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(54) Title: A VENTILATION AND COOLING DEVICE FOR AN IMAGING SYSTEM

(57) Abstract: This invention relates to a method and a system for ventilation & cooling arrangement for a compact visualization system. The cooling arrangement is for the heat generating components like the high intensity light source and the electrical assemblies. A timer circuit to control the working of fan to enhance the performance and the life of the high intensity light source and the electrical assemblies also accompanies the cooling arrangement.
A VENTILATION AND COOLING DEVICE FOR AN IMAGING SYSTEM

FIELD OF THE INVENTION

The present invention relates to the visualization systems using high intensity arc lamps and more particularly a ventilation and cooling device for the arc lamp and electronic circuitry of a light source unit of the visualization systems.

BACKGROUND OF THE INVENTION

Cool and white light is used in various applications such as in signs, displays, general area lighting and also with specialized applications like Medical, Scientific etc. In the medical and specifically surgical applications, a light source unit is used to provide cool and white light for various medical applications such as visualization of the body structures, curing of composite materials etc. The light source unit is used to provide the illumination light for the structures inside the body cavity through a light guide. A fiber optic cable is usually used as the light guide along with these units. A typical cable consists of a receptor end illuminated by a light source, the opposite end being adapted to receive a light emitter. Light travels from the light source through the fiber optic cable and is emitted by the light emitter. Such devices typically utilize a high intensity Xenon, halogen or other lamps as a light source.

The light source unit usually consists of several modules such as a lamp, a lamp holder in which the lamp is fitted, a heat sink, a fan, a power source and an
outer housing in which all these modules are installed. One such fiber optic illumination system described in the US Pat. No. 5653519 provides a cooling system for these high intensity arc lamps. Some equipment such as the medical visualization system, LCD projector, DLP projector and like need an electrical power source as well electronic circuitry along with the light source. Conventionally to provide a proper cooling arrangement for the Light Source and Electronic components two separate enclosures are provided.

To provide cool and white light, high intensity light bulbs are commonly used. These high intensity light bulbs also known as arc lamps create a large amount of heat while providing the light beam. As the medical visualization system are becoming very compact and portable various modules are integrated in a single enclosure. Modules such as the light source, electronic circuitry for image processing and an electrical system as a power source could be fitted in a single enclosure. Due to this kind of integration various heat-dissipating modules are arranged in close proximity with each other. As the heat generated within the enclosure is increased and the area to circulate the cooling medium is restricted, there is a need to have an appropriate ventilation and cooling arrangement for a compact visualization system whereby it provides a good & efficient cooling of the light source as well as the electronic components for better performance and life.

The light sources generate a significant amount of heat. As the temperature of the device rises, the receptor end of the fiber optic cable will frequently be
damaged or destroyed. Using a heat sink and the air blown by a fan on the heated light source dissipates heat produced by the high intensity light sources. Conventionally different types heat sinks are being used to dissipate the heat produced by the light sources. The heat sinks used for these applications are heavy and elaborate so that the weight of the Light source unit is considerably increased which hampers the portability of the unit. Also due to elaborate design of the heat sink onsite replacement of the bulb to provide an uninterrupted application of the light source unit, is severely hindered.

Medical applications of the Light sources as described earlier require high amount of reliability and safety. The operating temperature of the lamp itself is high, the lamp tends to expand against its heat sink which raises a danger of breakage of fragile components. Also due to comparatively short life expectancy of the high intensity light bulbs and a possibility of blowing out of these sources during the operations, back up of the supplies is essential. Therefore, a large inventory of equipment according to prior art is essential, more so, because replacement of lamps in the prior rat light units requires return of the equipment to a factory or distributor setting where a new lamp can be installed and adjusted for proper alignment. To maximize the life and quality of light high intensity, appropriate cooling of the light sources is necessary even after the bulb has been switched off.

Therefore there is a need to have a ventilation and cooling arrangement to effectively cool the heated light source including the electrical components fitted
in a single compact unit, to allow onsite replacement of the bulb with proper alignment and to protect the receptor end of the fiber optic cable.

**OBJECTS OF THE INVENTION**

It is therefore an object of the invention to propose a ventilation and cooling device in an imaging system, which provides an improved cooling effect to the light source and the electronic circuitry of the system.

Another object of the invention is to propose a ventilation and cooling device in an imaging system, which reduces the frequency of damage and obsolescence of the receptor end of the fibre optic cable of the system.

