A laser beam ophthalmological surgery method for ablating a cornea (16) of a patient's eye includes the steps of generating a laser beam (12) and directing the generated laser beam onto a scanner (13) and scanning the laser beam (12) in a random scanning pattern with a generated random scanning pattern signal on the surface of the cornea (16) of a patient to ablate the surface of the cornea of a patient's eye. A computer (17) generates the random pattern laser beam control signal which controls the scanner (13) to scan in the random scanning pattern over the cornea (16) and includes selecting a database of non-random scanning points to scan the laser beam onto the cornea (16) of a patient's eye and then randomly selects the non-random scanning points for the random scanning of predetermined scanning points. A laser ophthalmological surgery apparatus (10) is provided which includes a laser (11) for generating a laser beam (12) along with a scanner (13) positioned for receiving the laser beam (12) and producing a predetermined scanning pattern onto the cornea (16) of an eye. A computer (17) is used to generate a random scanning pattern signal and is connected to the scanner (13) for controlling the scanner in a random overlapping scanning beam pattern over a predetermined area.
**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

<table>
<thead>
<tr>
<th>Code</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>AM</td>
<td>Armenia</td>
</tr>
<tr>
<td>AU</td>
<td>Australia</td>
</tr>
<tr>
<td>BB</td>
<td>Barbados</td>
</tr>
<tr>
<td>BE</td>
<td>Belgium</td>
</tr>
<tr>
<td>BF</td>
<td>Burkina Faso</td>
</tr>
<tr>
<td>BG</td>
<td>Bulgaria</td>
</tr>
<tr>
<td>BJ</td>
<td>Benin</td>
</tr>
<tr>
<td>BR</td>
<td>Brazil</td>
</tr>
<tr>
<td>BY</td>
<td>Belarus</td>
</tr>
<tr>
<td>CA</td>
<td>Canada</td>
</tr>
<tr>
<td>CF</td>
<td>Central African Republic</td>
</tr>
<tr>
<td>CG</td>
<td>Congo</td>
</tr>
<tr>
<td>CH</td>
<td>Switzerland</td>
</tr>
<tr>
<td>CI</td>
<td>Côte d’Ivoire</td>
</tr>
<tr>
<td>CM</td>
<td>Cameroon</td>
</tr>
<tr>
<td>CN</td>
<td>China</td>
</tr>
<tr>
<td>CS</td>
<td>Czechoslovakia</td>
</tr>
<tr>
<td>CZ</td>
<td>Czech Republic</td>
</tr>
<tr>
<td>DE</td>
<td>Germany</td>
</tr>
<tr>
<td>DK</td>
<td>Denmark</td>
</tr>
<tr>
<td>EE</td>
<td>Estonia</td>
</tr>
<tr>
<td>ES</td>
<td>Spain</td>
</tr>
<tr>
<td>FI</td>
<td>Finland</td>
</tr>
<tr>
<td>FR</td>
<td>France</td>
</tr>
<tr>
<td>GA</td>
<td>Gabon</td>
</tr>
<tr>
<td>GB</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>GE</td>
<td>Georgia</td>
</tr>
<tr>
<td>GN</td>
<td>Guinea</td>
</tr>
<tr>
<td>GR</td>
<td>Greece</td>
</tr>
<tr>
<td>HU</td>
<td>Hungary</td>
</tr>
<tr>
<td>IE</td>
<td>Ireland</td>
</tr>
<tr>
<td>IT</td>
<td>Italy</td>
</tr>
<tr>
<td>JP</td>
<td>Japan</td>
</tr>
<tr>
<td>KE</td>
<td>Kenya</td>
</tr>
<tr>
<td>KG</td>
