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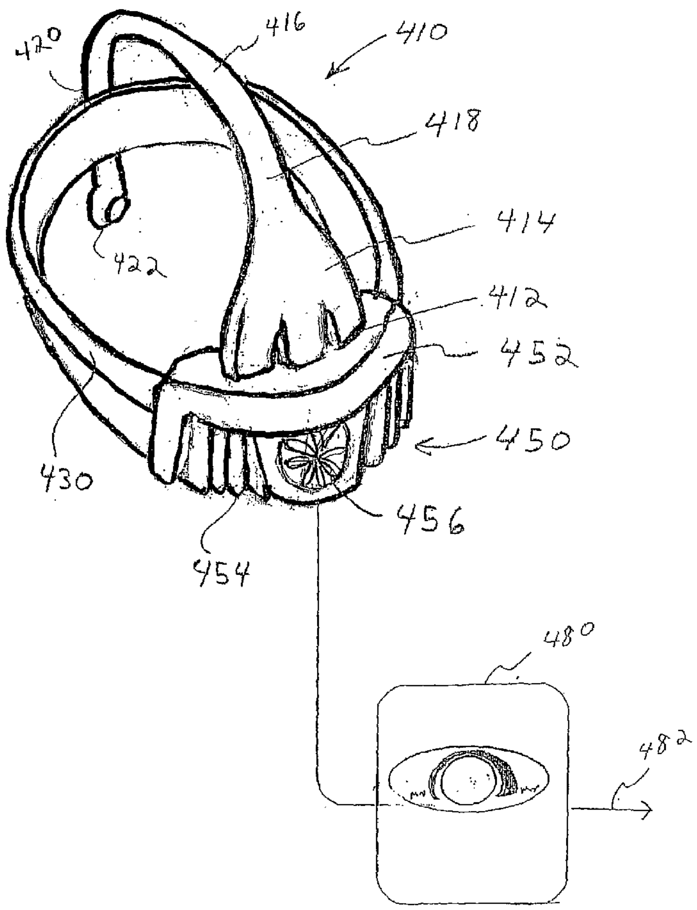
(54) **Title:** ILLUMINATION DEVICE



(57) Abstract: A surgical headlight that uses multiple LEDs to produce illumination. Heat sinks and heat transfer materials are used to dissipate heat produced from the LEDs. The light from the LEDs is directed, using collimizers, into a light conduit. The light from these multiple LEDs is combined, homogenized, and focused on a working area. The light transmission system may include an adjustable lens so that the light may be focused at multiple focal distances and with varied areas of illumination. The LEDs may be powered by a battery or an AC source and may comprise one or more red LEDs, one or more blue LEDs, and one or more green LEDs. A controller may be used to create specific frequencies of light by combining various colors of the LEDs.

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ILLUMINATION DEVICE

Field of the Invention

[0001] The present invention relates to an apparatus and method for illuminating work areas such as surgical fields.

Background of the Invention

[0002] Medical providers use surgical headlights to illuminate a surgical field. Such headlights are worn on the medical provider's head and may utilize halogen or metal halide light sources, as well as xenon lights, to provide illumination. The Xenon light source may be located on a rack. The light source projects light, via a fiber optic cable, to the headlight system. Light emitting diodes (LEDs) may also be used, providing various advantages over prior illumination methods including reducing the weight, cost, heat, maintenance and discomfort generally associated with the traditional headlight. Drawbacks for these devices include: limited bulb life, excessive cost, fragile fiber optic cables, insufficient illumination, and limited mobility for the user.

[0003] Examples of related devices include the 49820 Xenon Surgical Headlight System from WelchAllyn [WelchAllyn, Inc., 4341 State Street Road, Skaneateles Falls, New York 13153-0220 USA]. The device connects a Xenon light source, instead of LEDs, to a headlamp using fiber optic cables. The device is attached to a light source that has limited to no mobility. This constrains the user who is tethered, via the fiber optic cables, to the light source. Unsurprisingly, the fiber optic connection between the lamp and light source is placed under great strain, resulting in reliability issues for the headlight unit. WelchAllyn also supplies the 49020 5 watt LED Procedure Headlight, which utilizes a single 5 watt LED and produces 100 Lumens of white light. In addition, the HALO headlight, by Enova Medical Technologies (1839 Buerkle Road, St. Paul, Minnesota 55110 USA), uses two white LEDs and no fiber optic cables. However, the prior art's limited use of LEDs results in brightness that is not optimal, thereby producing less light than more traditional surgical headlights such as Xenon-board devices.

[0004] Thus, a need exists for a mobile surgical headlight that utilizes LEDs to lower cost, weight and heat, while still providing light adequate to illuminate the working area.

SUMMARY OF THE INVENTION

[0005] In one embodiment of the invention, a surgical headlight comprises multiple LEDs. Each LED is powered by a battery. Each LED is coupled to a heat sink to promote heat dissipation. Furthermore, each LED is connected to a collimator that directs light from the LED into a fiber optic cable. The collimator may comprise or be coupled to one or more lenses. The fiber optic cables guide light from the LED towards a LED combiner. There, the light from each LED is directed so that each LED's light is combined with light from the other LEDs. The surgical headlight produces light of an intensity greater than about 100 lumens. In other embodiments of the invention, the headlight produces light of an intensity greater than about 300 lumens. Still other embodiments produce light greater than about 500 lumens.

[0006] In another embodiment the fiber optic cable and collimator are made as one continuous light pipe. In this embodiment the light from the LEDs is directed into the light pipe and transmitted to a projection lens at the front of the headpiece. From this projection lens, light then is broadcast onto the working field.

