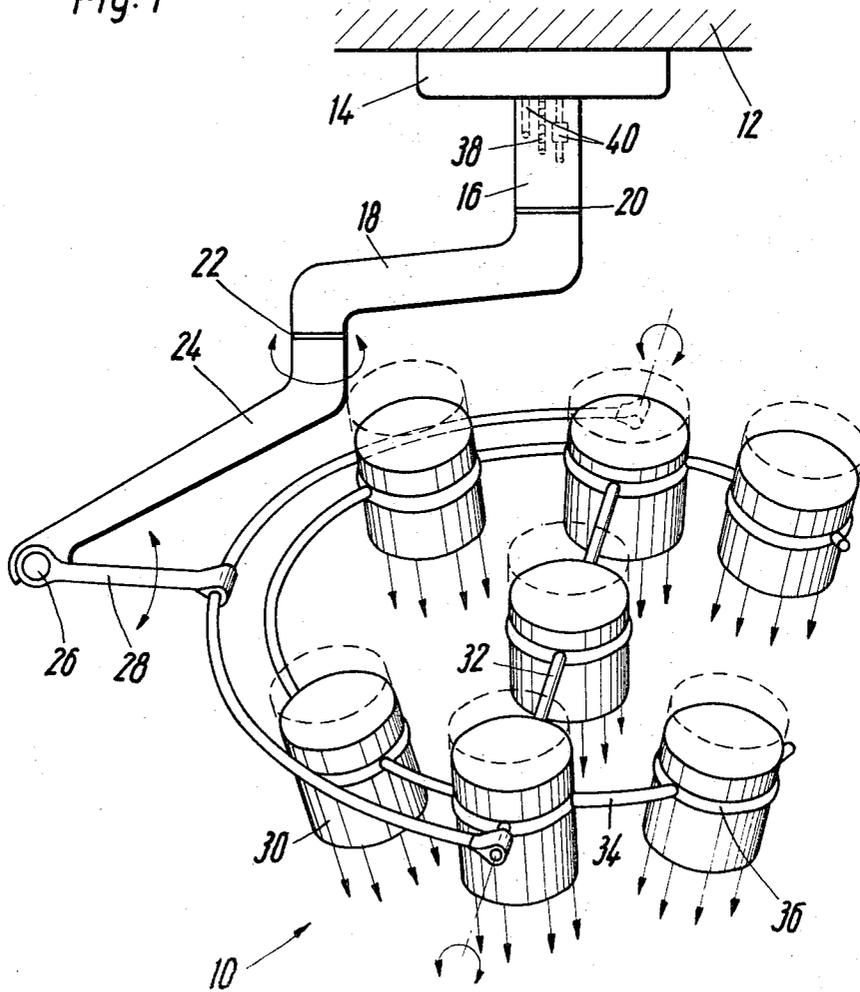


Fig. 1