<td>Kyrgyzstan</td>
</tr>
<tr>
<td>KP</td>
<td>Democratic People’s Republic of Korea</td>
</tr>
<tr>
<td>KR</td>
<td>Republic of Korea</td>
</tr>
<tr>
<td>KZ</td>
<td>Kazakhstan</td>
</tr>
<tr>
<td>LI</td>
<td>Liechtenstein</td>
</tr>
<tr>
<td>LR</td>
<td>Sri Lanka</td>
</tr>
<tr>
<td>LT</td>
<td>Lithuania</td>
</tr>
<tr>
<td>LU</td>
<td>Luxembourg</td>
</tr>
<tr>
<td>LV</td>
<td>Latvia</td>
</tr>
<tr>
<td>MC</td>
<td>Monaco</td>
</tr>
<tr>
<td>MD</td>
<td>Republic of Moldova</td>
</tr>
<tr>
<td>MG</td>
<td>Madagascar</td>
</tr>
<tr>
<td>ML</td>
<td>Mali</td>
</tr>
<tr>
<td>MN</td>
<td>Mongolia</td>
</tr>
<tr>
<td>MR</td>
<td>Mauritania</td>
</tr>
<tr>
<td>MW</td>
<td>Malawi</td>
</tr>
<tr>
<td>MX</td>
<td>Mexico</td>
</tr>
<tr>
<td>NE</td>
<td>Niger</td>
</tr>
<tr>
<td>NL</td>
<td>Netherlands</td>
</tr>
<tr>
<td>NO</td>
<td>Norway</td>
</tr>
<tr>
<td>NZ</td>
<td>New Zealand</td>
</tr>
<tr>
<td>PL</td>
<td>Poland</td>
</tr>
<tr>
<td>PT</td>
<td>Portugal</td>
</tr>
<tr>
<td>RO</td>
<td>Romania</td>
</tr>
<tr>
<td>RU</td>
<td>Russian Federation</td>
</tr>
<tr>
<td>SD</td>
<td>Sudan</td>
</tr>
<tr>
<td>SE</td>
<td>Sweden</td>
</tr>
<tr>
<td>SG</td>
<td>Singapore</td>
</tr>
<tr>
<td>SI</td>
<td>Slovenia</td>
</tr>
<tr>
<td>SK</td>
<td>Slovakia</td>
</tr>
<tr>
<td>SN</td>
<td>Senegal</td>
</tr>
<tr>
<td>SZ</td>
<td>Swaziland</td>
</tr>
<tr>
<td>TD</td>
<td>Chad</td>
</tr>
<tr>
<td>TG</td>
<td>Togo</td>
</tr>
<tr>
<td>TJ</td>
<td>Tajikistan</td>
</tr>
<tr>
<td>TT</td>
<td>Trinidad and Tobago</td>
</tr>
<tr>
<td>UA</td>
<td>Ukraine</td>
</tr>
<tr>
<td>UG</td>
<td>Uganda</td>
</tr>
<tr>
<td>US</td>
<td>United States of America</td>
</tr>
<tr>
<td>UZ</td>
<td>Uzbekistan</td>
</tr>
<tr>
<td>VN</td>
<td>Viet Nam</td>
</tr>
</tbody>
</table>
BACKGROUND OF THE INVENTION

This invention relates to refractive eye surgery and especially to refractive eye surgery using a random scanning of one or more laser beams in the ablation of cornea tissue to reshape the cornea of an eye. This application is a continuation-in-part of our prior U.S. patent application Serial No. 08/352,357, for LASER BEAM OPHTHALMOLOGICAL SURGERY METHOD AND APPARATUS, filed December 9, 1994.

The cornea is a thin shell with nearly concentric anterior and posterior surfaces and a central thickness of about 520 micrometers. It has an index of refraction of 1.377 and a nominal radius of curvature of 7.86 mm. The epithelium, forming the anterior surface of the cornea, is about 70 micrometers thick in young people at the center. Underlying the epithelium is a layer called Bowman's layer or Bowman's membrane, which is about 12 micrometers thick. This covers the anterior surface of the stroma, which makes up the bulk of the cornea and consists primarily of collagen fibers. The endothelium forms the posterior layer of the cornea and is a single layer of cells.

