Oct. 17, 1961 M. R. KLEIN 3,005,087

VARIABLE FOCUSING, MULTI-BEAM, ILLUMINATING DEVICE

Filed July 28, 1958 2 Sheets-Sheet 1

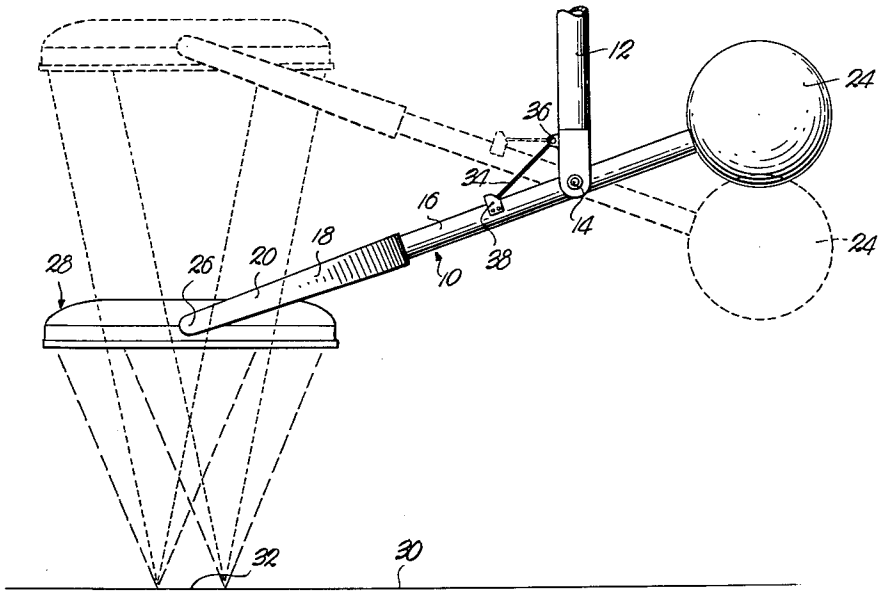

Fig. 1.

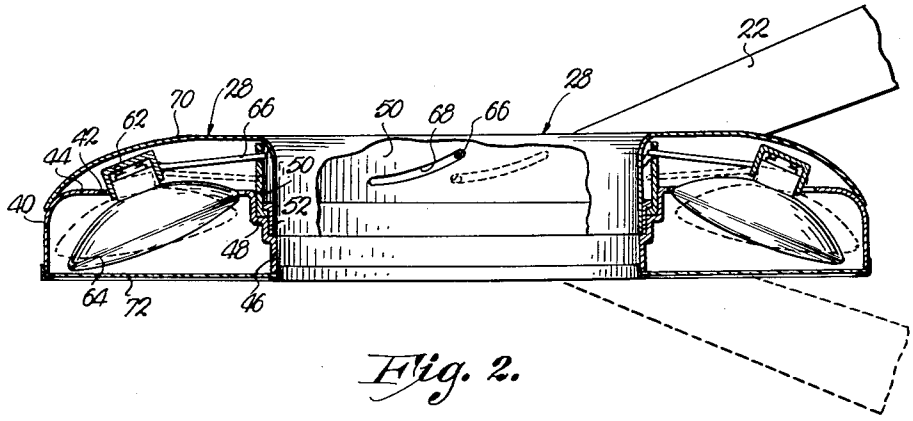

Fig. 2.

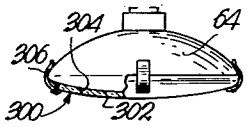

Fig. 5.

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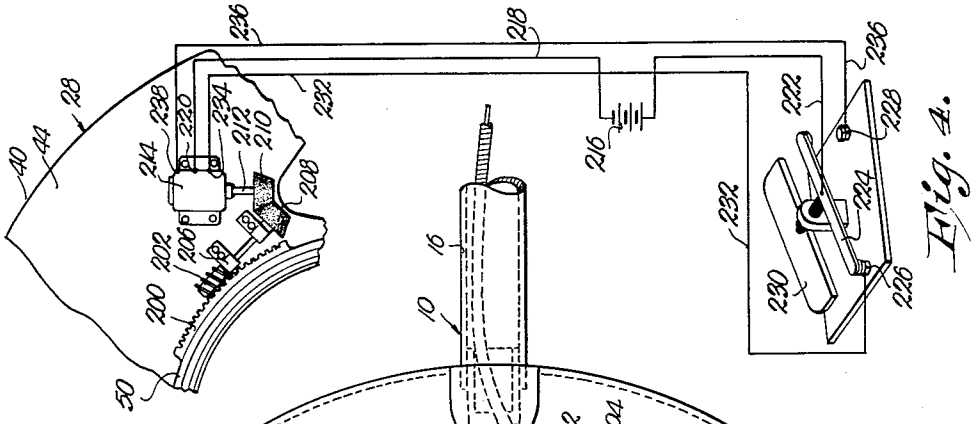

Fig. 4.