A still another object of the invention is to propose a ventilation and cooling device in an imaging system, which employ light and compact heat sink which allows portability of the device including in-situ replacement of the light source when replaceable.

A further object of the invention is to propose a ventilation and cooling device in an imaging system, which is simple and cost-effective.

**SUMMARY OF THE INVENTION**

Accordingly there is provided a method and a system for cooling a high-intensity light source including an electronic circuitry in compact visualization systems.
The system comprises several modules interposed in a housing such that the lamp and the other electronic components are enabled to operate at optimum temperature for effective functioning of the components and for getting desired output. The several modules including the active units are maintained in the internal environment within acceptable temperature limits. In critical instruments having application in the medical environment, where the quality and age of the light source is dependent on the ambient temperature it is very important to effectively control the inside temperature. For efficient functioning of these lights an effective ventilation and cooling device is provided. Appropriate arrangement and positioning of the active units (Fan) including the passive units (baffle) are very critical to achieve an efficient cooling result. Along with this new configured device, properly designed and configured heat sink, the high intensity light source and the electronic subassembly create air blocks for facilitating the heat dissipation by convection.

Placement of the heat generating components such as a light source and an electronic subassembly in a single housing is accompanied by a timer circuit for controlling the active components of the cooling assembly for enhancing and optimizing the performance and life of the light source and the electronic subassembly.

**BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS**

FIG. 1 is a schematic representation of a medical visualization system with arrangement of the of the components inside the light source unit.
FIG. 2 is an exploded view of a light source unit with illustration of a ventilation and cooling device.

FIG. 3 is an illustration of a fan assembly of the light source unit according to the invention.

FIG. 4 is an exploded view of a heat sink assembly and an illumination control means of the light source unit of the invention.

FIG. 5 is an illustration of the heat sink assembly with the light source subassembly and the illumination control means of the light source unit of the invention.

FIG. 6 is an illustration of the airflow vents and supporting member of the ventilation and cooling device of the invention.

FIG. 7 is a top view of the light source unit without the top cover illustrating the airflow in the light source unit.

FIG. 8 is a schematic representation of a timer circuit for controlling the active components of the ventilation and cooling device of the invention.

**DETAILED DESCRIPTION OF THE INVENTION**
For purposes of explanation, the figures and the description are provided with respect to an example of a cooling arrangement of a medical visualization system but it will be understood the invention can have applicability other areas. In particular, but without limitation, the present invention can have applicability to systems and methods used for cooling the high heat generating components and also where several heat-generating components are fitted in closed proximity with each other. Specifically some examples of such application would be in general purpose lightening, projector units, fiber optic lighting system, medical applications, and compact electronic equipment.

FIG. 1 is a schematic representation of a medical imaging system 100 wherein the application of an embodiment of the present invention is illustrated. The imaging system 100 typically includes a light source unit 200, a display and recording module 120, a video connector 126, a camera unit 150, a camera connector 180, a fiber optic cable 170 and an endoscope 190. The light source unit 200 includes a housing 110, a heat sink assembly 500, a light source subassembly 520, a cooling module 300, a power supply module 240, an electronic subassembly 800, and an indicator module 214, a fiber optic receptacle 560, and an illumination control means 570.

The light source subassembly 520 includes a light source 524, a reflector 522, and a bulb holder 526. The light source 524 and the reflector 522 are attached
to the bulb holder 526. The heat sink assembly 500 is coupled to the light source subassembly 520. The heat sink assembly 500 is provided to dissipate the heat generated by the light source assembly 520. The heat sink assembly 500 is also attached to the fiber optic receptacle 560. The fiber optic receptacle acts as an optic port and provides a slot to align the receptor end of the fiber optic cable 170 with the beam of light generated by the light source subassembly 520. The light source unit 200 is powered by the power supply 240. The power supply 240 has two major supply modules, a low voltage module 242 and a high voltage module 244. The low voltage module 242 is mainly made up of at least one transformer and the high voltage module 244 is mainly made up of ballast. The high voltage module 242 provides power supply to the light source subassembly 520 and the cooling module 300. The low voltage module provides power supply to the electronic subassembly 800 and the camera unit 150. The electronic subassembly 800 includes a timer circuit 810 and a video isolation circuit 850. The timer circuit 810 is attached to the indicator module 214. The cooling module 300 is placed within the housing 110 such that a fan assembly 310 blows cool air on the heat sink assembly 500, the light source subassembly 520 and an illumination control means 570. The cooling module 300 draws the cooling air such that air is sucked from the areas surrounding the power supply module 240 and the electronic subassembly 800.

