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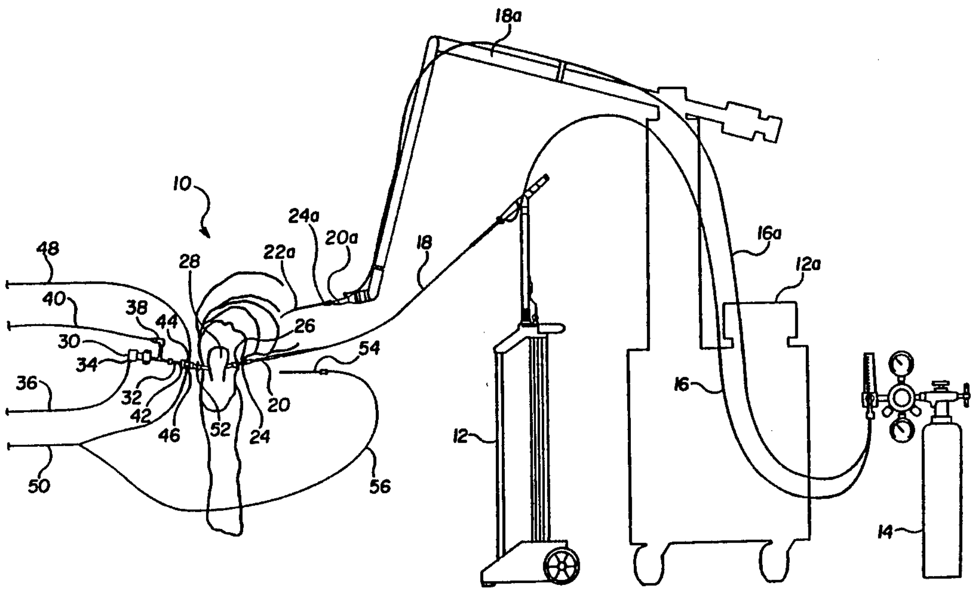
(54) Title: LASER ARTHROSCOPIC SYSTEM



(57) Abstract

A laser system for performing arthroscopic surgery having an arthroscope (30) and a laser insertion waveguide (18) inserted into the joint of a patient. The arthroscope (30) and insertion waveguide (18) are inserted into the knee through oversized access sleeves or cannulae (52) to allow gas to escape the knee between the cannulae (52) and the respective instrument therein. Charring caused by the laser burning away tissue in the joint is removed by irrigating the joint through one of the cannulae (52). Suction is provided through either or both of the cannulae (52) to remove debris and irrigating fluid. The insertion waveguide (18) is coupled to a handpiece (20a) which is connected to an intermediate laser delivery system (12). Carbon dioxide is transmitted to the joint through the handpiece (20a) and insertion waveguide (18) to prevent debris from obstructing the path of the laser to the surgical site.

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Description

LASER ARTHROSCOPIC SYSTEM

Technical Field

This invention relates to arthroscopic surgery, and more particularly, to a laser system for performing arthroscopic surgery.

Background of the Invention

The carbon dioxide (CO_2) laser derives its energy from the electrical excitation of carbon dioxide gas with the resultant emission of photons with a wavelength of 1.064 nm, which is invisible and in the infrared spectrum. Energy at this wavelength is highly absorbed by water. This provides the CO_2 laser with its ablative capabilities resulting from the instantaneous vaporization of water within cells and the attendant vaporization of solid cellular complements. This presents a problem for conventional arthroscopic procedures that use a saline solution to inflate the joint upon which the arthroscopy is to be performed. Unfortunately, because the energy is so effectively absorbed by fluid, a gas media must be used during laser arthroscopic procedures instead of a saline solution. Currently, CO_2 is the medium of choice because of both of its ready accessibility in the operating room and its rapid absorption by the body.

Conventional wisdom surrounding lasers focuses on their substantial destructive capabilities. Lasers used in medicine, however, are chosen for their precision rather than their destructive characteristics. Indeed, beyond the visible destruction, the CO_2 laser produces a zone of tissue alteration $<50\ \mu m$ thick, far less than the $500\ \mu m$ encountered with electrocautery. Thus, while unintended targets may fall victim to errant laser energy, the resultant damage is usually superficial and of little clinical consequence. Likewise, although it may be annoying and time-consuming to deal with the char and smoke plume resulting from tissue ablation, any associated clinical consequences also appear to be minor.

The major potential complication associated with the use of a CO_2 laser in arthroscopy is not a result of the use of laser energy but rather of the CO_2 gas medium. Escape of gas from the confines of the joint is known to cause subcutaneous emphysema, i.e., trapped bubbles of air, in various parts of the body. With laser procedures on the knee, various investigators have uncovered subcutaneous emphysema in the legs, trunk, neck and even the face. With CO_2

laser procedures in the shoulder, patients have developed pneumothoracies and subcutaneous emphysema of both the neck and scrotum lasting 24 hours.

The potential problems associated with the use of CO_2 gas as an arthroscopic medium arise not only from the presence of gas within the joint but also from the fact that the laser delivery device (probe or waveguide) must actively emit gas during insertion and use in order to remain free of tissue and debris.

