

[54] ZOOM LIGHT

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[51] Int. Cl.: F21v 7/00, G02b 5/10

[58] Field of Search: 240/44.1, 41 R, 41 B, 41 A, 240/10.69, 103 A, 78 B; 350/295

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[57] ABSTRACT

Multiple reflector elements of an optical system intercept rays emitted by an energy source for reflection into a beamwidth pattern varying from a spotlight configuration to a medium-width beam floodlight. Beamwidth variation is accomplished by adjusting the position of the reflector elements relative to each other in the optical system. Axial flow fans at both the supply and exhaust ends of coaxial ducts provide an airflow for both cooling the energy source (lamp) and the reflector elements of the optical system. In applications where selective radiation is required, a cylindrical filter assembly encloses the energy source to remove undesired portions of the spectral radiation before reflection from the optical system. The filter is extended or retracted from the area between the lamp and the reflector elements by remote control of electric actuators.

34 Claims, 17 Drawing Figures

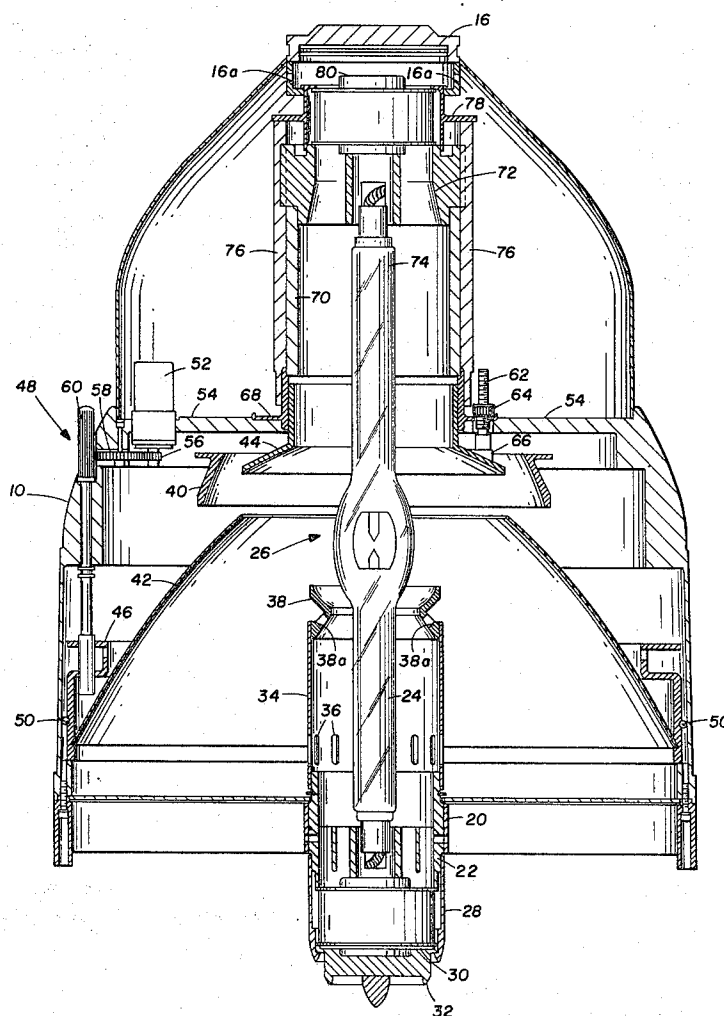


FIG. 1

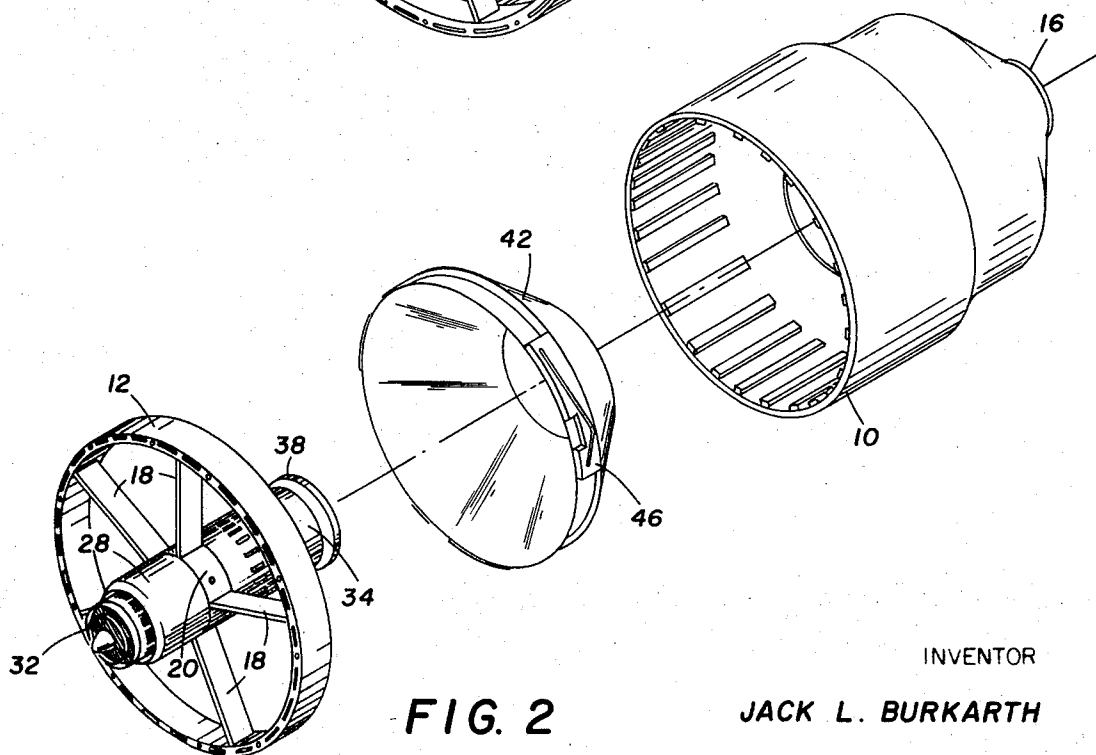
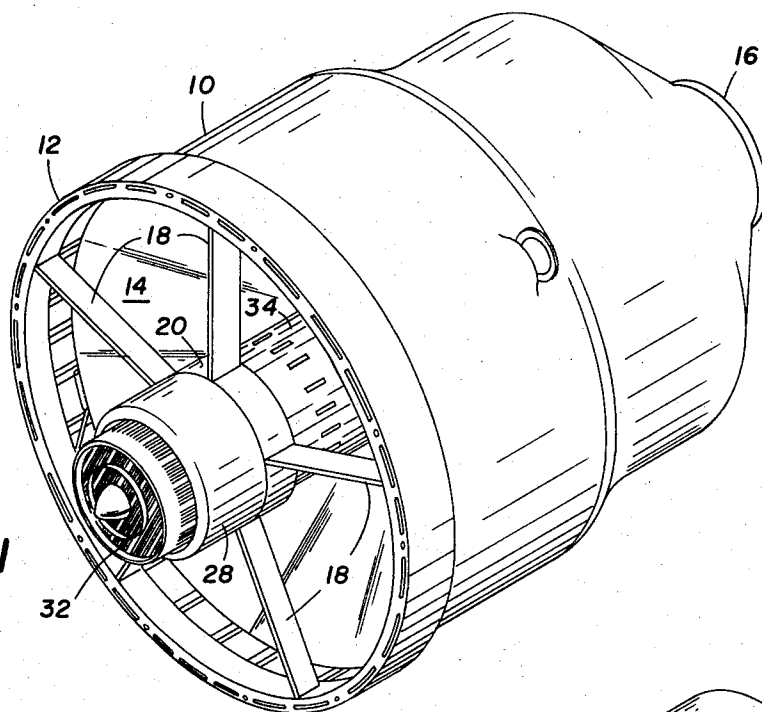