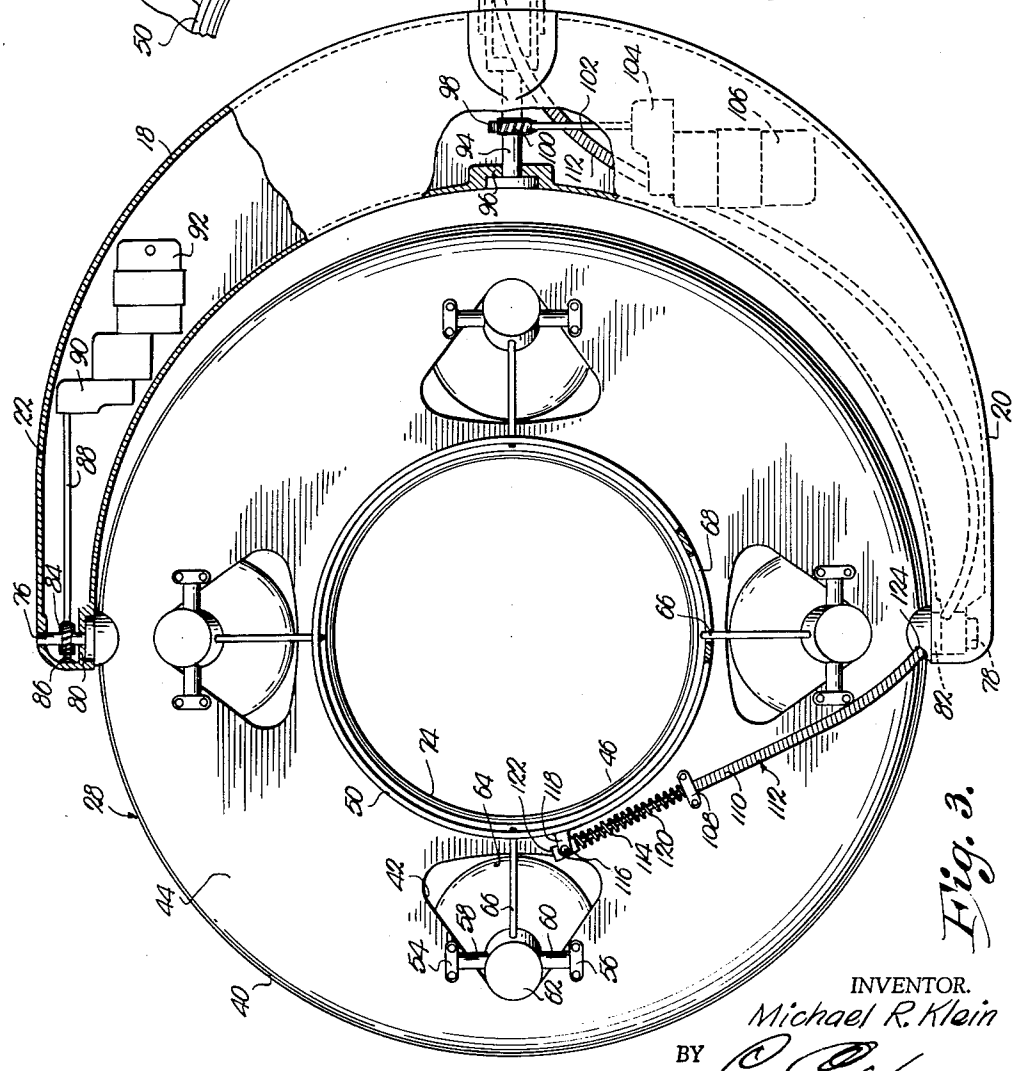

Fig. 3.

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VARIABLE FOCUSING, MULTI-BEAM, ILLUMINATING DEVICE

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This invention relates to illuminating apparatus and, more particularly, to an improved, focusing, multibeam, lighting structure especially adapted for use as a surgical light in operating rooms. Although other advantageous applications for the illuminating apparatus contemplated by the invention will probably occur to those skilled in the art and are, therefore, contemplated as broadly included within the scope of the invention, the particular adaptability of the structure for use as a surgical light will justify the illustration of the principles of the invention by means of a description of a preferred embodiment of surgical, operating room, illuminating apparatus.

