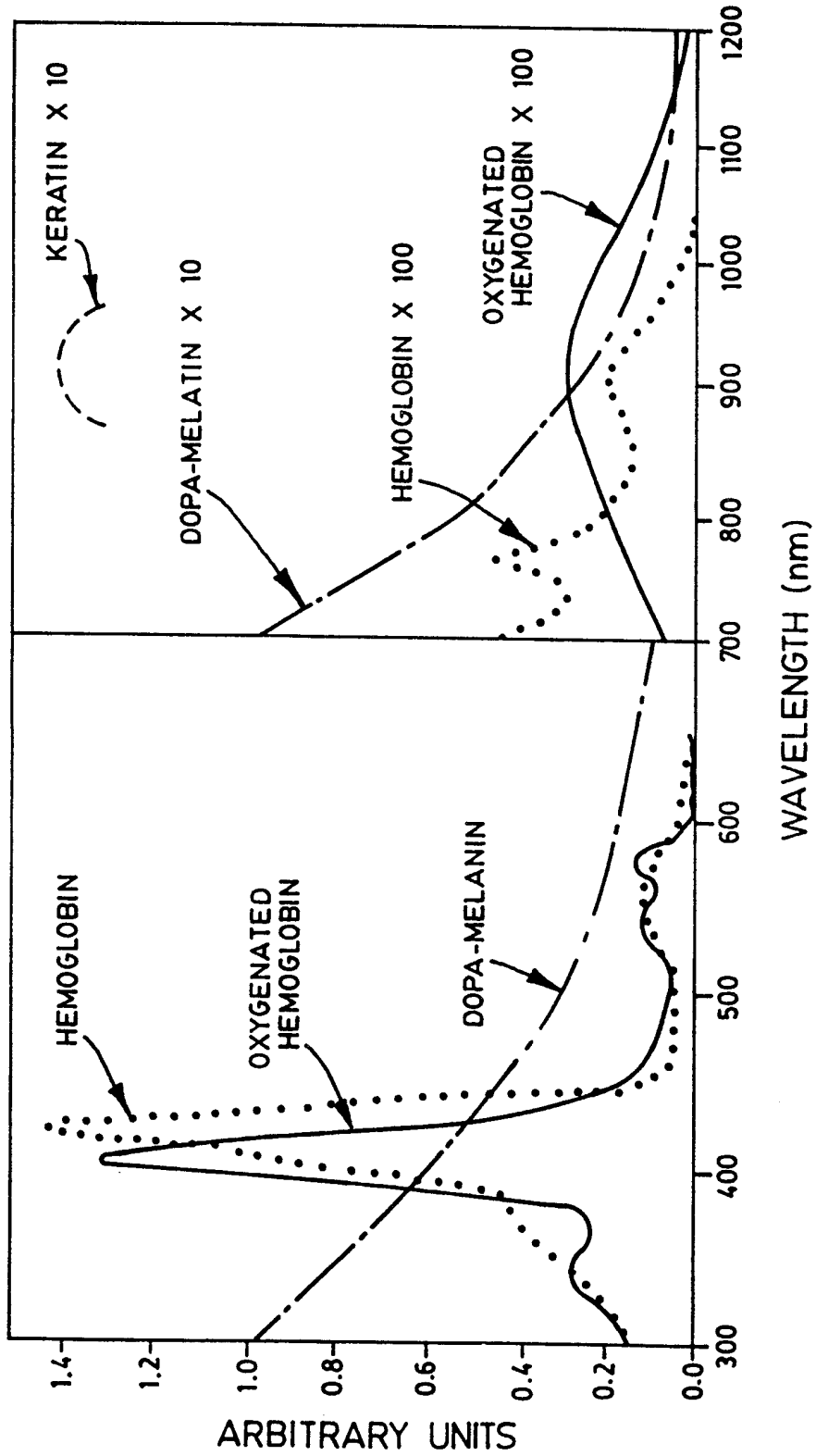
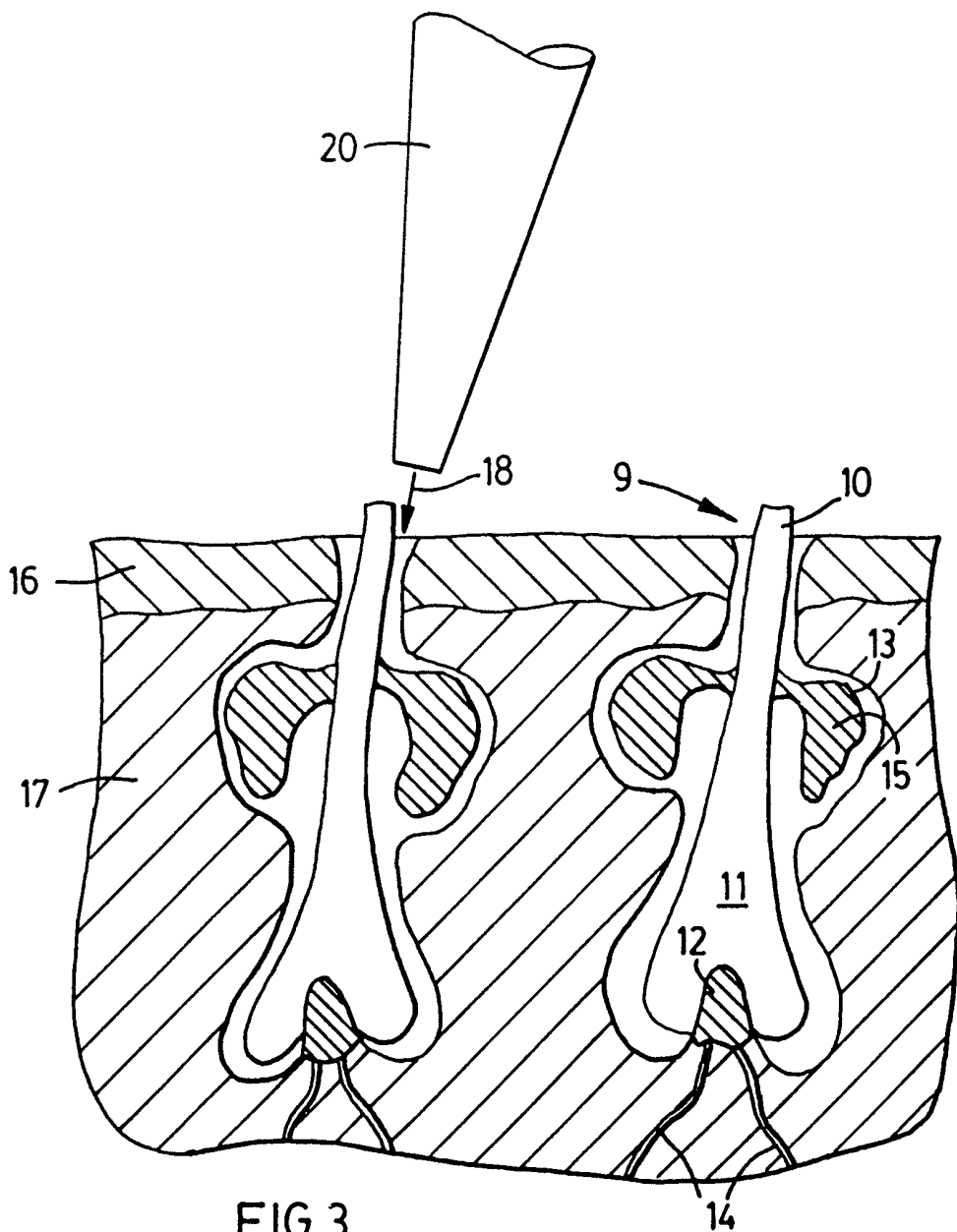