FIG. 2

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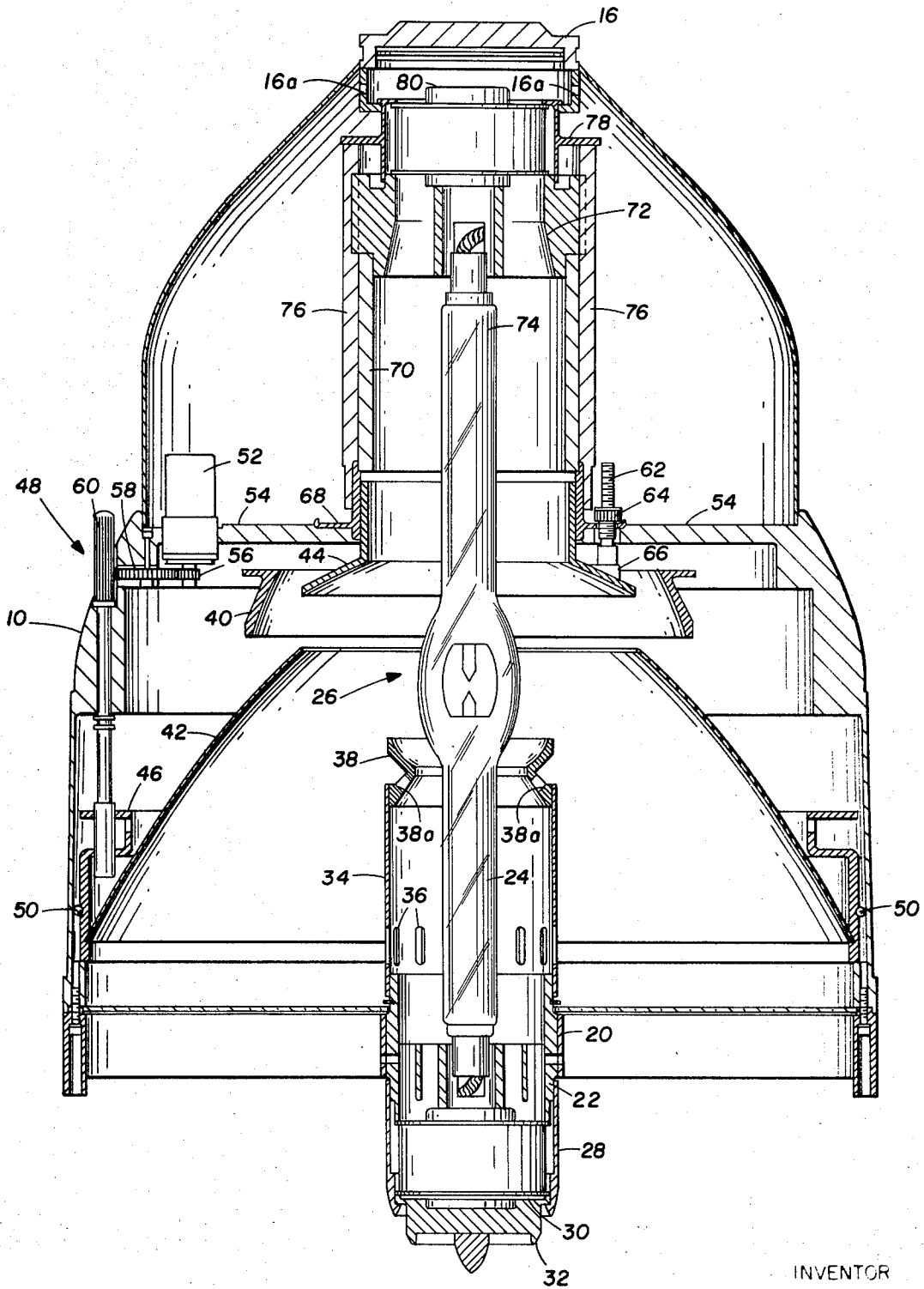


FIG. 3

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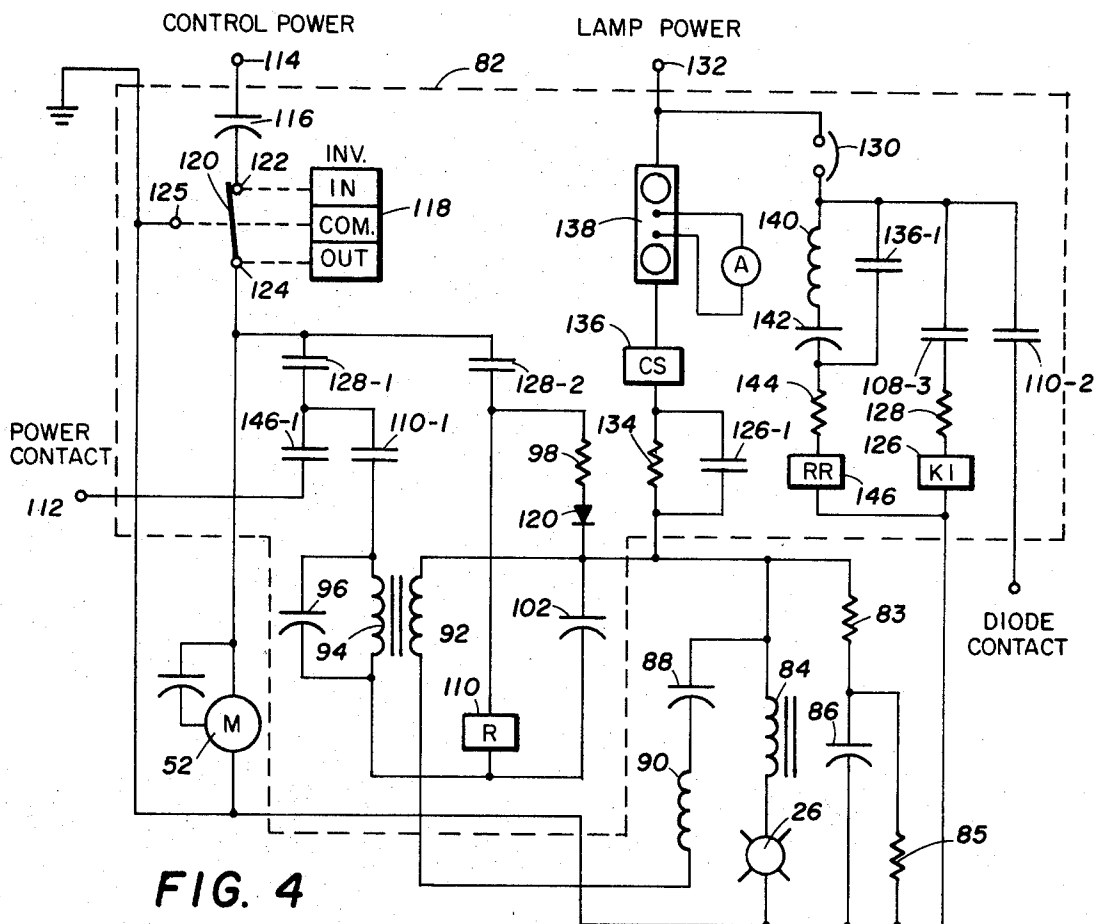


FIG. 4

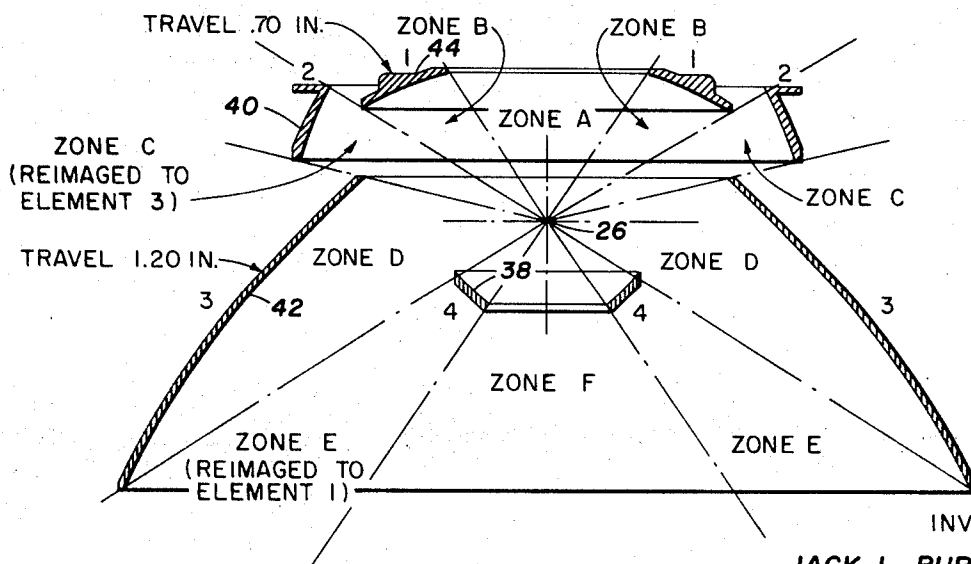


FIG. 5

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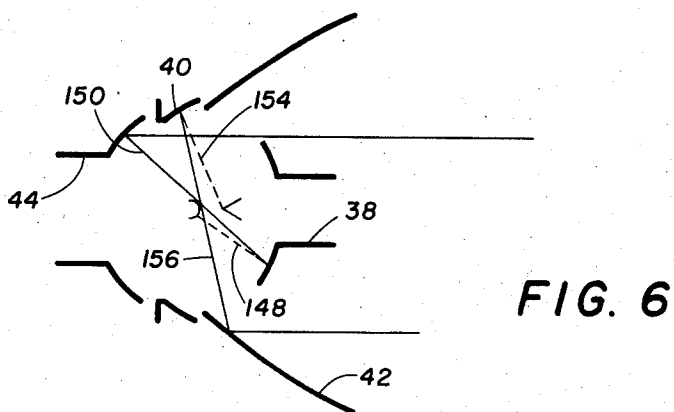