Several problems must be concurrently overcome by any illuminating apparatus which is entirely satisfactory for use as surgical lighting means. First, it must be possible to vary the intensity of the illumination of the area of the patient upon which surgical work is being performed, this normally being accomplished through adjustment of the position of the light source toward or away from the area being illuminated. Secondly, the means must illuminate or minimize the effects of shadows cast by the hands of the surgeon or the surgical tools which he is using, this normally being accomplished by means of using a single point type source of light provided with reflectors of relatively great expanse adapted to direct rays of light upon the illuminated area from a number of special points on the reflector. Thirdly, the amount of heat radiated both into the general working space involved and upon the area of the patient's anatomy particularly being illuminated, must be minimized. Fourthly, if it were possible so to provide, the general dimensions of the area being illuminated should remain substantially constant as the light source is moved toward or away from such area to vary the intensity of illumination upon the latter. It is particularly in the latter two respects that previous forms of surgical lighting apparatus have been deficient, in that, to obtain a sufficient intensity level of illumination from a single light source utilizing the conventional reflector means, a high level of energization of such source has been required with consequent high radiation of heat both in the general vicinity thereof and upon the area being illuminated. It is with respect to the fourth requirement of an optimized surgical light, however, that the greatest difficulty has normally been encountered, in that, as the light source is moved toward and away from the illuminated area to vary the intensity of illumination, conventional apparatuses are so conceived and constructed that the dimensions of the area being illuminated will be substantially varied. Thus, in adjusting the conventional surgical lighting apparatus, some compromise between the desired intensity of illumination and the desired dimensions of the illuminated area must normally always be made.

Accordingly, it is the primary object of this invention to provide improved illuminating apparatus overcoming the deficiencies of conventional surgical lights in each of the above-mentioned respects.

It is a further important object of this invention to provide such improved illuminating apparatus in which a plurality of separate light sources are employed, deployed and made subject to variable, controlled orientation in such manner that the intensity level of illumination upon the illuminated area may be controlled by shifting the assembly toward or away from the illuminated area, that radiations emanating from a plurality of directions are

employed to minimize the effects of shadows, that the employment of a number of separate, spaced, light sources of lower individual power, rather than a single high level light source, decrease both the heat delivered into the general working vicinity and the heat imposed upon the illuminated areas, and that the directions of focused beams of light emanating from the several sources can be coordinatedly controlled in such fashion as to maintain the dimensions of the illuminated area substantially constant regardless of the spacing of the assembly from the illuminated area chosen for suitably controlling the intensity level of illumination.

It is another important object of the invention to provide such improved illuminating apparatus in which a number of separate, automobile headlamp type, sealed beam, lamp units are employed with the beams of same directed downwardly in converging relationship to focus upon the area to be illuminated, together with means for simultaneously altering the inclination of the axes of all of the beams from the vertical to permit the dimensions of the illuminated area to be held constant within a relatively wide range of spacing of the assembly from the area being illuminated.

Another important object of the invention is to provide such improved illuminating apparatus in which is employed upon each of the sealed beam units a special type of filter adapted for further minimizing the radiation of heat upon the illuminated area, without adversely affecting the light of desired wave length directed thereto.

Other important objects of the invention include the way in which the orientation of the sealed beam light sources may be simultaneously controlled, and a number of significant details of construction whose nature and purposes will be made clear or become apparent as the following description of an illustrative embodiment of the invention progresses.

In the accompanying drawings:

FIG. 1 is a fragmentary, side elevational view of the overall arrangement of a preferred form of apparatus, with a second possible position thereof being illustrated in dotted lines;

FIG. 2 is a cross sectional view taken on a substantially central, vertical plan through a sealed beam lamp mounting portion of the apparatus, with parts broken away for clarity of illustration;

FIG. 3 is a fragmentary top plan view of the sealed beam lamp mounting portion of the apparatus, with the dust cover removed from the latter and certain parts broken away and shown in cross section for clarity of illustration;

FIG. 4 is a partially schematic and partially top plan representation of an alternate means for controlling the orientation of the several lamps; and

FIG. 5 is a side elevational view of one of the sealed beam units illustrating the manner in which the special filter contemplated by the invention may be applied thereto.

