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(54) **SURGICAL LIPOSUCTION INSTRUMENT WITH RADIANT ENERGY SOURCE**

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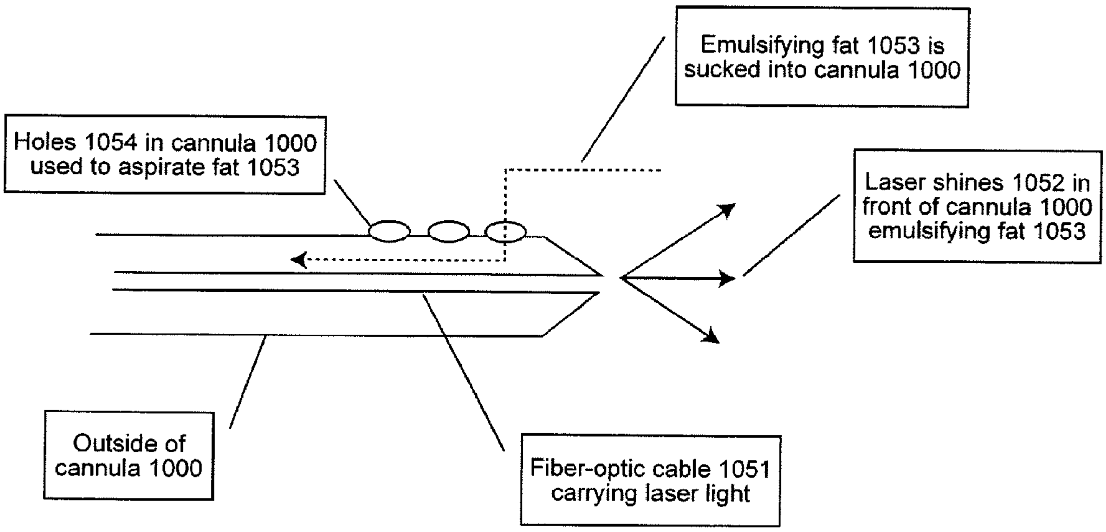
(52) **U.S. Cl.** **604/542**; 601/46; 601/97; 606/13; 606/16

(57) **ABSTRACT**

A cannula for a liposuction device includes an energy source for liquefying, emulsifying or softening fatty tissue near a tip end. The energy source can provide laser energy through a fiber optic cable, or can provide energy such as RF, ultrasound or IR/UV/Vis energy from a laser diode or the like. Fat is emulsified, liquefied or softened by the energy emitted from the cannula and is removed by aspiration through a series of holes disposed in the outside wall and at the distal end of the cannula. In a power assisted embodiment, the openings in the cannula shear or cut neighboring fat tissue. The tip of the cannula can be heated to promote skin tightening.