Most investigators maximize intra-articular gas pressures at 80 mm Hg. Although somewhat higher than the ideal pressure (20 mm Hg) used during diagnostic laparoscopy, intra-articular gas pressures of 80 mm Hg have not been associated per se with any clinical complications. However, gas leaks leading to subcutaneous or subfascial emphysema readily occur with compromise of synovial integrity from such sources as intentional or inadvertent synovial ablation, multiple punctures, or portals too large for the instruments inserted through them. Additionally, using prior art systems, any hesitation during insertion of the gas-emitting probe or waveguide will result in instant soft tissue insufflation.

The use of a tourniquet is one solution to the escaping gas problem. While this does not prevent gas egress, at least it limits it to the extremity being operated upon. Although neurovascular compromise has not been reported as a result of the escape of intra-articular gas, it is conceivable that gas escaping into the soft tissues and confined proximally by even an uninflated tourniquet could restrict blood circulation from the extremity. The use of a tourniquet during CO_2 laser arthroscopic procedures lessens the potential appeal of this technique, especially in light of the neurologic compromise associated with even modestly prolonged tourniquet use. In addition, tourniquet use is not applicable during shoulder arthroscopy.

Summary of the Invention

A laser system for performing arthroscopic surgery, which includes a laser console, an intermediate laser delivery system, and an insertion waveguide for delivering light from the laser console to a surgical site in a joint of a patient. An arthroscope having an insertion tube is inserted into a first cannula inserted into the joint. The insertion waveguide is inserted into a second cannula having an internal diameter larger than the insertion waveguide so that gas may escape the joint between the cannula and the waveguide. The oversized cannula prevents gas pressure in the joint from exceeding ambient air pressure.

A preferred embodiment employs irrigation and suction means to remove char and other debris from the joint. A carbon dioxide purge is used to keep the path of the laser free and help remove char during irrigation. The laser arthroscopic system may include an articulating arm or a flexible waveguide intermediate delivery system.

Brief Description of the Drawings

Figure 1 is an elevational view of the arthroscopic laser system of the present invention.

Figure 2 is an enlarged isometric view of the arthroscope and suction portions of the laser arthroscopic system shown in Figure 1.

Figure 3 is an enlarged isometric view of the laser delivery systems of Figure 1.

Detailed Description of the Invention

As shown in the drawings for purposes of illustration, the present invention is embodied in a laser arthroscopic system 10 having alternate laser delivery systems and the method of performing arthroscopic surgery. The first alternate laser delivery system includes a CO_2 laser console 12 coupled to an elongated, hollow, flexible intermediate waveguide 18 which conveys laser light from the laser console to a handpiece 20. Coupled to the handpiece is an insertion waveguide 22 (see Figure 3) which is inserted into a human knee joint 28 for delivery of the laser light to the surgical site within the joint. Surrounding a portion of the insertion waveguide 22 is a protective sheath 24 coupled to the handpiece 20. The sheath 24 and insertion waveguide 22 extend into a first access sleeve or cannula 26 which is inserted into the joint 28.

The intermediate waveguide 18 is coupled to a carbon dioxide source 14 via carbon dioxide gas tubing 16. Carbon dioxide is transmitted through the intermediate waveguide 18, the handpiece 20 and insertion waveguide 22 and into the joint 28. The carbon dioxide clears the path of the laser light of debris to allow the light to reach the surgical site unobstructed.

The second alternate laser delivery system employs a carbon dioxide laser console 12a coupled to an articulated arm 18a. The articulated arm 18a delivers laser energy from the laser console 12a to a handpiece 20a through a delivery channel (not shown) inside the articulating arm. Within the delivery channel is a series of articulating mirrors (not shown) that reflect the laser light through the delivery channel. The handpiece 20a delivers the laser energy through an insertion waveguide 22a to the surgical site within the joint 28. The insertion waveguide 22a is protected by protective sheath 24a which is inserted into the access cannula 26. Carbon dioxide gas tubing 16a is coupled to the carbon dioxide source 14 and to the handpiece 20a for delivery of carbon dioxide to the handpiece. The handpiece 20a delivers the carbon dioxide through the insertion waveguide 22a and into the joint 28 at the surgical site.

The insertion waveguide 22, 22a transmits the laser light to the surgical site by allowing the light to be repeatedly reflected off of its interior walls. To maximize the light reflected, the insertion waveguide preferably is made of aluminum oxide, sapphire or other highly reflective material. In addition, the interior of the insertion waveguide may be provided with a dielectric overcoat. The dielectric overcoat enhances reflectivity by producing constructive interference of the reflected light. Preferably, the overcoat has a thickness ranging from $\lambda/6$ to $\lambda/10$ for maximum reflectivity.

The laser arthroscopic system 10 includes an arthroscope 30 having an insertion tube 32 that is inserted into the joint 28. The arthroscope insertion tube 32 extends into a second access sleeve or cannula 52 that is inserted into the joint. The arthroscope 30 includes a video coupling 34 that transmits an image of the interior of the joint to a video monitor (not shown) via a video cable 36. The arthroscope includes an illumination coupler 38 connected to a light source (not shown) via an illumination cable 40. The light is conveyed by the illumination coupler 38 to the insertion tube 32 where it is transmitted to the surgical site within the joint 28 to enhance viewing.