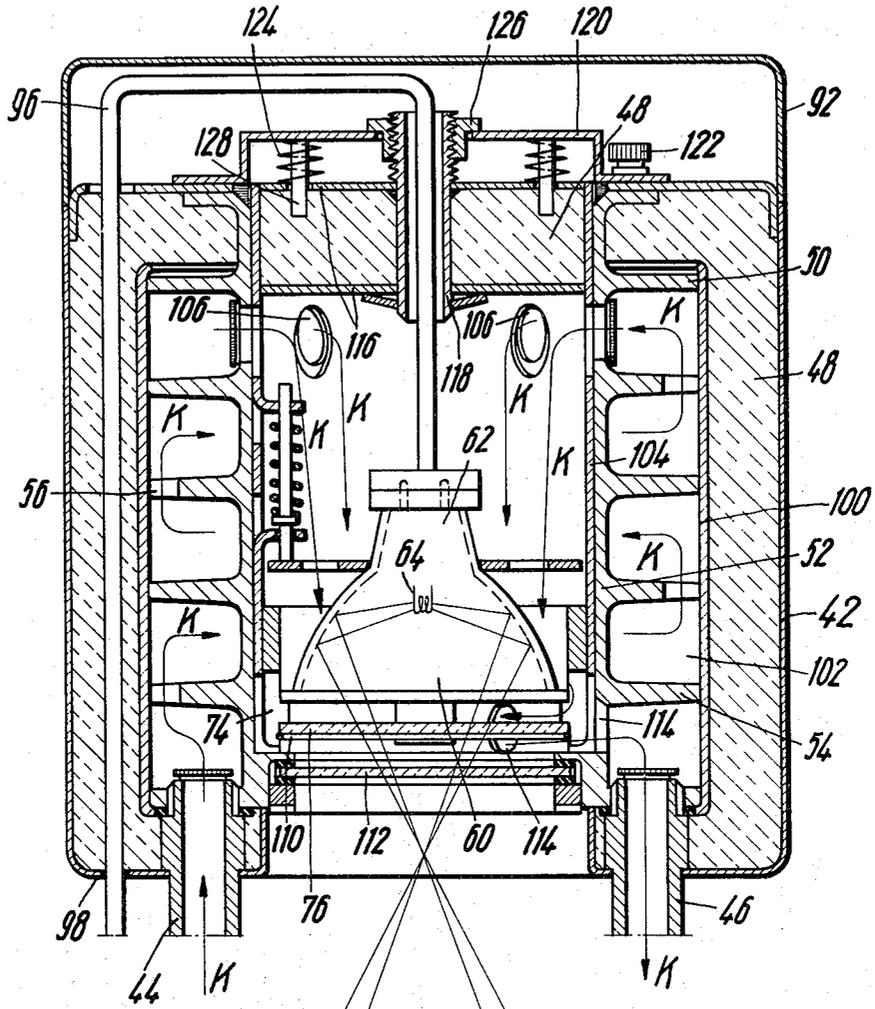
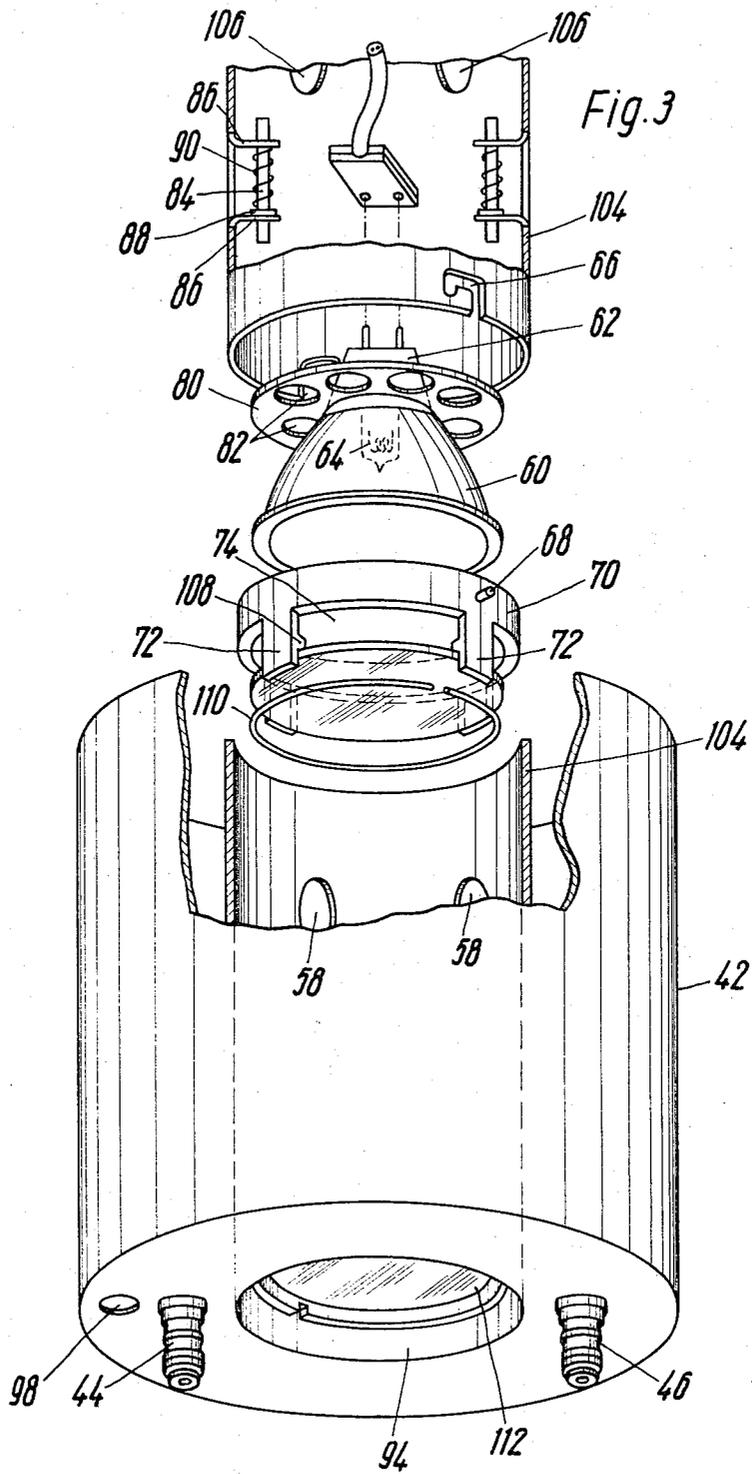