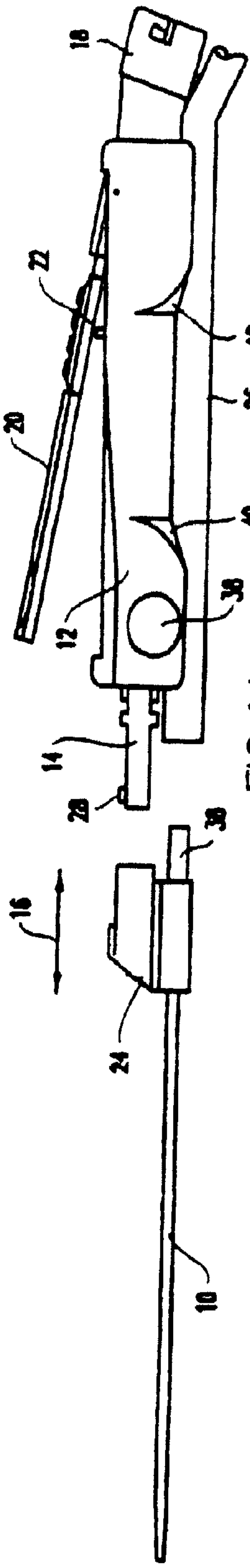


FIG.1A

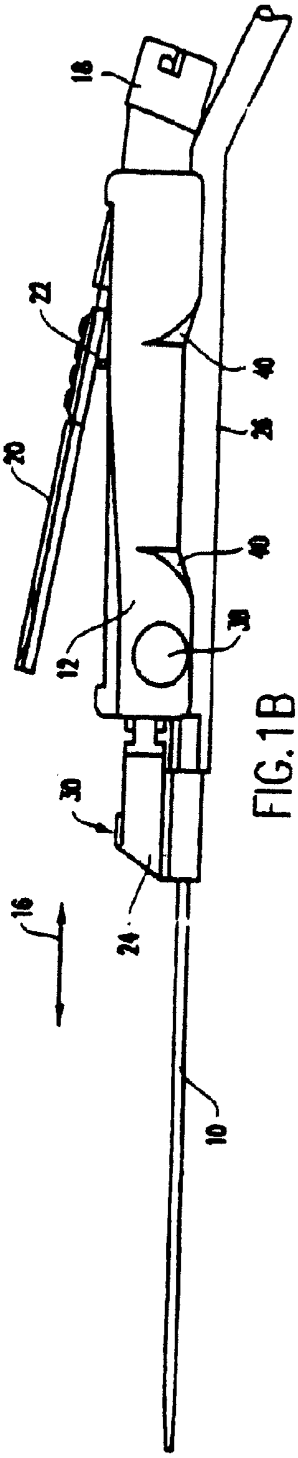


FIG.1B

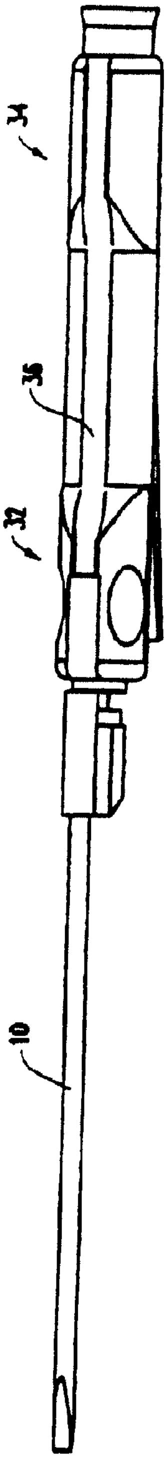


FIG.2

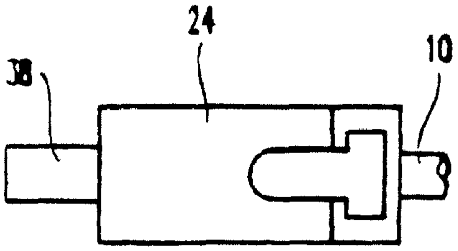


FIG.3

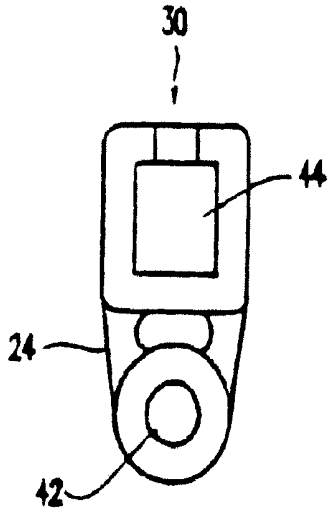


FIG.4

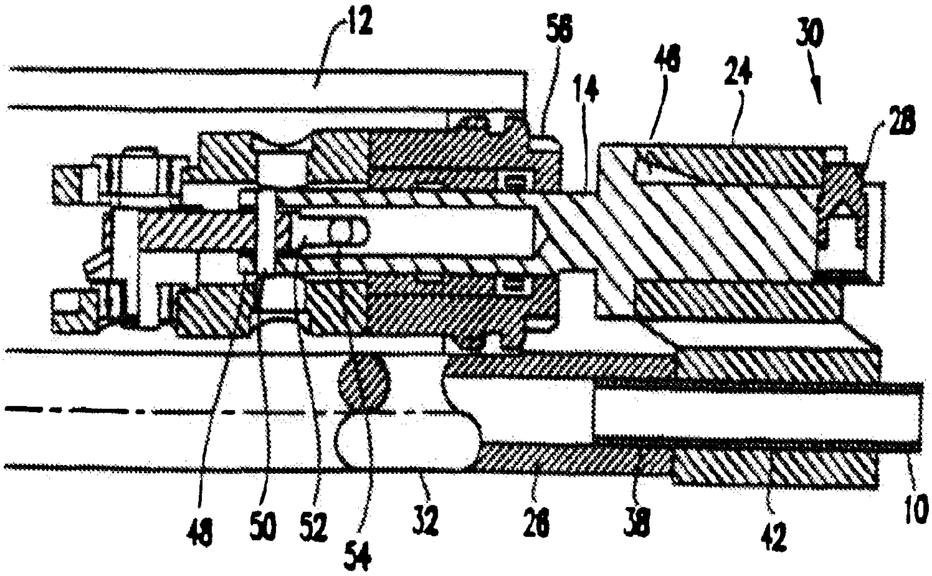


FIG.5

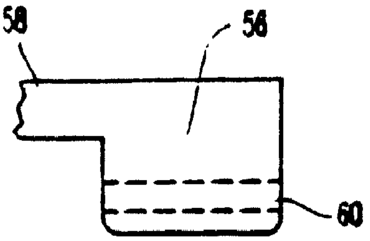


FIG.6

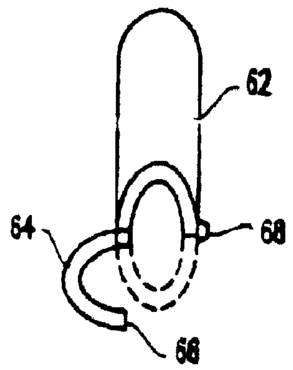


FIG.7

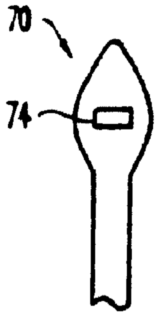


FIG.8A

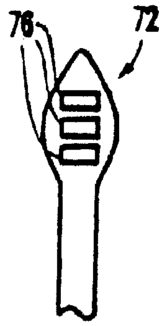


FIG.8B

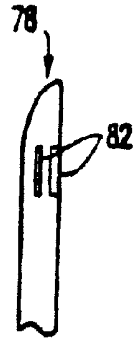


FIG.8C

FIG.8D

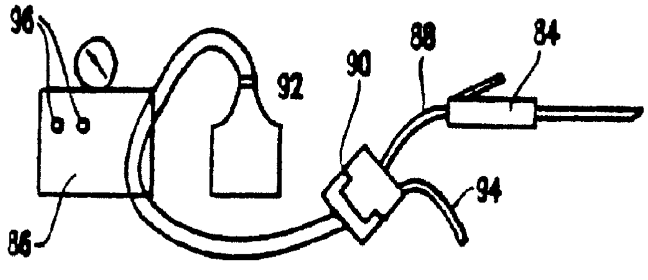


FIG.9

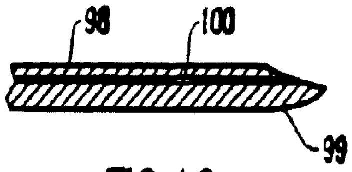


FIG.10

