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E. O. SEITZ ET AL

3,255,342

LIGHTING ARRANGEMENT

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FIG. 1

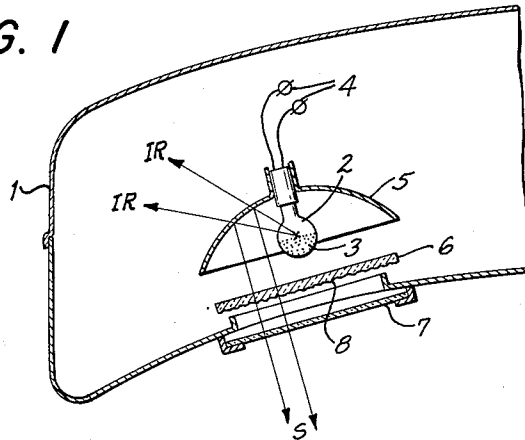


FIG. 2

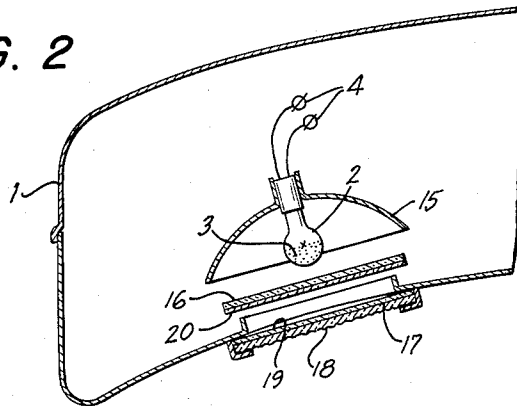
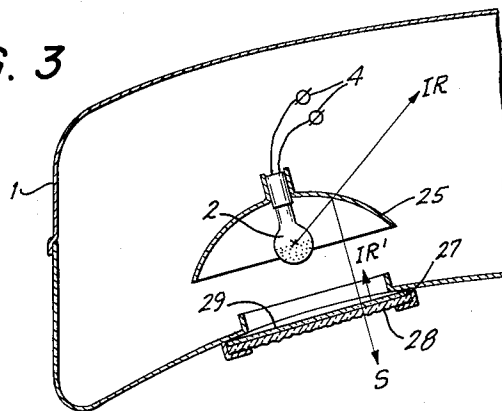


FIG. 3



INVENTORS

Ernst O. Seitz

Hans Ulrich Klippert

Wolfgang Friedl

Michael S. Striker

RH

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LIGHTING ARRANGEMENT

Ernst O. Seitz, Hans Ulrich Klippert, and Wolfgang Friedl,
Hanau am Main, Germany, assignors to Quarzlampen
Gesellschaft m.b.H., Hanau am Main, Germany

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5 Claims. (Cl. 240—1.4)

The present invention relates to a lighting arrangement and, more particularly, to a lighting arrangement such as is used for illuminating surgical operating tables and the like.

Lighting arrangements of this kind usually comprise a light source and a reflector for concentrating the light rays emitted by the light source. The reflector usually has a concave light-reflecting surface and adjacent thereto a shielding arrangement is provided, with the light source such as a light bulb interposed between the reflector and the shielding arrangement.

Conventionally, the shielding arrangement comprises three parallel plates each of which serves a different purpose.

The plate nearest the reflector and light bulb has heat-absorbing properties. This is important because only a small portion of the energy supplied to the light source such as a light bulb will be converted into visible light, while the major portion of the energy will be directly converted into heat. For instance, the optical effectiveness of an electric light bulb is only about 4% so that about 96% of the energy supplied to the light bulb will be emitted as heat radiation, particularly infrared radiation. While it is desired to concentrate the visible light towards a portion of the operating table, it is important to prevent as much as possible of the heat radiation from reaching the area of the operating table. The heat-absorbing plate or sheet will serve to absorb most of the radiant heat energy so that the same will not pass further towards the operating table.

The second plate or sheet conventionally consists of cathedral glass, i.e., of a sheet of glass having an unpolished or uneven surface which will scatter and diffuse the visible light rays passing therethrough. This is important in order to prevent blinding of personnel and patient by direct visibility of the light source. The sheet of cathedral glass is translucent but not transparent. Furthermore, the sheet serves for eliminating shadows and/or the reflection of the light source in the operating area.

Finally, the third sheet which is nearest to the operating table and furthest distant from the reflector and the light source serves as a shielding member and will prevent the dropping of any portion of the lighting arrangement, for instance, of glass splinters, into the operating area. This shielding member in conventional arrangements preferably consists of transparent synthetic plastic material, for instance, of the type known as "Plexiglas," i.e., a thermoplastic poly (methyl methacrylate)-type polymer.