[0007] In another embodiment of the invention, the headlight comprises three LEDs while in other embodiments; the headlight comprises six, nine or twelve LEDs. In one embodiment of the invention, a blue LED, a red LED and a green LED combine to produce white light. In another embodiment, a filter is used to remove color components from one or more LEDs. In still another embodiment, current balancing circuitry is used to vary the intensity of one or more of the multiple LEDs.

[0008] In yet another embodiment of the invention, the LED combiner comprises a lens and an actuator for actuating the lens. As a result, the light from the LEDs may be focused at various focal points.

[0009] In still another embodiment of the invention, the collimator comprises a dowel or complex light pipe to gather and direct the light from the LEDs.

[00010] In another embodiment of the invention, the LEDs are mounted on a headset. In other embodiments, the LEDs are mounted on an belt worn around the user's waist or on a belt fastened to the user's arm. The battery or batteries, that supply energy to LEDs, may be mounted on the headset or on a belt worn around the user's waist or arm.

[00011] One embodiment of the invention weighs less than about 12 ounces.

[00012] In still another embodiment, the invention is used to illuminate a surgical scope or, for example, a retractor involved in endoscopic procedures.

[00013] The foregoing has outlined rather broadly the features of the present invention in order that the detailed description of the invention that follows may be better understood. Additional features and advantages of the invention will be described hereinafter, which form the subject of the claims of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[00014] For a more complete understanding of the present invention, and the advantages thereof, reference is now made to the following description taken in conjunction with the accompanying drawings, in which:

[00015] FIGURE 1 is an example of one embodiment of a surgical headlamp.

[00016] FIGURE 2 is an example of one embodiment of a headset for use with a surgical headlight.

[00017] FIGURE 3 is an example of one embodiment of an LED combiner.

[00018] FIGURE 4A is perspective view of another embodiment of a surgical headlight.

[00019] FIGURE 4B is an alternative perspective view of the embodiment of FIGURE 4A.

DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

[00020] FIGURE 1 illustrates one embodiment of the invention. A surgical headlight 130 (also referred to as a headlamp) comprises three LEDs 145, 146, 147. The LEDs 145, 146, 147 are located on Each LED 145, 146, 147 is powered by a battery 170. Each LED 145, 146, 147 may be powered by its own power supply (e.g., battery 170) or one power supply may power all of the LEDs 145, 146, 147. The LEDs 145, 146, 147 may connect to the battery 170 (e.g., lithium-ion) via electrically shielded cables 148 or, for example, an integrated circuit or BUS. The battery 170 may be located on the headlight 130 or attached on a belt fastened to the user's arm or waist. In one embodiment of the invention, the battery 170 is capable of producing 10 volts per every 5 watt LED and could last four or more hours between recharging sessions. The battery 170 may be capable of "hot swapping" whereby a charge is retained thereby allowing the headlamp to temporarily produce light while batteries are exchanged.

[00021] Each LED 145, 146, 147 may be coupled to a heat sink 150, 151, 152 to promote heat dissipation. Each LED may be coupled to its own individual heat sink or multiple LEDs 145, 146, 147 may utilize one such heat sink. In addition, fans or micro pumps may be used to actively cool the LEDs 145, 146, 147 and/or heat sinks 150, 151, 152. The heat sinks 150, 151, 152 are employed because high powered LEDs 145, 146, 147 produce heat that must be dissipated to avoid causing the user discomfort. Due to the amount of heat generated by the LEDs 145, 146, 147, the heat sinks 150, 151, 152 may be distanced from the user by one to two inches. Such a position not only allows the user to be located a reasonable distance from the heat source, but also allows for airflow around the LED to promote cooling. The heat sinks 150, 151, 152 may have a "waffle" or "honeycomb" shape to increase their surface area

and piezoelectric crystals may be used to enable faster dissipation of heat. Alternatively, the heat sinks 150, 151, 152 may optionally comprise of any low weight, conductive material such as, for example, airplane aluminum, polycarbonate/metal alloys, fiber glass or bubble glass. The heat sinks 150, 151, 152 may also use an isolative material such as Areo gel to protect the user from any radiant heat created by the LEDs. This material may also function to dampen any vibrations that may result from the use of an active cooling system. In order to create greater surface area, a thermal transmission material may be used to transmit heat to remote locations. Some examples of thermal transfer materials include Pyrolytic Graphite sheets and Carbon Nano tubes.

[00022] The LEDs 145, 146, 147 selected may, for example, comprise a 5 watt Luxeon III Star and/or Luxeon V Star, available from Lumileds Lighting, LLC (370 West Trimble Road, San Jose, California, 95131 USA). Alternatively, the Osram LEWE3A available from Osram Opto Semicunductors Gmbh Wernerwerkstrasse 2 D-93049, Regensburg, Germany may be used. Those of ordinary skill in the art will appreciate that other LEDs may optionally be used. Additionally, lower wattage LEDs (e.g., 1 or 3 watts) may also be used if less heat and brightness are acceptable design choices. The LEDs 145, 146, 147 may be selected according to the desired end use for the headlight 130. For example, in neurological surgery, tissue differentiation is critical and thus, white light, of extreme brightness, is advantageous. Furthermore, "cool" lighting is desirable in order to avoid drying tissues during a procedure. To that end, color temperature of 5,000 degrees Kelvin, or less, may be advantageous.