Preferably, each of the first and second cannulae 26 and 52 has an internal diameter large enough to allow either the insertion waveguide 22, 22a or the arthroscope insertion tube 32 to be inserted therein. This allows the instruments to be interchanged quickly and easily without having to create more portals in the joint 28. Interchanging instruments is important during surgery so that the surgical site can be viewed and cut from either side of the joint 28.

As discussed in more detail below, arthroscopic surgery using the laser arthroscopic system 10 requires periodic cleaning of the joint by flushing the joint with water and suctioning off excess water and debris. To allow periodic cleaning, an arthroscope sheath 42 surrounding the arthroscope insertion tube 32 is provided with an irrigation stopcock 44 and a suction stopcock 46. An irrigation source (not shown) coupled to the irrigation stopcock via an irrigation line 48 provides water to the joint via the insertion tube. A vacuum source (not shown) coupled to the suction stopcock 46 via a suction line 50 provide a vacuum to the joint via the insertion tube to remove water and debris from the joint 28. To provide additional suction to the joint, a Frazier suction tip 54 is connected to the main suction line 50 via a secondary suction line 56. The Frazier suction tip is inserted in the first access cannula 26 to provide suction to the joint to remove water and debris.

Positive pressure within the joint 28 is avoided by introducing the insertion waveguide 22, 22a through the first cannula 26. Because insertion waveguides typically measure either 1.5 or 3 mm in external diameter and the first cannula has an internal diameter of 5.5 mm, there exists adequate space for gas leakage. In addition to the substantial flow rates (2-4 L/min) possible between the cannula 26 and the insertion waveguide 22, 22a, the provision for suction via the second cannula 52 around the arthroscope insertion tube 32 allows rapid evacuation of excess gas from the joint 28. The pressure within the joint is easily controlled by the stopcock 46 to which the suction line 50 is attached.

Reducing the number of portals or punctures is another means of minimizing leakage of gas into the soft tissues. Separate portals for gas or fluid ingress or egress are usually unnecessary. During the initial diagnostic portion of the procedure, fluid can be injected and withdrawn through the second cannula 52. Although the injection and withdrawal of fluid is slightly more time-consuming than the use of separate cannulae with high flow rates, in the vast majority of instances this adds but a few minutes to the length of the diagnostic portion of the procedure. This may be considered a legitimate trade-off with the lessened likelihood of gas escape into the soft tissues.

Once the diagnostic portion of the procedure is completed and the potential targets for the laser are identified, the location of the laser portal is chosen by the insertion of an 18-gauge spinal needle. If the target tissue can be touched by the tip of the spinal needle, one is assured that it will be equally accessible to the laser. If, on the other hand, the target cannot be palpated by the spinal needle, it can be repositioned at a different site, leaving only a minute hole in the synovium.

Both the laser and the diagnostic portals are created with the goal of a water/gas-tight seal between the synovium/capsule and the first and second cannulae 26 and 52. This is done by incising only the skin with a scalpel. The subcutaneous tissue is then spread with the tip of a small hemostat and the capsule and synovium punctured by a sharp trochar placed within the cannulae. Observation from within the joint 28 while a portal is being created suggests that the sharp trochar is less likely to produce synovial tearing (and a potential source of leakage) than the blunt obturator. Regardless of one's preference regarding the type of obturator, the scalpel should not be used to perforate the synovium.

Under no circumstances should the gas-emitting insertion waveguide 22, 22a be used forcibly as a trochar, because this assures one of subcutaneous emphysema.

All prior art instruments used in the performance of arthroscopic surgical procedures require physical contact with the tissue being incised or ablated. Often the instruments block visualization of the cutting or ablative process. Tissue contact with the CO_2 laser delivery system is unnecessary. The insertion waveguide 22, 22a may be positioned outside of the viewing field of the arthroscope when cutting to allow simultaneous viewing of the area being cut.

The vaporization of tissue produced by the highly localized and intense heating of a CO_2 laser occurs at temperatures greater than 100°C. Carbonization (charring) is a by-product of this vaporization. Not only does the char obscure visualization of the target and reduce the effectiveness of the laser, it also absorbs laser energy, ultimately vaporizing at the temperature of incandescence which is greater than 2,000°C. Thus, the charred material must be constantly removed.

The best solution for this problem is to minimize charring in the first place. This can be accomplished by using more energy for shorter periods of time; that is, pulsing the laser. Pulsing allows tissue the opportunity to relax or cool between bursts of energy, resulting in less charring but at the expense of slower ablative action.

The char can be easily removed by converting to a liquid media and using the tip of a Stiele probe, inserted through the first cannula 26, to dislodge the char. However, this exchange of media is time-consuming. A simpler method is to allow the ingress of irrigating fluid through the arthroscope insertion tube 32, using the tip of the insertion waveguide 22, 22a to dislodge the char. The irrigant and char can be removed by suction applied through the suction stopcock 46 or through the Frazier suction tip 54. CO_2 ingress through the insertion waveguide is continued through the entire process, with the bubbles produced assisting in dislodging the charred material.