Fig. 2





FLOODLIGHTING SYSTEM AND SPOTLIGHTS THEREFOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a floodlighting system and to spotlights therefor. The system finds particular application in medical operating theaters.

2. Description of the Prior Art

A problem which quite generally arises in connection with spotlights for instance in floodlighting systems for medical operating theaters and in film projectors, is that of abstracting the considerable quantity of heat generated. The spotlights, for instance in the form of incandescent lamps, are contained in a lamp housing and develop a considerable amount of heat, which raises the temperature of every component in the neighborhood of the incandescent lamp, such as the lamp housing itself, the reflector, and filters and cover plates if present. The components are therefore liable to be damaged, particularly those made of glass, which may crack or shatter. It is therefore necessary to ensure that lamps incorporated in operating theater floodlighting systems are adequately cooled, and it must also be borne in mind that the atmosphere in an operating theater cannot be used for cooling as it may be explosive. This is because anaesthetising gases used in an operation may form explosive gas mixtures with air, and if such a mixture is used as a coolant for the spotlights, an explosion may easily take place. In order to eliminate this explosion hazard, spotlights of previously proposed floodlighting systems for operating theaters generally each have a hermetically sealed explosion-proof casing. This makes the floodlighting system very expensive, and there is the disadvantage that continuous cooling and reheating of the casing may soon cause structural fatigue and the appearance of hairline cracks which may nullify the hermetic sealing of the casing.

In film projectors it has been proposed to cool incandescent lamps therein by introducing cooling air drawn from the atmosphere outside the projector through a hose. In other projectors the same cooling air is used and is recirculated and cooled with water.

It has also been proposed to take advantage of indirect air cooling in which the incandescent lamp is not cooled but instead a gastight lamp housing is fanned with cold air and thus cooled. This may be achieved by providing the lamp housing around its periphery with cooling fins which extend parallel to the longitudinal axis of the housing and at its top with a fan. This causes the heat radiated by the incandescent lamp to be distributed and carried by the air current which the fan generates into a zone where there is no risk of explosion. The risk of an explosion taking place is thus eliminated, even if the cooling air should be mixed with anaesthetising gases from the operating theater.

SUMMARY OF THE INVENTION

According to a first aspect of the invention, there is provided a spotlight formed internally with a circuit for the passage of a coolant, the spotlight being adapted so that coolant can be passed through the circuit without ambient atmosphere entering the circuit.

A second aspect of the invention resides in a floodlighting system comprising a plurality of such spotlights.

Since the spotlight of the invention does not use ambient atmosphere as a coolant, it may be used in areas of an operating theater where there is an explosion hazard.

Advantageously, the floodlighting system spotlights are mounted along a gapped ring, there also being a spotlight mounted within the ring, the ring being mounted on a linkage on a swivel pin which is or is adapted to be attached to a support above the system. Typically, the support is a ceiling. The spotlights other than the center spotlight are advantageously mounted in holders on the ring, the holders each being tiltable about a respective axis which intersects the points of contact of the holders with the ring.

In a preferred embodiment of the floodlighting system, the spotlight in the center of the ring is mounted on an axle of the ring, the axle being mounted between the ends of a fork member which surrounds part of the ring and is also mounted on the linkage, the ring being tiltable about said axle. Desirably, the holders of two of the spotlights serve to mount the ring on the axle, the spotlight in the middle of the ring being tiltable about the axle. The spotlights other than those on the axle are each tiltable about a respective axis which intersects the points of contact of the holders with the ring.