FIG. 6

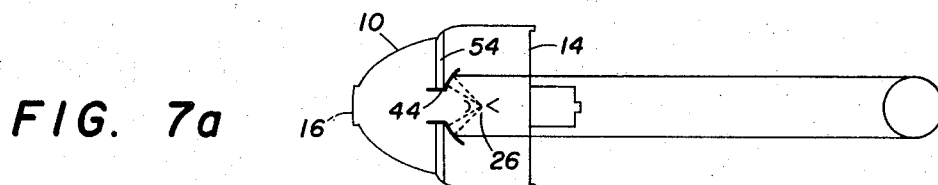


FIG. 7a

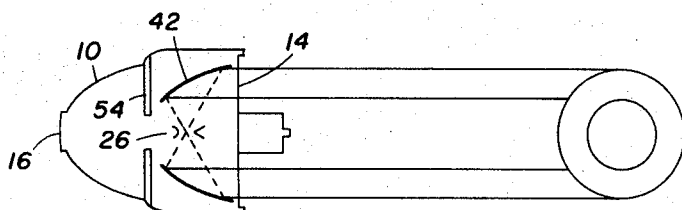


FIG. 7b

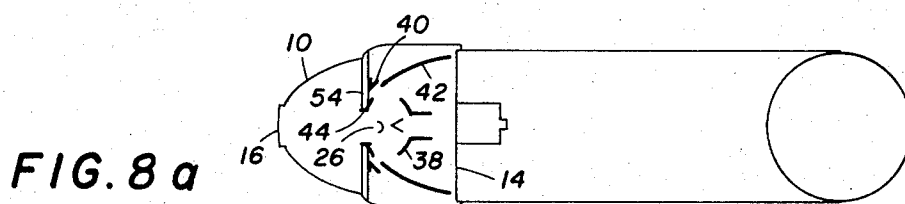


FIG. 8a

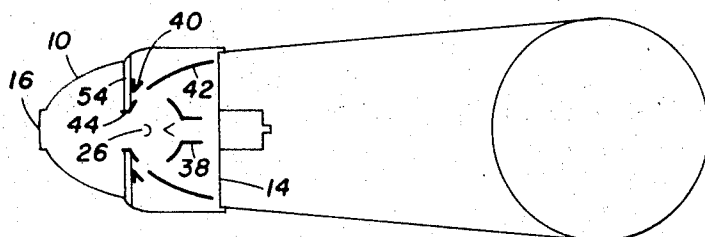


FIG. 8b

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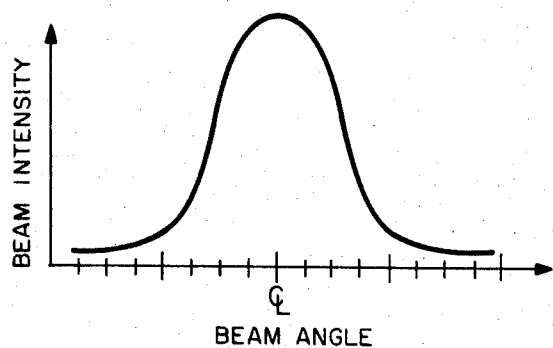


