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J. F. COLLINS ET AL  
HOSPITAL STERILIZING UNIT

2,215,634

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Fig. 1.

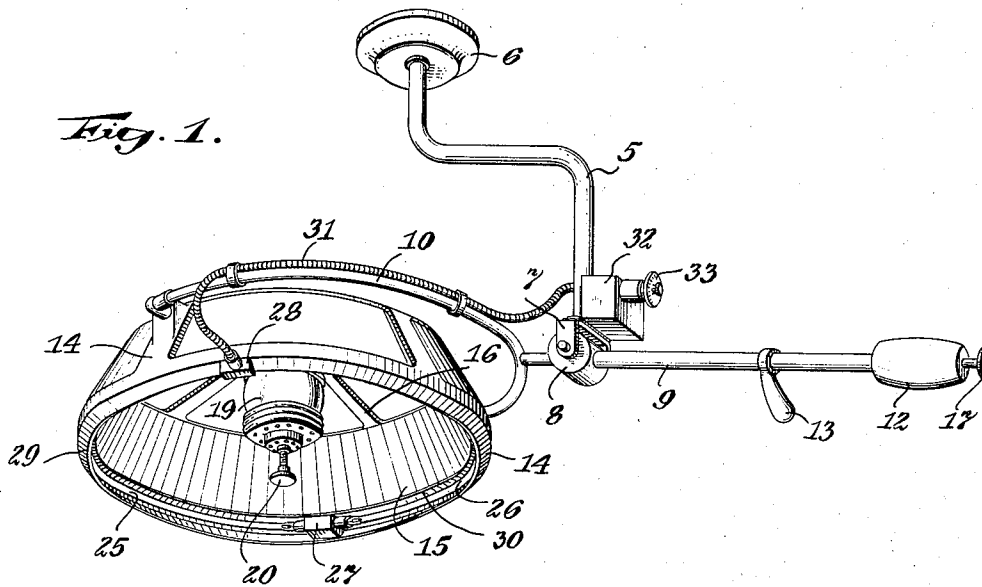


Fig. 2.

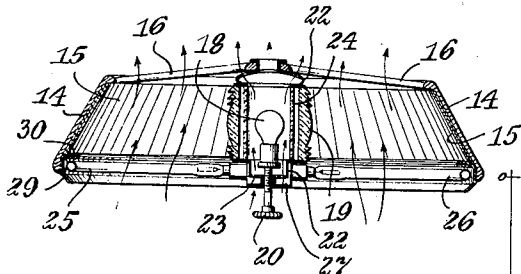


Fig. 3.

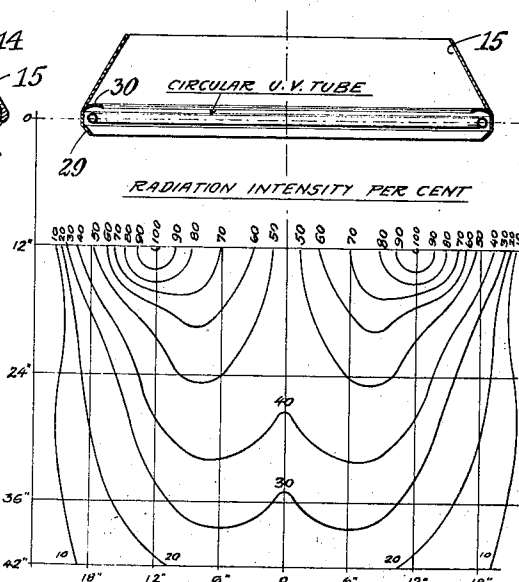
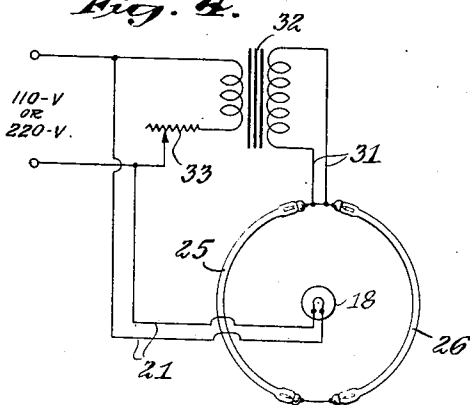


Fig. 4.