About three-quarters of the refractive power of the eye is determined by the curvature of the anterior surface of the cornea, so that changing the shape of the cornea offers a way to significantly reduce or eliminate a refractive error of the eye. The stroma is thick enough so that portions of its anterior region can be ablated away to change its profile and
thus change the refractive power of the eye for
corrective purposes, while leaving plenty of remaining
stroma tissue.

Various lasers have been used for ophthalmic
applications including the treatments of glaucoma,
cataract and refractive surgery. For refractive
surgeries (or corneal reshaping), ultraviolet (UV)
lasers, such as excimer lasers at 193 nm and fifth-
harmonic Nd:YAG at 213 nm have been used for large
area surface corneal ablation in a process called
photorefractive keratectomy (PRK). Corneal reshaping
may also be performed by laser thermal coagulation
currently conducted with Ho:YAG lasers using a fiber-
coupled, contact and non-contact type processes.

Refractive surgery has reached a new dimension
due to the development of the excimer laser (193nm)
and fifth harmonic solid state laser (190nm-215nm)
being used to photoablate the cornea tissue to reshape
the cornea. Several approaches have been proposed to
deliver the laser beams to the surface of the cornea
including using a mask or diaphragm and move the mask
or diaphragm to block the laser beam to achieve a
desired curvature on the outer surface of the cornea.
It has also been proposed to use a scanner to move a
laser beam spot on the outer surface of the cornea to
ablate the tissue to change the curvature on the
cornea. Combining the mask or diaphragm and scanner
to block and move a laser beam is also used to achieve
a desired curvature on the outer surface of the
cornea. The mask or diaphragm approach requires a
high energy laser and a rough or stepped cornea
surface is generated in the laser interacting with the
cornea. When the laser interacts with the corneal
tissue, it generates some water that remains on the
surface of the cornea (like sweat water). This changes the ablation rate when a new laser pulse reaches the cornea. If this is not taken into consideration, an irregular pattern can be induced called an "island". Central corneal islands have been described in connection with prior laser beam delivery systems.

The scanning or combination of mask and scanner approach produces a smoother cornea surface but nonsymmetrical beam profiles and the sweat water effect creates an island effect which is caused by a nonsymmetrical ablation on each side or point of the corneal surface.

The present invention may use one, two or more laser beams with the plural beams being formed by splitting one laser beam and uses a random scanning pattern of the beams to scan the lasers over the cornea. The spatial energy distribution mode is scanned on the cornea or in the cornea simultaneously by using one or more scanning devices controlled by a predetermined program in a computer controller. The computer generates a random scanning pattern from a database of non-random scanning points preselected for the area to be allotted. Because the laser beam is located and moved on the cornea, the cornea will compensate for the uneven situation of the sweat water effect when the laser interacts with the cornea tissue and non-symmetrical laser beam spatial energy distribution.

Refractive error can be divided in two categories, spherical and cylindrical. Spherical error can effect the eye vision as myopic or hyperopic. Cylindrical error can effect the eye vision as myopic or hyperopic astigmatism. The
present invention also uses a computer program to avoid ablation of the central part of the cornea in hyperopic astigmatism which results in a safer, more predictable, and faster surgery procedure. In the case of hyperopic combined with astigmatism of a cornea, the center is not ablated.