[00023] To achieve a high level of bright white light (e.g., 500 lumens) with LEDs, blue LEDs may be filtered, thus leaving white light. In addition, such light may be generated by using a combination of lights such as, for example, red, blue, and green lights. In one embodiment of the invention, as seen in FIGURE 1, the headlight 130 comprises three LEDs 145, 146, 147 including one red LED 145, one green LED 146 and one blue LED 147. To increase brightness, other embodiments of the invention may comprise six, nine, or twelve LEDs. For example, another embodiment of a headlight may comprise four red LEDs, four green LEDs, and four blue LEDs. It is understood that the number of LEDs disclosed herein are mere examples and that the number of LEDs used may vary depending on the type of application the headlight is used for. According to design preference, a red LED 145 may, for example, be replaced or coupled with a red-orange or amber LED. A blue LED 147 may be replaced or coupled with royal blue LED. Choosing different colors, and possibly adjusting current delivered to such LEDs, allows the headlight 130 to achieve varied levels of brightness in exchange for, as an example, varied levels of power consumption. Such flexibility also allows for cost, performance, and availability variances associated with differently colored LEDs to be accounted for without substantially varying the operation principles of the headlight 130.

[00024] In one embodiment, color LEDs may be coated with a phosphorus coating to create white light from, for example, the blue LED 147. As those of ordinary skill in the art will appreciate, color LEDs or LEDs with varied coatings may be incorporated into the headset to compensate for light color that is missing from the headlight's light spectrum. Further, BIN selection of the LEDs may be used to generate specific frequencies of light.

[00025] To vary the intensity of light produced from each LED 145, 146, 147, a person of ordinary skill in the art will appreciate how current balancing circuitry may be used to distribute current in varying levels to different LEDs. Accordingly, less current may be supplied to, for example, the red LED 145 than the blue LED 147. Adjusting the current level allows the headlight 130 to produce white light with no color tint. However, high current levels may also be supplied, for example, to the red LED 145 to produce light with a red tint. Different medical users may choose specific spectrums to identify varied tissues such as, blood vessels, bone or connective tissue. This effect is currently obtained by filtering the light from a white xenon light and is referred to as Narrow Band with Imaging (Olympus America Inc. 3500 Corporate Parkway P.O. Box 610, Center Valley, PA 18034-0610). As is appreciated by those of ordinary skill in the art, various techniques for dimming light from all or any LED 145, 146, 147 may be used. Typical techniques include pulse width modulation or current amplitude dimming with, for example, potentiometers and related circuitry. In one embodiment an "intelligent controller" such as the Avago Jazz Board (350 W. Trimble Rd. Bldg. 90 San Jose, CA 95131) may be used to enhance or contrast specific color spectrums that are to be broadcasted from the headlight 130. In one embodiment, an RGB Ostar, available from Osram Semiconductors (Gmbh Wernerwerkstrasse 2 D-93049, Regensburg, Germany) (www.osram-os.com), may be used to adjust illumination from different colored LEDs to produce white light or to produce a specific spectrum light.

[00026] The LEDs 145, 146, 147 may be coupled to an LED driver to regulate current to the LEDs. An example of such a driver is the 12VDC 5W LED Drive Module PowerPuck (Model # 2008) from LEDdynamics. (LuxDrive, Division of LEDdynamics, Inc., 44 Hull Street, Randolph, Vermont 05060-0444) or one of many drivers provided by Supertex (1235 Bordeaux Drive Sunnyvale, CA 94089). Such a DC to DC or AC to DC converter delivers a fixed output current by varying the output voltage as required to maintain the specified current. The drivers may be calibrated so that different levels of current are supplied to different LEDs to ensure white light is produced. Such current levels may be fixed or variable, as appreciated by those of ordinary skill in the art. These controllers may also be coupled to an active cooling system, such as fans and/or micro pumps. The active cooling system may be configured to increase its cooling output when the intensity of the LEDs are increased.

[00027] Through use of multiple LEDs, the surgical headlight 130 may produce light of an intensity greater than about 300 lumens. For example, blue LEDs are typically capable of producing 23

lumens, red LEDs may produce 140 lumens, and green LEDs may produce 64 lumens. When white light of insufficient brightness is produced, the number of LEDs can be increased. Using, for example, twelve LEDs may produce light of an intensity greater than about 500 lumens.

[00028] The LEDs 145, 146, 147 may attach, directly or indirectly, to a headset 155. The LEDs 145, 146, 147 may be attached to the headset 155 by brackets, clips, or other suitable fasteners. Alternatively, the LEDs 145, 146, 147 may optionally be attached by a quick release mechanism known in the art. The headset 155 comprises a horizontal band 156 having a substantially oval shape and multiple curved vertical bands 157, 158, 159. The shape and number of bands disclosed herein are mere examples and it is understood that the shape and number of bands may vary depending on design preference. Referring also to FIGURE 2, illustrated is another headset 230 that may be used with the headlight 130 of FIGURE 1. As shown in FIGURE 1, the headset 155 may incorporate one or more ratchets 125 to allow for adjustments so that the headlight 130 may accommodate multiple users. The ratchets 125 may be located on the horizontal band 156 as well as on the vertical band 157. The other vertical band 158, 159 may be used whereby, through use of various holes 120 and probes, the headset 155 may be customized further. The headset 155 may be composed of semi-ridged plastic or other suitable material. The headset 155 may be constructed so that it is rigid enough to uphold the weight of the LEDs 145, 146, 147 and heat sinks 150, 151, 152. In addition, the headset 155 may comprise hinges or pivots 181, 182 located on the horizontal band 156, thereby allowing the headset 130 to collapse into a compact form provided, for example, the vertical bands 157, 158, 159 can be unattached from the headset 155. In other embodiments, instead of attaching to the headset 155, the LEDs 145, 146, 147 may be mounted on an belt worn around the user's waist or on a belt fastened to the user's arm.