The imaging system 100 functionally comprises of two essential flows. The first being the flow of light for illuminating from the light source 524 to the site to be visualized. The second being the flow of the video signals from the examination
site to the display 120. The following paragraphs explain these flows and associated system modules.

The light originating from the light source 524 is transformed into a focused beam of light by the reflector 522. The focused beam of light passes through the illumination control means 570, which is located between the light source 524 and the fiber optic receptacle 560. The illumination control means 570 controls the intensity of the light beam that passes through the fiber optic receptacle 560. The light beam is thereafter, transmitted through the fiber optic cable 170 to the endoscope 190. The light beam passes through the endoscope 190, and illuminates the site to be visualized.

Once the site is illuminated, the object reflects the light and the reflected light passes through the objective lens of the endoscope 190 and further transmitted to the camera unit 150. The camera unit 150 converts the reflected light to video signal by an image-processing unit attached to the camera unit. Thereafter, the video signal is passed to the electronic subassembly 800 through the camera connector 180. The camera connector 180 is attached to the video isolation circuit 850 by a limo connector 880. The video signals are modulated and isolated by the video isolation circuit 850. The video isolation circuit 850 also includes video output ports 890. The output ports 890 provide the video signal to the display and recording module 120 through the video connector 126. The display and recording module 120 is used to view and/or record the video images from the visualized object.
Fig 2 is an exploded view of the light source unit 200 with illustration of the cooling arrangement. The housing 110 is a four-piece assembly and comprises a front panel 210, a top cover 220, a bottom plate 230, and a middle panel 600. The front panel 210 is fitted on the bottom plate 230 with a supporting plate 218. The supporting plate 218 is also attached to the middle panel 600 at the attachment member 616. The supporting plate 218 is attached via a fastening member to the bottom 230 including to the middle panel 600. The top cover 220 is fitted on the middle panel 600 and tightened by the knurl screws 222. The attachment of the top cover 220 with the middle panel 600 by knurl screws 222 makes the operation toolless. The housing 110 can be made of metal, alloy, carbon fiber, heat resistant plastic, glass, composites, ceramic, and the like. The housing provides protection to the inside components. The housing 110 also helps in dissipating the heat produced by the components inside the housing 110 and in reducing the EMI / EMC effect on the electronic subassembly 800 and power supply module 240 from electromagnetic interference caused by other electronic & electrical equipments in the surrounding environment of the light source unit 200 during the functioning of the unit 200.

The front panel 210 acts as an attachment arrangement for various components such as the indicator 214 and the indicator PCB 215, the front panel on/off switch 216 and the lemo connector 880. The front panel 210 comprises an opening 212 for fitting the fiber optic receptacle 560. The front panel 210 further comprises a window 213 for accommodating a intensity control knob 580.
An EMI filter 660 is mounted on rear of the middle panel 600. The EMI filter 660 is electrically connected to the Mains On/off Switch. This EMI filter 660 is used to suppress common mode noises and differential mode noises. Generally, these filters 660 eliminate electromagnetic interferences created by the equipment and the component itself. A safety micro-switch 670 is also installed in a frame mounted on the middle panel 600. This switch 670 is used to shut off the power supply to the light source 524 when the top cover 220 is removed.

The bottom plate 230 is used for fitting various modules of the light source unit 200. The electronic subassembly 800 and the power supply module 240 are arranged in a stacked configuration on same side of the cooling module 300. The high voltage module 244 comprises mainly a ballast therefore it is heavy and generates a high amount of heat. Therefore the high voltage module 244 is placed in the bottom of the stacked arrangement. The high voltage module 244 is covered with a ballast casing 250. Functionally the ballast casing 250 provides an EMI/EMC shield, a protective covering and dissipates the heat produced by the high voltage module 244. The low voltage module 242 and the electronic subassembly 800 is placed above the high voltage module 244 such that they are fitted on top of the ballast casing 250. The PCB chassis 252 covers the electronic subassembly 800 and it is fitted on the top of the ballast casing 250. Functionally the PCB chassis 252 provides an EMI/EMC shield, and a protective covering and dissipates the heat produced by the electronic subassembly 800. The Ballast casing 250 and the PCB chassis 252 has numerous openings 254. The openings 254 are created to facilitate the flow of air over the electronic subassembly 800 and the power supply module 240. Also the openings
254 reduce the overall weight of the light source unit 200. The openings 254 are illustrated in the fig 4. The embodiment of the present invention illustrates the openings 254 in the circular and rectangular configuration, however, numerous shapes other and their variations may occur to those skilled in the art, such as, triangular, polygonal, square and the like.