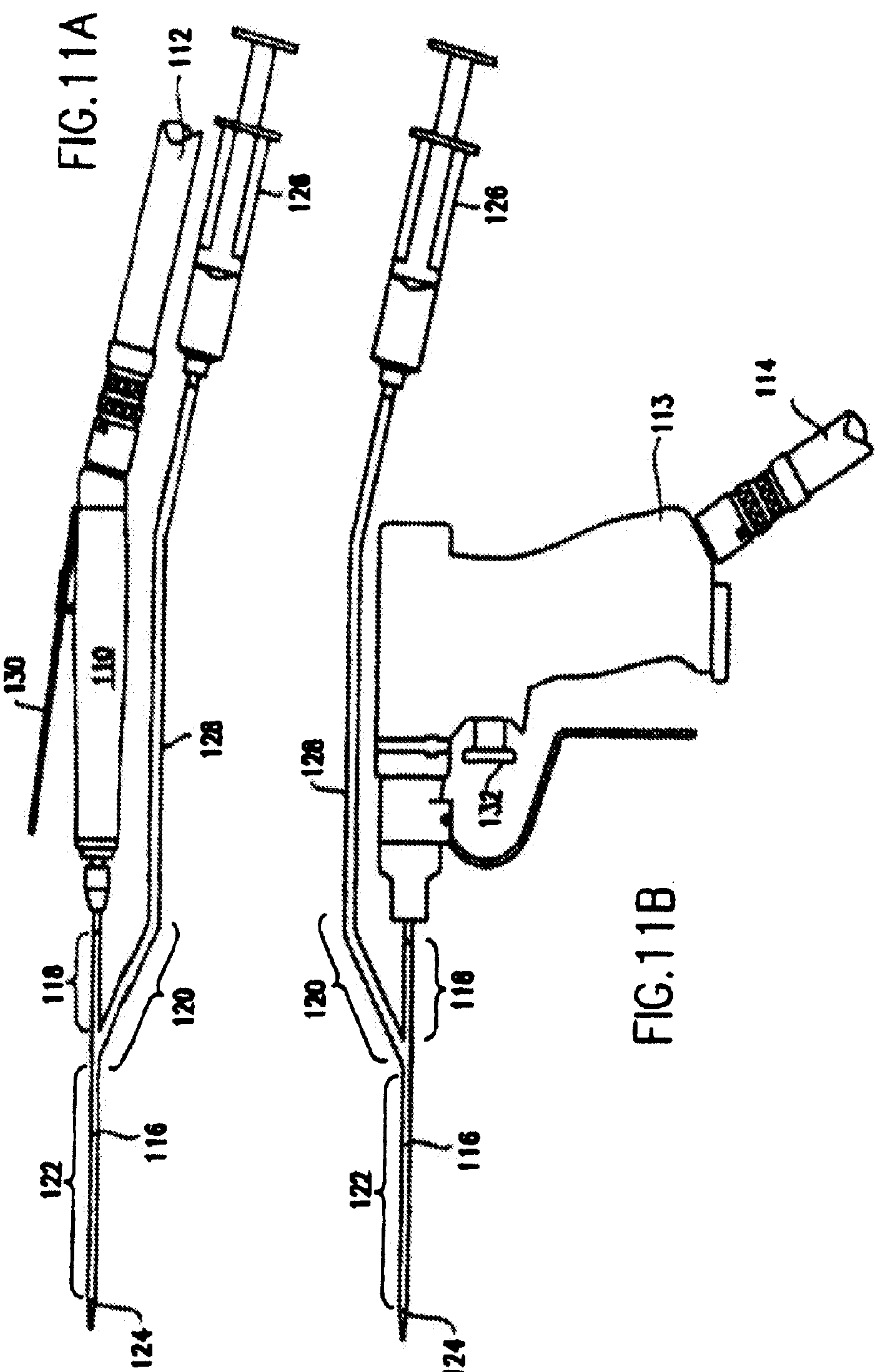


FIG. 11A

FIG. 11B

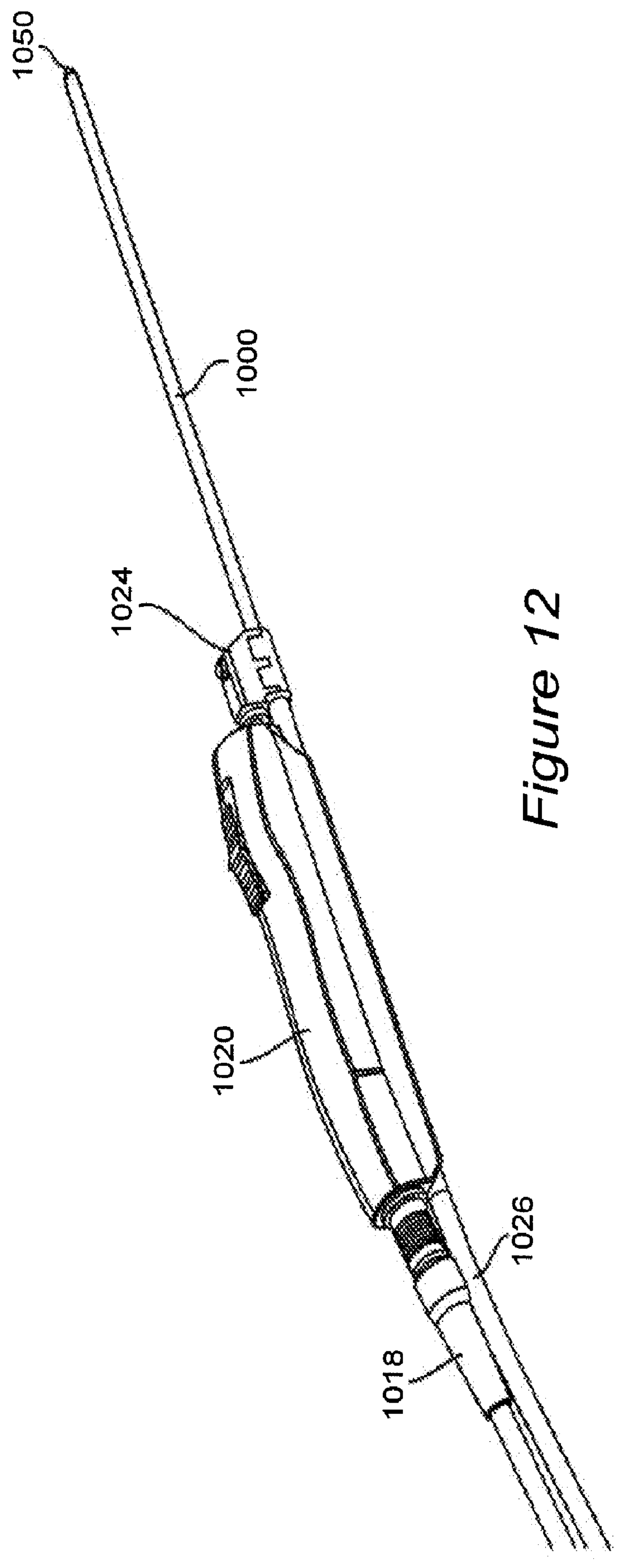


Figure 12

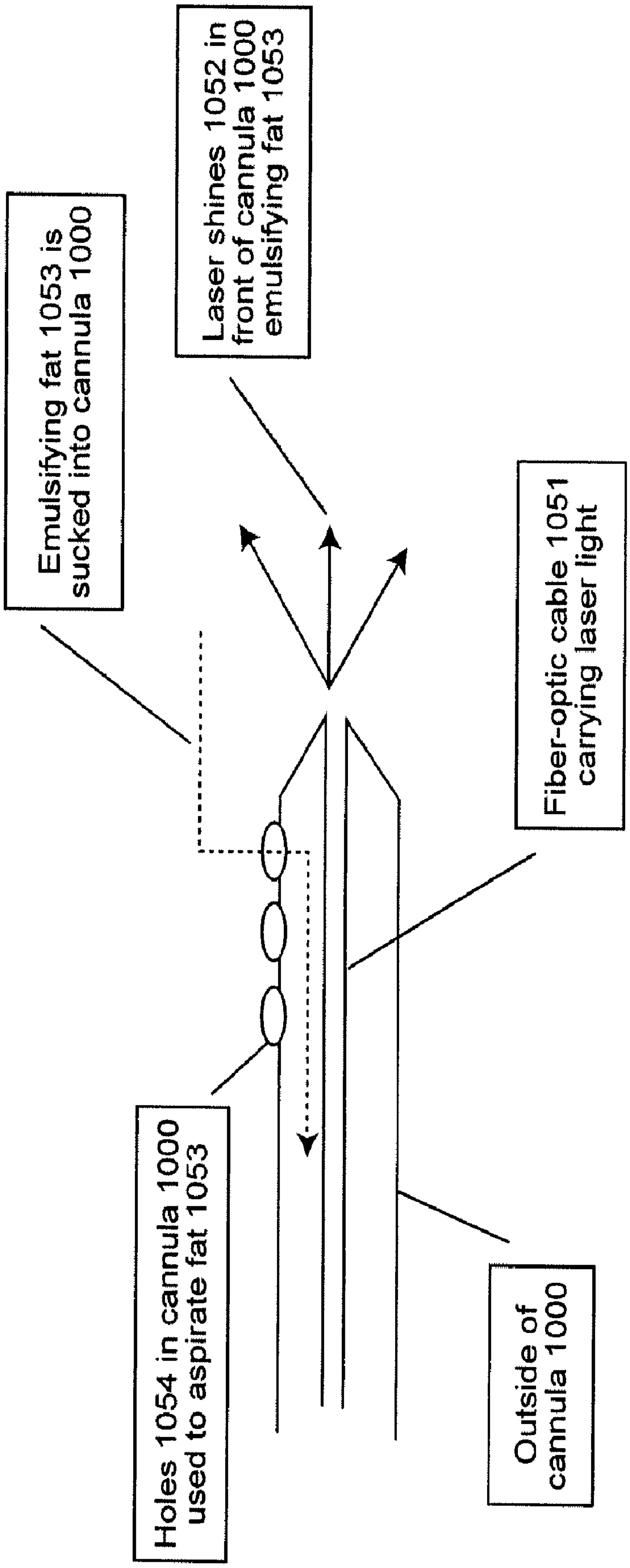

Laser shines 1052 in front of cannula 1000 emulsifying fat 1053
Emulsifying fat 1053 is sucked into cannula 1000
Fiber-optic cable 1051 carrying laser light
Holes 1054 in cannula 1000 used to aspirate fat 1053
Outside of cannula 1000

Figure 13

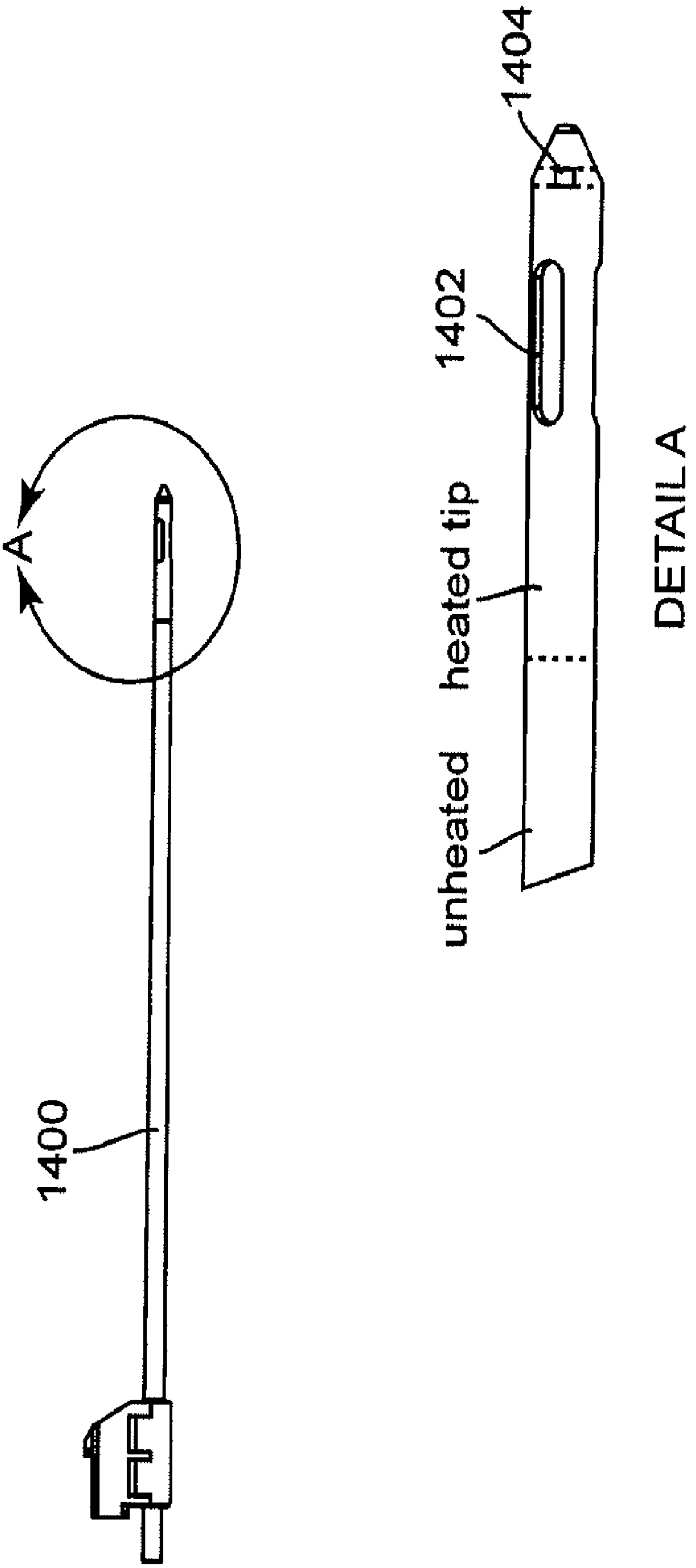


Figure 14

SURGICAL LIPOSUCTION INSTRUMENT WITH RADIANT ENERGY SOURCE

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The invention is generally related to surgical instruments used in liposuction surgical operations.