Owing to the adjustability of each individual spotlight the light from each spotlight can be directed at any desired point, and the size of the illuminated operating area can thus be controlled. The spotlight desirably comprises a cooling jacket which surrounds a double-walled lamp housing provided between its walls with cooling fins, part of said circuit being formed within the walls of the housing. Advantageously, the cooling fins embrace the inner wall of the lamp housing and extend from the inner wall to the outer wall thereof, each fin being provided with an opening for the passage of coolant, the openings of adjacent fins being on opposite sides of the lamp housing. Preferably, the spotlight comprises a hollow shell located within the lamp housing and a reflector case in the hollow shell containing an incandescent lamp and a reflector therefor, said circuit being such that coolant can pass into the spotlight, along the outside of the hollow shell between the walls of the lamp housing, back through the hollow shell, and out of the spotlight. Typically the hollow shell is cylindrical and the cooling fins are annular. The reflector may be elliptically shaped. Coolant is generally passed around the circuit under pressure. It will be appreciated that the lamp housing is cooled first, followed by the parts of the spotlight contained inside the hollow shell which is positioned in the lamp housing. The cooling effect is similar in principle to that of a counterflow system. The arrangement of openings in the cooling fins opposite one another ensures that the coolant which enters a chamber formed between two vertically consecutive fins and the intervening parts of the double wall of the lamp housing will flow peripherally around the lamp housing in this chamber before leaving through the opening in the next fin above and entering the next higher chamber. For increasing the cooling effect, the space between the external wall of the cooling jacket and the lamp housing is preferably packed with an insulating material. The cooling jacket may be provided with inlet and outlet connections, conveniently on the underside of the jacket, for the entry and return of the coolant, said connections being located on opposite sides of the light aperture of the spotlight.

In order to permit the coolant to flow out of the lamp housing into the interior of the hollow shell, the hollow shell and the inner wall of the lamp housing may be provided with adjacent openings at respective one ends thereof, whereby coolant can pass from between the walls of the lamp housing to the inside of the hollow shell.

Advantageously, the reflector case is held in position in the hollow shell by a locating plate which surrounds a connector at the apex of the reflector case and which is held against the reflector case by at least three spring-loaded pins. The locating plate may be formed with apertures for the passage therethrough of coolant. Preferably, each spring-loaded pin slidably extends through aligned holes in respective pairs of lugs which project into the interior of the hollow shell, and one end of the spring of each spring-loaded pin bears directly against the lug remote from the locating plate and the other end of the spring bears against a collar on the pin. The compression springs function at all times to keep the locating plate in contact with the reflector case. Should the locating plate tend to move against the pins these will yield against the resistance of their springs and slide in the holes of the lugs.

Advantageously, the reflector case is supported on abutments of a holder, and other abutments of the holder support a filter in alignment with the reflector, a spring ring being provided to secure the filter. Conveniently, the holder is detachably held in the hollow shell by means of a bayonet coupling. Preferably, said abutments are provided on depending portions of the holder, whereby coolant can flow through gaps between said depending portions to immerse completely the filter. Desirably, openings are formed in the inner wall of the lamp housing adjacent the gaps between the depending portions of the holder, whereby coolant can flow out of the hollow shell. More than one filter may be supported by the holder, each filter being located by a separate set of abutments.

Preferably, a cover plate is provided for sealing the light aperture of the spotlight. Desirably, the reflector is adapted to focus the light a short distance below the reflector and a Fresnel lens is provided for producing a parallel beam of light after the light has passed through the focus of the reflector. The cover plate may be etched, sandblasted or otherwise roughened on one or both sides for compensating faults of the spotlight.

The parallel beam from each spotlight of the floodlighting system permits any particular operating area to be specifically and fully illuminated, and by suitably tilting and combining the beams of all the spotlights a small operating area can be illuminated very intensely.