Tissue vaporization results in a plume of smoke that appreciably compromises visibility not only by its presence in the joint 28 but by its accumulation on the lens of the arthroscope 30. The smoke plume is most easily cleared by using active suction throughout the procedure. Suction can be applied by a third cannula or needle with its tip placed near the surgical site. This method results in another break in synovial continuity, and is a potential source of gas leakage. The most effective means of applying suction appears to be through the sheath 42 surrounding the arthroscope insertion tube 32. With adjustment of the suction stopcock 46 placed at the connection of the suction line 50 with the sheath 42, the suction can be regulated to permit removal of the smoke plume while neither collapsing nor allowing over-inflation of the joint 28.

The arthroscope 30 may be modified to allow the insertion waveguide 22, 22a to be inserted therein. An example of such a modified laser arthroscope may be found in Whipple et al., Arthroscopic Laser Menisectomy in a Gas Medium, *Arthroscopy 1*:2, 1985. Such modified arthroscopes allow the method of the present invention to be employed using a single portal in the joint 28.

The problem of escaping gas is minimized by the single portal and the fact that one is actually visualizing the area into which the CO_2 will be injected. Obstructions between the insertion waveguide 22, 22a and the surgical site are easily avoided because the line of vision parallels the course of the laser energy. Likewise, endangered structures beyond the surgical site are also visible. The smoke plume is evacuated by suction applied through the arthroscope sheath 42, and both lens and tissue can be cleansed by the ingress of fluid through the sheath. During irrigation the bubbles emitting from the insertion waveguide appear to effectively remove charred debris.

From the foregoing it will be appreciated that, although specific embodiments of the invention have been described herein for purposes of illustration, various modifications may be made without deviating from the spirit and scope of the invention. Accordingly, the invention is not limited except as by the appended claims.

Claims

1. A laser system for performing arthroscopic surgery, comprising:

a laser light source;

a delivery system that delivers laser light from the laser light source to a surgical site in a joint of a patient; and

a release port communicating with the surgical site to prevent gas pressure in the joint from exceeding ambient air pressure.

2. The laser system of claim 1, further including an arthroscope having an insertion tube partially inserted into the joint so that at least a portion of the inside of the joint may be viewed while the delivery system delivers laser light to the surgical site in the joint.

3. The laser system of claim 2, further including two cannulae, each cannula having a diameter sufficiently large to allow insertion of a portion of the insertion tube.

4. The laser system of claim 2 wherein a portion of the delivery system is coaxial with the insertion tube of the arthroscope.

5. The laser system of claim 1, further including a cannula partially inserted into the joint, the cannula being of sufficient diameter to allow a portion of the delivery system to be inserted therein.

6. The laser system of claim 1, further including a gas source that blows gas either through or collinear with the delivery system to prevent debris from hindering transmission of laser light.

7. The laser system of claim 1 wherein the delivery system includes an insertion waveguide and an articulating arm having a delivery channel communicating with the interior of the insertion waveguide such that laser light is directed through the delivery channel into and through the insertion waveguide and to the surgical site.

8. The laser system of claim 1 wherein the laser system further includes an irrigation system that provides liquid to the inside of the joint and removes liquid from the inside of the joint.

9. The laser system of claim 1 wherein the delivery system includes an insertion waveguide and the release port includes a cannula extending into the joint to receive the insertion waveguide therein, the cannula having an interior diameter larger than the exterior diameter of the insertion waveguide such that gas can escape from the joint between the cannula and the insertion waveguide while the insertion waveguide is positioned in the cannula.

10. The laser system of claim 1 wherein the delivery system includes a flexible intermediate waveguide coupled to the laser light source, an insertion waveguide, and a handpiece coupling the intermediate wave guide to the insertion waveguide.

11. The laser system of claim 10 wherein the insertion waveguide has an interior surface of aluminum oxide or sapphire.

12. The laser system of claim 10 wherein the insertion waveguide has an interior metallic surface with a dielectric overcoat having a thickness of between $\lambda/6$ to $\lambda/10$.

13. The laser system of claim 10, further including a gas supply coupled to the intermediate waveguide so that gas is transmitted through the intermediate waveguide, the handpiece, and the insertion waveguide into the joint simultaneously with the delivery of laser light.

14. A laser system for performing arthroscopic surgery, comprising:

a laser light source;

a delivery system that delivers laser light from the laser light source to a surgical site in a joint of a patient wherein the delivery system includes an insertion waveguide;

a first cannula inserted into the joint;

an arthroscope having an insertion tube insertable into the first cannula; and a second cannula having an interior diameter larger than the insertion waveguide to allow gas to escape from the joint between the second cannula and the insertion waveguide when the insertion waveguide is inserted in the second cannula.

15. The laser system of claim 14 wherein the delivery system includes an articulating arm having a delivery channel communicating with the interior of the insertion waveguide such that laser light is directed through the delivery channel into and through the insertion waveguide to the surgical site in the joint.