[00029] Furthermore, each LED 145, 146, 147 may be connected to a collimator 140, 141, 142 that directs light from the LED 145, 146, 147 into a respective fiber optic cable 105, 110, 115. The fiber optic cables 105, 110, 115 guide light from each LED 145, 146, 147 towards an LED combiner 100. The fiber optic cables 105, 110, 115 may extend, independently, from the LEDs 145, 146, 147 to the LED combiner 100. The fiber optic cables 105, 110, 115 may be securely fastened to the headset 155. Alternatively, the fiber optic cables 105, 110, 115 may optionally be bundled together, in a shielded shroud, to further protect the fiber optic cables.

[00030] In one embodiment of the invention, the collimator 140, 141, 142 may be avoided by directly connecting the LED 145, 146, 147 to the fiber optic cable 105, 110, 115. In other embodiments, however, a collimator 140, 141, 142, such as the LXHL-NX05 Luxeon Collimator, may be used. (Lumileds Lighting, LLC, 370 West Trimble Road, San Jose, California, 95131). Collimators with, for example, 90% efficiency may allow for the use of fewer LEDs to obtain the desired level of brightness.

As understood by a person or ordinary skill in the art, items such as glass dowels may be used instead of or in addition to the collimator 140, 141, 142.

[00031] In the LED combiner 100, the light from each LED 145, 146, 147 is directed so that each LED's light is combined with light from the other LEDs. The light from each LED 145, 146, 147 may be combined at the LED combiner 100 or projected on a path such that the light from each LED 145, 146, 147 is combined at a focal point that is, for example, twenty-four inches away from the headlight 130. The LED combiner 100 may comprise or be coupled to a fiber optic cable coupler, such as, for example, a 3 to 1 coupler from FOCI Fiber Optic Communications, Inc (20550 Nordhoff St., Chatsworth, California 91311 USA). In one embodiment, the LED combiner 100 may utilize a RGB scrambler to combine the red, green and blue light into, for example, white light. As those or ordinary skill in the art will appreciate, an RGB scrambler or combiner, comprised of, for example, multi-gradient lenses may be used. The LED combiner 100 may further comprise a lens 180 and an actuator 175 for actuating the lens connected to a housing 101. As a result, the light from the LEDs 145, 146, 147 may be combined and focused at various focal points. For example, the light may be focused at 18 inches, 30 inches, or at any point therebetween, to accompany a user's preferences. The LED combiner 100 may be supported on the headset 155 using brackets 160 and/or a telescoping mount. Furthermore, the lens 180 may also cooperate with a pivot joint to allow the user to direct the light beam.

[00032] Now referring to FIGURE 3, an LED combiner 300 is shown and may be used in the headlight 130 of FIGURE 1. The LED combiner 300 may be constructed by molding, fiber splitting or by gluing glass/quartz single fibers to a base 305 that comprises a lens. Acrylic, polycarbonate, high clarity plastic or any other molded material with low light resistance may be used in constructing the LED combiner 300. Flexible glass or quartz fiber reinforced with a thin coating, for protection, may also be used. A transparent adhesive may be used to couple the fiber optic cables 310 to the LED combiner base 305. The base 305 could be manufactured as a separate piece from the fiber optic cables 310.

[00033] In another embodiment, multiple glass fibers may be used with the headlight 130 of FIGURE 1. For example, a fiber bundle (e.g., 5,000 to 10,000 fibers) may be split and run to each individual collimator 140, 141, 142.

[00034] In other embodiments, those of ordinary skill in the art will appreciate that a laser may substitute for the LEDs 145, 146, 147 of FIGURE 1. For example, white lasers may be so utilized. In FIGURE 1, the LEDs 145, 146, 147 may be coupled to a respective fiber optic cable 105, 110, 115. However, the laser may be affixed to, for example, the headset 130 and project light onto the surgical field without use of any fiber optic cable.

[00035] Now referring to FIGURES 4A and B, another embodiment of a headlight is shown. As shown in FIGURES 4A and B, the light conduit is designed so that light from the LEDs may be combined at the LED end of the device, as opposed combining at the projection end as shown in FIGURE 1, thus requiring only one conduit to transmit light over the length of the device. Specifically, headset 400 includes three LED boards 412 disposed at the rear of the headset. Each LED board 412 includes six individual LED diodes. The LED boards 412 are optically connected to light combiner 414 via optically clear adhesive. The illustrated combiner includes three collection lenses each connected to an associated LED board 412. The output of the light combiner 414 is optically transmitted into the rear portion 418 of wave guide 416. Light is transmitted along the wave guide 416 from the rear portion 418 toward the front portion 420. The front portion 420 includes a projection lens 422 to focus the received light and/or adjust the aperture to modify the light spot size. In the illustrated embodiment, the projecting lens 422 is integrally formed with the wave guide 416. Alternatively, the projecting lens 422 may be one or more separate components optically coupled to the wave guide 416. Still further, in the illustrated embodiment, the light combiner 414, wave guide 416 and the projecting lens 422 are made as a single component in order to enhance optical efficiencies. It is contemplated that the optical transmission components are made from any material that is substantially optically clear, some examples of useful materials may include but are not limited to carbon and non-carbon based optically clear materials such as acrylic, PVC, and silicon.