SUMMARY OF THE INVENTION

A laser beam ophthalmological surgery method for ablating a cornea of a patient's eye includes the steps of generating a laser beam and directing the generated laser beam onto a scanner and scanning the laser beam in a random scanning pattern with a generated random scanning pattern signal on the surface of the cornea of a patient to ablate the surface of the cornea of a patient's eye. A computer generates the random pattern laser beam control signals which controls the scanner to scan in the random scanning pattern over the cornea and includes selecting a database of non-random scanning points to scan the laser beam onto the cornea of a patient's eye and then randomly selects the non-random scanning points for the random scanning of predetermined scanning points. A laser ophthalmological surgery apparatus is provided which includes a laser for generating a laser beam along with a scanner positioned for receiving the laser beam and producing a predetermined scanning pattern onto the cornea of an eye. A computer is used to generate a random scanning pattern signal and is connected to the scanner for controlling the scanner in a random overlapping scanning beam pattern over a predetermined area. Directing optics direct the random pattern scanning
beam onto the cornea of the patient's eye for ablating
a portion of the cornea of the eye.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects, features, and advantages of the
present invention will be apparent from the written
description and the drawings in which:

Figure 1 is a block diagram of a random laser
beam cornea ablation system;

Figure 2 is a schematic diagram of the optics for
a random pattern laser beam cornea ablation system;

Figure 3 is a diagrammatic scan pattern of
predetermined scan points to be scanned on the cornea;
and

Figure 4 is a diagrammatic scan pattern of Figure
3 with randomly picked scan spots from the
predetermined stored array of a database.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings and especially to
Figure 1, a block diagram of a random pattern laser
beam cornea ablation system 10 is shown having a laser
11 which can be an excimer laser producing a laser
beam 12 having an ultraviolet wavelength of 193 nm.
The laser beam 12 is impinged upon a scanner 13, which
may be a galvanometer scanner, which is a typical
scanner using a galvanometer having a mirror attached
thereeto to which the galvanometer produces a motion to
thereby move the mirror having the beam 12 impinged
thereupon to scan the beam. The scanning beam 14 is
directed against the mirror 15 or other optics to
apply the beam to a patient's cornea 16. A computer
17 produces control signals to the X,Y driver 18 which
2 is connected to the scanner 13 for directing the
3 scanner to produce the beam 14 and 20 onto the surface
4 of the cornea 16 at predetermined locations. A sync
5 control 21 is also connected between the computer 17
6 and the laser 11 to synchronize the scanner 13 and X,Y
7 drivers 18 with the laser beam 11.

The computer 17 includes a database or other
8 storage of all of the locations on the surface of the
9 cornea that may be ablated in the reshaping of the
10 cornea, as illustrated in Figure 3. The points have
11 all been calculated for directing the X,Y drivers to
12 drive the scanner to produce a pattern covering only
13 the predetermined spots, as in Figure 3 which, if
14 uniformly applied, will produce a constant thickness
15 of each ablation layer. All of these points are
16 stored in the computer as an array in a database. The
17 computer, however, has a random generator for
18 generating the signals for the X,Y driver 18. The
19 random generator generates continuously repeating
20 signals indicative of the spots in Figure 3 but
21 randomly selects from the complete set of spots in
22 Figure 3 to randomly apply consecutive laser beams
23 picked from the predetermined stored array database,
24 as shown in a typical pattern in Figure 4. The
25 randomly delivered laser beams to the cornea 16 can be
26 applied for a signal beam or multiple laser beam
27 delivery system. The use of a randomly selective
28 pattern of an application of the laser beam to the
29 cornea in overlapping patterns is for the purpose of
30 avoiding swelter water affect which causes the central
31 or lateral island problem found in a typical diaphragm
32 or linear scanning laser beam delivery system used for
33 ablation of the cornea of the eye.
Referring to Figure 2, the laser scanning system has the computer 17 connected to the laser 11 and also has an output connected to the X,Y driver 18. The laser 11 produces a laser beam 12 onto a shutter 23 which directs the laser beam through a focusing lens 24 and onto the X scanner 25 and which simultaneously directs the laser beam 26 having the X coordinate onto the Y scanner 27. The X,Y driver 18 has a control signal 28 directed to the Y scanner and a control signal 30 directed to the X scanner for controlling the X and Y axis of the scanned beam so that the beam 31 has the X and Y coordinates applied thereto and are applied through optics 15 onto the cornea 16 of an eye.