Advantageously, the end of the hollow shell remote from the light aperture is covered by two parallel plates, between which is insulating material, the centers of the plates having a bushing extending therethrough through which a power supply cable can pass. Preferably, the end of the cooling jacket remote from the light aperture is provided on an inner part with a cover, the interior of which carries two pins embraced by respective compression springs, the ends of the pins extending through holes in one of the end plates of the hollow shell, thereby to prevent rotation of the cover. The cover may be attached to the cooling jacket by means of screws. Desirably, a rotatable nut is provided in said bushing for raising or lowering the hollow shell, and thus for adjusting the reflector and lamp therein, the

compression springs serving to retain the hollow shell in the position to which it has been adjusted by rotation of the nut. The cooling jacket may be surmounted by a cap which is flush with the jacket and provides a space between the cap and the jacket for storing surplus power cable. The provision of a cap which is flush with the cooling jacket is desirable for reasons of hygiene.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to enable the invention to be more readily understood, reference will now be made to the accompanying drawings, which illustrate diagrammatically and by way of example, an embodiment thereof, and in which:

FIG. 1 is a perspective view of a floodlighting system comprising a plurality of spotlights,

FIG. 2 is a vertical section through one of the spotlights, and

FIG. 3 is an exploded view, partly in section and partly cut away of the spotlight shown in FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings, there is affixed to the ceiling 12 of an operating theater by means of a ceiling fitting 14 a swivel pin 16 which supports a floodlight assembly 10 suspended from interposed swivel arms 18, 24 and a bracket arm 28. The ends of the swivel arm 18 are provided with off-angled swivel joints 20, 22 which connect the ends of the swivel arm 18 to the swivel pin 16 and to the second swivel arm 24 respectively. One end of the latter is correspondingly angled, whereas its other end pivots on a hinge pin 26 mounted in the end of the bracket arm 28. The bracket arm 28 is pivotable about the pin 26 as indicated by a double-headed arrow in FIG. 1. At its end opposite the pin 26, the bracket arm 28 supports a floodlight assembly fork which is semicircular.

From the ceiling fitting 14 a power cable 38 enters the interior of the swivel pin 16 and in a manner not shown in the drawing passes through the swivel arms 18, 24 and the bracket arm 28 to the floodlight assembly 10, which comprises several spotlights 30. In addition, from the ceiling fittings 14 pipe means 40 for a coolant likewise lead to the spotlights 30 of the floodlight assembly 10 in analogous manner to the electrical power supply, as will be hereinafter described.

The spotlights 30 of the floodlight assembly 10 are mounted in annular holders 36 along the length of a ring 34, in which there is a gap diametrically opposite the bracket arm 28, each spotlight being tiltable about an axis which intersects the points of contact of the holders 36 and the ring 34. Six spotlights 30 are mounted on the ring 34 and a further spotlight is mounted in a holder on a transverse axle 32 which is itself mounted between the arms of the semi-circular fork of the floodlight assembly 10. The entire floodlight assembly 10 can be tilted about this transverse axle 32.

It will be readily understood that a floodlight assembly 10 comprising six spotlights 30 which can be tilted about the axle 32 is only illustrated by way of example. More or less than six spotlights 30 can be mounted on the ring 34. Furthermore, more than one spotlight may be located inside the ring 34.

The swivel pin 16, the swivel arms 18, 24 and the bracket arm 28 are hollow. In their interiors they con-

tain the cable 38 for the electrical power supply to the lamps of the spotlights 30. The interior of the swivel pin 16 and of the arms 18, 24 and 28 may also contain wiring for diverse other electrical equipment as well as pipe means for oxygen and anaesthetising gases and possibly other equipment, for instance exhaust ducting.

The ring 34 is tiltable about the transverse axle 32 within limits determined by the dimensions of the swivel pin 16, the swivel arms 18 and 24 and the bracket arm 28. Each individual spotlight 30 mounted on the ring 34, other than those also on the axle 32, can be tilted about an axis defined by the ring 34. These adjustment facilities permit the operating area below the flood light assembly 10 to be optimally illuminated. The gapped ring 34 permits a surgeon to stand within the gap between the ends of the ring 34 when the flood-light assembly has been lowered and thus to be close to the operating area, without casting a shadow.

Referring now particularly to FIGS. 2 and 3, each spotlight 30 has a cooling jacket 42 through which a coolant can pass so that all parts and components inside the jacket 42 are suitably cooled. The underside of the cylindrical cooling jacket 42 is provided with an inlet connection 44 for the admission of coolant and an outlet connection 46 for the discharge of coolant. Clearly, 44 could be made an outlet in practice and 46 an inlet. The inlet and outlet connections are on diametrically opposite sides of an aperture 94 for the light beam from the spotlight 30. Furthermore, an opening 98 is provided alongside the inlet connection 44 for the introduction of a cable 96 for supplying the spotlight 30 with current.