However, certain disadvantages are connected with such conventional arrangements. These disadvantages include the necessity of arranging a relatively large number of sheets or plates such as described above between the light source and the area which is to be illuminated and thereby a considerable portion of the visible light rays will not reach the operating area or the like. Furthermore, notwithstanding the arrangement of, for instance, all these three sheets described above, there will still be a marked and considerable heat radiation into the operating area due to the fact that all heat-absorbing materials are to a limited degree permeable for heat

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radiation and because after using the lighting arrangement for a prolonged period of time, the temperature of the heat-absorbing plate will rise to such an extent that this plate will act as a source of secondary heat radiation.

It is therefore an object of the present invention to overcome the above discussed difficulties and disadvantages connected with conventional lighting arrangements of the type described.

It is a further object of the present invention to provide a lighting arrangement which will allow a limited area to be illuminated with a high proportion of the visible light rays emitted from the light source while at the same time keeping the illuminated area substantially free of heat radiation.

Other objects and advantages of the present invention will become apparent from a further reading of the description and of the appended claims.

With the above and other objects in view, the present combination, a light source having opposite sides and adapted to emit visible light and infrared radiation from one of the opposite sides, reflector means located adjacent one of the opposite sides of the light source in the path of the radiation emitted therefrom for substantially reflecting the emitted visible light while permitting passage of at least a portion of the infrared radiation through the reflector means, and translucent shielding means arranged across the path of the reflected light for diffusing the reflected light passing therethrough.

According to a preferred embodiment, the present invention includes a lighting arrangement for an operating table and the like, comprising, in combination, a reflector having a concave, visible light-reflecting surface and adapted for the passage of infrared radiation there-through, a sheet of light-permeable synthetic plastic material arranged spaced from the reflector in the path of the visible light reflected by the concave light-reflecting surface, the sheet having opposite surfaces, the opposite surface further distant from the reflector having light-diffusing properties, an infrared radiation reflecting layer being located on the other of the opposite surfaces, and a light source interposed between the concave surface of the reflector and the light-permeable sheet, the light source being adapted to emit visible light and infrared radiation in the direction towards the reflector, whereby of the radiation emitted by the light source substantially only diffused visible light will pass through the sheet of light-permeable synthetic plastic material.

Thus, according to the present invention, improved lighting and reduced heat radiation into the illuminated area are accomplished without requiring any change in the light source and the general mode of operation of the lighting arrangement. This is achieved by increasing the proportion of the visible light reaching the operating area or the like, and/or reducing the amount of infrared radiation reaching said area.

According to preferred embodiments of the present invention, several means for achieving this result are combined. However, as will be seen hereinbelow, any one of these means taken alone will also result in a considerable improvement of the lighting effect.

According to one of the features of the present invention, the reflector of the lighting arrangement is a so-called "cold" light concave mirror which is known per se in the art. The term "cold-light mirror" denotes an optical surface which will substantially reflect visible light radiation, while long wave heat radiation will substantially pass through the same. Such mirrors are usually arranged in accordance with an interference filter principle. They can be produced by vapor deposition of several very thin layers of non-absorbing dielectric materials with alternately different indices of re-

fraction. The semi-spherical end portion of light bulbs used for illuminating operating tables and the like are generally provided with a substantially light and infrared radiation impermeable mirror layer so that the major portion of the heat radiation emanating from the light bulb will not be directed towards the area which is to be illuminated but towards the reflecting surface of the reflector. If the reflector is of the cold-light hollow mirror type, then most of the infrared radiation emanating from the light bulb is directed towards the reflector and will pass through the same without being reflected. Only a minor portion of the infrared radiation emitted by the light bulb will then have to be prevented from reaching the illuminated area by interposition of a heat-absorbing sheet or heat filter. Due to the relatively small amount of infrared radiation which will thus still have to be absorbed by the heat filter or infrared radiation-absorbing sheet, the latter may be of somewhat lesser heat-absorbing effectiveness and consequently can be of greater permeability for visible light rays so that a greater portion of the visible light rays emitted from the light source and reflected by the reflector will pass therethrough towards the area which is to be illuminated. In certain cases it is even possible by using a cold-light mirror reflector to eliminate the heat filter or heat-absorbing sheet altogether.