Fig 3 is an illustration of the cooling module 300. The cooling module comprises of a fan assembly 310, a dampner 320 and a bracket 330. The fan assembly 310 has a chassis 312 and a fan body 314 with rotating blades. The bracket 330 has a one front supporting plate 336, two supporting side plates 338, and two base plates 332. The base plate 332 has slots 334 for fastening member for fitting the fan bracket on the bottom plate 230. The body 314 is fixed on the chassis 312. The dampner 320 is made up of shock absorbing material and is fixed in between the fan assembly 310 and the bracket 320. Fastening member fits the fan assembly 310 on the bracket 330 with the dampner 320 in between. The dampner 320 is used to reduce the vibration of the fan assembly 310. The dampner 320 can be made of shock absorbing material made of foam, wool, carbon fiber, rubber, paper, plastic, silicone and the like. The cooling module is one of the essential components of the cooling arrangement and it provides ventilation of air inside the housing 110.

Fig 4 in conjunction with the fig 5 illustrates the heat sink assembly 500. The heat sink assembly 500 is described along with the light source subassembly 520 and the illumination control means 570. Fig 4 is an exploded view of the
heat sink assembly 500 along with the illumination control means 570. Fig 5 illustrates the heat sink assembly 500 wherein the light source subassembly 520 and the illumination control means 570 are fitted on the heat sink assembly 500.

A front flange 552, a rear flange 554, and a base plate 556 constitute body of a single unit heat sink 502. A base plate 554 connects the front flange 552 and the rear flange 554 such that they are placed at a fixed distance from each other and are parallel to each other. The single unit heat sink 502 is fitted on the C plate 530 by the fastening members. The C plate 530 is fitted on the bottom plate 230, thereby stabilizing the complete heat sink assembly 500. The fastening members are placed in at least four slots 557 having a multi-step configuration wherein the profile of the slots 557 decreases towards the C plate 530. This configuration provides a leeway for fixing the single unit heat sink 502 according to the desired optical alignment for different types of light sources intended to be used the heat sink assembly 500. The single unit heat sink 502 can be made of aluminum, copper, alloys, steel and the like.

In an embodiment of the present invention, as illustrated in Fig. 4 & 5 the single unit heat sink 502 has three main parts, the front flange 552, the rear flange 554 and the base plate 556. A base plate 556 connects the front flange 552 and the rear flange 554 such that they are placed at a fixed distance from each other and are parallel to each other. In various other embodiments of the present invention the front flange 552 and the rear flange 554 can be arranged such that there is a flexibility of adjusting the distance including the angle between the two. This can be achieved by an arrangement for sliding the front
flange 552 and the rear flange 554 on the base plate 556 with a fixing arrangement at a desired distance and angle. Adjusting the distance and the angle between the front and rear flange 552, 554 provides a flexibility to accommodate different type of light sources and subassemblies.

The rear flange 554 has an extension member 555 for sliding, holding, aligning and for removably fitting the light source subassembly 520 on the single unit heat sink 502. The extension member 555 is configured to be congruent with the light source holder 526. A hand operated knurl screw (not shown in the figure) is provided for removably fitting the light source subassembly 520 on the rear flange 554. As a part of the rear flange 554 and the extension member 555 is open and does not cover the light source holder 526, an a open portion 540 is formed. The open portion 540 provides a tolerance to accommodate thermal expansion of the light source holder 526, the rear flange 554 and the extension member 555.

The front flange 552 has fins 553 to increase the surface area for dissipating the heat generated by the light source subassembly 520. The light generated by the light source 524 is reflected by the reflector 522 towards the front flange 552 thereby creating a beam of light. Therefore the beam of light having high amount of heat comes directly in contact with the front flange 552 and transmits the heat to inner side of the front flange 552 and the receptor end of the fiber optic cable 170 fitted in the fiber optic receptacle 560. The fins 553 situated on the outer side of the front flange 552 readily dissipate the heat. The
front flange 552 also has a member 566 to fit the illumination control means 570. The front flange provides a stub 564 for accommodating the fiber optic receptacle 560. The fiber optic receptacle 560 is snugly fitted on the stub with a ring member 562 in between. The ring member fits inside the fiber optic receptacle 560 and has metal balls inserted in the body. The arrangement creates a snap fit arrangement for the fiber optic receptor end when inserted in the fiber optic receptacle 560.

