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(54) Title: LAPAROSCOPIC DEVICE

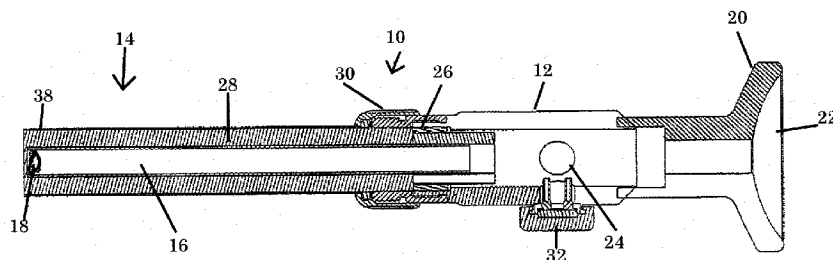


Fig. 1B

(57) Abstract: The invention is a laparoscopic device comprising an internal light source located at the distal end of the handle section, a central core comprising an optical system, and a light guide in the form of a cylindrical tube that is slipped over the central core. The light guide is adapted to cause the light emitted by the internal light source to propagate through it by internal reflection until light exits the light guide at the distal end of the laparoscope.

LAPAROSCOPIC DEVICE

5 Field of the Invention

The invention is in the field of medical instrumentation. Specifically the invention is from the field of laparoscopic devices.

Background of the Invention

10 Endoscopes and laparoscopes are devices used in medical applications for observation, diagnosis, and treatment, e.g. biopsy or cauterization inside a human or animal body and in industrial applications for inspection in hard to reach locations, e.g. to inspect the turbine blades in jet engines. They comprise an objective lens system, normally at the distal end and means for
15 carrying the images gathered to the proximal end of the device where they can be directly viewed or displayed allowing the operator to observe the space in front of the objective lens. The objective lens can be part of a camera, an optical relay system, or can focus the image onto a fiber optic cable that transfers the image to the viewer.

20

In conventional laparoscopic devices the light necessary to illuminate the region in front of the objective lens is transmitted from the proximal to the distal end of the insertion tube by optical fibers. It is not uncommon for the fragile optical fibers to break rendering the instrument unusable unless
25 costly repairs are undertaken.

Another problem associated with conventional laparoscopic devices is the expense and "down time" involved in sterilization procedures that must be carried out between procedures. An associated problem is "wear and tear",
30 especially on the optical and electronic components, that is caused by the

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high temperatures of autoclaving or harsh chemicals and shortens the useful lifetime of the device.

It is a purpose of the present invention to provide laparoscopic devices that
5 overcome these drawbacks of the conventional devices.

Further purposes and advantages of this invention will appear as the description proceeds.

10 Summary of the Invention

The invention is a laparoscope comprising a handle section, a central core comprising an optical system having an objective lens at the distal end of the central core, and an internal light source.

15 The laparoscope of the invention is characterized in that the internal light source is located at the distal end of the handle section and the laparoscope comprises a light guide in the form of a cylindrical tube that is slipped over the central core. The light guide is adapted to cause the light emitted by the internal light source to propagate through it by internal reflection until
20 light exits the light guide at the distal end of the laparoscope. The light guide can be made from either glass or plastic.

In embodiments of the laparoscope of the invention the proximal end of the light guide is shaped like a lens to focus the light propagated through it at a
25 predetermined distance in front of the objective lens or to control the size of the volume illuminated by the light or to control the angular position of the center of the illuminated volume relative to the longitudinal symmetry axis of the central core of the laparoscope.

30 Embodiments of the laparoscope comprise a metal or elastomer outer protector tube that is slipped over the light guide.

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Embodiments of the laparoscope of the invention comprise a collar which is adapted to fit over the light guide and to be attached to the distal end of the handle section in order to keep the light guide firmly attached to the handle
5 section.

Embodiments of the laparoscope of the invention comprise a transparent window that is sealed at the distal end of either the light guide or the protector tube.
10

In embodiments of the laparoscope of the invention the internal light source is either LEDs or optical fibers. In embodiments of the laparoscope of the invention the internal light source is a ring-shaped optical fiber.

15 In embodiments of the laparoscope of the invention at least one of the following components are disposable: the light guide, the protector tube, and the collar.