16. The laser system of claim 14, further including a means for blowing gas either through or collinear with the delivery system to prevent debris from hindering transmission of laser light.

17. The laser system of claim 14 wherein the delivery system includes a flexible intermediate waveguide coupled to the laser light source and a handpiece coupled to the intermediate waveguide, and the insertion waveguide is coupled to the handpiece, the laser light being transmitted from the laser light source through the intermediate waveguide, handpiece and insertion waveguide to the surgical site.

18. The laser system of claim 17 wherein the intermediate waveguide is coupled to a carbon dioxide source such that carbon dioxide may be blown into the joint through the intermediate waveguide, handpiece, and insertion waveguide to prevent debris from hindering transmission of the laser light.

19. A method of performing arthroscopic surgery on a joint of a patient, comprising:

inserting a waveguide of a laser into the joint;

burning away tissue in the joint using laser light provided by the laser through the insertion waveguide; and

maintaining ambient air pressure within the joint while burning away the tissue.

20. The method of claim 19, further including making two portals in the joint and inserting an arthroscope insertion tube through one of the portals and the waveguide through the other portal.

21. The method of claim 20, further including inserting a cannula in each of the portals and inserting the arthroscope insertion tube into one of the cannulae and the insertion waveguide into the other of the cannulae.

22. The method of claim 19 wherein maintaining ambient air pressure includes inserting a cannula into the joint and inserting the waveguide into the cannula, the cannula having an interior diameter larger than the exterior diameter of the waveguide so that gas may escape from the joint between the cannula and the insertion waveguide.

23. The laser system of claim 19 wherein maintaining ambient air pressure includes providing suction to the joint while burning away tissue.

24. The method of claim 19 further including irrigating the joint with liquid to remove debris from the joint.

25. The method of claim 19 further including transmitting gas into the joint to prevent debris from hindering transmission of laser light to the joint.

AMENDED CLAIMS

[received by the International Bureau on 29 November 1993 (29.11.93); original claim cancelled; original claims 1-3,8-10,13-17 and 19 amended; claims 5-25 renumbered as claims 4-24 (4 pages)]

1. A laser system for performing arthroscopic surgery at a surgical site within a joint of a patient, comprising:

a laser light source;

a delivery system coupled to the laser light source and to the surgical site, the delivery system being adapted to deliver laser light from the laser light source to the surgical site; and

a release portal in fluid communication with the surgical site, the portal defining a fluid passageway sized to release gas and prevent gas pressure in the joint from exceeding ambient air pressure during performance of the arthroscopic surgery using the laser light of the laser light source.

2. The laser system of claim 1, further including an arthroscope having an insertion tube partially inserted into the joint and in fluid communication with the surgical site so that at least a portion of the inside of the joint may be viewed through the arthroscope while the delivery system delivers laser light to the surgical site in the joint.

3. The laser system of claim 2, further including two cannulae partially inserted into the joint, each cannula having a diameter sufficiently large to allow insertion of a portion of the insertion tube, one of the cannulae forming the release portal and other cannula forming a portal for partial insertion of the insertion tube.

4. The laser system of claim 1, further including a cannula partially inserted into the joint, the cannula being of sufficient diameter to allow a portion of the delivery system to be inserted therein.

5. The laser system of claim 1, further including a gas source coupled to the delivery system to blow gas through a passageway defined in the delivery system to the surgical site to prevent debris from hindering transmission of laser light.

6. The laser system of claim 1 wherein the delivery system includes an insertion waveguide and an articulating arm having a delivery channel communicating with the interior of the insertion waveguide such that laser light is

directed through the delivery channel into and through the insertion waveguide and to the surgical site.

7. The laser system of claim 1 wherein the laser system further includes an irrigation line in fluid communication with the surgical site to provide liquid to the inside of the joint and a suction line in fluid communication with the surgical site to remove liquid from the inside of the joint.

8. The laser system of claim 1 wherein the delivery system includes an insertion waveguide and the release portal includes a cannula extending into the joint to receive the insertion waveguide therein, the cannula having an interior diameter larger than the exterior diameter of the insertion waveguide such that gas can escape from the joint between the cannula and the insertion waveguide while the insertion waveguide is positioned in the cannula.

9. The laser system of claim 1 wherein the delivery system includes a flexible intermediate waveguide coupled to the laser light source, an insertion waveguide, and a handpiece having a passageway coupling the intermediate wave guide to the insertion waveguide such that laser light is delivered from the laser light source through the intermediate waveguide, handpiece and insertion waveguide to the surgical site.

10. The laser system of claim 9 wherein the insertion waveguide has an interior surface of aluminum oxide or sapphire.

11. The laser system of claim 9 wherein the insertion waveguide has an interior metallic surface with a dielectric overcoat having a thickness of between $\lambda/6$ to $\lambda/10$.

12. The laser system of claim 9, further including a gas supply coupled to the intermediate waveguide so that gas is transmitted through the intermediate waveguide, the handpiece passageway, and the insertion waveguide into the joint simultaneously with the delivery of laser light.