FIG. 9a

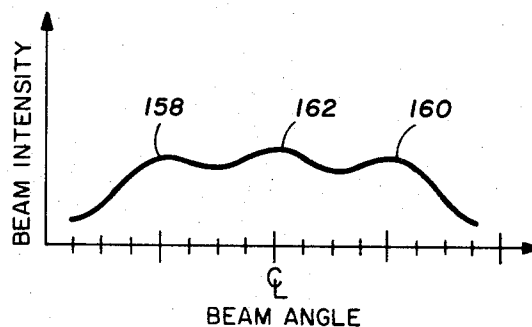


FIG. 9b

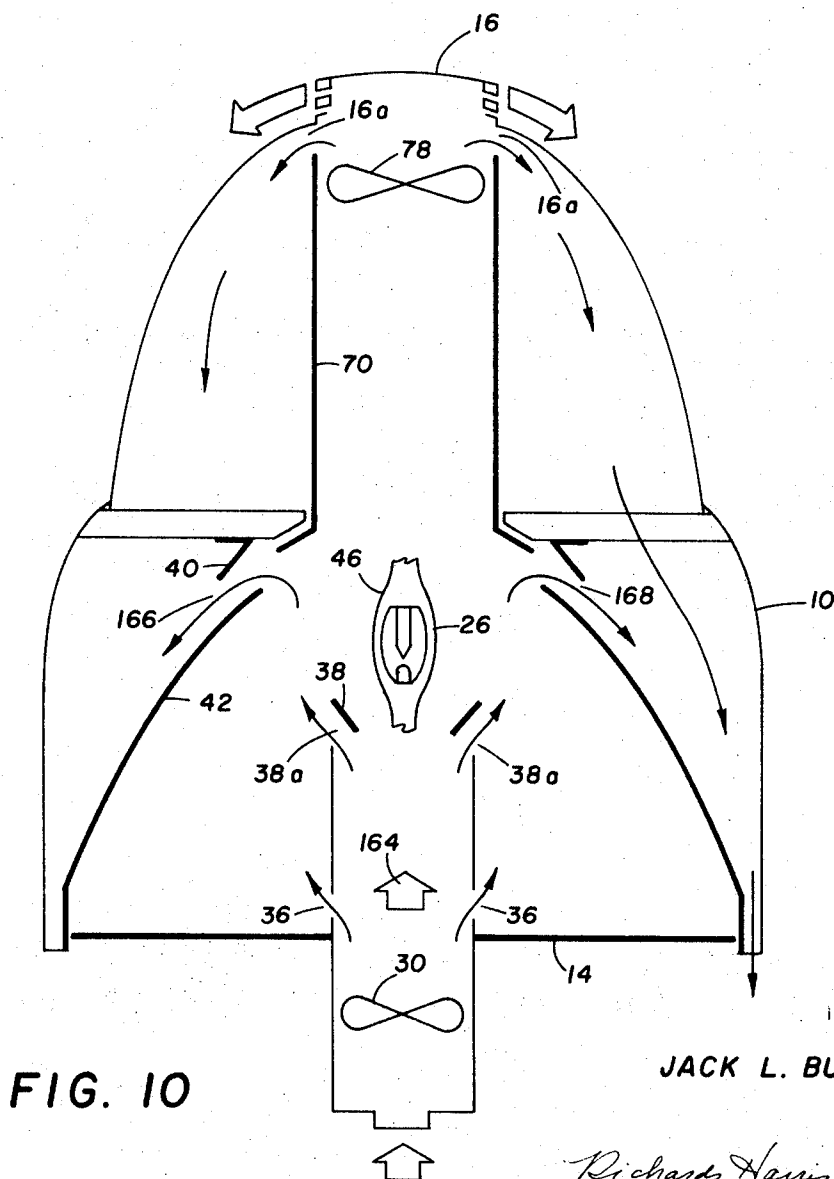


FIG. 10

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FIG. 11

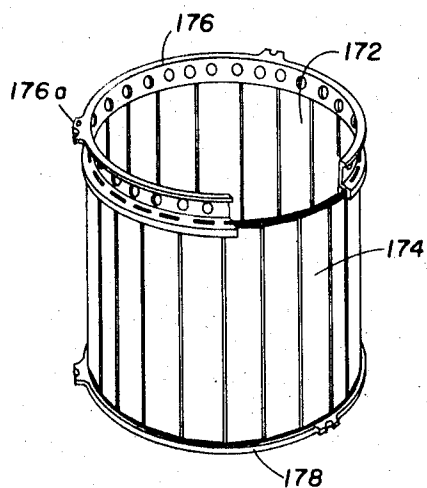
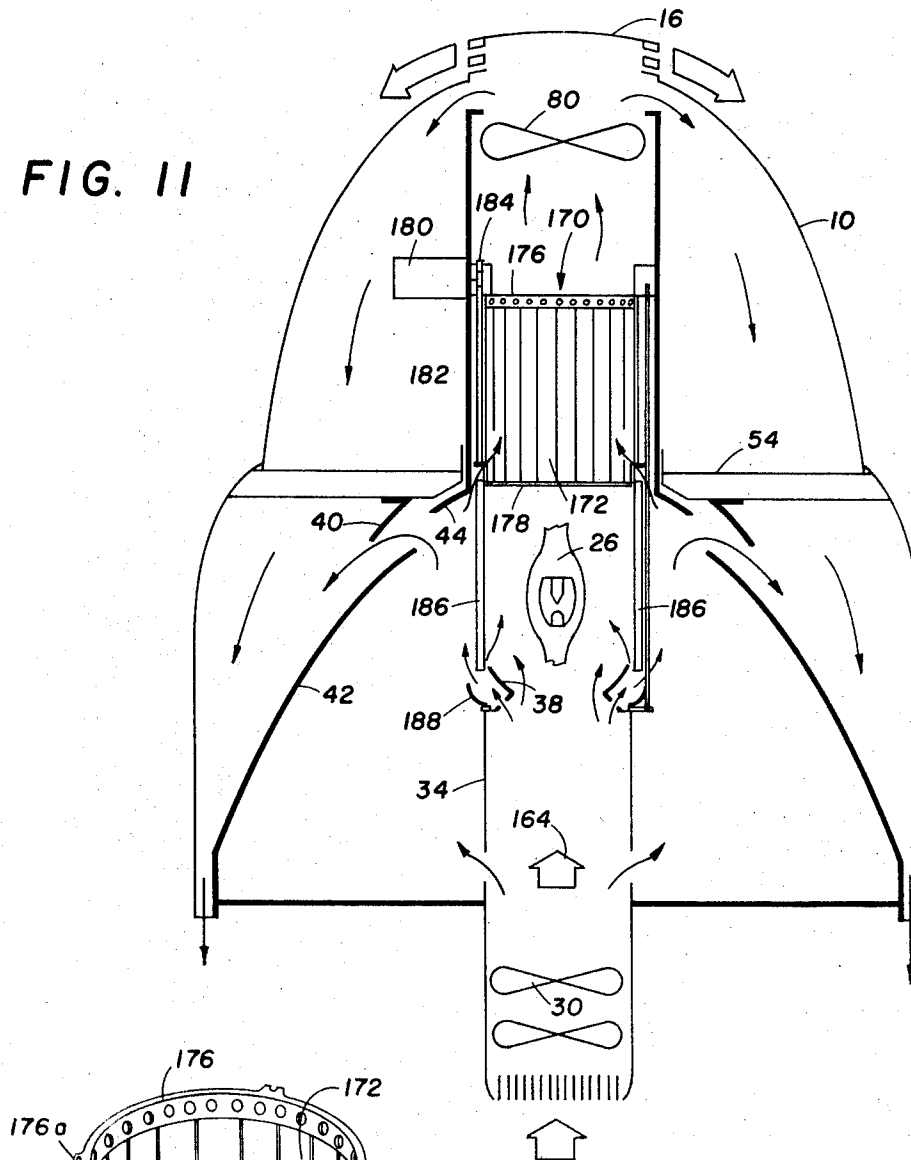


FIG. 12

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FIG. 13

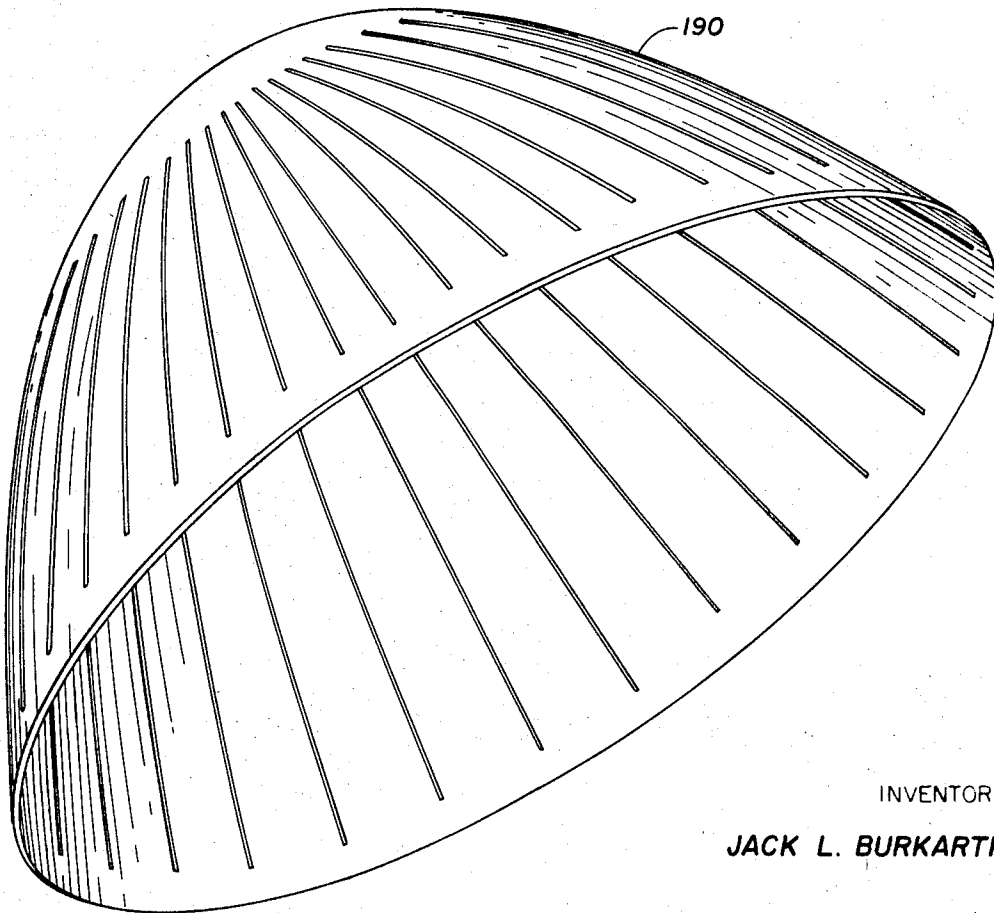
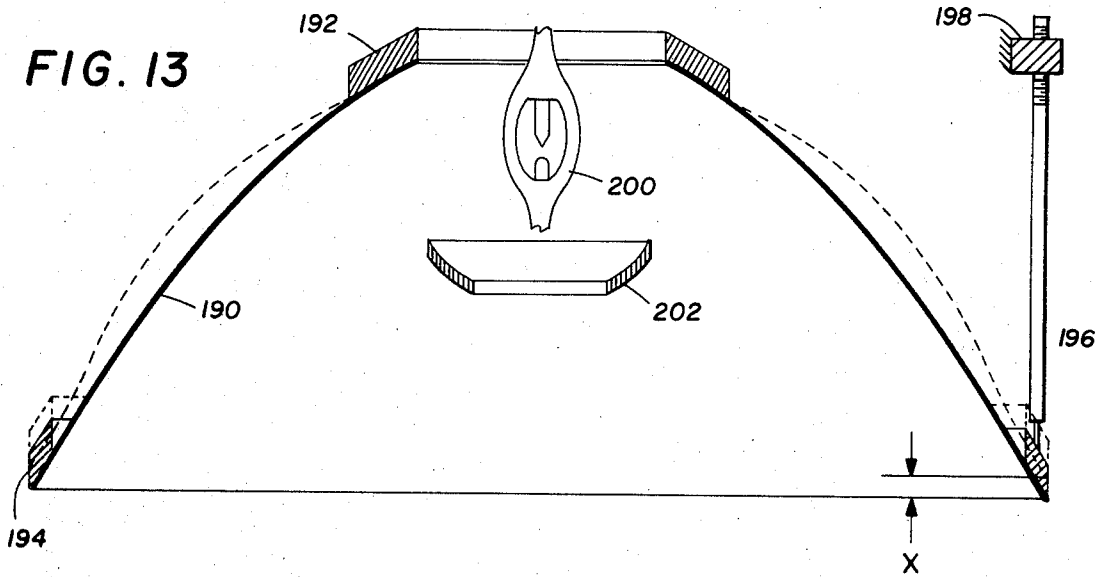


FIG. 14

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ZOOM LIGHT

This invention relates to a reflector system, and more particularly to a variable beamwidth reflecting device.

Heretofore, variable beamwidth light sources usually employed a fixed reflector in conjunction with a movable source of visible radiation. A change in beamwidth was accomplished by changing the angle of incidents of radiation from a source upon a shaped, fixed, reflector element. Such systems usually allowed only a few degrees change in the conical angle of the light beam. Other, more complicated arrangements employed sophisticated systems for changing the reflecting element configuration. While such systems provided considerable change in the beamwidth pattern, there was a considerable loss of energy resulting in a low efficiency lighting device.