Spaced away inwards from its external wall, the jacket 42 contains a double-walled lamp housing 50 having an outer wall 100 and an inner wall 52. The space between the lamp housing 50 and the external wall of the jacket is filled with an insulating material 48 to prevent substantial heating of the coolant from outside the spotlight. Between the inner walls 52 and the outer wall 100 of the lamp housing 50 are cooling fins 54 which embrace the entire circumference of the lamp housing 50. The cooling fins 54 have the form of flat vertically spaced circular rings extending from the wall 100 to the wall 52. Each two vertically consecutive cooling fins 54 and the intervening portions of the walls 100 and 52 thus define a substantially self-contained annular chamber 102, each of which is provided with an opening 56 in part of the top and part of the bottom thereof, so that adjoining chambers 102 are in communication. The two openings 56 in each chamber are at diametrically opposite points so that the coolant which enters through the opening 56 at the bottom must flow around the circumference of the lamp housing 50 in the chamber 102 before it can enter the next chamber 102 above through the upper opening 56 on the diametrically opposite side of the chamber. This arrangement forces the coolant to flow in a substantially helical path upwards through the interior of the double-walled lamp housing 50 and thus to provide an optimum cooling effect. The upper end of the inner wall 52 contains circumferentially distributed openings 58 through which the coolant enters the interior of a cylinder 104 surrounding a reflector case or dish 60 containing a reflector for an incandescent lamp 64 of the spotlight 30. The cylinder 104 contains openings 106 at the level of and registering with the openings 58 in the wall 52 to permit the coolant to enter the interior of the cylinder 104

without being obstructed. The top of the reflector dish 60 is provided with a connector 62 for supplying electrical spring-loaded to the lamp 64, all times

The reflector dish 60 is held in position inside the cylinder 104 by a locating plate 80 and a holder 70. For this purpose the holder 70 has two or more bayonet pins 68 projecting from its periphery and adapted to engage cooperating slots 66 in the cylinder 104 and thus to form a push-and-turn joint, i.e., a bayonet coupling. The holder 70 has three or more downward extensions 72 each of which is formed on its inside with one or more abutments 108. If each extension 72 has more than one abutment 108, the abutments may be vertically tiered. The reflector dish 60 rests on the first of these abutments 108. The locating plate 80 is pushed over the connector 62 in the dish 60 and is resiliently urged from above into contact with the dish. This arrangement ensures firm location of the reflector dish 60 inside the cylinder 104. The locating plate contains several circular holes 82 through which coolant can flow downwards, thereby to cool the reflector dish 60 and the reflector as well as one or more filters 76 located inside the holder 70. In the illustrated embodiment only a single filter 76 is provided; however, it will be understood that two or more such filters could be located in the holder 70. The filters 76 associated with the incandescent lamp 64 of the spotlight 30 may be heat filters resting on the vertically tiered abutments 108 inside the holder 70 where they are kept in position by spring rings 110. The upper surface of the locating plate 80 bears against three or more pins 84 each of which is urged against the locating plate 80 by a compression spring 90 surrounding the pin between respective pairs of lugs 86 inside the cylinder 104. Each pin 84 is slidable in aligning holes in the two lugs 86. The compression spring 90 is interposed between the upper lug 86 and a collar 88 on the pin 84. When the locating plate 80 presses against the pins 84, they are upwardly displaced through the hole in the upper lug 86 against the resistance of the compression springs 90. The pins are of sufficient length to project through the holes in the upper and the lower lugs 86. Alongside each pin 84, the cylinder 104 contains openings which have been created by the lugs 86 being punched out of the material of the cylinder and bent inwards into the cylinder 104.

The rays emitted by the incandescent lamp 64 impinge upon the reflector (which is a cold light reflector) inside the dish 60, the heat rays passing through the reflector, whereas the visible light rays are reflected downwards the filter 76. After having passed through the filter 76 the rays also pass through a cover plate 112 which seals the light aperture 94 in the bottom of the cooling jacket 42. This cover plate 112 is etched or sandblasted on one or both sides to compensate for any faults in the lamp. The reflector is designed to focus the rays a short distance beyond the cover plate 112, the rays then diverging until they reach a Fresnel lens 78 which refracts them to form a parallel beam projected towards the operating area in the downward direction.