[0003] 2. Background Description

[0004] Liposuction is a well known surgical procedure for surgically removing fat tissue from selected portions of a patient's body. Current practice is to make an incision and then insert a cannula in the space occupied by fat tissue. The cannula is then moved in such a manner as to mechanically break up the fat tissue. While moving the cannula, pieces of the fat tissue are aspirated from the space through the cannula by vacuum pressure from a syringe or pump. This technique requires significant effort on the part of the surgeon in terms of both the physical effort required to move the cannula back and forth, and the effort required to control the direction of movement of the cannula in order for fat tissue to be withdrawn only from specific areas of the patient's body.

[0005] U.S. Pat. No. 4,886,491 to Parisi et al. discloses a surgical instrument which utilizes an ultrasonic probe to break up fat tissue. U.S. Pat. No. 5,295,955 to Rosen discloses a surgical instrument which employs microwave energy to soften fat tissue. These approaches may produce a lumpy surface upon completion of the surgery.

[0006] Swartz discloses, in U.S. Pat. Nos. 4,735,605, 4,775,365, and 4,932,935, power assisted liposuction tools which include an external sheath which houses a rotary driven auger type element. Fat tissue is selectively sheared at an opening in the external sheath by the auger element pulling tissue within the opening and shearing it off at the opening. In one of the designs, Swartz contemplates oscillating the direction of rotation of the auger element. U.S. Pat. No. 4,815,462 to Clark discloses a lipectomy tool which has an inner cannula with a knife edge opening which rotates within an outer cannula. In Clark, fat tissue is drawn by suction into an opening the outer cannula, and is then sheared off by the knife edge of the inner cannula and aspirated to a collection vessel. A disadvantage with each of these Swartz and Clark designs is that they may tear the tissue. This can be problematic when working in confined spaces near blood vessels and the like. U.S. Pat. No. 5,112,302 to Cucin discloses a powered liposuction hand tool that moves a cannula back and forth in a reciprocating manner. Back and forth movement is akin to the movements made by surgeons, and is therefore a marked improvement over the rotary designs of Swartz and Clark. However, the Cucin design requires the cannula and reciprocating mechanism to move within a portion of the hand held base unit. U.S. Pat. No. 5,352,194 to Greco et al. describes an automated liposuction device with reciprocating cannula movement that is akin to Cucin's; however, this device relies on a pneumatic cylinder drive system, with multiple sensors, and a computer controller to adjust and regulate the cannula movement. Overall, the Greco system is complex and may be subject to a variety of drive control problems, as well as high costs for various elements. In addition, the Greco system is designed to provide cannula stroke lengths which are in excess of 1 cm, which may not be ideal in a number of different circumstances. U.S. Pat. No. 5,348,535 to Cucin discloses another power assisted liposuction instrument. This instrument utilizes movement of an internal sleeve within an external sleeve to shear off fat tissue pulled within an opening in the external sleeve. The design is complex in that it requires multiple sleeves, and the reciprocating movement causes periodic changes in the aspiration aperture. U.S. Pat. No. 4,536,180 to Johnson discloses a surgical system for suction lipolysis which employs an internal or external air conduit which directs airflow at or near the cutting tip of the cannula to enhance fat tissue clearance during aspiration through the cannula. U.S. Pat. No. 5,013,300 to Williams discloses suction lipectomy tool which allows suction control via the surgeons thumb covering and uncovering vent holes in the lipectomy tool housing.

[0007] U.S. Pat. No. 6,464,694 to Massengill discloses a liposuction cannula which has a source of aqueous solution, a laser source, and a suction source. Laser energy is emitted at the distal end of the cannula and simultaneously one or more jet streams of water or aqueous solution are emitted into the same area. As a result of the laser bombardment, the water molecules supplied by the jet stream are stated to be "hyper-kinetized". When released violently from the tip of the cannula, the water molecules disrupt the wall of the adipocyte cells and release the liquefied fat which is aspirated by the cannula. U.S. Pat. No. 6,206,873 to Paolini et al. describes a device and method for removing subcutaneous adipose layers with a laser source, optical fiber and a hollow needle for guiding the fiber. The laser beam is stated to be generated with an intensity and wavelength for liquefying and maintaining liquid the adipose cells so that the membranes of adipose cells are disrupted without substantially damaging collagen in the adipose layers. The liquid material may be suctioned by means of a vacuum pump. However, the suction line is not shown to be incorporated into the device. U.S. Pat. No. 6,902,559 to Taufig describes a liposuction device for removing subcutaneous fatty tissue. The Taufig device comprises a suction cannula including openings for sucking fatty tissue as well as an injection line with an injection opening disposed at the front injection line end for injecting a working fluid. For loosening the tissue, an ultrasonic generator is arranged near the injection opening of the suction cannula. Additionally, or alternatively, a laser may be provided at the suction cannula for heating and detaching the fatty tissue. U.S. Pat. No. 5,642,370 to Mitchell et al. describes a medical laser device for ablating and emulsifying biological material. The laser, including erbium: YAG gain medium, is stated to be optimized to generate a pulsed output of preferably at least 100 hertz which is delivered to the target tissue via an optical fiber. A suction source is provided to aspirate the tissue as it is being ablated. This laser system provides accurate ablation with minimal damage to surrounding tissue. In addition to ophthalmic and urinary organ procedures, the targeted removal of cancerous tissue and/or tumors and procedures, the erbium laser can be used for removal of fatty tissue.

[0008] U.S. Pat. No. 6,176,854 to Cone discloses a method of percutaneous and subcutaneous laser treatment of the tissue of a patient. The light energy is introduced into the proximal end portion of the optical fiber, passes through a handpiece and is emitted from the bare distal tip of the optical fiber. The tip of the optical fiber is passed through the skin and advanced through the tissue subcutaneously to a desired treatment area. Laser energy can be emitted at different levels during any or all of the skin penetration, advancement, tissue treatment and withdrawal phases.

[0009] MicroAire Surgical Instruments has been making a product known as the "PAL" for power assisted liposuction. The product represents a substantial improvement over previous liposuction handpieces, and implements features described in U.S. Pat. Nos. 5,911,700, 6,139,518, 6,258,054, and 6,817,996, each of which are herein incorporated by reference.

SUMMARY OF THE INVENTION

[0010] It is an object of this invention to provide an improved, power-assisted, reciprocating liposuction tool which includes a source of energy at its tip region which emits, for example, electromagnetic radiation such as radio waves, microwaves, infrared radiation, visible light, and ultraviolet radiation or ultrasound at power levels sufficient to soften or melt surrounding adipose tissue which can be aspirated by the liposuction tool. In a particular embodiment, the source is laser or light emitting diode (LED) which is either continuously or periodically energized.

[0011] It is another object of this invention to provide an improved, power assisted, reciprocating liposuction tool which includes a source of energy which provides heat at the cannula tip or along the length of the cannula which results in improved skin tightening post surgery.

[0012] According to an embodiment of the invention, a laser source is combined with a power-assisted liposuction tool. The cannula may be provided with a fiber-optic cable which carries the laser light and extends from a laser source through the handpiece and the length of the cannula until its distal end. Alternatively, a laser diode can simply be positioned on the end of the cannula. Laser energy delivered by the laser diode or fiber-optic cable to the targeted fatty tissues is of sufficient energy strength to be able to emulsify, soften, or liquefy the fat at the treatment site. Although laser energy is preferred, any type of energy can be used within the scope of the present invention (e.g., ultrasound, radiofrequency, IR, UV, Vis or other forms of electromagnetic energy).

[0013] According to another embodiment of the invention, the cannula is heated to provide for greater skin tightening post surgery. This can be accomplished using a wire heater along the length of the cannula or particularly at the tip region, but can also be accomplished using a laser source, including, for example, the same laser source used to emulsify, soften or liquefy surrounding fat tissue, where the laser source applies radiant energy to the tip of the cannula to increase its temperature.

[0014] According to yet another embodiment of the invention, the powered surgical handpiece includes a reciprocating member to which a cannula is connected. The handpiece drives the cannula back and forth under the control of a drive mechanism that preferably provides for variable speeds of reciprocation. The handpiece can employ any type of drive mechanism, including for example electric or pneumatic variable speed drive. In the preferred embodiment, cannulas are connected external to the hand piece by a connector which secures the cannula to a reciprocating member. The connector can either be integral with the cannula, integral with the reciprocating member or constitute a piece which is separate from and connectable to each of the reciprocating member and the cannula. In the most preferred embodiment, the connector is separate from the reciprocating member, and is designed to quickly connect to and disconnect from the reciprocating member by a pushbutton fitting or similar device. In the preferred configuration, the connector spaces the cannula radially from the axis of the reciprocating member such that the when the cannula is installed, it moves in a reciprocating motion along an axis that is parallel to the axis of the reciprocating member. The offset thus created allows the cannula to be positioned in alignment with a vacuum hose or other vacuum mechanism, such that fat tissue will be freely aspirated through the cannula into the vacuum tube. In the most preferred configuration, the vacuum hose fits directly onto the end of the cannula.