Embodiments of the laparoscope of the invention may comprise a centrifugal lens protector unit. The centrifugal lens protector unit may be disposable.
20

Embodiments of the laparoscope of the invention may comprise one or more working channels.

25 All the above and other characteristics and advantages of the invention will be further understood through the following illustrative and non-limitative description of embodiments thereof, with reference to the appended drawings.

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Brief Description of the Drawings

- Fig. 1A is an isometric view schematically showing features of a first embodiment of the laparoscope of the invention;
- Fig. 1B is a schematic cross-sectional view of the embodiment of the invention shown in Fig. 1A;
- Fig. 2A is an isometric view schematically showing a second embodiment of the laparoscope of the invention;
- Fig. 2B is a schematic cross-sectional view of the embodiment of the invention shown in Fig. 2A; and
- Fig. 3 is a cross-sectional view of a prior art centrifugal lens protector comprised of a motor assembly and rotating disc.

Detailed Description of Embodiments of the Invention

A first embodiment of the laparoscopic device **10** of the invention is shown schematically in isometric view in Fig. 1A and in a cross-sectional view in Fig. 1B. Laparoscope **10** is comprised of a handle section **12** and an insertion section **14** comprising a long central core **16**. Central core **16** comprises an optical system having an objective lens **18** at the distal end of central core **12**. The exact nature of the optical system, which can be any type of system known in the art, e.g. a video camera or an optical fiber bundle or optical relay system to transfer light gathered by objective lens **18** to ocular lens **22** in eyepiece **20** or a proximal image forming system and a connection to a display device (not shown in the figures), is not relevant to the present invention and therefore not discussed in detail herein.

25

In laparoscope **10**, the internal light source **26** is not located at the distal end of insertion section **14** but at the distal end of the handle section **12**. The internal light source **26** can either be, for example, LEDs that receive their electrical power through connector **32** on handle section **12** or optical fibers that carry light from an external source via connector **24**. In the

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embodiment shown in the figures, the internal light source **26** is a ring-shaped optical fiber.

In order to convey the light emitted by internal light source **26** to the distal
5 end of the laparoscope, where it can illuminate the region in front of
objective lens **18**, a transparent light guide **28** is slipped over central core
16. Light guide **28** is a cylindrical tube made of glass or plastic. The
proximal end of the light guide is optically coupled to the internal light
source **26**. The material of which light guide **28** is made is selected such that
10 it has an index of refraction that causes light to propagate through the guide
by internal reflection until it exits the light guide at the circumference of the
objective lens.

In embodiments of the invention, the proximal end of light guide **28** can be
15 shaped like a lens to focus the light that has propagated through it at a
predetermined distance in front of objective lens **18** or to control the size of
the illuminated volume or the angular position of the center of the
illuminated volume relative to the longitudinal symmetry axis of the central
core **16** of laparoscope **10**.

20 A metal or elastomer outer protector tube **38** can be slipped over the light
guide to prevent leakage of light through the sides of the light guide and
also to lend rigidity to the insertion section **14**, if desired. A collar **30** fits
over the light guide **28** and is screwed onto threads at the distal end of the
25 handle section **12** in order to keep the light guide firmly attached to the
handle section.

The collar **30** is fitted with seals, e.g. o-rings or other means known in the
art, to prevent passage of air or liquids. A transparent window can be sealed
30 at the distal end of either the light guide **28** or protector tube **38** to protect
the objective lens **18**. The combination of seals at collar **30** and a window at

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the distal end hermetically isolates the hollow inside of light guide 28, which is occupied by central core 16, and the handle section 12, which comprises the internal light source 26, from the exterior of the light guide.

5 After a procedure has been performed with laparoscope 10, collar 30 is loosened, and light guide 28 is separated from the handle portion 12. Collar 30, light guide 28, and protector tube 38, which are the only components of laparoscope 10 that have been in contact with bodily fluids or other contaminants can be discarded.

10

To ready endoscope 10 for another procedure it is only necessary to wipe down central core 16 and handle section 12 with a cloth that has been wet with a disinfection solution and to attach a new sterile light guide 28 and protector tube 38 by means of a new collar 30.

15

In embodiments of the invention at least one of light guide 28, protector tube 38, and collar 30 can be reused after being sterilized.