An object of the present invention is to provide a reflector device having a beamwidth adjustable from a spot to medium width beam flood condition. Another object of this invention is to provide a reflector device having adjustable reflector elements for beamwidth variation. A further object of this invention is to provide a lighting device having a fixed light source and an adjustable beamwidth. A still further object of this invention is to provide a lighting device having light source and reflector element cooling. Still another object of this invention is to provide a radiant energy device having a selective filter for suppressing undesired radiation. A still further object of this invention is to provide a radiant energy device having a selective wavelength filter positionable between a filtering location and a stored location.

In accordance with the objects of this invention, an adjustable beamwidth reflector includes a first reflecting means receiving radiation along a first path for reflection along a second path and a second reflecting means positionable with respect to the first reflecting means. The second reflecting means receives radiation along a first path for reflection along a second path to and from the first reflector. The first and second path of the second reflecting means being variable with the position of the second reflector with respect to the first reflector.

Further, in accordance with this invention, an adjustable beamwidth energy system includes a source of visible wavelength radiation and a generally parabolically shaped reflector receiving radiation from the source and reflecting such radiation along a path determined by the spaced relationship of the reflector and the energy source.

In an energy system in accordance with the present invention, a source of radiation emits energy to a generally parabolically shaped adjustable reflector. This reflector reflects the received radiation along a path determined by the spaced relationship of the reflector to the source. A selective wavelength filter, having coaxial symmetry, is mounted to transmit energy in selected wavelengths from the source to the parabolically shaped reflector.

In a lighting system in accordance with the present invention, a source of visible wavelength radiation is emitted to a generally parabolically-shaped adjustable reflector. This adjustable reflector reflects the received radiation along a path determined by the spaced relationship of the reflector to the source. An air duct aligned with the source directs an airflow around and

passed the source. Mounted within the air duct is a fan for producing the airflow through the duct.

A more complete understanding of the invention and its advantages will be apparent from the specification and claims and from the accompanying drawings illustrative of the invention.

Referring to the drawings:

FIG. 1 is a perspective view of a variable beamwidth lighting device including coaxial duct cooling;

FIG. 2 is an exploded view of the lighting device of FIG. 1 illustrating the main reflector element;

FIG. 3 is a cross section of the lighting device of FIG. 1 taken along a plane passing through the longitudinal axis;

FIG. 4 is an electrical schematic of a system for powering a typical light source of the lighting device of FIG. 1;

FIG. 5 is a schematic of the reflector elements of an adjustable beamwidth reflector;

FIG. 6 is a schematic of the reflector elements of an adjustable reflector illustrating the primary and secondary ray paths;

FIGS. 7a and 7b are schematics illustrating the light pattern of the main and secondary reflector elements of an adjustable reflector;

FIGS. 8a and 8b are schematics illustrating the beam outline generated by the combination of the main and secondary reflector elements for a spotlight and medium beamwidth floodlight;

FIGS. 9a and 9b are distribution curves of light intensity as a function of beam angle for the adjustable reflector of the present invention;

FIG. 10 is a schematic of an adjustable beamwidth lighting device showing the flow pattern for a coaxial airflow cooling system;

FIG. 11 is a schematic of a selective wavelength filter for an adjustable beamwidth lighting device;

FIG. 12 is a perspective of a coaxially symmetric selective wavelength filter;

FIG. 13 is a schematic of an alternate embodiment of an adjustable beamwidth lighting device having a flexible reflector element; and

FIG. 14 is a perspective of a flexible reflector element for the embodiment of FIG. 13.

Referring to the drawings, FIGS. 1 - 3 illustrate an embodiment of a variable beamwidth radiation source including a housing 10 having a circular bezel 12 supporting a lens 14 at one end. At the opposite end of the housing 10 from the lens 14, there is mounted an exhaust deflector 16 through which cooling air is discharged.

Extending radially inward from the bezel 12 is a plurality of spokes 18 for supporting a hub 20. The hub 20 has an axis coaxial with the longitudinal axis of the housing 10. Mounted within the hub 20 is a front lamp support 22 having an aperture supporting an electrode 24 of a radiation source 26.

The source 26 is any source of visible radiation. In a preferred form, the source 26 may be a compact plasma arc lamp having a power range of from 2,000 to 8,000 watts. Typically, a xenon arc lamp may be used to provide the desired spectral distribution. A xenon arc lamp radiates light at a color temperature closely approximate that of natural daylight (6,000° Kelvin). Such a lamp provides several times the electrical

to illuminous conversion efficiency of incandescent type light sources.

In addition to the front lamp support 22, the hub 20 provides a mounting for a fan shroud 28 containing an axial flow fan 30. The outer end of the fan shroud 28 is capped with a grill 32 for retaining the fan 30 in the fan shroud. Also mounted to the hub 20 is a front air duct 34 having a series of circumferentially spaced apertures 36 for diverting an airflow produced by the fan 30 to within the housing 10 for cooling reflector elements, as will be described.

At the inner termination of the front air duct 34 there is mounted a reflector 38 having apertures 38a spaced around the circumference. This reflector is one of the four used in the system of FIGS. 1 - 3 for generating a radiation beam that varies from a spot condition to a medium beamwidth flood condition. Reflector 38 is one of the two fixed reflectors of the system illustrated. The reflector 38 has a radius of curvature with the center along the longitudinal axis of the light source. Radiation from the source 26 impinges on the reflector 38 along a first fixed path and is reflected therefrom along a second fixed path.

Reflector 40 is also maintained in a fixed position relative to the light source 26. The reflector 40 has a radius of curvature with the center along the longitudinal axis of the light source 26. The inner reflecting surface of the reflector 40 is defined by passing two parallel planes through a sphere. Radiation emitted from the light source 26 impinges on the reflecting surface of the reflector 40 along a fixed path and is reflected therefrom along a second fixed path.

Adjustable reflectors of the four elements include a main, generally parabolically-shaped, reflector 42 and a secondary, generally parabolically-shaped, reflector 44. The major diameter end of the main reflector 42 is supported within a ring guide 46 that is axially adjustable by means of a rack and pinion assembly 48. Bell bearings 50, moving in a track formed in the housing 10 and the guide 46, defines the path along which the main reflector 42 moves from one extreme position to the other. As illustrated, the main reflector is positioned about halfway between its end positions.

To move the main reflector 42 through the rack and pinion 48, a servomotor 52 is mounted to a cross brace 54 of the housing 10. A gear 56, on the output shaft of the motor 52, engages an idler gear 58 which in turn engages a gear 60 of the rack and pinion assembly 48. Energization of the motor 52 may be by remote control.

The mechanism to adjust the position of the secondary reflector 44 includes a machine screw 62 threaded through a nut 64 and attached to the secondary reflector at a tab 66. The nut 64 is fastened to the cross brace 54. To vary the position of the secondary reflector 44, a manual adjustment of the screw 62 is required. It should be understood, that through suitable gearing and a servomotor, the position of the secondary reflector 44 may be adjusted automatically and by remote control.

To produce the desired beamwidth variation, the main reflector 42 has a first focal radius and the secondary reflector 44 has a second focal radius. Both radii having a center along the longitudinal axis of the radiation source 26. By properly selecting the focal radius of

the main reflector 42 and the secondary reflector 44, a generally elliptically shaped reflector configuration can be obtained by adjusting both reflectors such that the minor diameter of the main reflector mates with the major diameter of the secondary reflector.

Also mounted to the cross brace 54 is a bracket 68 supporting a rear air duct 70. At the extreme end of the air duct 70 is a rear lamp support 72 having an aperture receiving an electrode 74 of the source 26. The assembly of the rear air duct 70 and the rear lamp support 72 is maintained in place by supporting rods 76 and a rear fan shroud 78. Mounted within the rear fan shroud 78 is an axial flow exhaust fan 80. The exhaust deflector 16 is supported on the rear fan shroud 78 and extends through the housing 10, as explained.

Electrical power is supplied to the energy source 26 from a circuit shown schematically in FIG. 4. Components of this circuit within the dotted outline 82 are contained on a circuit board mounted in the housing 10. Where the energy source 26 is a xenon lamp, ionization of the xenon gas is accomplished by a 50,000 volt R.F. pulse. Since the pulse duration is one of the factors influencing the life of a xenon lamp, it is desirable to keep this pulse as short as possible. In the circuit shown, this is accomplished by utilizing the release time of an electro-mechanical relay to accomplish the timing function. This results in approximately a 30 millisecond pulse duration.

Referring to FIG. 4, the source (lamp) 26 is in series with a coil 84 and also connects to ground. In parallel with the lamp 26 and the coil 84 is a resistor 83 and capacitor 86 that is charged to a level sufficient to produce the starting voltage. A resistor 85 parallels the capacitor 86 in a discharge circuit for the capacitor.