[00036] The optical system described above is mounted on head band 430 which is similar in construction to previously described headband 230. Additionally, a heat sink system 450 is connected to LED boards 412. Heat sink system 450 includes heat sink housing 452, a series of connected fins 454 and a motorized fan 456. The fins 454 may also be constructed as pins or other geometries that increase surface area and allow air flow. In addition, as shown more clearly in FIGURE 4B the heat sink system includes a heat transmission conduit 458 which is connected to fins 460 and 462. This structure allows the heat sink system 450 to utilize greater surface area to dissipate heat. A similar heat transmission conduit and series of fins is disposed on the opposite side of the headset 400. The heat sink system 450 is formed from materials described above with respect to heat sinks 150 and 151. The present embodiment enhances cooling efficiency by actively removing heat with the inclusion of a fan to increase air flow across the fins. In contrast to the embodiment of FIGURE 1 where the LED's and heat sinks are the distributed about the wears head, the present embodiment had the LED's closely arranged and a single heat sink is utilized for all of the LED's to remove the heat generated. The system further includes a controller 480 that controls the LED output and the heat sink system. As set forth above with respect to the embodiment FIGURES 1-3, the controller may perform a variety of functions. As more fully described above, the head set may be powered by a connection 482 to batteries or power from wall receptacles.

[00037] One embodiment of the invention weighs less than about 12 ounces.

[00038] In still another embodiment, the invention is used to illuminate a surgical scope involved in endoscopic procedures such as, for example, laparoscopic gall bladder removal. The headlight is also appropriate for other lighting environments including: dental, emergency room, paramedics, auto mechanics and mineral mining.

[00039] The presently disclosed embodiments are to be considered in all respects as illustrative and not restrictive. The scope of the invention is indicated by the appended claims, rather than the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are, therefore, intended to be embraced therein.

WHAT IS CLAIMED IS:

1. A surgical illumination system comprising:
multiple LEDs;
a heat sink coupled to one or more of said LEDs;
multiple collimators, wherein each of said LEDs is coupled to one of said collimators;
multiple fiber optic cables, wherein each of said collimators is coupled to one of said fiber optic cables;
an LED combiner coupled to said fiber optic cables; and
a power supply coupled to said LEDs.

2. The system of claim 1, wherein said LED combiner comprises a lens for focusing light from said LEDs onto a working area.

3. The system of claim 2, wherein said LED combiner further comprises an actuator coupled to said lens for actuating said lens to provide multiple focal points for said light from said LEDs.

4. The system of claim 1, wherein said LEDs combine to provide illumination greater than about 300 lumens.

5. The system of claim 1, wherein said LEDs combine to provide illumination greater than about 500 lumens.

6. The system of claim 1, wherein said LEDs comprise three or more LEDs.

7. The system of claim 1, wherein said LEDs comprise six or more LEDs.

8. The system of claim 1, wherein said LEDs comprise nine or more LEDs.

9. The system of claim 1, wherein said LEDs comprise twelve or more LEDs.

10. The system of claim 1, wherein said LEDs combine to provide white light.

11. The system of claim 1, wherein said LEDs comprise a blue LED, a red LED, and a green LED.

12. The system of claim 1, wherein one or more of said LEDs is not a white LED.

13. The system of claim 1, further comprising a filter coupled to one or more of said LEDs.

14. The system of claim 1, further comprising a current balancing circuitry coupled to one or more of said LEDs, wherein the current balancing circuitry is configured to allow for broadcast of specific spectrums of light.

15. The system of claim 1, further comprising an endoscopic device coupled to said LEDs.

16. The system of claim 1, further comprising a headset coupled to said LEDs.

17. The system of claim 1, wherein said surgical illumination system weighs less than about 12 ounces.

18. A surgical headlight apparatus comprising:

multiple LEDs;

one or more fiber optic conduits, wherein said LEDs are coupled to said one or more fiber optic conduits;

a lens coupled to said one or more fiber optic conduits; and

a power supply coupled to said LEDs.

19. The apparatus of claim 18, wherein said LEDs combine to provide illumination greater than about 300 lumens.

20. The apparatus of claim 18, wherein said LEDs combine to provide illumination greater than about 500 lumens.

21. The apparatus of claim 18, wherein said LEDs comprise three or more LEDs.

22. The apparatus of claim 18, wherein said LEDs comprise six or more LEDs.

23. The apparatus of claim 18, wherein said LEDs comprise nine or more LEDs.

24. The apparatus of claim 18, wherein said LEDs comprise twelve or more LEDs.

25. The apparatus of claim 18, wherein said LEDs comprise a blue LED, a red LED and a green LED.

26. A method for providing illumination comprising:
projecting light from multiple LEDs into two or more fiber optic conduits;
combining said light from said two or more fiber optic conduits into a light beam; and
projecting said light beam onto a working field.

27. The method of claim 26, wherein said LEDs combine to provide illumination greater than about 300 lumens.

28. The method of claim 26, wherein said LEDs combine to provide illumination greater than about 500 lumens.

29. The method of claim 26, wherein said LEDs comprise three or more LEDs.

30. The method of claim 26, wherein said LEDs comprise six or more LEDs.

31. The method of claim 26, wherein said LEDs comprise nine or more LEDs.

32. The method of claim 26, wherein said LEDs comprise twelve or more LEDs.

33. The method of claim 26, wherein said LEDs comprise a blue LED, a red LED, and a green LED.

34. A surgical headlight comprising:
a head unit for wearing on a user's head;
at least three LEDs, wherein each LED includes a heat sink;
an LED combiner optically coupled to said LEDs;
a lens coupled to said LED combiner; and
a power source electrically coupled to said LEDs.

35. The headlight of claim 34, wherein said head unit comprises a top portion, front portion, first side portion, second side portion, and rear portion.

36. The headlight of claim 35, wherein said LED combiner is located on said front portion.

37. The headlight of claim 36, wherein one of said LEDs is located on said top portion, another one of said LEDs is located on said first side portion, another one of said LEDs is located on said second side portion, and said power source is located on said rear portion.