[0015] The power-assisted liposuction tool includes a series of one or more holes disposed on the outside wall and distal end of the cannula. The cannula holes are used to aspirate into the vacuum hose the fat liquefied by laser energy, and therefore to remove liquefied fat from the treatment site. Also, it is preferred that the forward and rearward stroke length of the cannula can be set to be equal to or greater than the size of the cutting window or windows in the cannula.

[0016] The power assisted liposuction tool preferably supplements the movements currently used in liposuction procedures. That is, it has been found that the reciprocal movements of the cannula, which may be 0.1 to 6 mm in length, tend to make it significantly easier for the surgeon to move the cannula back and forth in the same manner as is done with a non-power assisted liposuction tool. The precise reason for the reduction in force required is not known but may be related to enhanced fat bursting attributed to the head of the cannula and window sections being moved into and across the fat cells in a repetitive motion while the cannula is being manually moved forward and rearward by the surgeon. Preferably, the power assisted liposuction handpiece will allow regulation of the suction pressure applied and/or the stroke length of the cannula (i.e., the distance the cannula tip travels from its fully extended to fully retracted positions in one reciprocal motion) and/or the degree of heating of the cannula or cannula tip for skin tightening benefits and/or the degree of energy emitted by the energy source. In this way, the tool can be used for excising different types of tissue and for working on different types of body fat. For example, it will be understood by one of ordinary skill in the art that the requirements of a liposuction tool in the neck region are different from those in the abdomen and/or legs. The liposuction handpiece of the present invention can be designed to allow for the interchange of cannulas using the same handpiece, the regulation of reciprocation speed, the regulation of suction, and the regulation of stroke length, thereby allowing the same tool to be used in a variety of applications and to meet the needs and desires of several different specialists.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The foregoing and other objects, aspects and advantages will be better understood from the following detailed description of the preferred embodiments of the invention with reference to the drawings, in which:

[0018] FIGS. **1***a-b* are side views of an exemplary power assisted, liposuction/lipoinjection tool according to the present invention respectively showing a cannula disconnected and connected to a reciprocating member of the handpiece;

[0019] FIG. **2** is a bottom plan view of the exemplary power assisted liposuction/lipoinjection tool showing hose clamping slots formed in the handle region;

[0020] FIG. **3** is a top view of a cannula connector;

[0021] FIG. **4** is a cross-sectional view of a cannula connector;

[0022] FIG. **5** is a cut-away cross-sectional view of a portion of a connector affixed to a reciprocating member of the handpiece, with a vacuum hose attached to the cannula end;

[0023] FIG. **6** is a side view of a connector which is integral with a reciprocating member and which is selectively connectable to and disengagable from disposable or re-usable cannulas;

[0024] FIG. **7** is an end view of a connector which can selectively connect different cannulas;

[0025] FIGS. **8***a-d* are plan views of several different cannula tips showing a variety of different window configurations;

[0026] FIG. **9** is a schematic of the exemplary liposuction/lipoinjection equipment showing collection of fat tissue in a filter, and suction control;

[0027] FIG. **10** is a schematic cross-sectional view of a cannula with an internal fluid or gas delivery tube;

[0028] FIGS. **11***a-b* are side views of exemplary alternative power-assisted liposuction handpieces, each having a branched cannula;

[0029] FIG. **12** is an image of an exemplary power-assisted laser liposuction handpiece having a cannula with a laser added to the tip;

[0030] FIG. **13** is a cut-away cross-sectional view of a cannula with added laser; and

[0031] FIG. **14** is a schematic drawing of a cannula with a heated tip.

DETAILED DESCRIPTION

[0032] The preferred embodiment of the invention is practiced with a power assisted liposuction tool such as the "PAL®" product sold by MicroAire Surgical Instruments of Charlottesville, Va. In particular, the energy application devices as best shown in FIGS. **12-14** of this patent application may be incorporated into a power assisted liposuction tool as described in U.S. Pat. Nos. 5,911,700, 6,139,518, 6,258,054, and 6,817,996, each of which are herein incorporated by reference. However, it should also be understood that the energy application devices and configurations may be employed with other power assisted liposuction tools in the practice of this invention. That is, any liposuction cannula which reciprocates or vibrates, which includes an aspiration mechanism, can benefit from having an energy source which delivers electromagnetic radiation or other energy from its tip area to emulsify, soften or liquefy fat tissue near the tip region of the cannula. Furthermore, any liposuction cannula which includes an aspiration mechanism, can benefit from having the cannula or a portion thereof (e.g., the tip region) heated to facilitate skin tightening after surgery. Thus, for exemplary purposes only, the invention is described in conjunction with the features of a power assisted liposuction tool as described in U.S. Pat. Nos. 5,911,700, 6,139,518, 6,258,054, and 6,817,996.

[0033] FIGS. **1***a* and **1***b* show the preferred embodiment of an exemplary power assisted liposuction/lipoinjection handpiece. A cannula **10** is selectively connectable and disconnectable from a handle **12**. The handle **12** includes a reciprocating member **14** which moves back and forth, as indicated by double headed arrow **16**, in a reciprocating motion. In the preferred embodiment, the handle **12** includes a pneumatic drive assembly (not shown) and is connectable to a compressed air source by connector **18**. An example of a suitable handle with internal pneumatic drive could be the MicroAire® 1400-100. However, it should be understood that any drive mechanism, including electrical, magnetic, etc., can be used to move the cannula **10** in a reciprocating motion **16**.

[0034] The speed of reciprocation is preferably variable under the control of a lever **20** actuated button or switch **22**, whereby complete depression of the lever **20** accelerates the reciprocation to its maximum speed, and partial depression of the lever **20** accelerates the reciprocation to speeds which are less than maximum speed. This enables the surgeon to adjust the speed as conditions require. However, it will be apparent to those skilled in the art that the liposuction tool could employ a simple on/off switch with a preset speed of reciprocation, or a series of pre-set speed buttons which allow the surgeon to selectively alter the reciprocation speed to any pre-established level. The optimum speed of reciprocation **16** may vary for different liposuction operations and/or from patient to patient. It is expected that for most liposuction operations, a maximum speed ranging from 10-100,000 cycles/minute will be suitable. While not shown, the handle **12** could be equipped with sensors and protection circuits which sense the speed of reciprocation **16**, and prevent the speed from exceeding a pre-set level, where the pre-set level could be established to protect either the patient or drive mechanism inside the handle **12**.

[0035] While FIGS. **1***a* and **1***b* show a "wand" style handle **12**, it will be understood by those of skill in the art that the configuration of the handle can vary widely to meet the needs or desires of the surgeon. Thus, the handle **12** could take the form of a pistol grip or other configuration, and the lever **22** could take the form of a trigger or other suitable mechanism. In the preferred embodiment, the stoke length, which is defined as the difference between the furthest point to which the cannula **10** extends and the shortest point cannula **10** extends in one reciprocating movement **16**, will preferably be greater than 0.1 mm and less than 1 cm. The preferred range in most applications will be 1-60 mm, and the most preferred is 1-3 mm. While the reciprocating motion **16** itself will allow for breaking up fat particles and aspiration of fat, it is expected that the surgeon will still move the cannula **10** back and forth, or in any other direction, during the liposuction procedure; thereby removing fat from areas he or she deems most appropriate. The reciprocating motion **16** enhances the surgeon's ability to move the cannula **10** after it has been inserted into the patient. When the cannula **10** is being reciprocated by a powered mechanism, particularly for short lengths of less than 1 cm, it is physically easier for the surgeon to move the cannula **10** through material to be aspirated. In this sense, the liposuction tool supplements the motions and procedures currently used by surgeons by making them easier and less tiring to perform. However, for certain procedures, the reciprocating movement **16** might serve as a complete replacement for back and forth movements made by the surgeon.

[0036] While not specifically shown in FIGS. **1***a-b*, a switch or dial or other suitable control structure may be associated with the handle **12** to allow the surgeon to change the stroke length for the cannula to meet his or her requirements for different applications. This control structure would then limit the movement of reciprocating member **14** to desired distance.