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## UNITED STATES PATENT OFFICE

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## HOSPITAL STERILIZING UNIT

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6 Claims. (Cl. 250—88)

The present invention relates to lighting apparatus and has particular reference to apparatus adapted to produce intensive visible illumination as well as invisible radiation, thus rendering the apparatus especially applicable to hospital operating rooms and the like.

Lighting apparatus for operating rooms has long been known to the art for collecting and projecting illumination on the operating table in such manner that no shadows are cast by the operating team upon the patient. In addition, it is customary to take precautions to prevent all possible danger from bursting of the lamp with the generation of a spark which might otherwise cause explosion of the anesthesia present in the operating room.

There are, however, still further requisites of such a unit which have heretofore been given very little, if any, consideration. For example, it is essential that besides elimination of shadows caused by the heads and shoulders of the operating team, there must be maximum possible intensity without troublesome glare being reflected by other objects disposed in the operating room. Also, this maximum possible intensity must be available on the working plane and to meet the exacting requirements of the individual surgeon, the downward control of the intensity is essential.

Moreover, the illumination must be of such color quality as to produce, in the working plane, the maximum degree of differentiation of natural tones of the human tissues without deficiency in necessary colors which might otherwise produce a false ghastly appearance of the patient that would be deceptive to the anesthetist who is guided to some extent by the color of the patient as an indication of his condition. All possible heat should also be eliminated from the light beam both for the safety of the patient, whose exposed delicate organs and tissues might suffer serious damage from undue heat, and for the comfort of the surgeon and operating team, since their exacting work, at best, is performed under trying conditions.

To further facilitate the work of the surgeon the lighting apparatus must permit the projection of light from any angle without the necessity of moving either the patient or the operating table. At the same time, the apparatus should offer the least possible interference to student spectators watching an operation.

Aside from the foregoing requisites as to visible illumination from an operating room apparatus, the present invention contemplates the

incorporation of a source of highly bactericidal ultra-violet radiations. It has been found that such radiations, particularly when the greater percentage thereof lie within a definite region of the spectrum, are a very efficient means of sterilizing atmosphere contaminated with air-borne micro-organisms. Moreover, such micro-organisms, which in many instances and despite precautions are inadvertently expelled or exhaled by the operating team, are a very important cause of post-operative infection. Not only does such source of highly bactericidal radiations destroy the micro-organisms present, but it has been found that such radiations have a very definite therapeutic value in wound healing.

Again, however, it is essential that such invisible ultra-violet radiations conform to certain requisites. For example, it is preferable that such radiations be projected rather than radiated in all directions and substantially in a cone which coincides with that of the visible radiations or light from the apparatus. By so projecting the bactericidal ultra-violet radiations the surgical team, with the exception of the surgeon and his assistants, is in a shadow outside of the cone of ultra-violet radiations. This makes it possible to apply maximum safe intensity on the patient in the operative site, assuring greatest possible protection immediately over the incision. At the same time the operating team, with the exception of the surgeon and assistants who are protected by hoods or the like, is given the utmost protection against the possibility of developing erythema and conjunctivitis through repeated exposure during a great many successive operations.

The intensity of the ultra-violet at the level of the noses and throats of the operating team, the sources of continuing contamination, is considerably greater than that at the operating table level due to closer proximity to the ultra-violet source. This is of further advantage since the upward air-currents beneath the apparatus not only assist in cooling the visible light source, but apparently either carry the air-borne micro-organisms through a barrage of even greater intensity radiations or, in the case of the heavier droplets, these upward air-currents retard their falling and increase the time of exposure to the bactericidal radiations.