38. The headlight of claim 36, wherein one of said LEDs is located on said rear portion, another one of said LEDs is located on said first side portion, and another one of said LEDs is located on said second side portion.

39. The headlight of claim 38, wherein said power source is mounted on a user's body and spaced from said user's head.

40. A surgical illumination system comprising:
a light source mountable on a person;
a waveguide optically connected to said light source;
a head lens optically connected to said waveguide;
wherein said light source is spaced from said head lens.

41. The system of claim 40, further comprising a head mounting assembly having a front portion and a rear portion.

42. The system of claim 41, wherein said light source is located on said rear portion and said head lens is located on said front portion.

43. The system of claim 40, wherein said light source is mounted on said person's body and spaced from said person's head.

44. The system of claim 40, further comprising a cooling system.

45. The system of claim 44, wherein said cooling system is an active cooling system.

46. The system of claim 45, wherein said active cooling system and said light source are mounted on said person's head.

47. The system of claim 40, wherein said waveguide is a single conduit between said light source and said head lens.

48. The system of claim 40, wherein said light source includes at least three LEDs.

49. The system of claim 48, wherein said light source includes a blue LED, a red LED, and a green LED.

50. The system of claim 40, wherein said light source includes at least three LEDs and a combiner optically coupled to said waveguide.

51. A lighting system, comprising:

a plurality of LED light elements;

a light combiner optically connected to said plurality of LED light elements;

a light conduit having a first end connected to said light combiner and an opposite second end, light being transmittable from said first end to said second end.

52. The system of claim 51, wherein said light combiner and said light conduit are integrally formed from a single piece of material.

53. The system of claim 51, wherein said second end is formed to utilize optical geometries to focus light received from said first end.

54. The system of claim 51, further including a lens attached to said second end.

55. The system of claim 54, wherein said lens is an aperture adjusting lens.

56. The system of claim 51, wherein said LED light elements comprise two or more LED boards having a plurality of LED diodes formed thereon.

57. The system of claim 56, wherein said LED light elements are of different BIN selection configured to produce specific frequencies of light.

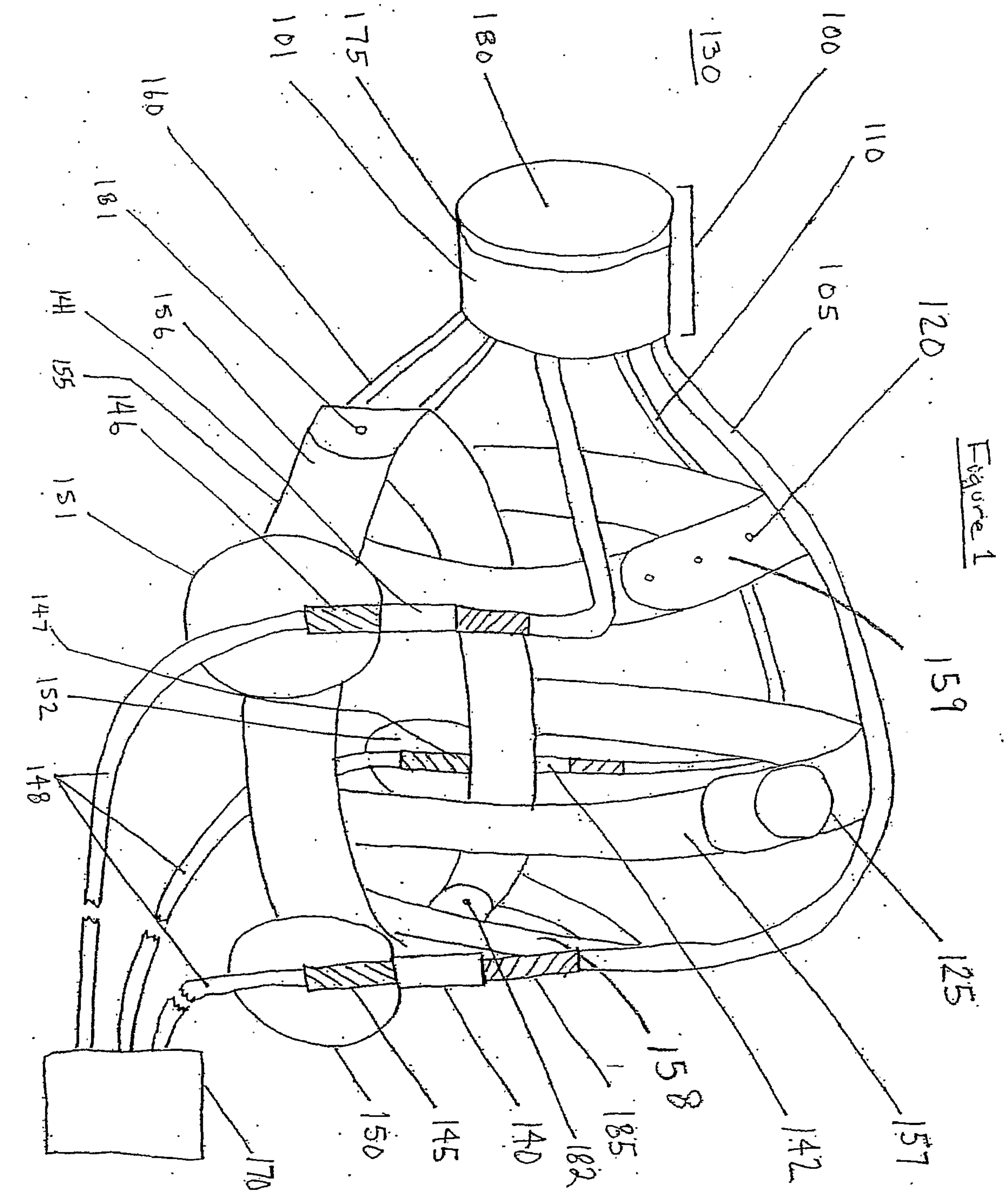
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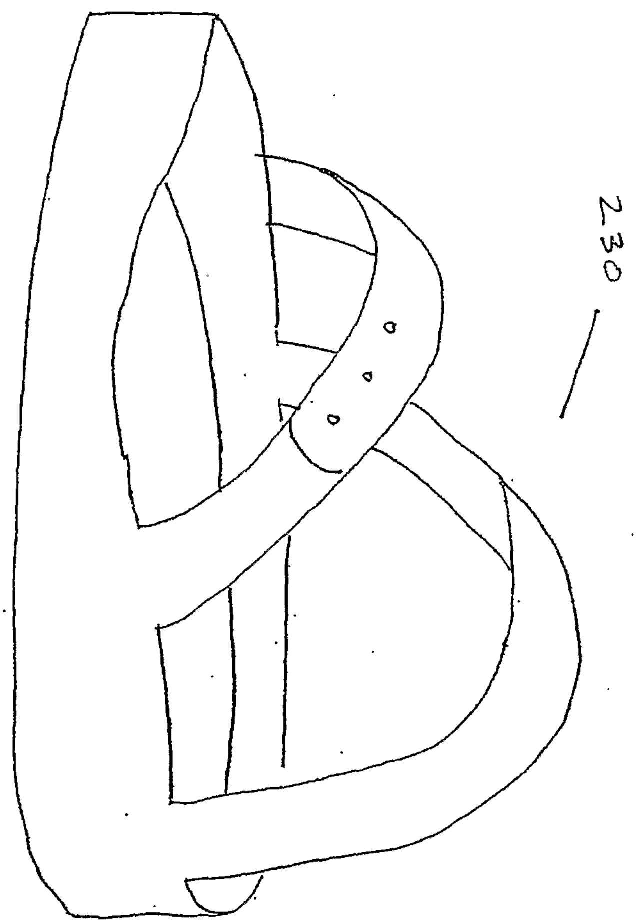
Figure 1