A second feature of the present invention will be found in the provision of at least one infrared radiation-reflecting mirror in the shielding member of the lighting arrangement. The infrared reflecting mirror is understood to be an optical surface which substantially permits the passage therethrough of visible light rays and which, however, will substantially reflect heat radiation such as infrared radiation. Such infrared reflecting mirror may be formed as an interference filter by vapor deposition of several very thin layers of different dielectric materials with alternately differing indices of refraction. By arranging one or more infrared mirrors in the paths of radiation after the same has passed through the heat-absorbing sheet or filter, it is possible to reflect the major portion of the residual heat rays, such as infrared rays, which have passed through or are emitted by the heat-absorbing sheet. By combining an infrared mirror as described above with a reflector formed as a cold-light mirror, and omitting the heat-absorbing sheet or heat filter, better results are obtained than are obtainable with heat filters but without infrared mirrors and cold-light reflectors. This is due to the fact that the heat radiation is thus twice eliminated, namely, once by passing through the cold-light reflector and the residual heat radiation by being reflected from the infrared mirror. Furthermore, due to elimination of the heat-absorbing sheet or plate, the same cannot become a secondary source of heat radiation.

According to a third feature of the present invention, either the heat-absorbing sheet, or the protective shielding plate or sheet of synthetic plastic material may be formed with a light scattering or diffusing surface so as to achieve the so-called "cathedral glass effect" without requiring a separate sheet or plate for this purpose. In this manner, two of the objects of conventional shielding arrangements are achieved with only one plate or sheet and thereby the number of sheets of the shielding arrangement is reduced and the overall light permeability of the shielding arrangement is increased.

It will be clear from the foregoing that by combining the three features of the present invention which were discussed above, the objects of the present invention will be achieved in a most effective manner, namely by providing a lighting arrangement which includes a cold-light mirror reflector and a shielding arrangement which consists of a single shield or plate having an infrared mirror on its face directed towards the light source and reflector, and having a light-diffusing surface structure

at the opposite surface, i.e., the surface directed towards the area which is to be illuminated.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1 is a sectional elevation of an embodiment of the present invention.

FIG. 2 is a sectional elevation of another embodiment of the present invention; and

FIG. 3 is a sectional elevation of a further embodiment of the present invention.

In all three figures is shown a housing 1, a light bulb 2 as the light source, and it will be noted that the outer hemispherical portion 3 of the light bulb is mirror-plated so that light can be emitted only in the direction toward the reflector 5, 15 or 25 and, furthermore, all figures of the drawing show electric terminals 4 and wire connections from the terminals to bulb 2.

Referring now to the embodiment of the present invention illustrated in FIG. 1, a reflector 5 is shown which is formed as a cold-light concave mirror. In other words, the relatively short wave infrared radiation emitted by bulb 2 indicated by arrows and indicia IR will pass through the reflector without being reflected, while the visible light indicated by arrows S will be reflected.

The shielding means comprise an inner or second sheet 6 of light-permeable heat-absorbing material which is interposed between a first light-permeable sheet 7 of synthetic plastic material and light bulb 2. The outer surface of second sheet 6, i.e., the surface directed towards first sheet 7 and towards the area to be illuminated is formed so as to give a cathedral glass effect, in other words, so as to diffuse light so that the light which passes from bulb 2 to reflector 5 and from there through second sheet 6 and first sheet 7 towards the area which is to be illuminated will be diffused, will not give any sharp shadows and so that the light source will not be visible when viewed from the illuminated area. Thus, a special plate for producing the cathedral glass effect is not required since this effect is achieved by the suitably roughened lower surface of heat-absorbing plate 6. The shielding arrangement according to FIG. 1 is of greater light permeability than the conventional 3-plate shielding arrangements. Furthermore, due to the fact that only relatively little infrared radiation reaches heat-absorbing sheet 6, the latter can be made thinner and with better permeability for visible light than is possible in conventional arrangements in which a greater portion of the infrared radiation reaches the shielding arrangement. It will be noted that a major portion of the infrared radiation passes in the direction of arrows IR through the cold-light reflector and thus will not contact the shielding arrangement. According to FIG. 2, a conventional reflector 15 is combined with a shielding arrangement according to the present invention. The conventional reflector reflects not only visible light but also infrared radiation.

The shielding arrangement again consists of two sheets or plates, namely heat-absorbing plate or sheet 16 and plate or sheet 17 of synthetic plastic material. The lower face 18 of sheet 17 is unpolished or rough so as to give the cathedral glass effect of diffusing light passing therethrough. The upper surface of plate 17 consists of infrared mirror 19 which will reflect relatively long wave infrared radiation. Heat filter or heat-absorbing sheet 16 is formed with infrared mirror 20 at its lower face which serves the purpose of reflecting relatively short wave infrared radiation back towards bulb 2 and reflector 15.