Also connected to the coil 84 is a capacitor 88 and a coil 90. Capacitor 88 and coil 90 are in turn in series with a winding 92 of a transformer including a winding 94. Winding 94 is shunted by a capacitor 96. The transformer having windings 92 and 94 is part of a control circuit for controlling the operating energy to the lamp 26. This circuit includes a resistor 98 in series with a diode 100 and a capacitor 102. The circuit including the resistor 98 is controlled by a master switch including contacts 108-1, 108-2 and 108-3. Contact 108-2 also controls the energizing of a relay 110 having contacts 110-1 and 110-2. Contact 108-1 completes a circuit to a power contact (not shown) connected to a terminal 112 and also controls the energization of the winding 94 through the contact 110-1. Both the contacts 108-1 and 108-2 connect to a control power source at a terminal 114 through a master switch including a contact 116. Also connected to the control power source through the contact 116 is the servo motor 52 for positioning the main reflector 42.

Depending on the control power source, an inverter 118 may be connected into the circuit between the terminal 114 and the contacts 108-1 and 108-2. With the inverter 118 in the circuit, the jumper bar 120 is removed and the contact 122 connected to the input of the inverter 118 and a contact 124 connects to the output of the inverter. A contact 125 provides a ground connection for the inverter.

Contact 108-3 of the current supply source for the lamp 26 controls the energizing of a relay 126 through a resistor 128. The relay 126 is energized through a cir-

cuit breaker 130 connected to a lamp power supply (not shown) at a terminal 132. The relay 126 controls a contact 126-1 that short-circuits a resistor 134 connected to the junction of coil 84, the resistor 104 and the transformer winding 92 along with the diode 100 and the capacitor 102. Resistor 134 is also in series with a relay 136 connected to the terminal 132 through a shunt 138. The relay 136 controls a contact 136-1 that short-circuits a coil 140 in series with a capacitor 142. Capacitor 142 and coil 140 are in series with a resistor 144 and a relay 146. Relay 146 controls a contact 146-1.

In the operation of the circuit shown, the capacitor 86 is charged to store energy sufficient to ionize the gas in the lamp 26. After the plasma state has been reached, the arc runs at typically 39 volts and 165 amps. This running lamp energy is provided by the electrically regulated constant current source.

Energy emitted by the source 26 radiates into zones A - F as illustrated in FIG. 5. These zones include the four reflector elements.

Referring to FIG. 5, the reflecting zones A - F are illustrated with reference to the reflectors 38, 40, 42 and 44. The physical configuration of the source 26 cuts off radiation to the zones A and F. Radiation emitted from the source 26 in zone B is incident on the secondary reflector 44 and further reflected therefrom along a path determined by the position of this reflector with respect to the light source 26 and the fixed reflector 38. Radiation from the source 26 into zone E is incident on the reflector 38 and is reimaged into the zone B and onto the secondary reflector 44. As explained, radiation incident on the reflector 38 is received along a first fixed path and reflected along a second fixed path. Radiation from the source 26 in zone D is incident on the main reflector 42 and further reflected into a beam through the lens 14. Radiation emitted from the source 26 into zone C impinges on the reflector 40 and is reimaged therefrom into zone D and the main reflector 42. The reflector 40, as explained, receives radiation along a first fixed path and reflects the same radiation along a second fixed path to the main reflector 42. Radiation from the main reflector 42 is transmitted along a beam path determined by the position of this reflector with respect to the light source 26 and the fixed reflector 40.

Referring to FIG. 6, there is shown the primary and secondary reflecting ray paths from the fixed reflector elements to their respective adjustable reflector elements. Reflector element 38 is a fixed position spherical reflector designed to intercept rays along the primary ray path 148 that would normally diverge to an angle greater than desired. Primary rays from the reflector element 38 are reflected as secondary rays along a path 150 to the controlled, parabolic, secondary reflector 44. Reflector element 44, when set at a predetermined distance from a focal point, provides an equal distribution of light flux at a given beam angle at the center of the beam along a path 152. A beam produced by the reflector element 44, both from secondary radiation and from primary radiation, is illustrated in FIG. 7a. As explained, the secondary reflector 44 is adjustable along the longitudinal axis of the lamp source 26. When the reflector element 44 is moved toward the focal point of the lamp source 26, the beam is widened.

When it is moved away from the focal point of the lamp source, the beam is narrowed.

Radiation from the source 26 to the fixed position spherical reflector 40 is received along a primary path 154 and reflected to the remote controlled, parabolic, main reflector 42 along a secondary path 156. The radius of curvature of the reflector element 40 is so designed that when light rays are intersected in the focus position, they are reimaged to the main reflector element 42 and are allowed to diverge into a greater beam angle.

The main reflector element 42 is designed such that when set at the focus position and moved along the longitudinal axis of the lamp source 26, the generated energy beam can be controlled from a spotlight configuration to a narrow beamwidth floodlight configuration. This reflector has three basic functions: (a) intercept primary rays from the source 26, (b) intercept secondary rays reimaged from the reflector 40, and (c) control the beam spread when moved along the longitudinal axis away from the focal point of the source 26. Without reflected energy from the secondary reflector 44, the beam generated by the main reflector 42 when in the medium beamwidth floodlight position will be "doughnut" shaped, as illustrated in FIG. 7b. It should be understood that the illustrations of FIGS. 7a and 7b are idealized patterns. Actually some illumination will be present outside the patterns as they appear.

Referring to FIGS. 8a and 8b, there is shown a combination of the light beams produced by the main reflector element 42 and the secondary reflector element 44. These beam patterns are a combination of the patterns of FIGS. 7a and 7b. FIG. 8a illustrates the spotlight configuration and the relative displacement of the reflector elements to produce this pattern. When the system is changed from this narrow beam configuration to the medium-width floodlight beam, as illustrated in FIG. 8b, the reflector element 40 is progressively overlapped by the remote controlled, parabolic reflector element 42, thereby allowing the beam to widen as the main reflector element is moved away from the source focal point. As the reflector element 42 is positioned to produce the medium beamwidth floodlight distribution pattern, the reflector element 44 is adjusted to allow a more even distribution of light in the beam. This is graphically illustrated in FIGS. 9a and 9b.

FIG. 9a is a plot of beam intensity as a function of beam angle for the spotlight configuration. FIG. 9b is a plot of beam intensity as a function of beam angle for the floodlight configuration. In the spotlight configuration, all the light energy is concentrated in a relatively few degrees of distribution. This allows a fairly uniform distribution pattern over a narrow beam. When adjusting the main reflector element 42 for the floodlight configuration, the light intensity from this element produces two outer peaks of light intensity spread over a wide angular distribution. Thus, the peaks 158 and 160 of the curve of FIG. 9b are produced by the main reflector element 42. To provide a more even light intensity distribution pattern, the secondary reflector element 42 is adjusted to spread the center of the beam and produce the peak 162. Thus, a reasonably even beam intensity light distribution is produced.

A light source, such as a xenon lamp, operating at 165 amperes at a normal 6,500 watt level generates considerable internal heat that radiates to the surrounding structure. To provide temperature control of the source 26 and the surrounding structure, the axial flow fans 30 and 80 are provided at the front and rear of the housing 10. These axial flow fans at the supply and exhaust ends of coaxial ducts 34 and 70, respectively, control the air pressure and the quantity of air-flow necessary for cooling the source 26 and the surrounding structure including the four reflector elements.

Referring to FIG. 10, there is schematically illustrated the airflow pattern created by fans 30 and 80. The main airstream, as indicated by the arrow 164, is confined to the critical center diameter of the housing by means of the air duct 34 and the configuration of the reflector 38. A small amount of air is bled off from the main airstream through the apertures 36 of the duct 34 and the apertures 38a of the reflector 38. This bled air circulates around the reflectors 40, 42, and 44 to provide cooling therefor. The bleed air is confined to the reflector system by means of the lens 14. After passing through and around the reflector assembly along a path as indicated by the arrows 166 and 168, the bleed air provides cooling for the housing 10.

Continuous direct evacuation of the hot air of the main airstream passing around the source 26 is accomplished by the exhaust fan 80. This fan reduces the overall peak temperature of the housing and the elements therein. The main exhaust stream from the fan 78 passes through openings in the deflector 16 for dissipation into the atmosphere. A small amount of this exhaust air, however, is directed through the apertures 16a for cooling the shroud end of the housing 10.

Cooling air passing through the housing is confined to a plurality of circumferentially spaced ducts formed into the inner surface of the housing 10, as best illustrated in FIG. 2. Cooling air channeled through these ducts exhausts from the housing 10 through openings in the bezel 12.

Due to the extreme amount of heat that can be generated by the source 26, specific control of the main cooling airflow is critical to the operating life of a lamp as well as controlling the temperature of the lamp when operated at abnormal angular attitudes.