It is accordingly the primary object of the present invention to provide a lighting apparatus particularly adaptable to hospital operating rooms which is so constructed as to incorporate among others all of the above noted essential fea-

tures, both as to the generation of visible illumination and highly bactericidal invisible ultra-violet radiations.

Still further objects of the present invention will become obvious to those skilled in the art by reference to the accompanying drawing wherein:

Fig. 1 is a perspective view of a lighting apparatus constructed in accordance with the present invention which is shown suspended from the ceiling of a hospital operating room.

Fig. 2 is a cross-sectional view of the lighting unit proper as shown in Fig. 1.

Fig. 3 is a graphic illustration of the intensity distribution of ultra-violet radiations from the apparatus as shown in the preceding figures, and

Fig. 4 is a schematic diagram of the electrical circuits for the apparatus of the present invention.

Referring now to the drawing in detail, the lighting apparatus as shown in Fig. 1 comprises an offset support 5 rotatably secured to a spider or ceiling flange under the canopy 6. A bifurcated member 7 is carried by the lower extremity of the support 5 and suitably journaled therein is a substantially cylindrical member 8 provided with stops (not shown). Extending through this member 8 and rotatable with respect thereto, but limited by the stops carried by 8, is a shaft 9 having a bifurcated end portion 10. The opposite end of such shaft is provided with a counterweight 12 and near this end is a handle 13 for manually rotating the shaft 9.

Pivotally connected to the extremities of the bifurcated end portion 10 is the lighting unit proper comprising a framework 14 supporting a plurality of inclined trapezoidal mirrors 15 circumferentially positioned with respect to a common axis. As will be noted in Fig. 1 the unit is open both at the top and bottom, but at the top is provided with a spider 16, the radial arms of which intersect coincidentally with the common axis about which the reflecting mirrors 15 are disposed. For the purpose of adjusting the unit about the pivot formed at the extremities of the bifurcated end portion 10, a control knob 17 protrudes from the counterweight 12 as shown in Fig. 1, which operates mechanism (not shown) disposed interiorly of the shaft 9 and bifurcated end portion 10 so that upon rotation of the control knob 17 the unit is rotated about the above noted pivot. Inasmuch as the apparatus is rotatable about the point of connection of the support 5 with the ceiling flange 6 and the lighting unit adjustable about the pivotal connection of the bifurcated member 7 with the cylindrical member 8, as well as about the pivot at the ends of the bifurcated end portion 10, substantially universal movement of the entire apparatus is thus attainable.

Supported by the spider 16 at the common axis of the radial arms thereof and the reflecting surfaces 15, as can be more readily seen in Fig. 2, is a source of illumination such as an incandescent lamp 18. This lamp is adapted to be disposed at the focus of an annular Fresnel lens 19 upon adjustment of a control knob 20 and is supplied with electrical energy from a domestic source of supply, as shown in Fig. 4, through concealed wires 21 (Fig. 4) interiorly of the unit. The source of illumination 18 and lens 19 are supported by upper and lower closure members or caps 22 to prevent scattering of glass particles in the event of bursting of the lamp and these caps are provided with perforations 23 for the free circulation of air

for the purpose of cooling the source during operation. In addition a heat intercepting cylinder 24 is disposed between the source and lens for filtering out the infra-red radiations and the heat absorbed thereby is transferred to the continuously rising column of air passing through the perforations 23 in the caps 22 caused by the chimney effect of the open dome.

The illumination from the source 18, after absorption of the infra-red, is condensed by the Fresnel lens 19 and following refraction of the light rays they are directed in parallel relation or a horizontal band onto the reflecting mirrors 15. Since these mirrors are inclined, the light rays are reflected in beams which intersect at a point lying in or slightly above the plane of operation by the surgeon which is the apex of an inverted cone. This accordingly results in the projection of a light beam of sufficient intensity which gives maximum spread of light within a cavity, even though the incision or orifice be smaller than the cavity.