20

A problem commonly encountered when using a laparoscope is that the lens or window protecting the lens becomes at least partially occluded by body fluids and particles. In many cases the occlusion becomes so great that the laparoscope becomes inoperative. In such circumstance the lens must be cleaned. One method of cleaning the lens that has been developed is to spray the outer surface of the lens with a jet of water, air or other gas. The water or gas is supplied to one or more nozzles on the distal end of the laparoscope adjacent to the lens through channels that are an integral part of the instrument. In some instances the laparoscope must be withdrawn from the body for cleaning and reinserted, which is a time-consuming and risk-increasing procedure.

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Another solution to this problem is a centrifugal lens protector. A centrifugal lens protector comprises a spinning glass disc that is placed in front of the lens, so that the debris is intercepted by the disc. The centrifugal force generated by the disc as it rotates throws the debris
5 towards the circumference of the disc, where it falls off or sometimes accumulates but in any case no longer interferes with the image.

Fig. 3 is a cross-sectional view of a prior art centrifugal lens protector unit **100** that is described in US 7,104,657 to the inventor of the present
10 invention. The centrifugal lens protector is comprised of motor assembly **34** and rotating disc **36**.

Disc **36** is provided with a plurality of axially aligned magnets **110**. One end of each magnet is affixed to disc **36**, for example using an adhesive or using
15 a tension ring surrounding the magnets. Optionally, the magnets are mounted directly on disc **36**, for example, being held in depressions formed in disc **102**. Magnets **110** extend axially from disc **102** into the interior volume of housing **140**. Disc **36** is optionally held in place by a plurality of ball or cylinder bearings **150**, which enable rotation. In some embodiments
20 the diameter of a bearing **150** is 0.2 millimeter. Alternatively or additionally, a slip-ring bearing is used. At the base of motor assembly **34**, a second bearing **160** is optionally provided, for example, a slip-ring bearing.

In an exemplary embodiment, magnets **110** are interconnected by a pair of
25 optional sliding rings **112** and **114** which serve, as tension rings, to prevent the centrifugal force of rotation from detaching the magnets from disc **36** or causing undue distortion. Sliding rings **112** and **114** slide in contact with bearings **160** and **150**. In some embodiments, the life time of the lens protector unit **100** is relatively short, so wear of the bearings is not crucial.
30 Such slip rings may be mounted on the moving part (e.g. the disc) or on the static part (e.g., housing **140**).

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A plurality of coils **130** are provided within the body of housing **140**, at or close to the inner surface of housing **140**. In some embodiments, coils **130** are fabricated by a process of depositing electroconductive material, e.g. copper or silver or platinum or an electroconductive plastic in a specially formed cavity in housing **140**. Many different lithographic methods may be used for fabricating coils **130**. Alternatively, the coils are deposited on a rigid or flexible substrate and the substrate is inserted into housing **140**. Alternatively or additionally, coils **130** are wound on cores, optionally ferromagnetic cores. Coils **130**, on their cores, are inserted into a receptive depression in housing **140**.

Additional description of different embodiments of the motor assembly of the lens protector **100**, including typical dimensions speeds of rotation, arrangements of the coils, etc. are given in US 7,104,657.

A second embodiment of the laparoscopic device **10'** of the invention is shown schematically in isometric view in Fig. 2A and in a cross-sectional view in Fig. 2B. This embodiment is identical in all respects to the first embodiment with the exception of a recess that is created at the distal end of laparoscope **10'**. The hollow center of a motor assembly **34** of a centrifugal lens protector unit is slipped over the distal end of central core **16** such that the motor assembly **31** is inserted between and coaxial with the light guide **28** and central core **16** with the rotating disc **36** located proximally to objective lens **18**. Connectors **32** for the electricity supply to motor assembly **34** are located on the side of the handle section **20**.

In embodiments of the laparoscopes of the invention the centrifugal lens protector unit is used for only one procedure and then discarded with the other disposable components of the laparoscope.

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Embodiments of the laparoscope of the invention, either with or without the centrifugal lens protector unit can be supplied with one or more working channels.

- 5 Although embodiments of the invention have been described by way of illustration, it will be understood that the invention may be carried out with many variations, modifications, and adaptations, without exceeding the scope of the claims.