FIG. 2



**FIG. 3**

**SUBSTITUTE SHEET (RULE 26)**

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/CA 98/01005

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC 6 A61N5/06

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 A61B A61N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 630 811 A (MILLER IAIN D) 20 May 1997 see column 5, line 48 - column 6, line 12 ---	
A	WO 97 28752 A (CLEMENT ROBERT MARC ;GEORGE DAVID SIMON (GB); JONES GARY LEWIS (GB) 14 August 1997 see page 11, line 6 - line 22 see page 13, line 13 - line 30 see page 14, line 9 - line 12 ---	
A	US 5 735 844 A (FARINELLI WILLIAM ET AL) 7 April 1998 see column 8, line 33 - column 9, line 24 ---	
A	GB 2 308 307 A (LASER IND LTD) 25 June 1997 see page 5, line 6 - line 20 ---	
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Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
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Date of the actual completion of the international search

22 June 1999

Date of mailing of the international search report

29/06/1999

Name and mailing address of the ISA

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# INTERNATIONAL SEARCH REPORT

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 97 37602 A (FURUMOTO HORACE W ;CHO GEORGE (US); CYNOSURE INC (US); KOSCHMANN E) 16 October 1997 see page 3, line 15 - line 17 -----	

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/CA 98/ 01005

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.  Claims Nos.: 1-5  
because they relate to subject matter not required to be searched by this Authority, namely:  
Rule 39.1(iv) PCT - method for treatment of the human or animal body by surgery. The laser probe as described on pages 5-7 of the application has been searched.
2.  Claims Nos.:  
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
3.  Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1.  As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2.  As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3.  As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4.  No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

### Remark on Protest

- The additional search fees were accompanied by the applicant's protest.
- No protest accompanied the payment of additional search fees.

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/CA 98/01005

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