Referring to FIGS. 11 and 12, there is shown a modification of the light source of FIGS. 1-2 including a selective wavelength filter 170. Except for the filter 170 and the hardware associated therewith, FIG. 11 is a schematic representation of a light source similar to that of FIGS. 1-3. In some applications, it is desirable to have a radiation beam restricted to selected wavelengths of the spectrum. For example, infrared illumination is often desirable in certain nighttime conditions, especially in a war zone. The filter assembly 170 consists of multiple (two in the configuration shown) overlapping layers of absorption type filter glass slats 172 and 174 retained in a cylindrical shape by an upper retainer ring 176 and a lower retainer ring 178. Each layer of glass slats has a thickness greater than the previous inner layer. Thus, the layer of slats 174 is thicker in cross section than the slats of layer 172.

Since any one particular lighting system may be needed for both white light and selective wavelength

radiation, the filter 170 is mounted for retraction from the position illustrated to a position between the radiation source 26 and the reflector elements. The retraction mechanism for the filter assembly 170 consists of a rotary electric actuator 180 connected to a rack 182 through a pinion 184. Tubular guides 186 are equally spaced around the source 26 and serve as tracks for the filter assembly. These tubular guides fit into the semi-circular cutouts of tabs extending from the retainer rings 176 and 178. The rack 184 is attached to the retainer ring 176 at the tab 176a.

In the position shown, radiation from the source 26 is directed to the reflector elements 38, 40, 42 and 44 in the manner as described to produce a variable beam-width source of visible radiation. Upon energization of the actuator 180, the filter assembly 170 is moved from the position shown into a position between the source 26 and the reflector element. With the filter assembly 170 so located, only selected wavelengths from the source 26 will pass to the reflector elements. The selected wavelengths passed by the filter assembly 170 will be reflected from the main reflector 42 and the secondary reflector 44 in a spotlight configuration or a narrow beam floodlight.

Again, as in the embodiment of FIGS. 1-3, a cooling airflow is established by an inlet fan 30, and inlet fan 30a and an exhaust fan 78. To provide adequate cooling of the filter assembly 170 when in an operative position, a deflector 188 is attached to the air duct 34 at the end with the reflector 38. This deflector causes cooling air to surround the filter elements thereby maintaining temperature control.

Referring to FIGS. 13 and 14, there is shown an alternate embodiment of a variable beamwidth energy source. Only the light source and the reflector elements along with a mechanical adjustment is illustrated in FIG. 13. It will be understood, however, that such an assembly will be included as part of a system as illustrated in FIGS. 1-3.

With the present embodiment, the adjustable filter elements 42 and 44 and the fixed reflector element 40 are replaced with a flexible, generally parabolically-shaped reflector 190. The reflector 190 has a polished inner surface and includes a plurality of circumferentially spaced slots. These slots run in a direction generally parallel to the longitudinal axis of the reflector. They provide flexibility and enable the reflector to be distorted to an outline as shown by the dotted line of FIG. 13. To distort the reflector 190, a bracket 192 is mounted to the cross brace 54 of the housing 10 as shown in FIG. 3. A guide ring 194, similar to the guide ring 46 of FIG. 3, is fitted to the major diameter of the reflector 190. Ring 194 connects to an adjusting rod 196 threaded through a nut 198. The nut 198 is attached to the housing. It will be understood, that the adjustment mechanism consisting of the ring 194, the adjusting rod 196 and the nut 198 can be replaced with the servomotor mechanism illustrated and described in FIG. 3.

Energy from a lamp 200 radiates into zones similar to that illustrated in FIG. 5. Due to the construction of the lamp 200, no radiation will be transmitted into the area above or below the lamp. Radiation into the zone occupied by a fixed reflector element 202 is reimaged along secondary ray paths to the parabolically-shaped reflector

tor 190. Radiation in all other zones is incident on the reflector 190 along primary ray paths.

As the reflector 190 is distorted by an adjustment of the rod 196, the angle of incidence of both the primary rays and the reimaged rays from the reflector 202 will change. This change in the angle of incidence of the light rays produces a change in the angle of reflection. Thus, an energy beam reflected from the reflector 190 can be made to change from a spotlight configuration to a narrow beamwidth floodlight configuration. Due to the continuous reflecting surface up to the dark zone behind the lamp 200, the reflector 190 produces a uniform beam intensity light distribution pattern.

In an experimental model of the reflector configuration of FIGS. 13 and 14, the major diameter of the reflector 190 was 18.10 inches. The length of travel X of the reflector end was constrained to 0.24 inches. For a travel of 0.24 inches, the angle of the reflector surface, with reference to a longitudinal axis, had a differential change of 6.5 degrees. This produced a 26 degree beam angle change, that is, the beam spread 26 degrees from a lower limit to an upper limit. In this experimental model, the total surface area of the reflector 190 equalled 391.6 square inches. There were 36 slots spaced circumferentially around the reflector. Each slot had a width of 0.008 inches and a length of 8.56 inches for a total slot area of 2.46 square inches. This, as can be seen, is less than 1 percent of the total reflecting area. Thus, the amount of energy radiated from the slotted reflector was less than 1 percent degraded from a continuous surface reflector of the same size and configuration.

Although the invention has been described with reference to a light source, it will be understood that it also finds application as a collector of incident radiation to a central receiving location. In such applications, the light source is replaced with a selective energy responsive device, such as an antenna, that produces electrical signal fluctuations varying with the magnitude of the collected radiation.

An application of a variable beamwidth energy reflector is in a communications system. The reflector elements are adjusted to the wide beam configuration when attempting to locate a source of energy. Once the source has been located, the reflectors are adjusted to the narrow beam configuration. In the narrow beam configuration, peripheral radiation can be selectively removed and the maximum amount of energy reflected by a source collected for reflection to a receiver location.

While several embodiments of the invention, together with modifications thereof, have been described in detail herein and shown in the accompanying drawings, it will be evident that various further modifications are possible without departing from the scope of the invention.

What is claimed is:

1. An adjustable beamwidth reflector comprising: first reflecting means receiving radiation in a first direction with respect thereto for reflection in a second direction with respect thereto, second reflecting means positionable with respect to said first reflecting means, said second reflecting means receiving radiation in a first direction with respect thereto and coextensive with the second

direction of the first reflecting means for reflection in a second direction with respect thereto, and said reflecting means having a plurality of circumferentially spaced longitudinally directed slots to enable varying the parabolic configuration to vary the first and second direction, and

means for varying the parabolic configuration of said second reflecting means.

2. An adjustable beamwidth reflector comprising: first reflecting means receiving radiation for reflection in a fixed direction to a stationary receiver location,

second reflecting means having a generally parabolic configuration with a first focal radius, said second reflecting means positionable with respect to said first reflecting means and receiving radiation in a beamwidth variable with its position with respect to said first reflecting means for reflection to said first reflecting means,

third reflecting means having a generally parabolic configuration with a second focal radius different from said first focal radius, said third reflecting means positionable with respect to said first reflecting means and receiving radiation in a first direction with respect thereto for reflection in a second direction with respect thereto to the stationary receiver location,

means for positioning said second reflecting means with respect to said first reflecting means to vary the beamwidth of received radiation, and

means for positioning said third reflecting means with respect to said first reflecting means to form an elliptically shaped reflector surface.

3. An adjustable beamwidth energy system, comprising:

a source of visible wavelength radiation mounted along a predetermined axis,

a first reflector having a generally parabolic shape and an axis coaxial with the predetermined axis of said source of visible wavelength radiation for receiving radiation from said source and reflecting such radiation in a direction determined by the spaced relationship of said reflector to said source, means for adjusting the spaced relationship between said first reflector and said source along the axis thereof, and

a second reflector positioned from said source opposite the first reflector receiving radiation from said source for reflection to said first adjustable reflector.

4. An adjustable beamwidth energy system as set forth in claim 3 including a second generally parabolically shaped adjustable reflector receiving radiation from said source and reflecting such radiation in a direction determined by the spaced relationship of said reflector to said source, and

means for adjusting the spaced relationship between said second parabolically shaped reflector and said source.

5. An adjustable beamwidth energy system as set forth in claim 4 including a reflector receiving radiation from said source for reflection to said second generally parabolically shaped adjustable reflector.

6. An adjustable beamwidth energy system as set forth in claim 5 wherein said first generally parabolically

cally shaped adjustable reflector has a first focal radius and said second generally parabolically shaped adjustable reflector has a second focal radius different from said first radius.