The top of the cylinder 104 is sealed by two parallel end plates 116, the space between the two end plates being likewise filled with an insulating material 48. A bushing 118 for a cable 96 is fitted centrally into the end plates 116. An outside cover 120 is secured to the bushing 118 and fastened to the top of the cooling jacket 42 by screws 122 evenly spaced around the cir-

cumference. The cover 120 has a central raised portion which in its interior contains two pins 128 surrounded by compression springs of each of which one end bears against the underside of the raised part of the cover, and the outer end bears against and locates the upper end plate 116. The pins 128 pass through holes in the end plate 116 and prevent the cover 120 from turning. The cover 120 is attached to the top of the cooling jacket 42 not only by the screws 122 but also by a cylindrical nut 126, and is thereby held in position against the thrust of the springs 124. The nut 126 has a milled edge and engages an external thread on the bushing 118. The nut 126 serves for raising or lowering the cylinder 104 and thus for adjusting the lamp 64. The compression springs 124 keep the cylinder 104 in the pre-adjusted position selected by rotating the nut 126. The cooling jacket 42 is surmounted by a cap 92 which clears the top of the cooling jacket 42 at a sufficient distance to permit surplus lengths of electrical cable 96 to be accommodated beneath the cap. The cap 92 may be attached to the lamp housing 50 by screws with milled heads. The cap is flush with the jacket, for reasons of hygiene.

In FIG. 2 the path of flow of the coolant is indicated by arrows K. After having passed through the double-walled lamp housing 50 and having entered the cylinder 104 the coolant flows through the holes 82 in the locating plate 80, and over the reflector dish 60 containing the incandescent lamp 64. After having passed down the outside of the dish 60 the coolant flows through the gaps between the downward extensions 72 of the holder 70. At the level of these gaps 74 openings 114 are provided in the inner wall 52 of the lamp housing 50 through which the coolant can escape to leave through the outlet connection 46. The path along which the coolant is conducted through the cooling jacket 42 ensures that, firstly, all the internal parts of the spotlight 30 are cooled, and secondly, that the internal parts are kept under a given pressure, i.e., at the pressure of the coolant, which may for instance be compressed air. The cooling effect is similar to that achieved by an application of the counterflow principle, the double wall of the lamp housing 50 which contains all the internal components of the spotlight 30 being cooled first by the coolant in upflow, whereupon the direction of flow of the coolant is reversed before it passes through the interior of the cylinder 104 which contains the dish 60 and the incandescent lamp 64. The coolant thus provides an easily controlled cooling effect by flowing over the reflector dish 60 past the filter or filters 76 and the cover plate 112. At the same time the special advantage is gained that the filter or filters 76 are completely immersed in the coolant so that the maximum possible degree of abstraction of heat from the absorption filters 76 is achieved as these become hot.

It will be appreciated that many modifications may be made to the design of the cooling jacket 42, the lamp housing 50, its double walls and cooling fins 54, the reflector dish 60 and the manner of its location inside the cylinder 104, and the holder 70 for the filters 76.

What is claimed is:

1. A spotlight assembly, comprising:

a. a lamp and reflector unit having a closed light exit face,

b. a sealed housing surrounding the unit and including a light transparent portion spaced from the light exit face,

c. coolant passage means formed within the housing and extending between the light exit face and the light transparent portion and

d. means for circulating a non-explosive, gaseous coolant under pressure through the passage means, whereby if any leaks develop in the assembly the pressure causes the gaseous coolant to escape to the surrounding atmosphere and thereby prevents any explosive gases in the atmosphere from penetrating into the assembly.

2. A spotlight assembly as defined in claim 1, wherein the housing includes a double walled cylindrical cooling jacket surrounding the unit and mounting it therein, and spaced cooling fins mounted between the jacket walls and forming part of the coolant passage, each fin being apertured for the passage of coolant, the apertures of adjacent fins being on opposite sides of the housing.

3. A spotlight as claimed in claim 2 wherein the reflector unit is adapted to focus the light a short distance below the light exit face and a Fresnel lens is provided for producing a parallel beam of light after the light has passed through the focus of the reflector unit.

4. A spotlight assembly as defined in claim 2 further comprising a layer of heat insulating material between the outer wall of the cooling jacket and the housing.

5. A spotlight as claimed in claim 4, wherein the cooling jacket is provided with inlet and outlet connections for coolant, said connections being located on opposite sides of the exit face of the spotlight.