[0037] In one embodiment, a connector **24** or other suitable device, secures the cannula **10** to the reciprocating member **14** and to a vacuum hose **26** or other suitable source of vacuum pressure. Preferably, a push-button **28** or other selectively actuatable member on the reciprocating member **14** will be used to install and lock the connector **24** to the reciprocating member **14**, such that the cannula **10** will be safely retained on the handle **12** during liposuction. Push-button **28** is depressed as it enters a bore passage in the connector **24**, and when the connector is correctly installed the push-button returns to the upright position and is locked within a locking region **30** of the connector **24**. To remove the cannula **10**, the surgeon simply depresses the push-button **28**, and slides the connector **24** off the reciprocating member **14**. The connector **24** and its installation on the reciprocating member are discussed in more detail below in conjunction with FIGS. **3-5**. It should be understood that other locking mechanisms besides push-buttons **28** could be used within the practice of this invention, including for example latch mechanisms, pin mechanisms, and the like.

[0038] FIG. **2** shows that in one embodiment, the vacuum hose **26** is secured to the handle **12** via hose clamping slots **32** and **34** formed on the base of the handle **24**. The hose clamping slots **32** and **34** are open at the base so that the vacuum hose can be press-fit in place on the bottom of the handle **24** along region **36**. This allows the surgeon's hand to comfortably hold the handle **12** without becoming entangled with the hose **26**, and assures that the hose **26** remains firmly in place during operation of the liposuction/lipoinjection equipment. To enhance the ergonomics of the handle **12**, cut-out spheres **38**, and contours **40** can be provided.

[0039] To allow aspiration of fat tissue from the cannula, the vacuum hose **26** is fitted onto hose engaging member **38** at the rear of cannula **10** (or, alternatively a projection on the connector **24**). The hose engaging member **38** preferably takes the form of a hollow cylinder or a polygonal conduit which is wider in cross-section than the portion of the cannula **10** which is extended into the patient; however, it may be desirable to simply have the hose engaging member **38** simply be the end of the cannula **10**. All that is required is that the hose **26** fit onto the hose engaging member **38** and be securely held thereto.

[0040] It should be understood that the hose engaging member **38** can either be part of the connector **24** or be part of the cannula **10**. In the embodiment where the hose engaging member **38** is part of the connector **24**, a passage (not shown) through the connector **24** allows vacuum communication between the cannula **10** and the hose **26**. However, in a particular embodiment, the cannula **10** is directly connectable to the hose **26**. In the configuration shown in FIGS. **1***a-b*, the cannula **10** extends through the connector **24** and its base would be the hose engaging member **38**, and the thickness of the base would, if desired, be widened or made polygonal so that it fits snugly within the internal diameter of the hose.

[0041] The vacuum hose **26** will preferably be optically clear, thus allowing the surgeon to determine if the hose **26** is clogged with fat tissue aspirated from the patient's body through the cannula. By monitoring the vacuum pressure and hose line, the surgeon can determine when corrective measures need to be taken during liposuction. Polyvinylchloride is an example of a suitable material for the hose **26**. The chief requirements for the hose **26** is that it be flexible enough that it be able to be press-fit within and retained by the hose clamping slots **32** and **34**, it be sufficiently "stretchable", "pliable" or the like, that it can stretch with reciprocating movements **16** of the cannula without being released from the hose engaging member **38**, and have a sufficient internal diameter (not shown) to allow fat tissue and fluids aspirated from the patient's body to flow to a collection vessel or filter.

[0042] The design shown in FIGS. **1***a* and **1***b* shows the preferred embodiment of this invention where the cannula **10** is offset radially from the axis of the reciprocating member **14** such that it is in direct alignment with the vacuum hose **26**. Thus, the cannula **10** reciprocates along an axis which is parallel to the reciprocating member **14**, but which is in alignment with the section of the vacuum hose **10** affixed to the handle **12**. Alignment of the cannula **10** and vacuum hose **26** eliminates bent regions and, thereby enhances the ability of vacuum pressure to aspirate fat tissue through the cannula **10** into the vacuum hose **26**. Furthermore, the alignment makes it easier for the vacuum hose to remain affixed during reciprocation of the cannula **10**, as well as making it simpler to affix the connector **24** to the reciprocating member **14** and hose **26**.

[0043] While the design in FIGS. **1***a* and **1***b* provides for neat storage of the hose **26**, in some applications it may be desired to have the hose **26** more directly clamped to the cannula (e.g., by a hose clamp or other suitable device), and be freely moveable therewith. In this embodiment, the hose **26** would simply not be stowed under the handle **12** as shown, or, if the invention took the form of a pistol grip design the hose would simply project off to one side or be oriented in any other convenient manner which preferably does not interfere with the surgical operations being performed.

[0044] Having the cannula **10** disconnectable from the reciprocating member **14** provides advantages in terms of cleaning and or disposal; however, it should be understood that more permanent connections can be made. In some applications the cannula might be directly connected to the handle **12**, such as by a connection of the cannula **10** directly to a reciprocating drive mechanism, rather than to an intermediate reciprocating member **14**.

[0045] FIGS. **1***a* and **1***b* show an embodiment of the invention where the cannula **10** and connector **24** are be more or less permanently joined together. That is, they are integral such that the cannula **10**/connector **24** combination form a self-contained unit which can be selectively installed on the handle **12**. In this way, the cannula **10**/connector **24** can be sterilized together, and packaged in tubes or sterile packages for later shipment and use. Thus, when required by the surgeon, the package will be opened in the operating room and cannula **10** will be connected to the handle **10** in one step. The cannula **10** and connector **24** can be made from the same or different materials. In this embodiment the cannula **10** is a hollow metal tube and the connector is made from plastic. The cannula **10** and connector **24** can be permanently bonded together by an adhesive to create an integral structure, or simply be connected by a friction fit.

[0046] FIGS. **3-5** show additional details where the cannula **10** is affixed to a connector **24**. In FIG. **3**, the hose engaging member **38** at the rear end of the cannula **10** is shown as an enlarged conduit which is either integral with or affixed to the cannula **10**. Conversely, in FIG. **5**, the rear end of the cannula **10** is not enlarged and the vacuum hose **24** is affixed directly to the base of the cannula **10**. In either case, the cannula **10** extends through a cylindrical bore **42** in the connector **24**. The vacuum hose **26** is held on the handle **12** by the hose clamping slot **32** shown in partial cross-section, and the inner diameter of the hose **26** is in alignment with the inner diameter of the cannula **10** such that fat tissue broken or sliced off from a patient, or which is liquefied using laser or other energy output as described in more detail below, moves through the cannula **10** into the hose **26** and to a collection vessel. As explained above, the offset provided by the connector **24** assures proper alignment of the hose **25** and cannula **10**.

[0047] The vacuum hose **26** under the handle **12**, in one embodiment, does not move in conjunction with the reciprocating motion of the cannula **10** caused by the reciprocating member **14**. Rather, the hose **26** could elongate and contract with each reciprocal stroke of the cannula. Alternatively, the cannula **10** could move freely within the inner diameter of the vacuum hose **26**. In this case, the stroke length for the cannula **10** would need to be less than the length of the hose engaging end of the cannula **38** protruding from the connector **24**, such that the hose remains connected to the cannula at all times. As a further alternative, as discussed above, the hose **24** could be clamped to the hose engaging end **38** of the cannula and could be freely movable therewith; however, this alternative does not take advantage of the neat and clean hose storage feature of this invention.

[0048] The connector **24**, in one embodiment, includes a square bore **44** for connecting with the reciprocating member **14**. Making the reciprocating member **14** polygonal in shape assists in preventing the connector **24** from rotating axially about the reciprocating member **14** during high speed reciprocation. To affix the connector **24** on the reciprocating member **14**, the reciprocating member **14** is inserted into square bore **44**. An incline **46** formed in the connector **24** depresses the pushbutton **28**. However, once the pushbutton **28** reaches locking region **30**, it moves upward, via a spring mechanism or by other suitable means, and locks the connector **24** onto the reciprocating member **14**.

[0049] If desired, the reciprocating member **14** could be removed from the handle **12** to allow connecting other tools (e.g., saw blades, drill bits, etc.) to the same handle **12**. As indicated above, a suitable powered handle could be the MicroAire.RTM. 1400-000 which is used for driving reciprocating saw blades. Thus, if multi-tool functionality is desired, the reciprocating member **14** can be equipped with a drive connecting end **48** that fits on a pin connector **50**. The reciprocating member **14** may also have a guide slot **52** which slides on pin guide **54** during reciprocating movements. The reciprocating member **14** would be disconnected by removing securing ring from the front of the handle **12**, and then disconnecting the drive connecting end **48** from the pin connector **50**. This feature may also be used to connect larger and smaller reciprocating members, or reciprocating members having different shapes to the same handle **12**.