Figure 2



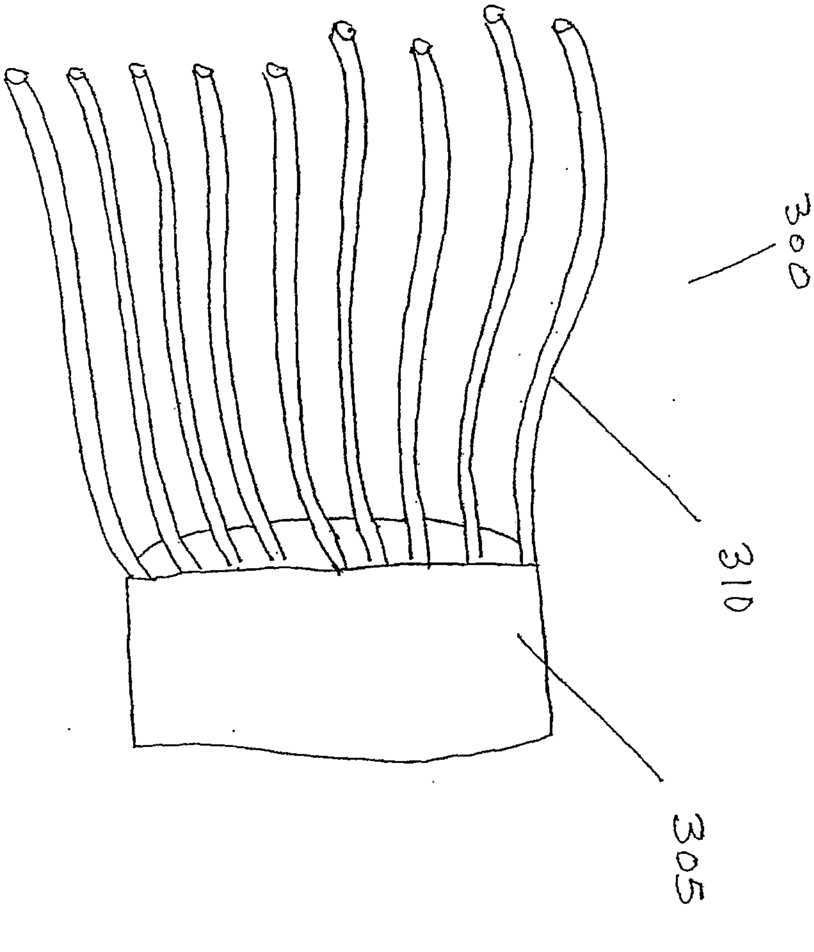


Figure 3

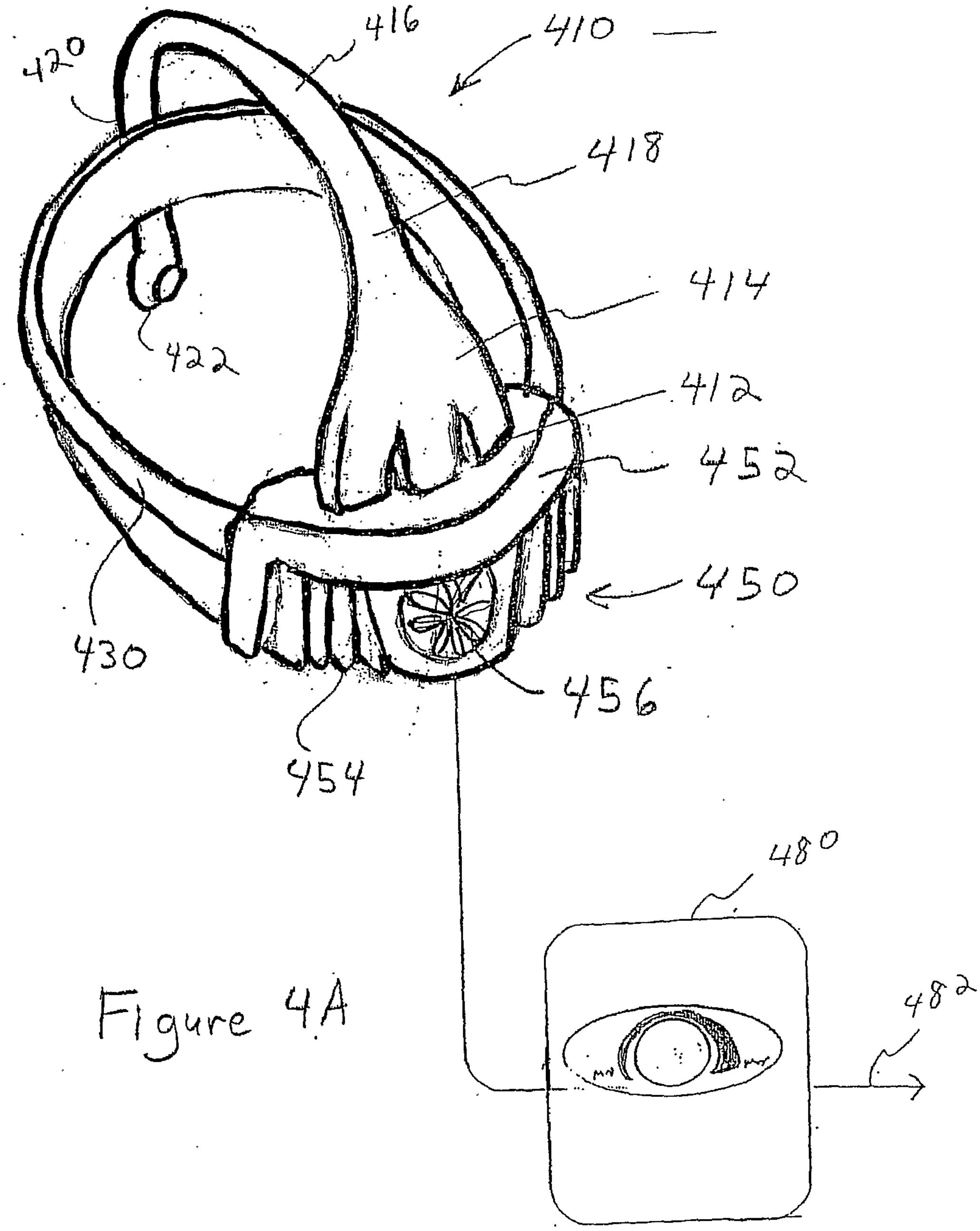