6. A spotlight as claimed in claim 5, further comprising a hollow shell located within the housing between the lamp and reflector unit and the inner wall of the cooling jacket such that coolant can pass into the spotlight, along the outside of the hollow shell between the walls of the cooling jacket, back through the hollow shell, and out of the spotlight.

7. A spotlight as claimed in claim 6 wherein the hollow shell and the inner wall of the cooling jacket are provided with adjacent openings at respective one ends thereof, whereby coolant can pass from between the walls of the cooling jacket to the inside of the hollow shell.

8. A spotlight as claimed in claim 6, wherein the reflector unit is held in position in the hollow shell by a locating plate which surrounds a connector at the apex of the reflector unit and which is held against the reflector unit by at least three spring-loaded pins.

9. A spotlight as claimed in claim 8, wherein the locating plate is formed with apertures for the passage therethrough of coolant.

10. A spotlight as claimed in claim 8 wherein each spring-loaded pin slidably extends through aligned holes in respective pairs of lugs which project into the interior of the hollow shell.

11. A spotlight as claimed in claim 10, wherein one end of the spring of each spring-loaded pin bears directly against the lug remote from the locating plate and the other end of the spring bears against a collar on the pin.

12. A spotlight as claimed in claim 6 wherein the reflector unit is supported on abutments of a holder, and wherein other abutments of the holder support a filter

in alignment with the reflector unit, a spring ring being provided to secure the filter.

13. A spotlight as claimed in claim 12 wherein the holder is detachably held in the hollow shell by means of a bayonet coupling.

14. A spotlight as claimed in claim 12 wherein said abutments are provided on depending portions of the holder, whereby coolant can flow through gaps between said depending portions to completely immerse the filter.

15. A spotlight as claimed in claim 14 wherein openings are formed in the inner wall of the cooling jacket adjacent the gaps between the depending portions of the holder, whereby coolant can flow out of the hollow shell.

16. A spotlight as claimed in claim 6 wherein the end of the hollow shell remote from the light exit face is covered by two parallel plates, between which is insulating material, the centers of the plates having a bushing extending therethrough through which a power supply cable can pass.

17. A spotlight as claimed in claim 16, wherein the end of the housing remote from the light exit face is provided on an inner part with a cover, the interior of which carries two pins embraced by respective compression springs, the ends of the pins extending through holes in one of the end plates of the hollow shell, thereby to prevent rotation of the cover.

18. A spotlight as claimed in claim 17 wherein the cover is attached to the cooling jacket by means of screws.

19. A spotlight as claimed in claim 17 wherein a rotatable nut is provided in said bushing for raising or lowering the hollow shell to adjust the lamp and reflector unit therein, the compression springs serving to retain the hollow shell in the position to which it has been adjusted by rotation of the nut.

20. A spotlight as claimed in claim 2 wherein a cover

plate is provided for sealing the light exit face of the spotlight.

21. A spotlight as claimed in claim 20, wherein the cover plate is roughened on at least one side to compensate for faults of the spotlight.

22. A spotlight as claimed in claim 2 wherein the housing is surmounted by a cap which is flush with the housing and provides a space between the cap and the housing for storing surplus power cable.

23. A floodlighting system comprising a support on which are adjustably mounted a plurality of spotlights as claimed in claim 2 whereby illumination suitable for a particular use can be obtained.

24. A floodlighting system as claimed in claim 23, wherein the spotlights are mounted along a gapped ring, there also being a spotlight mounted within the ring, the ring being mounted on a linkage on a swivel pin which is adapted to be attached to a support above the system.

25. A floodlighting system as claimed in claim 24 wherein the spotlights other than the spotlight within the ring are mounted in holders on the ring, the holders each being tiltable about a respective axis which intersects the points of contact of the holders with the ring.

26. A floodlighting system as claimed in claim 24, wherein the spotlight within the ring is mounted on an axle of the ring, the axle being mounted between the ends of a fork member which surrounds part of the ring and is also mounted on the linkage, the ring being tiltable about said axle.

27. A floodlighting system as claimed in claim 26, wherein the holders of two of the spotlights serve to mount the ring on the axle, the spotlight in the middle of the ring being tiltable about the axle, and wherein the spotlights other than those on the axle are each tiltable about a respective axis which intersects the points of contact of the holders with the ring.

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