A thermal protection plate 510 covers the single unit heat sink 502 along with the light source subassembly 520. The thermal protection plate 510 is fitted on the single unit heat sink 502 by means of at least two hand operated knurl screws 512. The thermal protection plate 510 has a light protection member 514. The light protection member 514 essentially blocks the light emitted from the light source 524 from traveling towards the front panel 210. The thermal protection plate 510 creates a barrier between the light source 524 and the top cover 220, blocking the direct transmission of heat to the top cover 220. The thermal protection plate 510 also helps in dissipating the heat generated by the light source 524.

The Illumination control maens 570 is mounted on the front flange 552 by a mounting block 420 by fixing it in the slot 566. The illumination control means 570 includes a control member 410, a mounting block 420, a motion transmission means 430, a driving means 580, an elongated limiting member 450, and coupling members 460 and 470. The second coupling member 470
couples the control member 410 to the mounting block 420. The second coupling member 470 also connects the motion transmission means 430 to the control member 410. The motion transmission means 430 is further, coupled to the mounting block 420 by the coupling first member 460. The first coupling member 460 also connects the driving means 580 to the motion transmission means 430. In various embodiments of the present invention, the coupling members 460 and 470 are moveably or rotatably coupled to the mounting block 420 and the other components are attached to the coupling members 460 and 470 using screws, keyway-pin arrangement, hole-pin arrangements, glue, and the like. Hence, the movement of the driving means 580 governs the movement of the control member 410. However, the elongated limiting member 450 is provided to limit the movement of the driving means 580. As shown in the figure 4, the elongated limiting member 450 is attached to the mounting block 420. Further, the elongated limiting member 450 engages with one or more planar members (not shown in Figure 4) to limit the movement of the driving means 580.

In an embodiment of the present invention, as illustrated in Fig. 4, the control member 410 is in form of a circular disc. The disc is centrally attached to the second coupling member 470 by means of screw. In various embodiments of the present invention, other means of attaching the control member 410 to the second coupling member 470 can be used.

The second coupling member 470 is in form of a shaft rotatably coupled to the mounting block 420 by means of bearings, bushings, clips and the like. The second coupling member 470 is also coupled to the motion transmission
means 430. In an embodiment of the present invention, the motion transmission means 430 is a belt drive, as illustrated in Fig. 4. The belt drive includes a set of toothed gears and a driving belt connecting the gears. One of the toothed gears is attached to the second coupling member 470. The other toothed gear is attached to the first coupling member 460. The embodiment of the present invention illustrates the use of a belt drive for motion transmission, however, numerous other motion transmission mechanism and their variations may occur to those skilled in the art, such as, rack and pinion arrangement, a gear drive, a belt-pulley arrangement, frictional drives, pneumatic transmission system, hydraulic transmission system magnetic transmission systems and the like.

The first coupling member 460, as shown in Figure 4, is a shaft rotatably coupled to the mounting block 420 by means of a bearing, bushing, clips and the like. As mentioned hereinabove, the motion transmission means 430 is also attached to the first coupling member 460. Further, the driving means 580 is also attached to the first coupling member 460. In an embodiment of the present invention, the driving means 580 is a manually actuated knob. In another embodiment of the present invention, the driving means 580 is an electric stepper motor combined with a switch to control the motion. Various other embodiments of the driving means 580 are known to those skilled in the art, for example, pneumatic, hydraulic, magnetic, and the like.