Referring first to FIG. 1, a preferred form of the apparatus contemplated by the invention is generally designated by the numeral **10**. Apparatus **10** includes a fixed vertical mounting post **12** adapted for stationary suspension from the ceiling of the operating room, as illustrated, or might just as well be supported by means of an upstanding standard or the like (not shown). Pivotally mounted upon the post **12** for swinging about a horizontal axis as at **14** is an elongated arm **16** provided at one end thereof with a bifurcated yoke **18** having legs **20** and **22** (see FIG. 2) and at the opposite end thereof, which is on the opposite side of the pivotal axis **14**, with a counterweight **24**. Pivotally mounted upon the legs **20** and **22** of the yoke **18** for swinging movement about a horizontal axis **26** parallel to axis **14**, is a lamp assembly generally

designated 28. It will be understood that the counterweight 24 is so chosen as to render the entire arm 16, yoke 18 and assembly 28 in balanced condition with respect to the axis 14, so that the arm 16 may be easily swung as between the solid line position and the dotted line position in FIG. 1 to adjust the spacing of the lamp assembly 28 above the level indicated by the line 30 of an area to be illuminated as at 32. A flexible cable 34 whose nature and purpose will be hereinafter more fully described, has its extremity coupled with the post 12 as at 36, which is spaced above the pivotal axis 14 a predetermined distance, and oppositely extends into the arm 16, which is hollow, through an opening guard bracket 38.

Referring next particularly to FIGS. 2 and 3, it will be seen that the lamp assembly 28 includes a main frame piece 40, which is annular in overall configuration, channel-like in radial cross section and provided with a plurality of lamp clearing openings 42 in the upper wall 44 thereof. The inner wall 46 of frame 40 is stepped as at 48 to provide running surfaces for an upright annular bank member 50 rotatably carried thereby and held in place by an inner retaining ring 52 secured in any suitable fashion to the inner wall 46 of frame 40 as by pass fitting.

A pair of spaced brackets 54 and 56 adjacent each of the openings 42 pivotally receive pins 58 and 60 oppositely extending from a lamp-receiving socket 62, the axis of pivot of the sockets 62 being coplanar with each other and substantially tangent to and equally spaced from the center of the frame 40. In the illustrated embodiment there are provided four openings 42 each with its corresponding pivoted lamp-receiving socket 62, although it will be understood that a greater or lesser number could conceivably be used.

Each socket 62 receives therein a light source 64 in the nature of a conventional sealed beam headlamp unit such as are employed in automobiles. From each of the sockets 62 there extends radially inwardly a follower element 66 whose innermost portion is slidably received within a corresponding, inclined cam slot 68 in the rotatable bank 50. Since all of the slots 68 are similarly formed relative to the sockets 62 and follower elements 66 with which they respectively cooperate, it will be clear that as the band 50 is rotated relative to the frame 40 all of the sockets 62 and lamps 64 will be simultaneously shifted about their respective pivotal axes. In the preferred form of the invention, the cam slots 68 are so formed that with a given rotation of the band 50 all of the lamps 64 will be swung through an equal angle, although it will be clear to those skilled in the art that, if desired, certain of the lamps 64 could be spaced from the center of the frame 40 by a greater or lesser distance than the remaining lamps with appropriate adjustment of the slopes of the various slots 68 being made to maintain a desired cooperation between the shifting of the various lamps 64 when the band 50 is rotated.

An annular dust cover 70 is provided upon the top of frame 40 and, when in place, covers the sockets 62, elements 66 and band 50. If desired, lower transparent dust covers 72 of clear or filter glass may be provided to close the otherwise open bottom of the frame 40 below the lamps 64. It is also significant that the assembly 28 is provided with an open center as at 74 to clear a line of sight to the illuminated area 32 from a television camera (not shown), which may be carried atop the assembly 28 with appropriate modification of the counterweight 24.