[0050] With reference back to FIGS. **1***a-b*, in some applications the cannula **10** could be disconnectable from the connector **24**. To aid installation and reduce connecting operations needed by the surgeon, the connector **24** could be formed as an intregal part of the reciprocating member. FIGS. **6** and **7** show alternative designs for a connector where the cannula can be disconnected. By allowing the cannula to be disconnected and connected as desired, the cannula configuration can be very simple (i.e., a hollow tube, preferably made of metal, with one or more cutting windows).

[0051] FIG. **6** shows a connector **56** which is integral with a reciprocating portion **58** which is fitted to a reciprocating drive mechanism (not shown). The connector has a bore hole **60** which extends through the length of the connector **56**. Cannulas (not shown) can be connected and/or disconnected from the connector **56** by inserting them through the bore hole **60**. A friction engagement, which can be supplemented with glue or other adhesives, holds the cannula within the bore hole **60**. While connector **56** is shown as being integral with reciprocating portion **58**, it should be understood that the same connector **56**, which allows for selective attachment and/or disengagement of desired cannulas thereto, could be attachable to a separate reciprocating member **14**, as is shown in FIGS. **1***a-b*.

[0052] FIG. **7** shows an alternative embodiment where a connector **62** includes a cannula locking portion **64** which rotates between an open position and a closed position (shown in dashed lines). A cannula (not shown) is inserted in the space between the connector **62** and locking portion **64**, and is secured to the connector **62** by shutting the locking portion **64** and securing its free end **66** by a lock **68** or other securing member. To disengage the cannula, the lock **68** is released, and the locking portion **64** of the connector is pivoted away from the connector **62** body.

[0053] FIGS. **8***a-d* show several examples of cannula tips. It should be understood that any type of cannula tip can be used in the practice of the present invention. As will be discussed in more detail below, a wire or laser can be employed to heat the tip region to enhance skin tightening post surgery. In addition, a laser diode or fiber optic or waveguide can extend to the tip to project electromagnetic energy, ultrasound or other energy into the surrounding adipose tissue to soften, liquefy or emulsify fat tissue near the tip region.

[0054] FIGS. **8***a* and **8***b* show cannulas **70** and **72** with spatula shaped heads. These types of cannulas are preferred in facial surgery and other types of liposuction where there is a need to separate fat from skin and muscle tissue and where space requirements are restricted. The spatula shaped head aids in separating the tissues. The face of the spatula shaped head can have a single cutting window **74** or a plurality of cutting windows **76**. The shape of the cutting window **74** or **76** can vary to suit the needs of the surgeon. While oval windows are commonly employed, it has been determined that square or rectangular windows **74** and **76** are preferred for spatula shaped heads since they tend to allow for more accurate shaving and sculpting of tissue. In facial surgery, in addition to allowing for aspirating fat tissue from the patient's body, the cutting window **74** or **76** tends to be used to cut tissue from the patient's body during each reciprocal motion. Therefore, it is preferred to have the stroke length of the cannula be equal to or larger than the longitudinal distance from the bottom of the cutting window to the top of the cutting window. In this way, each reciprocating stroke of the cannula **70** or **72** will slice off a piece of fat tissue for subsequent aspiration. By keeping the stroke length small (e.g. 1-3 mm) and the longitudinal length of the window **74** or **76** small (e.g., less than or equal to 1-3 mm), fat particles of a small size are excised, and these fat particles are less likely to clog the vacuum hose or cannula.

[0055] FIGS. **8***c* and **8***d* show cannulas **78** and **80** which are commonly used in full body or abdomen liposuction. FIG. **8***c* shows a blunt end cannula **78**, and FIG. **8***d* shows a bullet end cannula **80**. Each of these cannulas have one or a plurality of windows **82**, which are typically oval shaped, around the periphery of the cannula near the tip of the cannula **78** or **80**. In this type of liposuction, the reciprocating movement of the cannula **78** or **80**, as well as the forward and backward movements of the entire handpiece made by the surgeon, tends to break up fat particles. The fluids and particles which are released from these motions, or which are liquefied or emulsified using radiant energy delivered from the tip region, are simply aspirated through the windows **82** in the cannula **78** or **80**. In these applications, slicing by the windows **82** may or may not occur.

[0056] FIG. **9** shows a reciprocating liposuction tool **84** connected to a pump **86** or other vacuum pressure producing device. Fat aspirated through the cannula into the vacuum hose **88** is collected in a filter **90**. The filter **90** should have openings which are large enough to allow fluids such as blood, plasma, etc. to pass through, but be small enough to allow larger fat particles to be collected. Preferably the filter **90** can be placed directly in line with the hose **88** or be integral with the hose **88**. Fluids including blood pass through the filter **90** and are collected in collection vessel **92**.

[0057] Collected fat tissue is typically used for lipoinjection procedures. Thus, by collecting the fat from a liposuction operation in a filter **90**, the collected fat tissue can be more easily washed and then re-used in a lipoinjection procedure. In order to wash the collected fat, one would only need to remove the filter **90** and run wash or lavage fluids over the fat tissue until blood and other contaminants are removed. The cleaned fat tissue then can be re-injected into the cannula using a delivery hose and other pressure source. In a preferred embodiment, the pump **86** and vacuum hose **88** could be used for both the liposuction and lipoinjection procedures. Cleaned fat tissue would travel down the length of the cannula and would be layered into bores in the patient's body parts made by the surgeon by deposition through the windows **74**, **76**, or **82**. Thus, the use of a collection filter **90** in a liposuction/lipoinjection device provides the advantage of being able to more quickly wash and refuse excised fat tissue. Having the filter **90** in line with the vacuum hose allows the cleaning procedure to be performed immediately after liposuction. Alternatively, a wash line **94** could be connected to the filter **90** to allow cleaning to be performed during liposuction.

[0058] The fat collection filter **90** aspect of this invention can be used both with the liposuction/lipoinjection tool described above, and with conventional liposuction tools. All that is required is to provide a filter mechanism which allows isolation of fat tissue from other fluids during liposuction procedures. Prior art systems suffer from requiring a separate washing step to be performed on all of the collected tissue in the collection vessel **92** after the liposuction procedure is completed.

[0059] In a particular embodiment of this invention, the pump **86** or other vacuum pressure source could have controls **96** which allow the surgeon to adjust the vacuum pressure exerted at the cannula end. These controls **96** can take the form of dials, switches, buttons, or the like, and are designed to achieve vacuum pressures of varying strength. In most liposuction operations, a vacuum pressure ranging from 70-76 mm Hg is desired. However, greater vacuum pressures may be required if it is desired to use the liposuction tool of this invention in other applications. For example, this tool might also be used for removing bone chips in arthroscopic surgery, or removing cancerous lumps in biopsies, or in other applications. In addition to being able to select the type of cannula desired (e.g., selecting a cannula with large enough windows for cutting and removing cancerous tissue or bones), being able to adjust the vacuum pressure with controls **96** allows for the selective removal of different tissues. For example, at certain vacuum pressures only fat tissue will be aspirated into the windows of the cannula and removed from the patient's body, and surrounding muscle tissue will not be aspirated. However, if a cancerous lesion is desired to be removed, the surgeon would insert the cannula into the lesion and adjust the suction exerted by the pump **86** upward using controls **96**.

[0060] FIG. **10** shows an embodiment of the invention wherein the cannula **98** includes an internal member **100** which is intended to assist in clearing the cannula **98** of fat tissue aspirated through window **99**. Thus, in this embodiment, the internal member **100** is intended to prevent clogging during liposuction. The internal member **100** can take several different forms. In one embodiment, the internal member **100** delivers a gas (hydrofluorocarbons, oxygen, etc.) or fluid (water, saline, etc.) to the tip of the cannula **98**, which, in addition to the vacuum pressure exerted by the pump or other suction device, is intended to help carry the fat tissue down the length of the cannula and into the vacuum hose. To assist in connecting a fluid or gas delivery mechanism to the internal member, the vacuum hose can be fabricated with an internal conduit which carries the fluid or gas to the internal member. In this way, a single connection of the vacuum hose will connect both the cannula and its internal member for both suction and fluid or gas delivery, respectively. In another embodiment, the internal member **100** heats the cannula in order to enhance skin tightening after surgery. For example, the internal member **100** could take the form of a wire or heating member including, for example, a laser that applies energy to the surface of the cannula. In yet another embodiment, the internal member **100** can be an optical waveguide or fiber optic cable to deliver energy (laser, IR, UV, Vis, etc.) out the tip of the cannula **98** or a wire connected to a laser diode or other device (ultrasonic horn, RF antenna) positioned at the tip of the cannula **98** to deliver energy to the surrounding tissue. In an alternative embodiment, the internal member **100** could be an electrode or similar device which is intended to melt fat material after it is aspirated through window **99**. In this application, the internal member **100** could provide microwave energy, ultrasonic waves or heat energy during liposuction. Furthermore, it should be recognized that the cannula **99** could include a plurality of internal member **100** each which achieve different or identical functions as described above. While FIG. **10** shows the use of an internal member **100** for fluid or gas delivery or heat application to the cannula or energy delivery to the surrounding adipose tissue, it should be understood that the internal member **100** could also be positioned external to the cannula **98**, and be positioned to direct the fluid or gas through the window **99** of the cannula.