According to the embodiment illustrated in FIG. 2, the shielding arrangement again consists only of two plates

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or sheets and the special plate conventionally used for obtaining the cathedral glass effects is omitted since the function of this plate, namely diffusion of the light passing therethrough, is achieved by surface portion 18 of sheet or plate 17. Heat radiation is absorbed in a conventional manner by sheet or plate 16. However, residual relatively short wave infrared primary radiation which may pass through sheet 16 is reflected by the infrared mirror surface 20 and thus will not reach the area of illumination, for instance the surgical operating area. Upon increase in the temperature of heat absorbing sheet 16, relatively long wave infrared radiation formed thereby will be reflected by infrared mirror 19 forming the upper surface of sheet 17 and thus also will be prevented from reaching the area of intended illumination.

According to the embodiment illustrated in FIG. 3, the reflector 25 is formed as concave cold-light mirror reflector.

The shielding arrangement consists of only a single sheet or plate, namely sheet 27 of synthetic material such as Plexiglas. Lower surface 28 of sheet 27 is roughened so as to give the cathedral glass effect of diffusing light passing therethrough, while on the upper face of plate 27 infrared mirror 29 is formed.

Visible light, emitted by light bulb 2 is reflected at reflector 25 and passes through the shielding arrangement as indicated by arrow S. Short wave infrared radiation emitted by light bulb 2 passes substantially through cold-light reflector 25 as indicated by arrow IR, while any reflected portion of infrared radiation which reaches plate or sheet 28 will be reflected by infrared mirror 29, as indicated by arrow IR' and thus eventually will reach again cold-light reflector 25 and pass outwardly through the same substantially as indicated by arrow IR.

Due to the fact that in this case the shielding arrangement requires only a single sheet or plate, a relatively very large proportion of the visible light emitted by bulb 2 will in fact reach the area intended to be illuminated while, on the other hand, only an insignificant amount of heat or infrared radiation will penetrate through the shielding member.

It is also possible to combine the features of the present invention differently from the manner in which these features were combined in the illustrated embodiments, or also to use one or the other feature alone.

For instance, the cold-light concave mirror of FIG. 1 or the infrared mirror or mirrors of FIG. 2 may be utilized in a 3-sheet shielding arrangement, whereby only heat radiation into the operating area or the like is reduced without increasing the efficiency of visible light transmission. On the other hand, it is possible by just combining two functions of different sheets of the shielding arrangement in a single sheet thereof to increase the efficiency of light transmission without reducing the transmission of heat or infrared radiation below the values obtained with conventional devices of this type. However, it is preferred to combine the three above described features of the present invention, for instance in the manner illustrated in FIG. 3.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of lighting arrangements differing from the types described above.

While the invention has been illustrated and described as embodied in a lighting arrangement for an operating table and the like, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

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Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired is to be secured by Letters Patent is:

1. In a lighting arrangement, in combination, a light source having first and second opposite sides and adapted to emit visible light and infrared radiation from said first and second opposite sides in a first and second opposite direction, respectively; an opaque shielding means arranged closely adjacent to and substantially commensurate in size to said first opposite side of said light source blocking passage of directly emitted visible light and infrared radiation in said first opposite direction; reflector means located adjacent said second of said opposite sides of said light source in the path of said visible light and infrared radiation emitted therefrom in said opposite direction, thereby substantially reflecting said emitted visible light in said first opposite direction and past said opaque shielding means while permitting passage of at least a portion of said infrared radiation through said reflector means in said second opposite direction; and a translucent shielding and diffusing element arranged across the path of said reflected light and carrying on one surface thereof an infrared radiation reflecting layer so as to substantially prevent passage of said infrared radiation through said element while permitting said reflected light to pass through the element and diffusing said light thereby.

2. A lighting arrangement as defined in claim 1, wherein said reflector means is concave.

3. A lighting arrangement as defined in claim 1, wherein said reflector means is concave and said translucent shielding and diffusing element is a sheet of light-permeable material.

4. A lighting arrangement as defined in claim 1, wherein said reflector means is concave and said translucent shielding and diffusing element is a sheet of light-permeable synthetic plastic material.

5. A lighting arrangement as defined in claim 1, wherein said reflector means is concave and said translucent shielding and diffusing element is a sheet of light-permeable synthetic plastic material having a second surface opposite said one surface, said second surface having light-diffusing properties.

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EVON C. BLUNK, *Primary Examiner.*

NORTON ANSHER, J. F. PETERS,
Assistant Examiners.