13. A laser system for performing arthroscopic surgery at a surgical site within a joint of a patient, comprising:

a laser light source;

a delivery system coupled to the laser light source and to the surgical site, the delivery system being adapted to deliver laser light from the laser light source to the surgical site wherein the delivery system includes an insertion waveguide coupled to the surgical site to deliver the laser light to the surgical sight;

a first cannula inserted into the joint to be in fluid communication with the surgical site;

an arthroscope having an insertion tube inserted into the first cannula; and

a second cannula in fluid communication with the surgical site and having an interior diameter larger than the insertion waveguide to allow gas to escape from the joint through a gap formed between the second cannula and the insertion waveguide when the insertion waveguide is inserted in the second cannula.

14. The laser system of claim 13 wherein the delivery system includes an articulating arm having a delivery channel communicating with the interior of the insertion waveguide such that laser light is directed through the delivery channel into and through the insertion waveguide to the surgical site in the joint.

15. The laser system of claim 13, further including a means coupled to the delivery system for blowing gas through the delivery system to prevent debris from hindering transmission of laser light.

16. The laser system of claim 13 wherein the delivery system includes a flexible intermediate waveguide coupled to the laser light source and a hollow handpiece coupled to the intermediate waveguide, and the insertion waveguide is coupled to the handpiece, the laser light being transmitted from the laser light source through the intermediate waveguide, handpiece and insertion waveguide to the surgical site.

17. The laser system of claim 16 wherein the intermediate waveguide is coupled to a carbon dioxide source such that carbon dioxide may be blown into the joint through the intermediate waveguide, handpiece, and insertion waveguide to prevent debris from hindering transmission of the laser light.

18. A method of performing arthroscopic surgery on a joint of a patient, comprising:

inserting a waveguide of a laser into the joint;

burning away tissue in the joint using laser light provided by the laser through the inserted waveguide; and

maintaining ambient air pressure within the joint while burning away the tissue.

19. The method of claim 18, further including making two portals in the joint and inserting an arthroscope insertion tube through one of the portals and the waveguide through the other portal.

20. The method of claim 19, further including inserting a cannula in each of the portals and inserting the arthroscope insertion tube into one of the cannulae and the insertion waveguide into the other of the cannulae.

21. The method of claim 18 wherein maintaining ambient air pressure includes inserting a cannula into the joint and inserting the waveguide into the cannula, the cannula having an interior diameter larger than the exterior diameter of the waveguide so that gas may escape from the joint between the cannula and the insertion waveguide.

22. The laser system of claim 18 wherein maintaining ambient air pressure includes providing suction to the joint while burning away tissue.

23. The method of claim 18 further including irrigating the joint with liquid to remove debris from the joint.

24. The method of claim 18 further including transmitting gas into the joint to prevent debris from hindering transmission of laser light to the joint.

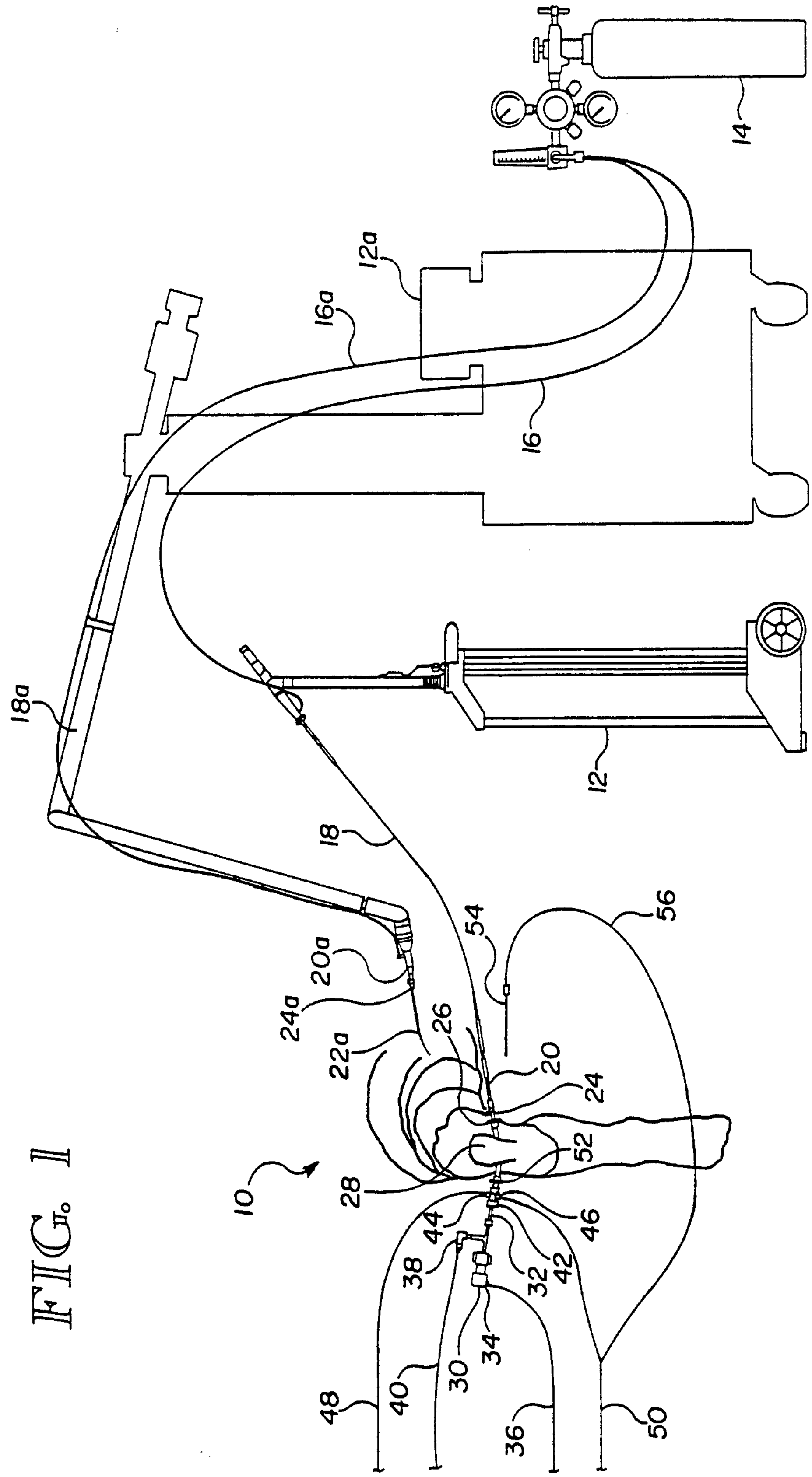
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FIG. 1