As shown in Figure 2, a plurality of beams 20 are producing a random pattern in different portions of the eye, which pattern can be an overlapping pattern in accordance with the random pattern generator of the computer 17. The random pattern generator can include a database, as shown in Figure 3, of all the points that the scanning laser beam is to be applied to the cornea of the eye, which points have been calculated and arranged over the surface of an area to cover the cornea surface with a smooth and controlled beam for a constant thickness ablation layer. All of these locations are stored in the computer as an array in a database and, if run consecutively, would produce a laser beam having laser impingement on the cornea in a uniform overlapping manner over the predetermined surface of the cornea. When the scanning device, however, delivers the beam to the cornea, in accordance with the computer 17, the location of consecutive laser beams are randomly picked from the database of Figure 3 from predetermined stored array
data and randomly deliver the laser beams to the
cornea, as shown in Figure 3, with successive pulses
spaced within the pattern of calculated predetermined
laser spots. The randomly delivered laser beams can
be applied for a single laser beam or multiple laser
beam delivery systems to ablate the cornea of an eye
in a random fashion to avoid swelter water affect and
to avoid the central or lateral island problem
connected with diagram or linear scanning laser beam
delivery systems.

The laser beam ophthalmological surgery method
for ablating the cornea of a patient's eye includes
generating a laser beam in the laser 11 of Figures 1
and 2, directing the generated laser beam onto the
scanner 13, which includes X and Y scanners 25 and 27,
while simultaneously generating a random pattern laser
beam control signal in the central processing unit 17
for controlling the scanner 13 through the X,Y driver
18 to control the laser beam 14 and 20 being applied
to the cornea 16. The laser beam 12 is being scanned
by the scanner in a random scanning pattern with the
generated random scanning signal applied laser beam 20
onto the surface of the cornea of a patient to ablate
the surface of the cornea of a patient's eye. The
method includes selecting a database of non-random
scanning points, such as shown in Figure 3, to scan
the laser beam onto the cornea of a patient's eye and
then to randomly select the non-random scanning points
to randomly scan the laser beam over the cornea of the
patient's eye. Figure 4 illustrates the selection of
random scanning points by the numbers 1-9 selected of
the possible scanning points in the database.

The method also includes the step of generating
a laser beam which may be split into a plurality of
laser beams and scanning each of the plurality of
laser beams in a randomly generated pattern onto the
surface of the cornea. A plurality of laser beams can
be simultaneously impinged on the cornea of the eye in
a random fashion, which random fashion can still
produce a uniform ablation of the eye. Either single
or plural beams can be impinged upon the cornea in
parallel spots around the center axis of the cornea,
which parallel spots are randomly applied groups of
plural spots without departing from the spirit and
scope of the invention.

The laser 11 may have an ultraviolet wavelength
output between 193 nm and 215 nm by using an excimer
laser with the 193 nm output or a solid state laser
using one of the harmonics generated with non-linear
crystals. Selected scanning spots may be
simultaneously selected by plural beams to ablate an
area in an annular circle around the cornea or in any
other portion of the cornea desired by the selection
of the location of the scanning laser beam spots, as
indicated in Figure 3. It will also be clear that
when the database of numbers randomly selected from
Figure 3 is stored in a database, that same random
pattern can be applied to the cornea at a laser time
in the same predetermined manner by control of the
computer 17 driving the X,Y driver 18 and scanners 13.
The patterns are also selected in accordance with the
desired surgery procedure for myopia, hyperopia, or
astigmatism corrections, which determines the scanning
pattern to be covered on the cornea of the eye, which
information may be previously stored in accordance
with Figure 3 for each type of operation so that the
computer can issue the necessary signals. The
computer may also have an input for the amount of
dioptic correction for a particular patient's eye
which then puts out signals based on an algorithm for
either myopic, hyperopic, or astigmatism correction
and for the dioptics of correction necessary for a
particular patient's eye. The computer then produces
a scan to ablate the cornea with one or more pair of
laser beams in accordance with the random pattern
generator from the non-random points of Figure 3 for
the desired correction.