FIG. 6a and 6b is an illustration of the airflow vents and a supporting member. The middle panel 600 holds a supporting member 620. The supporting member
620 has two portions, an open portion 622 and a solid portion 624. The open portion 622 provides an area for air inflow as well the outflow. The open portion 622 is geometrically symmetrical arrangement carved out from the solid portion 624. The solid portion 624 provides strength to the supporting member 620 and platform for a baffle member 630. The baffle member 630 is an array for vertically arranged liner baffles as shown in the figure 6b. The baffle member 630 is arranged at a particular angle so that the air inflow and outflow is directed to enhance the efficiency of the cooling arrangement. The airflow configuration within the light source unit is explained further with help fig 7. The baffle member 630 is attached to the middle panel 600 with the help of a plate 632. The baffle member 630 is attached to the middle panel 600 such that the supporting member 620 is on the outside and the baffle member 630 is on the inside of the middle panel 600. The baffle member 630 is arranged such that the airflow is directed on the open portion 622 of the supporting member 620. This particular arrangement provides maximum open area for ventilation of air in and out of the light source unit 200. In accordance with the present invention, the baffle member 630 provides three main functionalities such as, the arrangement directs the air in proper direction in and out of the light source unit 200, it blocks the light coming out of the light source unit 200; and it prevents entry of unwanted subjects inside the light source unit 200. The unwanted subjects could be like dust particles, paper pieces, and small objects alike.

The middle panel 600 provides a first slanted slot 612 for fitting the top cover 220 by an interlock mechanism. Similarly the bottom 230 is interlocked with the
middle panel 600 at a second slanted slot 614. The middle panel 600 also provides a third slot 618 for fixing the hand operated knurl screw 222. The middle panel 600 is fitted on the bottom 230 at the attachment member 617 by a fastening member (not shown).

Placement of the previously explained components within the light source unit 200 make a cooling arrangement. In conjunction with Fig. 7, following paragraphs explain the cooling arrangement and more particularly the airflow pattern. Fig 7 is a top view of the light source unit 200 without the top cover 220 illustrating the airflow in the light source unit 200.

The baffle member 630 along with the supporting member 620 allows the inlet of cool air inside the light source unit 200. A first group of flow indicators 710 provide inlet airflow direction and a second group of flow indicators 750 provide outlet airflow direction. The baffle member directs the incoming cool air on the electronic subassembly 800 and power supply 240 situated inside PCB chassis 252 and ballast casing 250 respectively. The front panel 210 and the low voltage power supply module 242 keep maximum air is contained within the area surrounded by the PCB chassis 252 and ballast casing 250. A first air block indicated by 720 denotes this contained air. The heat generated by the electronic subassembly 800 and the power supply 240 is dissipated to by convention thereby cooling the components within. In this process the first air block 720 is conditioned and moderately heated. Gradually, this first air block 720 is directed towards cooling module 300. The cooling module 300 sucks the air mainly from
the first air block 720. The cooling module 300 creates a vortex and forcibly pushes the air in a second air block 730 thereby providing air for cooling the light source subassembly 520, the illumination control system 570 and the heat sink 502. The thermal protection plate 510, the front flange 552, the rear flange 554 and the base plate 556 create air restriction area and become a boundary wall of the second air block 730. The air in the second air block 730 is continually circulated within the block thereby enhancing the heat dissipation from the surrounding components. The cooling module 300 pressurizes the air contained in the second air block 730 and the air tries to escape through the baffle member 630 on the air outlet side. The baffle member 630 is arranged such that it creates positive backpressure by resisting the air outflow from the second air block 730. Therefore the air remains in second air block 730 for a longer time and facilitating heat dissipation by convection. This process provides effective cooling of the heat sink 502, light source subassembly 520 and the illumination control means 570. Positive backpressure created by the baffle member 630 on the fan assembly 310 makes operation of the fan silent. The cooling module also generates a relatively narrow air stream denoted by 740. This stream 740 passes behind the rear flange 556 and over and below the extension member 555 providing cooling air to the rear flange 554, extension member 555 and the light source holder 526. The heated air travels through the baffle member 630 on the outflow side and passes out of the light source unit 200 in a direction shown by flow indicators 750. A timer circuit 810 is also integrated for controlling the operation of the fan assembly 310 and light source subassembly 520. The timer circuit 810 and its functioning is explained in detail in the following paragraphs.
FIG. 8 is a schematic representation of the timer circuit for controlling the active components of the cooling assembly 300. The timer circuit 810 mainly comprises of a microcontroller 811, a Micro-controller reset circuit 812, a crystal 813, Pair of DIP switches 815, and an EPPROM 814. The timer circuit also constitutes the indicator 214 along with the electrical isolation circuit 830. The pair of DIP switches 815 allows settings of the Micro-controller 811 in the range of 0-250, 250-500, 500-750 & 750-1000 hrs. EPPROM 814 stores the code for timer circuit 810 and holds all the subroutines used for functioning of the timer circuit 810. Crystal 813 provides clock frequency to the Micro-controller 811. Micro-Controller reset circuit 812 helps in write protection of EEPROM, microcontroller reset & watchdog timer. Transformer 242 provides electrical energy to the timer circuit 810. The Micro-controller 811 is connected to the front panel on-off switch 216. The microcontroller 811 is connected to the indicator 214 through an electrical isolation circuit 830. The indicator 214 has three LEDs Red, Yellow & Green and the indicator PCB 215. These LED's are interfaced with Microcontroller 811. The Yellow LED indicates that only 50 hours of the life of the light source 524 is remaining and that a new light source subassembly 520 is needed for replacement. The Red LED indicates that the life of the light source 524 has ended and needs immediate replacement. The Green LED indicates that the Light source unit 200 and more specifically the light source subassembly 520 is being cooled and that the cooling assembly 300 should not be switched off before the Green LED turns off. This cooling of the light source subassembly 520 is essential to improve life of the light source 524. The Green LED also helps the
user to decide when to restart the light source 524 after power cut-off or similar situations. The following paragraphs explain the working of the timer circuit 810.