Figure 4A

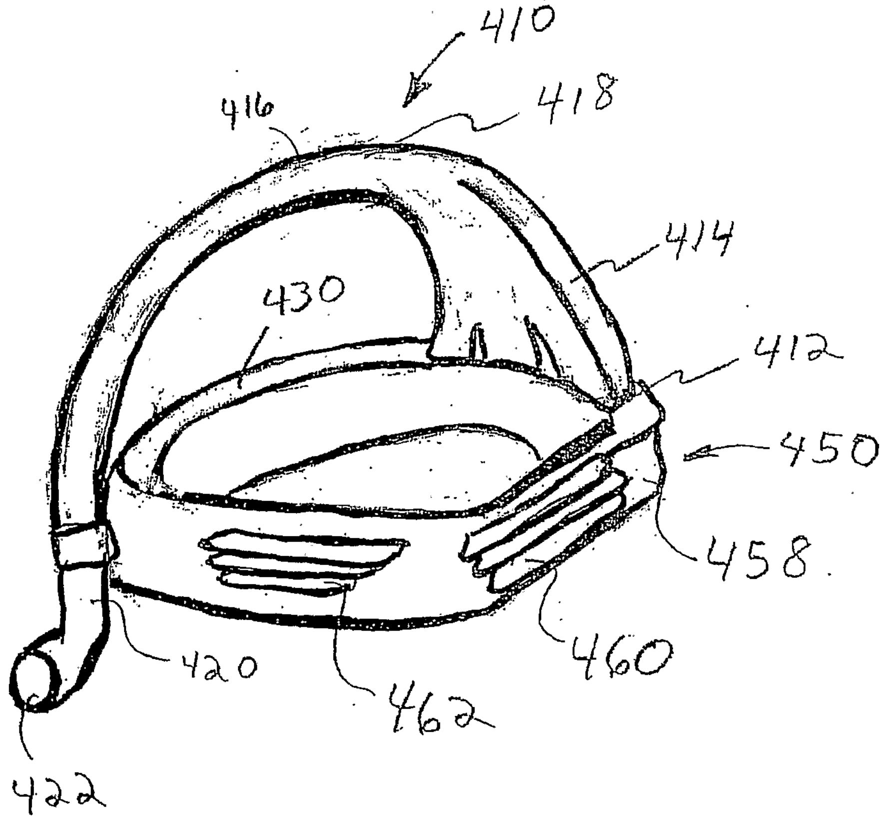


Figure 4B