It should be clear at this time that the present
invention is directed to both a method and an
apparatus for use in ophthalmological surgery on the
outer surface of the cornea or in the cornea to reduce
astigmatism or myopic or hyperopic correction or
combinations of myopic and astigmatisms or
combinations of hyperopic and astigmatism corrections
by using one or more laser beams simultaneously
applied in a random fashion of predetermined selected
points on the surface of the cornea. The beams are
scanned using computer control laser scanners to
perform refractive surgery on the patient's eye. The
ablation with a laser beam, in accordance with the
present scanning, produces a refractive correction in
the eye, symmetrically ablating the central part of
the cornea tissue when correcting hyperopic
astigmatism and resulting in a safer and more
predictable surgical procedure to correct hyperopic
astigmatism. However, the present invention should
not be construed as limited to the forms shown which
are to be considered illustrative rather than
restrictive.
CLAIMS:

I claim:
1. A laser beam ophthalmological surgery method for ablating the cornea of a patient’s eye comprising the steps of:
   generating a laser beam (12);
   directing said generated laser beam (12) onto a scanner (13);
   generating a random pattern laser beam control signal in a central processing unit (17);
   controlling said scanner (13) and the laser beam (12) being applied thereto with said central processing unit (17) generated random scanning pattern for scanning said generated laser beam (12) in a random overlapping pattern; and
   scanning said laser beam (12) in a random scanning pattern with said generated random scanning pattern signal onto the surface of the cornea (16) of a patient to ablate the surface of the cornea of a patient’s eye whereby surgical ablation is performed on the cornea tissue of the eye with a randomly overlapping laser beam.

2. A laser beam ophthalmological surgery method for ablating the cornea of a patient’s eye in accordance with claim 1 including the step of selecting a database of non-random scanning points to scan said laser beam (12) onto the cornea (16) of a patient’s eye and randomly selecting said non-random scanning points to randomly scan laser beam over the cornea of a patient’s eye.
3. A laser beam ophthalmological surgery method for ablating the cornea of a patient’s eye in accordance with claim 1 in which the step of generating a laser beam (12) includes generating a plurality of laser beams (20) and scanning each of plurality of laser beams in a randomly generated pattern onto the surface of the cornea (16) of a patient’s eye.

4. A laser beam ophthalmological surgery method for ablating the cornea of a patient’s eye in accordance with claim 3 in which the step of generating a plurality of laser beams (12) includes splitting the generated laser beam (12) into multiple laser beams (20) and impinging each of said multiple laser beams (20) onto the cornea (16) of a patient’s eye.

5. A laser beam ophthalmological surgery method for ablating the cornea of a patient’s eye in accordance with claim 4 in which each of said plurality of scanning laser beams (20) is scanning in a random pattern in an area on the cornea spaced from each of the other laser beams.

6. A laser beam ophthalmological surgery method for ablating the cornea of a patient’s eye in accordance with claim 5 in which the step of scanning a plurality of laser beams (20) includes scanning a plurality of laser beams (20) with the central processing unit (17) controlled scanner whereby each of said laser beams is scanned with the same random pattern onto the surface of the cornea (16) of a patient’s eye.
7. A laser beam ophthalmological surgery method for ablating the cornea of a patient's eye in accordance with claim 6 in which the step of generating a laser beam (12) includes generating a laser beam (12) having an ultra-violet wavelength between 193nm and 215nm or infrared wavelength between 1000 nm and 3100 nm.

8. A laser beam ophthalmological surgery method for ablating the cornea of a patient's eye in accordance with claim 7 in which the step of generating a laser beam (12) includes generating a laser beam from an eximer laser (11) having a wavelength of about 193nm.