The number of hours of the life of the light source 524 are set in the microcontroller 811 using DIP-switches 815. The DIP-switches 815 are connected to the microcontroller 811 through a port, by programming that port in input mode. When the front panel on off switch 216 is activated to turn on the light source 524, it activates the opto-isolator on the PCB, thereby providing a high signal at port that is selectively programmed as an Input-Output port. This high signal activates the counter in the microcontroller 811, which in turn starts decrementing the set hours value in the microcontroller 811.

As the count keeps on decreasing, at one time, the count reaches the window of Low-life (in this case, its 50 hours). When this value is reached, the microcontroller 811 sends a signal to light up the Yellow LED. As the count gets further decremented, at one time, the count reaches value of 0 hours. When this happens, the microcontroller sends a signal to light up the Red LED, indicating that life of the light source 524 is over. When the new light source subassembly 520 is installed, then life of the light source 524 in the microcontroller 811 has to be reset, else the microcontroller will continuously keep the current value of hours as 0, and thus would keep the Red LED flashing.

The Micro-Controller Reset Circuit (812) connected to the microcontroller 811 runs a RESET subroutine, thereby erasing the values present in all the variables of microcontroller. New value of hours is set in microcontroller for a new light
source 524. The EEPROM 814 holds all the subroutines that are used to carry out
the necessary actions. The proper subroutine address is calculated and the
microcontroller 811 runs that Interrupt-subroutine by jumping to the appropriate
address location.

Hence, the cooling arrangement has advantages over the above background
arts. Firstly, a cooling arrangement to effectively cool the heated light source and
electrical components fitted in a single compact unit; Secondly, a cooling
arrangement to prevent damage to the fiber optic end, Thirdly to facilitate
cooling of the light source unit after the operation of the heated components has
been switched off and lastly an arrangement to allow onsite replacement of the
light source with proper alignment.

While the present invention has been illustrated by description of several
embodiments, it is not the intention of the applicant to restrict or limit the scope
of the appended claims to such detail. Numerous other variations, changes, and
substitutions will occur to those skilled in the art without departing from the
scope of the invention.
WE CLAIM

1. A ventilation and cooling device (300) in an imaging system (100) for maintaining an optimum internal temperature within a light source unit (200), in particular a light source (524) including an electronic circuitry (800) for enhancing the performance and life of the light source (524) including the electronic circuitry (800), the imaging system (100) comprising:

   a light source unit (200), a display and recording module (120); a video connector (126); a camera unit (150), a camera connector (180); a fibre optic cable (170); and an endoscope (190); the light source unit (200) comprising a light source subassembly (52) having a light source (524), a reflector (522), and a bulb holder (526); a heat sink assembly (500) attached to the light source subassembly (520) for dissipating the generated heat a power supply module (240); an electronic subassembly (800) having a timer circuit (810); an indicator module (214); an illumination control means (570); and a fibre optic receptacle (560) attached to the heat sink assembly (500), the ventilation and cooling device comprising:

   - a housing (110) for enclosing the light source subassembly (520), the power supply module (240), the heat sink module (500), and the electronic subassembly (800);

   - the housing 9110) comprises a front panel (210) rigidly attached to a bottom plate (230) via a supporting plate (218), the supporting plate (218) detachably attached via fastening means to a middle
panel (600) through an attachment joining the middle panel (600); and a ballast casing (250) accommodating the power supply module (210) and a PCB-chasis (252) to allow dissipation of heat produceable respectively by the power supply module (240) and the electronic subassembly (800) enclosed by the PCB chasis (252);