Inasmuch as the many individual reflected light beams are superimposed over the same spot, intercepting of some of such individual beams by the head or hands of the surgeon still leaves a sufficient number of remaining beams to illuminate the spot without shadows, particularly since the reflecting mirrors 15 are in a ring whose diameter is considerably greater than the dimensions of the obstructing body, thus allowing but a few of the total number of individual beams to be intercepted at one time.

Control of the intensity to meet the exacting requirements of the individual surgeon is very simply accomplished by spreading the light over a greater or lesser area. To do this it is necessary for the operator only to grasp the handle 13 and move the shaft 9 about the pivot formed between the cylindrical member 8 and the bifurcated member 7, thus moving the unit away from or nearer to the operating table. Greatest intensity is accordingly obtained when the unit is moved so that the apex of the cone of light beams touches the table.

As the unit is moved so that the operating table cuts the cone farther and farther from the apex, the diameter of the light spot on the operating table increases; and as the amount of light projected on the table may be considered constant, the intensity per unit area decreases with the increase in area. Control of the intensity in this manner is exceptionally superior to that of decreasing the quantity of light available at the source by rheostatic control or extinguishment of lamps in a multiple group, as a decrease in intensity by rheostatic control materially alters the color of the light and extinguishing filaments gives to marked steps in intensity reduction which is extremely undesirable.

The heat intercepting cylinder 24 as above noted eliminates heat from the light beam by absorption of the infra-red, and in so doing, the positive flow of cooling air caused by the chimney effect of the open dome reflector induces upward air currents of the surrounding atmosphere, as shown by the arrows in Fig. 2, thus preventing vital organs of a patient being exposed to injurious heat. These induced air-currents also definitely ventilate the operative field, carrying away the body heat thrown off by the group of persons beneath the light as the air moves upward through the funnel-shaped open dome of the unit.

The importance of this to the comfort of the operating team may be appreciated by pointing

out that actual measurements show that a group of six active persons working around the table and the inactive patient lying on it give off a total of approximately 3400 B. t. u., which is about four 5 times the amount of heat liberated by the light source of 250 watts. Moreover, the heat intercepting cylinder 24, by decreasing the amount of longer wave-length radiations in the light beam, serves to correct the color characteristic, since it 10 has the effect of raising the apparent filament temperature several hundred degrees. By raising the apparent temperature of the light source, the qualities of sunlight are more nearly approached which gives the light beam the characteristics 15 that aid in tissue differentiation.

In addition to the projection of illumination, the apparatus is provided with a pair of ultra-violet lamps which generate radiations, the greater percentage of which lie in the bactericidal 20 region of the spectrum between 2530 and 2540 Angstrom units. As shown in Fig. 1, these ultra-violet lamps 25 and 26 are semi-circular in configuration to conform to the contours of the unit and are supported by terminals 27 and 28 secured 25 to the lower peripheral rim or skirt 29 of the framework 14.

As will be noted from Figs. 1, 2 and 3, the skirt 29 is slightly curved inwardly and thus forms a section or portion of a metallic reflector which, in 30 conjunction with an upper parabolic section 30, forms a complete ultra-violet reflecting portion integral with the reflector 15 for causing the projection of the ultra-violet in the form of a cone which substantially coincides with the cone of 35 visible light above described. This accordingly positions the operating team, other than the surgeon and assistants, in the shadow outside the cone of ultra-violet where the intensity is less than ten per cent and at the same time concentrates the radiations on air-borne organisms 40 passing upward through the open dome or held suspended therein.

These ultra-violet lamps 25 and 26 are electrically connected by means of a cable 31 to a transformer or the like 32 which also houses an intensity control means 33 such as a rheostat, a reactance, or taps provided on the transformer, as can be more readily seen in Figs. 1 and 4. The 45 transformer and rheostat or other suitable control means 33 may be mounted on the offset support 5 immediately above the bifurcated member 7.