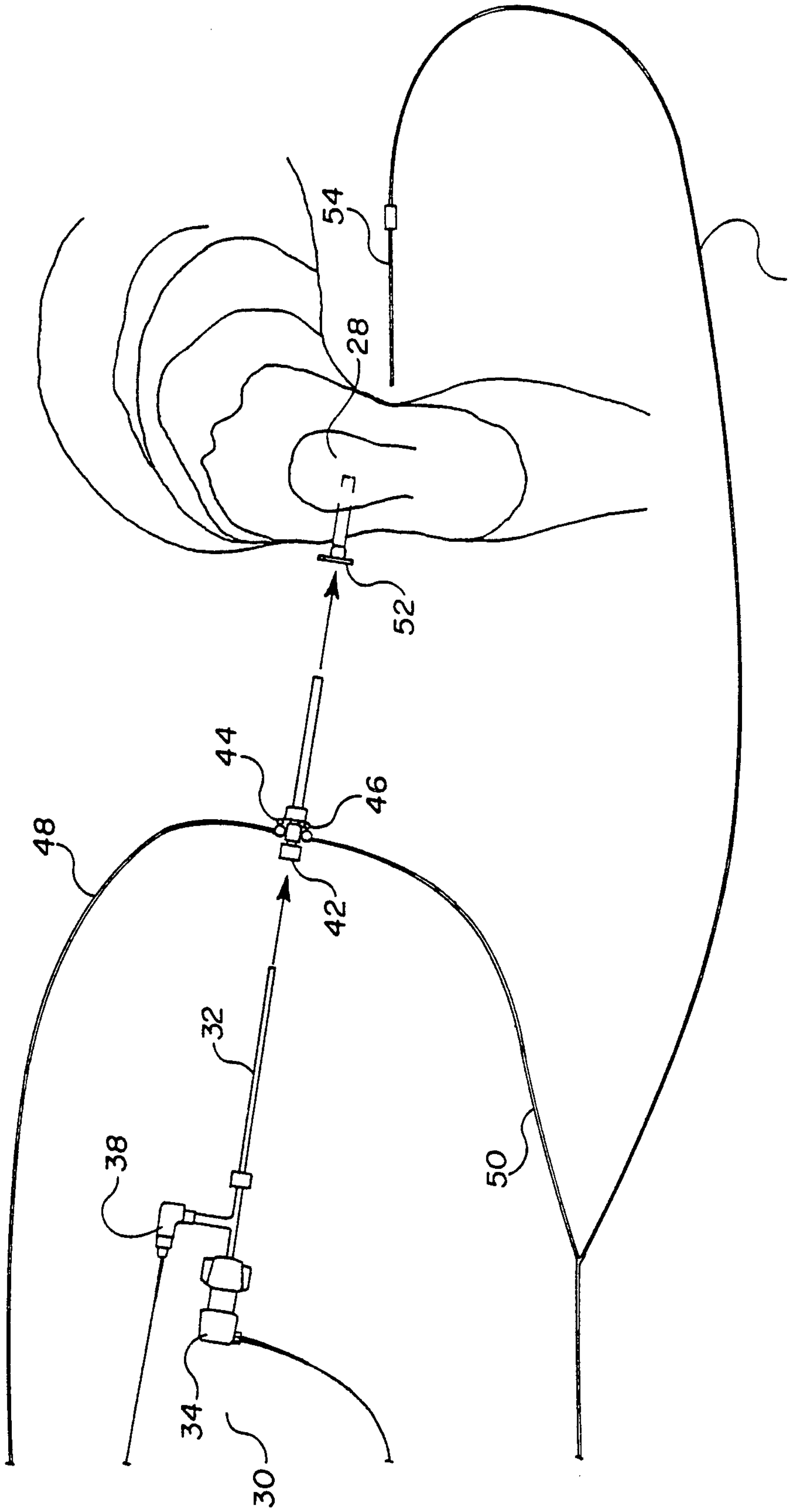

FIG. 2

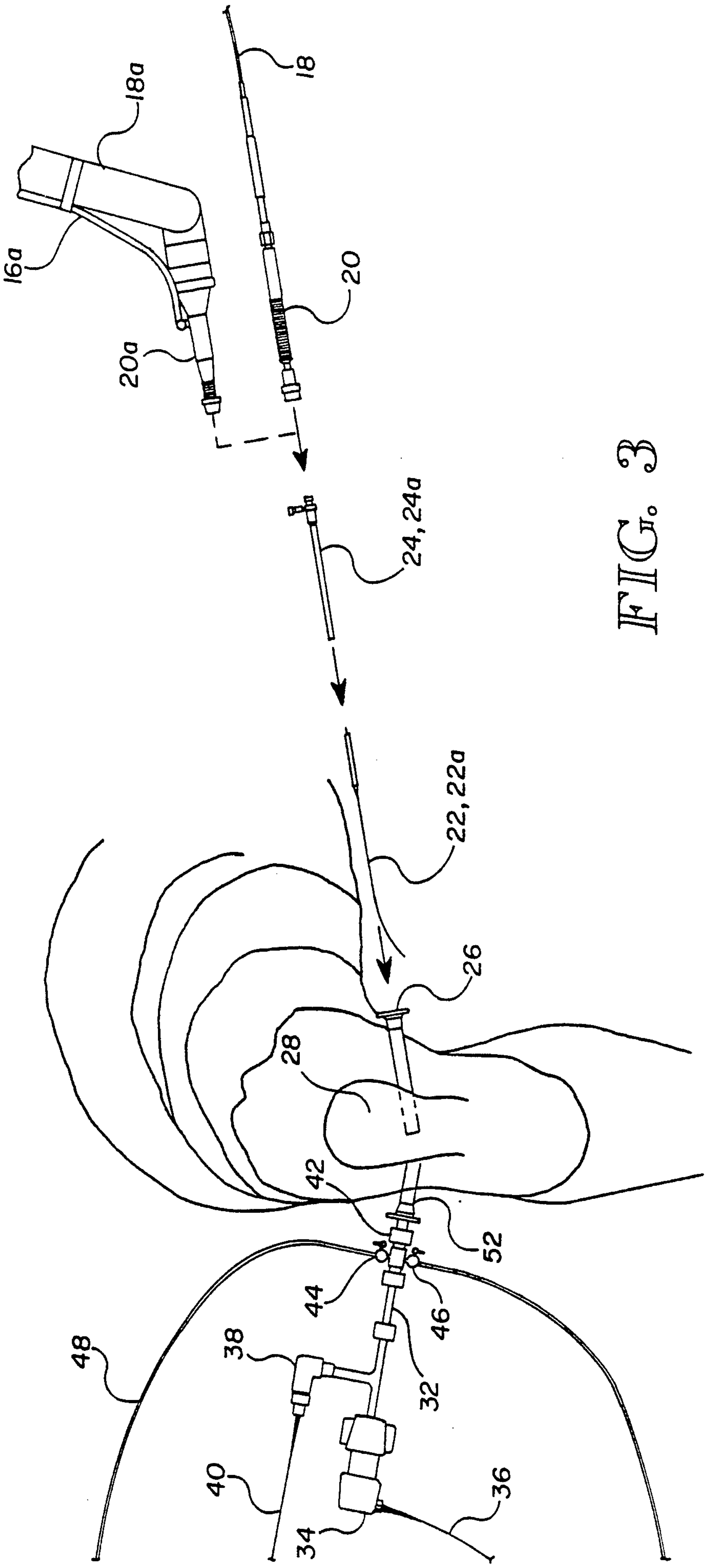

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US93/05660

A. CLASSIFICATION OF SUBJECT MATTER

IPC(5) :A61B 17/36
US CL :606/14
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. : 606/2, 10, 13-16, 19, 45, 46, 79; 128/4, 6, 395-398; 604/20-22, 26, 35, 53, 129

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)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y --- X	US, A, 4,638,800 (Michel) 27 January 1987, whole document	1-2, 4-6, 19, 22-23, 25 ----------- 3, 7-18, 20-21, 24
Y	US, A, 4,646,738 (Trott) 03 March 1987, see Figures	3, 14-18, 20-21
Y	US, A, 4,917,083 (Harrington et al) 17 April 1990, see Figure 3	7, 9, 11, 15
Y	US, A, 5,037,421 (Boutacoff et al) 06 August 1991, see Figure 1 and column 4, lines 3-9	8, 10-13, 17-18, 24

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

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11 AUGUST 1993	SEP 29 1993

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INTERNATIONAL SEARCH REPORT

International application No.
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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.
Y	US, A, 4,469,098 (Davi) 04 September 1984, see column 2, lines 59-64	12