9. A laser beam ophthalmological surgery method for ablating the cornea of a patient's eye in accordance with claim 8 in which the step of scanning each said laser beam (12) includes scanning each laser beam with a galvanometer scanner (13).

10. A laser beam ophthalmological surgery method for ablating the cornea of a patient's eye in accordance with claim 1 in which said scanner (13) scans each of said laser beams (12) parallel to each other in the same random scanning pattern and in a circular beam pattern around the central portion of the cornea (16).
11. A laser beam ophthalmological surgery method for ablating the cornea of a patient's eye in accordance with claim 10 in which said scanner (13) scans each said laser beam with generally parallel scanning beam spots in a random scanning pattern of generally parallel spots around the central portion of the cornea (16).
12. A laser ophthalmological surgery apparatus comprising:
   a laser (11) for generating a laser beam (12);
   a scanner (13) positioned for receiving said laser beam (12) from said laser (11) and producing a predetermined scanning pattern from the laser beam (12) impinging thereupon;
   a computer (17) for generating a random scanning pattern signal therein, said computer (17) being connected to said scanner (13) for controlling said scanner (13) to produce a random overlapping scanning beam pattern from said laser beam (12) over a predetermined area; and
   directing optics (15) for directing said random pattern scanning beam onto the cornea (16) of a patient’s eye for ablating a portion of the cornea (16) of the eye whereby a laser beam (12) can perform a surgical procedure on a patient’s eye.

13. A laser beam ophthalmological surgery apparatus (10) in accordance with claim 12 including a beam splitter for producing a plurality of laser beams from said laser beam.

14. A laser beam ophthalmological surgery apparatus (10) in accordance with claim 13 in which said beam splitter splits the generated laser beam (12) into a plurality of laser beams and each laser beam is impinged onto the same beam scanner (13).
15. A laser beam ophthalmological surgery apparatus (10) in accordance with claim 14 in which said computer (17) includes a database of non-random scanning points on the cornea (16) surface of a patient's eye and randomly or symmetrically selecting said scanning points to control said scanner to scan said laser beam (12) in random pattern.

16. A laser beam ophthalmological surgery apparatus (10) in accordance with claim 15 in which said laser (11) generates a laser beam (12) having an ultra-violet wavelength between 193nm and 215nm or infrared wavelength between 1000 nm and 3000 nm.

17. A laser beam ophthalmological surgery apparatus (10) in accordance with claim 16 in which said laser (11) is an eximer laser having a wavelength of 193nm or solid state laser having a wavelength 208-215 nm.

18. A laser beam ophthalmological surgery apparatus (10) in accordance with claim 17 in which each said scanner is a galvanometer scanner (13) having a mirror mounted to a galvanometer.
### INTERNATIONAL SEARCH REPORT

**A. CLASSIFICATION OF SUBJECT MATTER**
- IPC(6) : A61B 17/36; A61N 5/06
- US CL. : 606/4
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)
  - U.S. : 128/898; 606/4-6, 10-12

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

Electronic database consulted during the international search (name of database and, where practicable, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>US 5,411,502 A (ZAIR) 02 May 1995, entire document.</td>
<td>1, 2</td>
</tr>
<tr>
<td>&amp;</td>
<td>US 5,480,396 A (SIMON et al) 02 January 1996, entire document.</td>
<td>1-18</td>
</tr>
</tbody>
</table>

- Further documents are listed in the continuation of Box C.
- See patent family annex.

* Special categories of cited documents:
  - "T" later document published after the international filing date or priority date and not in conflict with the application but not considered to be of particular relevance.
  - "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone.
  - "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
  - "G" document member of the same patent family.

Date of the actual completion of the international search: 21 DECEMBER 1996

Date of mailing of the international search report: 11 FEB 1997

Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231
Facsimile No. (703) 305-3590
Form PCT/ISA/210 (second sheet)(July 1992)