In order to initially set the intensity of the ultra-violet radiations, the rheostat 33 is adjusted so as to give maximum safe intensity at the operative sight simultaneously with maximum intensity of visible illumination, which thus assures greatest possible bactericidal protection 60 at the level of the incision or exposed viscera of the patient without causing erythema.

As the unit is moved toward or away from the patient, the intensity of the ultra-violet radiations naturally varies and in order to maintain maximum intensity the rheostat must be re-set 65 at each new position of the unit. This can be more readily appreciated from Fig. 3 wherein the intensity of the ultra-violet is shown. At the top of the graph the intensity is expressed in percentage, taking 12 inches as minimum distance 70 between the ultra-violet sources 25 and 26 and the patient. The abscissa represents distance in inches from the center line of the unit, whereas the ordinate represents distance from the light to the patient.

75 From this it will be seen that at a spacing of 12

inches between the ultra-violet source and the patient the intensity per unit area is much greater as indicated by the many intensity lines intersecting the line indicative of the 12-inch 5 spacing. As the spacing is increased, however, from 12 inches up to 42 inches, the intensity per unit area progressively decreases at various intermediate spacings as shown by the lesser number of intensity lines which intercept the various 10 spacing lines. This is the opposite of the case of the visible light because the ultra-violet lamps 25 and 26 are not in focus with the reflecting mirrors 15 as is the lamp 18.

Moreover, as previously mentioned, the operating team is positioned in the shadow outside of 15 the cone of ultra-violet radiations; but at the level of the noses and throats where the source of contamination is more or less continuous, the intensity is greater than at the level of the operating sight. This results in rapid destruction 20 of the bacteria borne by the ascending air currents passing from the patient and operating team through the open dome of the unit which apparently has a chimney effect, drawing the air currents upward.

It thus becomes obvious to those skilled in the art that a lighting apparatus is herein provided particularly adaptable to hospital operating rooms and the like which produces intensive visible illumination, as well as invisible radiations. 30 Since both the visible and invisible radiations are projected in the form of substantially coinciding cones, the apex of which is at the level of the operating sight, shadowless illumination together with bactericidal radiations of maximum intensity 35 are available at the required location.

Due to the open dome construction of the lighting unit, ascending air currents are created which serve to maintain the lighting unit cool 40 during operation and at the same time destruction of bacteria results, thus preventing the likelihood of infection to a patient from contaminated air. In addition, the source of illumination has the proper color characteristics so as to properly distinguish the various tissues of the 45 patient.

Although one specific embodiment of the present invention has been shown and described, it is to be understood that other modifications thereof may be made without departing from the 50 spirit and scope of the appended claims.

We claim:

1. A lighting apparatus particularly adaptable to hospital operating rooms comprising a support, an open dome reflector for causing the free and unobstructed circulation of ascending air currents therethrough and provided with a reflecting surface on the interior thereof secured to said support for substantially universal movement 60 thereabout, and a source of highly bactericidal ultra-violet radiations carried by said reflector and positioned in the path of the ascending air currents to destroy bacteria therein, and said reflector projecting said radiations in a conical concentrated beam to radiate maximum surface 65 area within a surgical cavity during an operation on a patient to produce maximum therapeutical effect, and of sufficient intensity at the level of the cavity orifice to reduce the possibility of infection resulting from air-borne micro-organisms 70 during said surgical operation.

2. A lighting apparatus particularly adaptable to hospital operating rooms comprising a support, an open dome reflector for causing the circulation of ascending air-currents therethrough car- 75

ried by said support and provided with a shielding skirt portion about its periphery, a reflecting surface on the interior of said open dome reflector a source of highly bactericidal ultra-violet radiations carried by said reflector adjacent the skirt portion thereof and projected by said reflector in a concentrated beam of bactericidal radiations of sufficient intensity at the level of a patient on an operating table to reduce the possibility of infection resulting from air-borne micro-organisms during a surgical operation and for killing air-borne micro-organisms in the ascending air-currents caused by said open dome reflector.