Claims

1. A laparoscope comprising
 - a. a handle section;
 - b. a central core comprising an optical system having an objective lens
5 at the distal end of said central core; and
 - c. an internal light source;characterized in that said internal light source is located at the distal end of said handle section and said laparoscope comprises a light guide in the form of a cylindrical tube that is slipped over said central core;
10 said light guide adapted to cause the light emitted by said internal light source to propagate through said light guide by internal reflection until it exits the light guide at the distal end of said laparoscope.
2. The laparoscope of claim 1 wherein the light guide is made from glass or
15 plastic.
3. The laparoscope of claim 1 wherein the proximal end of the light guide is shaped like a lens to focus the light propagated through it at a predetermined distance in front of the objective lens or to control the size
20 of the volume illuminated by said light or to control the angular position of the center of the illuminated volume relative to the longitudinal symmetry axis of the central core of said laparoscope.
4. The laparoscope of claim 1 comprising a metal or elastomer outer
25 protector tube that is slipped over the light guide.
5. The laparoscope of claim 1 comprising a collar which is adapted to fit over the light guide and to be attached to the distal end of the handle section in order to keep said light guide firmly attached to said handle
30 section.

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6. The laparoscope of claim 1 comprising a transparent window that is sealed at the distal end of either the light guide or the protector tube.
7. The laparoscope of claim 1 wherein the internal light source is either
5 LEDs or optical fibers.
8. The laparoscope of claim 3 wherein the internal light source is a ring-shaped optical fiber.
- 10 9. The laparoscope of claim 1 wherein the light guide is disposable.
10. The laparoscope of claim 4 wherein the protector tube is disposable.
11. The laparoscope of claim 5 wherein the collar is disposable.
15
12. The laparoscope of claim 1 comprising a centrifugal lens protector unit.
13. The laparoscope of claim 12 wherein the centrifugal lens protector unit is disposable.
20
14. The laparoscope of claim 1 comprising one or more working channels.