[0061] FIGS. **11***a-b* show alternative designs for the power-assisted liposuction handpiece of the present invention, each of which use a "Y" shaped cannula. FIG. **11***a* shows a "wand" style handpiece **110** connected to a pneumatic hose **112**, while FIG. **11***b* shows a "pistol grip" style handpiece **113** connected to a pneumatic hose **114**. A "Y" shaped cannula **116**, having a drive arm region **118**, a vacuum branch region **120**, and an insertion tip region **122**, is connected to the front portion of each handpiece **110** and **113**. The tip **124** of the cannula **116** can be narrowed into a point or spatula shape as shown in FIGS. **8***a-b*, or can be blunt ended, bulled shaped, or assume any other configuration desired. Suction from source **126**, which can be a syringe, pump, or other suitable device, is directed through vacuum hose **128** to the vacuum branch region **120** and into the insertion tip region **122**. As discussed above, the cannula **116** is hollow and allows fat tissue to be withdrawn from the patient into the insertion tip region, through the vacuum branch region and into a collection vessel (not shown), under the pressure exerted by source **126**. The drive arm branch **118** is connected to the handpiece **110** or **113** and, as described in detail above, the handpiece **110** or

113 reciprocates the cannula **116** back and forth. Lever **130** or trigger **132** can be used to vary the speed of reciprocation or simply to turn the reciprocating movement on and off. FIGS. **11***a-b* show that the same cannula **116** can be fitted onto different styles of handpieces, and it should be understood that the cannula **10** shown in FIGS. **11***a-b* can also be fitted onto different styles of handpieces in a similar fashion.

[0062] FIG. **12** shows a power-assisted laser liposuction handpiece with a laser **1050** added to the tip of the cannula **1000**. It should be understood that other energy sources could be positioned at the tip of the cannula **1000**, such as ultrasonic sources, RF sources, etc. The cannula **1000** is safely retained on the handle **1020** by a connector **1024**. The other end of the handpiece includes a connector **1018** to the power source (or compressed air source) and the vacuum hose **1026** used for liposuction, as described previously. The laser **1050** is preferably optimized to emulsify, liquefy or soften human or animal fatty tissue that is near the tip of the cannula **1000**. The laser **1050** (or other suitable energy source) projects the energy out the tip of the cannula **1000** to the surrounding tissue so that it might be softened, emulsified or liquefied. As discussed above, the surrounding tissue is then suctioned into the cannula **1000** to remove it from the patient's body.

[0063] FIG. **13** illustrates the combined action of the laser and the suction function of an exemplary power assisted liposuction device. A laser light generated from a laser source is conducted via a fiber-optic cable or waveguide **1051** through the length of the cannula **1000** to its tip. Alternatively, a laser diode or other source of laser energy emissions is placed at the tip of the cannula an is operated by a wired or wireless connection. Laser energy, or other energy (e.g., RF, ultrasound, etc.) is emitted in front of the cannula as is indicated by arrows **1052**. As a result, fat **1053** of adipose tissues targeted by the surgeon are emulsified, softened or liquified immediately. In addition, the cannula **1000** of the present invention, on its outside wall and distal end, provides at least one or a series of holes **1054** which are used to aspirate the emulsified or liquefied fat **1053** into the cannula **1000** for storage or disposal. The holes **1054** can also be used to slice or cut fat for suctioning into the cannula as described above in conjunction with FIGS. **8**A-D and elsewhere.

[0064] Although the use of laser or LED light conducted via a fiber-optic cable is utilized in one embodiment, other types of energy and means for directing and transferring the energy may be used in the operation of the present invention. Thus, any type of energy that can emulsify fat and tightens the skin at the same time can be used within the scope and operation of the present invention.

[0065] The concept of skin tightening using localized heat in the tip of a cannula can be practiced with powered liposuction hand pieces, as described by example in detail above, as well as in non-powered liposuction handpieces. Many patients who undergo surgery to remove excess fat end up with extra or loose skin. A device which can increase skin tightening effects will lead to a better patient outcome. By applying heat subcutaneously, collagen contraction can be stimulated. This can be accomplished during liposuction using a powered or a non-powered liposuction handpiece. In order to achieve the desired skin tightening heat is introduced subcutaneously by means of a cannula with a heated tip. An exemplary embodiment is shown in FIG. **14**. The tip temperature at the cannula can be controlled precisely by the surgeon in order to achieve desired results. Typically best skin tightening can be achieved by elevating the temperature of the skin to around 41° C., but depending on application this temperature may vary (e.g., temperatures of slightly above ambient to much warmer (e.g., 32-50 Celsius may be suitable in some applications).

[0066] As shown in FIG. **14**, the cannula **1400** may have a window **1402** which will allow adipose tissue to be removed while heating the skin. FIG. **14** shows that the tip region can be heated while the remainder of the cannula is not heated; however, in some applications, the entire cannula might be heated. Heating of the cannula might be achieved by a wire heater or other device being located within at least a portion of the cannula (e.g., the tip region), or be a laser or LED or other energy source which transfers radiant energy to the surface of the cannula. In some applications the same laser or LED source used to transfer energy to the surrounding adipose tissue, schematically designated as **1404**, could be used to heat the cannula tip. Alternatively, the heated cannula may be separate from the cannula which removes excess adipose tissue, depending on the needs of the surgery.

[0067] While the invention has been described in terms of its preferred embodiments, those skilled in the art will recognize that the invention can be practiced with modification within the spirit and scope of the appended claims.

1. A power assisted liposuction handpiece, comprising:

a handle;

a reciprocating or vibrating cannula connected to said handle, said reciprocating cannula having a hollow interior and at least one opening at a tip region which permits human or animal tissue to pass into an interior region of the cannula;

a suction device for applying suction to said interior region of the cannula to suction human or animal tissue which passes into the interior region of the cannula; and

an energy emitting member which emits energy from a tip region of said cannula to surrounding human or animal tissue so as to emulsify, liquefy or soften said surrounding human or animal tissue.

2. The power assisted liposuction handpiece of claim **1** wherein said energy emitting member includes a laser.

3. The power assisted liposuction handpiece of claim **1** wherein said energy emitting member includes a fiber optic cable or optical waveguide.

4. The power assisted liposuction handpiece of claim **1** wherein said energy emitting member elevates a temperature of at least a portion of said cannula.

5. The power assisted liposuction handpiece of claim **1** wherein said at least one opening in said cannula includes a plurality of openings.

6. The power assisted liposuction handpiece of claim **1** wherein said at least one opening in said cannula includes an edge for cutting human or animal tissue adjacent said at least one opening.

7. A liposuction handpiece which provides for improved skin tightening, comprising:

a cannula having a forward end and a distal end, said cannula having a window at its forward end for extracting fat; and

a heating member for heating at least a portion of said cannula.

8. The liposuction hand piece of claim **7** further comprising a means for reciprocating said cannula back and forth along in line with its longitudinal axis.

* * * * *

patsnap

专利名称(译)	带有辐射能源的手术吸脂器械		
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[标]申请(专利权)人(译)	FERENCE JEFF 巴拉德·瑟曼 GEISERT DANIEL		
申请(专利权)人(译)	FERENCE JEFF 巴拉德·瑟曼 GEISERT DANIEL		
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摘要(译)

用于吸脂装置的套管包括用于在尖端附近液化，乳化或软化脂肪组织的能量源。能量源可以通过光缆提供激光能量，或者可以从激光二极管等提供诸如RF，超声波或IR / UV / Vis能量的能量。脂肪通过套管发出的能量乳化，液化或软化，并通过设置在外壁和套管远端的一系列孔抽吸除去。在动力辅助实施例中，套管中的开口剪切或切割邻近的脂肪组织。可以加热插管的尖端以促进皮肤收紧。