7. An adjustable beamwidth energy system, comprising:

a source of visible wavelength radiation,
a generally parabolically shaped reflector having a plurality of spaced slots extending generally in the direction of the longitudinal axis for receiving radiation from said source and reflecting such radiation in a direction determined by the spaced relationship of said reflector to said source, and means for adjusting the parabolic shape of said reflector to vary the spaced relationship between the reflector and source.

8. Adjustable beamwidth lighting apparatus comprising:

a light source,
first reflecting means having a configuration formed from a portion of a sphere with the center of radius at said light source and having a spaced relationship with respect to said light source and receiving radiation therefrom in a first direction for reflection in a second direction,

second reflecting means having a generally parabolic shape positionable with respect to said first reflecting means along an axis coaxial therewith receiving radiation reflected from said first reflecting means for further reflection in a direction variable with the position of said second reflecting means, and

means for positioning the second reflecting means with respect to said first reflecting means to vary the beamwidth of reflected radiation from the second reflected means.

9. Adjustable beamwidth lighting apparatus as set forth in claim 8 including third reflecting means positionable with respect to said lighting source receiving radiation therefrom for reflection in a direction that varies with the position thereof with respect to said light source, and

means for positioning said third reflecting means with respect to said light source to vary the intensity distribution of light in the adjustable beamwidth.

10. Adjustable beamwidth lighting apparatus as set forth in claim 9 including fourth reflecting means having a fixed spaced relationship with respect to said light source receiving radiation therefrom for reflection to said third reflecting means.

11. Adjustable beamwidth lighting apparatus as set forth in claim 10 wherein said fourth reflecting means includes a reflector having a configuration formed by a portion of a sphere with a center of radius at said light source.

12. Adjustable beamwidth lighting apparatus as set forth in claim 9 wherein said third reflecting means includes a generally parabolically shaped reflector having internal reflecting surfaces.

13. Adjustable beamwidth lighting apparatus, comprising:

a light source,
a first reflector having a configuration formed by a portion of a sphere, said first reflector having a

fixed spaced relationship with respect to said light source and receiving radiation thereof,

a first generally parabolically shaped reflector positionable with respect to said first reflector receiving radiation reflected therefrom for further reflection in a beam width variable with the position of said first parabolically shaped reflector with respect to said first reflector,

a second generally parabolically shaped reflector positionable with respect to said light source receiving radiation therefrom for reflection in a beam width variable with respect to the position of said second parabolic reflector with respect to said light source, and

means for positioning said first and second parabolic reflectors with respect to said light source to vary the reflected beam light direction.

14. Adjustable beamwidth lighting apparatus as set forth in claim 13 including a second reflector having a configuration formed by a portion of a sphere, said second reflector having a fixed spaced relationship with respect to said light source receiving radiation therefrom for reflection to said second generally parabolically shaped reflector.

15. Adjustable beamwidth lighting apparatus as set forth in claim 13 wherein said first generally parabolically shaped reflector has a first focal radius and said second generally parabolically shaped reflector has a second focal radius different from said first radius.

16. Adjustable beamwidth lighting apparatus as set forth in claim 15 wherein said means for positioning said parabolic reflectors includes means for spacing said first and second parabolic reflectors to form an elliptically shaped reflector surface.

17. Adjustable beamwidth lighting apparatus as set forth in claim 14 wherein said first reflector has a center of radius at said light source.

18. Adjustable beamwidth lighting apparatus as set forth in claim 17 wherein said second reflector has a center of radius at said light source.

19. In a radiation system comprising:

a source of visible wavelength radiation,
a generally parabolically shaped adjustable reflector receiving radiation from said source and reflecting such radiation in a direction determined by the spaced relationship of said reflector to said source, means for adjusting the spaced relationship between said reflector and said source, and

a selective wavelength filter of a first layer of filter elements having a first thickness surrounded by additional layers of filter elements, each additional layer having a filter element thickness greater than the first layer, said filter having coaxial symmetry and mounted to transmit energy of selected wavelengths from said source to said parabolically shaped reflector.

20. In a radiation system as set forth in claim 19 wherein said filter selectively transmits radiation in the infrared wavelengths.

21. In a radiation system comprising:

a source of visible wavelength radiation,
first reflecting means having a configuration formed from a portion of the sphere with the center of radius at said light source and at a fixed space relationship with respect to said source receiving

radiation therefrom therefrom for reflection in a fixed direction,

second reflecting means having a generally parabolic shape positionable with respect to said first reflecting means along an axis coaxial therewith receiving radiation reflected from said first reflecting means for further reflection in a direction variable with the position of said second reflecting means, means for positioning said second reflecting means with respect to said first reflecting means to vary the reflected beamwidth, and a selective wavelength filter having coaxial symmetry and mounted to transmit energy of selected wavelengths from said source to said reflector means.

22. In a radiation system as set forth in claim 21 including means for positioning said filter from a first position removed from said source and said reflecting means to a second position in the radiation path between said source and said reflecting means.

23. In a radiation system comprising:
a source of visible wavelength radiation,
first reflecting means having a fixed space relationship with respect to said source receiving radiation therefrom for reflection in a fixed direction,
second reflecting means positionable with respect to said first reflecting means receiving radiation reflected therefrom for further reflection in a direction variable with the position of said second reflecting means with respect to said first reflecting means,
means for positioning said second reflecting means with respect to said first reflecting means to vary the reflected beamwidth, and
a selected wavelength filter having a first layer of filter elements with a first thickness surrounded by additional layers of filter elements, each additional layer having a filter element thickness greater than the first layer, said filter having coaxial symmetry and mounted to transmit energy in selected wavelengths from said source to said reflector means.

24. In a radiation system as set forth in claim 23 wherein said filter elements, as arranged in layers, forms a cylinder surrounding said light source.

25. An adjustable beamwidth reflector comprising:
first reflecting means receiving radiation for reflection in a fixed direction to a stationary receiver location, said reflecting means having a configuration formed from a portion of a sphere with the center of radius at the stationary receiver location,
second reflecting means having a generally parabolic shape positionable with respect to said first reflecting means along an axis coaxial therewith receiving radiation for reflection to said first reflecting means,
means for positioning said second reflecting means with respect to said first reflecting means to vary the direction of received radiation, and
a selected wavelength filter having coaxial symmetry and mounted to transmit energy in selected wavelengths from said first reflecting means to the stationary receiver location.

26. An adjustable beamwidth reflector as set forth in claim 25 including means for positioning said filter

from a first position removed from said reflecting means and the stationary receiver location to a second position in the radiation path between said reflecting means and the stationary receiver location.

27. In a lighting system comprising:
a source of visible wavelength radiation,
a generally parabolically shaped adjustable reflector receiving radiation from said source and reflecting such radiation in a direction determined by the spaced relationship of said reflector to said source,
an air duct aligned with said source for directing an air flow around and past said source,
a fan for producing an air flow through said duct,
a second duct positioned to produce an air flow around said source from said first duct, and
a second fan for producing an air flow through said second air duct.

28. In a lighting system as set forth in claim 27 including means for directing a portion of the airflow from said duct to said reflector.

29. In a lighting system as set forth in claim 27 including means for directing the airflow discharge from said second duct to said reflector.

30. An adjustable beamwidth reflector comprising:
first reflecting means having a configuration formed by a portion of a sphere for receiving the radiation in a first direction with respect thereto for reflection in a second direction with respect thereto,
second reflecting means having a generally parabolic configuration and an internal reflecting surface and an axis coaxial with the axis of said first reflecting means, said second reflecting means positionable with respect to said first means along an axis thereof receiving radiation in a first direction with respect thereto and coextensive with the second direction of the first reflecting means for reflection in a second direction with respect thereto, the first and second directions being variable with the position of said second reflecting means with respect to said first reflecting means, and

means for positioning said second reflecting means with respect to said first reflecting means.

31. In a lighting system comprising:
a source of visible wavelength radiation,
first reflecting means having a fixed spaced relationship with respect to said source receiving radiation therefrom,

second reflecting means positionable with respect to said first reflecting means receiving radiation reflected therefrom for further reflection in a direction variable with the position of said second reflecting means with respect to said first reflecting means,

third reflecting means positionable with respect to said source receiving radiation therefrom for reflection in a direction variable with the position of said third reflecting means with respect to said source,

means for positioning said second and third reflecting means with respect to said source to vary the beam path direction therefrom,

an air duct aligned with said source for directing cooling air around and passed the source, and
a fan for producing the airflow through said duct.

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32. In a lighting system as set forth in claim 31 including means for directing a portion of the airflow from said duct to said reflecting means.

33. In a lighting system as set forth in claim 32 including a second air duct positioned to draw an airflow around said source from said first duct, and

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a second fan for producing an airflow through said second air duct.

34. In a lighting system as set forth in claim 33 including means for directing the airflow discharge from said second duct to said reflecting means.

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