- a plurality of openings 9254) configured on the ballast covering (250) and the PCB-chasis (252) to allow flow of air over the power supply module (240) and the electronic subassembly (800);

- a fan assembly (310) having at least one damper (310) disposed in the housing (110) for providing ventilation of air inside the housing (110);

- a thermal protection plate (510) covering a single unit heat sink (502) of the heat sink assembly (500) and the light source subassembly (520) to create an air block;

- a supporting member (620) attached to the middle panel (600), and comprising at least one open portion (622) and a solid portion (624), the open portion (622) providing an area for air inflow and outflow, the solid portion (624) platforming a baffle member (630) consisting of an arrayof vertically arranged liner baffles, the baffle member (630) being disposed at a predetermined angle so that the air inflow and the outflow is directed to enhance the efficiency of the cooling device; and
- a timer circuit (810) comprising a microcontroller (811) for controlling operation of the fan assembly (310) including the light source subassembly (520) and providing indications in respect of the residual life need for replacement, and life improvement of the light source subassembly (520).

2. The device as claimed in claim 1, wherein the fan assembly (310) comprising:

- at least one fan body (314) with rotatable blades and a chasis (312);

- a bracket (330) for fitting the at least one fan wherein the bracket (330) is fitted on the housing (110);

- a dampener (320) for dampening the vibrations of the fan wherein the dampener (320) is fitted between the fan and the bracket (330).

3. The device as claimed in claim 1, wherein the single unit heat sink (502) comprising:

- a front flange (552) and a rear flange (554) connected by a base plate (554), wherein the base plate (554) is fitted on the housing (110);

- means for (562, 564) a receptacle (560) for fitting to a light transmission element; and

- a knurl screw for removably fitting the light source subassembly (520) on the rear flange (554).
4. The device as claimed in claim 1 or 3, wherein the light source subassembly (520) and the fibre optic receptacle (560) for fitting light transmission element on the single unit heat sink (502) are arranged such that the required optical alignment is achieved.

5. The device as claims 1, 3 or 4, wherein the single unit heat sink, further comprises fins (553) for increasing the surface area and to act as a heat dissipation unit.

6. The device as claimed 4, wherein the single unit heat sink (502) and the light source subassembly (524) is covered with a thermal protection plate (510) which creates the air block.

7. The device as claimed in claim 1, wherein the air flow vents (254) are positioned on the housing (110) and are formed of at least two functional parts comprising:

   - a baffle (630) for directing the flow and blocking the light coming out of the housing (110), and
   - a support member (620) for providing strength to the array of slits.

8. The device as claimed in claim 7, wherein the support member (620)
has geometrically arranged openings for providing maximum area for air flow.

9. The device as claimed in claim 7, wherein the baffle angle is such that it creates positive back pressure on the air passing through the air block.

10. The device as claimed in claim 7, wherein the timer circuit (810) for controlling the operation of the fan assembly (310) and light source subassembly (520) comprising:
   - a controller (811) for counting the usage information of the light source subassembly (520);
   - a memory (814) for storing the usage information of the light source subassembly (520); and
   - an indicator (214) for providing information regarding usage, cooling and remaining life of the light source (524).

11. A method of ventilation and cooling a light source and an electronic circuitry in a ventilation and cooling device as claimed in claim 1 to 10, the method comprising the steps of:
- arranging the light source and the electronic circuitry on opposing sides of a cooling module;

- arranging the baffle such that the inlet air is directed on the electronic circuitry;

- creating a first air block around the electronic circuitry and the power supply module;

- drawing the air by the fan assembly from the first air block thereby cooling the electronic circuitry and the power supply module;

- creating a second air block within the heat sink assembly and forcefully circulating the air in the block for dissipating the heat by convection;

- creating a positive back pressure by the arrangement of the baffles at the air outlet zone thereby promoting a silent operation of the fan assembly; and

- controlling the operation of the ventilation and cooling device by a timer circuit for effective cooling of the light source and the electronic circuitry.

12. A ventilation and cooling device (300) in an imaging system (100) for
maintaining an optimum internal temperature within a light source unit (200), in particular a light source (524) including an electronic circuitry (800) for enhancing the performance and life of the light source (524) including the electronic circuitry (800), as substantially described herein and illustrated with reference to the accompanying drawing.