3. A lighting apparatus particularly adaptable to hospital operating rooms comprising a support, an open dome reflector for causing the circulation of ascending air-currents therethrough carried by said support and having a reflecting surface on the interior thereof for projecting a conical concentrated beam of shadowless illumination on an operating table, a source of illumination disposed at the axis of said reflector, a lens surrounding said source for projecting illumination from said source in a horizontal band onto said reflecting surface, a source of highly bactericidal ultra-violet radiations carried by said reflector and projected thereby in a conical concentrated beam substantially coinciding with the conical beam of illumination to produce radiations of maximum intensity without detrimental effect at the level of a patient on an operating table for reducing the possibility of infection resulting from air-borne micro-organisms during a surgical operation and for killing bacteria in the ascending air-currents caused by said open dome reflector.

4. A lighting apparatus particularly adaptable to hospital operating rooms comprising a support, an open dome reflector carried by said support for inducing the flow of ascending cooling air-currents therethrough, a reflecting surface on the interior of said reflector, a source of illumination disposed at the focus of said reflector so that the illumination therefrom is reflected into a conical concentrated beam of shadowless illumination on an operating table, means for moving said reflector relative to an operating table to vary the intensity of the illumination at the level of said operating table, a source of highly bactericidal ultra-violet radiations carried by said reflector and projected thereby in a conical concentrated beam substantially coinciding with the beam of illumination to produce radiations of maximum beneficial intensity at the level of a patient on an operating table without resulting erythema for reducing the possibility of infection resulting from air-borne micro-organisms during a surgical operation and for killing bacteria in the ascending air-currents caused by said open dome reflector, and manually operable means for altering the intensity of the ultra-violet radiations generated by said source.

5. A lighting apparatus particularly adaptable to hospital operating rooms comprising a support, an open dome reflector carried by said support for inducing the flow of ascending cooling air-currents therethrough and provided with a shielding skirt about its periphery, a reflecting surface on the interior of said reflector, a source of illumination disposed at the focus of said reflector so that the illumination therefrom is reflected into a conical concentrated beam of shadowless illumination on an operating table, means for moving said reflector relative to an operating table to vary the intensity of the illumination at the level of the operating table, a source of highly bactericidal ultra-violet radiations carried by said reflector about its periphery adjacent the shielding skirt portion thereof and projected by said reflector in a conical concentrated beam substantially coinciding with the beam of illumination to produce radiations of maximum beneficial intensity at the level of a patient on an operating table without resulting erythema, for preventing infection from air-borne micro-organisms during a surgical operation and for killing bacteria in the ascending air-currents induced by said open dome reflector, and manually operable means for altering the intensity of the ultra-violet radiations generated by said source.

6. A lighting apparatus particularly adaptable to hospital operating rooms comprising a pivoted support to enable movement of said apparatus in a horizontal and vertical plane, an open dome reflector for causing the circulation of ascending air-currents therethrough and pivotally connected to said support and cooperating therewith to produce substantially universal movement of said apparatus, a reflecting surface on the interior of said open dome reflector for projecting a concentrated beam of shadowless illumination on an operating table, a source of illumination disposed at the axis of said reflector, a lens surrounding said source for projecting illumination from said source in a horizontal band onto said reflecting surface, means carried by said open dome reflector for intercepting the illumination from said source to absorb the infra-red radiations and positioned to be cooled by the ascending air currents caused by said open dome reflector, and a source of highly bactericidal ultra-violet radiations carried by said reflector adjacent the skirt portion thereof and projected by said reflector in a concentrated beam of sufficient intensity at the level of a patient on an operating table to reduce the possibility of infection resulting from air-borne micro-organisms during a surgical operation and for killing air-borne micro-organisms in the ascending air-currents caused by said open dome reflector.

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