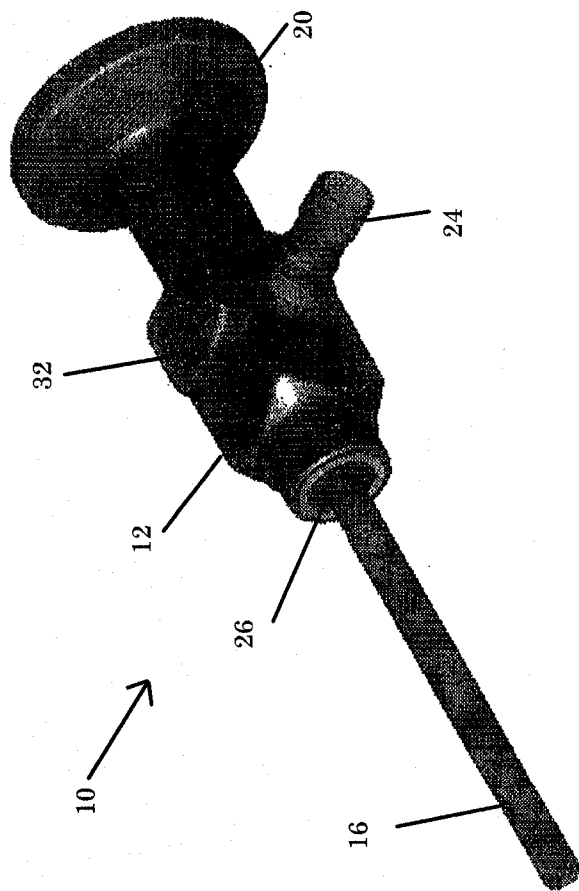


Fig. 1A

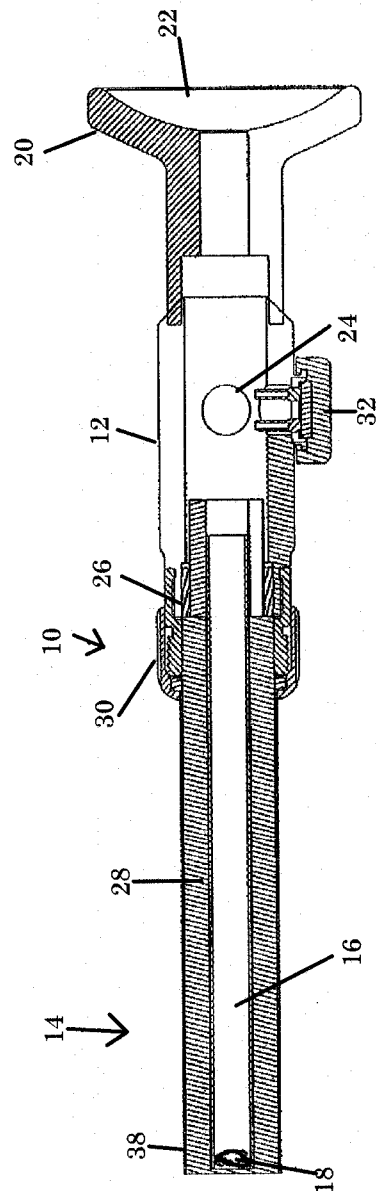


Fig. 1B

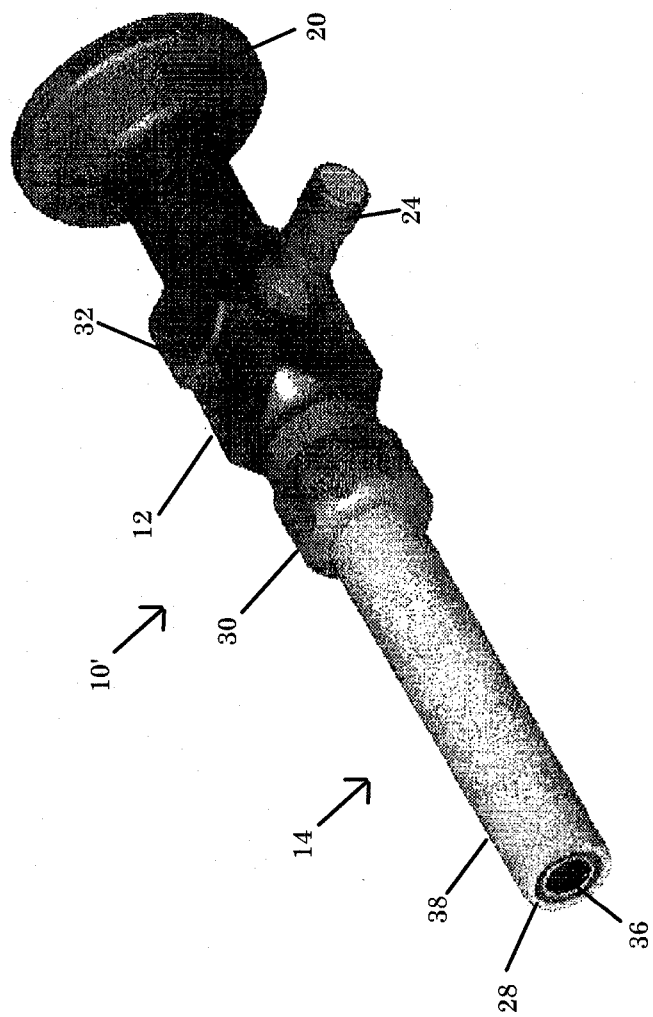


Fig. 2A

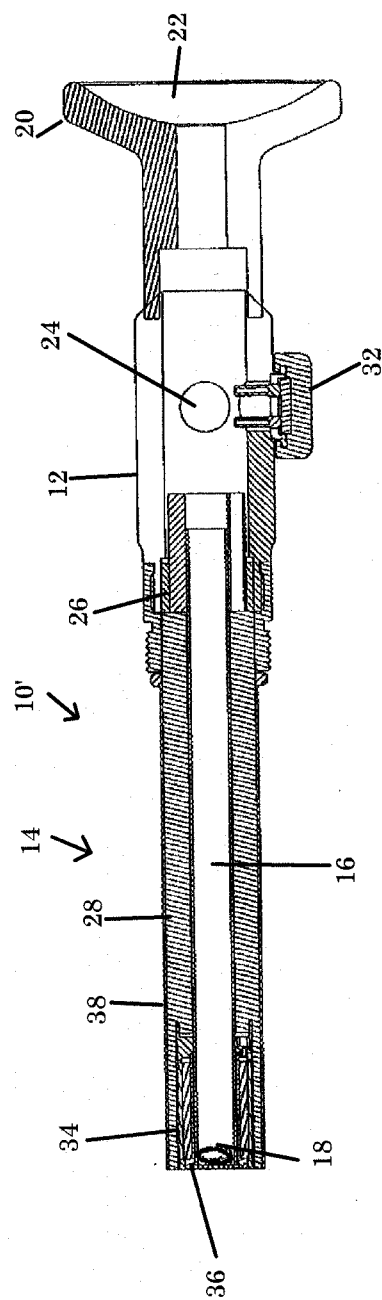


Fig. 2B

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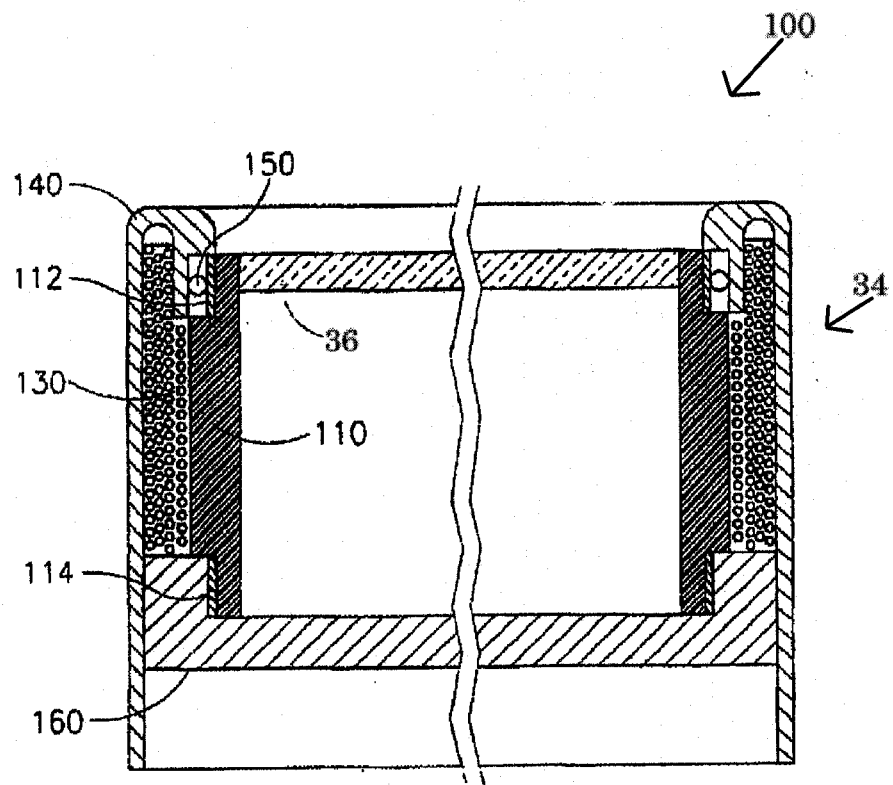


Fig. 3
(Prior Art)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/IL2012/000337

A. CLASSIFICATION OF SUBJECT MATTER

IPC (2012.01) A61B 1/00, A61B 1/06

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 (2012.01) A61B 1/00, A61B 1/06

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 practicable, search terms used)

Databases consulted: THOMSON INNOVATION, Esp@cenet, Google Patents

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	US 6863651 B2 Remijan et al. 08 Mar 2005 (2005/03/08) The whole document	1,5,9,14
X	US 5402768 A Adair 04 Apr 1995 (1995/04/04) (Abstract, Figs. 1-2, 5, 7, endoscope 10, light fiber 14, object lens 19, window 12, sheath 11, end cap 30, plastic cover 44, pull tap 48).	1,2,4,5,9
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☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

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Date of the actual completion of the international search

31 Dec 2012

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International application No.

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专利名称(译)	腹腔镜装置		
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代理机构(译)	MAIWALD专利ADVOCATE GMBH		
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其他公开文献	EP2755543A1		
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摘要(译)

本发明是一种腹腔镜装置，包括位于手柄部分远端的内部光源，包括光学系统的中心芯，以及在中心芯上滑动的圆柱形管形式的光导。光导适于使内部光源发出的光通过内部反射传播通过它，直到光离开腹腔镜远端的光导。