Referring now more particularly to FIG. 3, it will be seen that the frame 28 is provided at opposite sides thereof with oppositely extending pivot pins 76 and 78 respectively received by corresponding bearings 80 and 82 in the legs 22 and 20 respectively of the yoke 18, which it may now also be noted, is preferably hollow. One of such pins 76 is provided with a pinion 84 thereon with which is operably meshed a worm 86 coupled by a shaft 88, and a speed reduction box 90 with a reversible electric motor 92, all internal to the arm 22 of yoke 18. It will similarly be clear from FIG. 3 that the yoke 18 is itself pivotally mounted for rotation relative to the axis of the arm 16 by means of a shaft 94 extending from the arm 16 and rigid thereto which is pivotally received by bearings in the yoke 18 as at 96. Shaft 94 has a pinion 98 thereupon with which is operably meshed a worm 100 coupled by a shaft 102 and a speed reduction box 104 with a reversible electric motor 106 enclosed within arm 20 of yoke 18. As will be apparent, when the motor 92 is operated, the worm 86 turns the pinion 84 and the pin 76 to swing the lamp assembly 28 upon the axis defined by the pins 76 and 78, and, when the motor 106 is operated, the worm 100 walks around the pinion 98 to vary the positioning of the yoke 18 and lamp assembly 28 relative to the arm 16 upon the axis defined by the shaft extension 94 from the latter. Suitable means for controlling the operation of the motors 92 and 106 may consist simply of a source of power with suitable manually or automatically controlled switching means, a suitable type of arrangement being later herein described in connection with the possible application thereto of a reversible motor shown in FIG. 4 and utilizable for purposes explaned in connection with such figure.

Means for rotating the band 50 relative to the frame 40 may take various forms, manual or automatically controlled, one preferred form of such means being illustrated in FIG. 3 and a modified form of such means being illustrated in FIG. 4. Considering first the preferred means of FIG. 3, there is provided upon the top wall 44 of frame 40 a bracket 108 to which is secured one extremity of the sheath portion 110 of a flexible cable assembly generally designated 112, which may be of the form often utilized as speedometer cables or the like, and which includes an inner rod part 114 which is shiftable reciprocably relative to the sheath 110. A stretch of the rod part 114 extends in exposed fashion beyond the bracket 108 and is pivotally connected as at 116 to a lug 118 formed on the outer side of the band 50. A spring 120 bearing at one end thereof against the bracket 108 holding the end of sheath 110 is coiled about the exposed rod part 114 and oppositely bears against a block termination 122 by which the latter is coupled with the lug 118. Cable 112 may be extended through the pin 78 as at 124, and thence through the leg 20 of yoke 18 and tubular arm 16 to a point of emergence of the rod part 34 thereof from the opening guard 38 shown in FIG. 1, it being understood that the opposite end of the sheath 110 will be secured to the guard 38. Since the pivotal connection of the exposed rod part 34 to the post 12 at 36 may be spaced in predetermined fashion from the pivotal axis 14, it will be clear that the slots 68 may be so inclined and curved as to alter the inclination of the beams from the lamps 64 in exactly the right amount to maintain the area 32 substantially constant as the arm 16, yoke 18 and lamp assembly 28 are swung between the solid line and dotted line positions thereof illustrated in FIG. 1. Although the exposed part 34 of cable 112, which is simply the opposite end of the reciprocable inner part which is oppositely exposed at 114, might be reciprocated manually, the automatically compensating arrangement described is obviously more convenient because no separate operator attention thereto is required when the height of the lamp assembly 28 is adjusted.

In FIG. 4 is illustrated an alternate means for controllably rotating the band 50 relative to the frame 40 of lamp assembly 28. In such means, an arcuate rack segment 200 is provided upon the outside of the band 50 and a worm 202 meshed therewith is carried by a shaft rotatably mounted upon the top wall of frame 40 by brackets 206. The shaft is provided with a beveled, friction drive roller 208 engaged with a similar roller 210 carried by the driven shaft 212 of a reversible electric motor 214. The frictional coupling 208, 210 provides a safety clutch against inadvertent attempts to shift

the band 50 through an angle which might damage the elements 66 or other portions of the apparatus.

A suitable means for controlling the reversible motor 214, which as above noted, may likewise be applied to the motors 92 and 106, if desired, comprises a source of electrical power represented by a battery at 216 having one terminal thereof connected by conductive means 218 with a common terminal 220 of the motor 214 (or 92 or 106), and the opposite terminal thereof connected by conductive means 222 with the manually shiftable pole piece 224 of a single pole, double throw electrical switch having stationary contacts 226 and 228 and, if desired, foot pedal means 230 for shifting the pole piece 224 between a neutral position engaging neither of the contacts 226 and 228 at extreme positions for engaging either of the latter. The contact 226 is coupled by conductive means 232 with one of the latter. The contact 226 is coupled by conductive means 232 with one of the directional winding termials 234, while the other contact 228 is coupled by conductive means 236 with the other directional winding terminal 238 of motor 214. Thus, when the switch pole piece 224 is in neutral position, the motor 214 is deenergized and the segment 200 and band 50 are held in stationary position by the worm 202, but, when the pole piece 224 is moved into contacting engagement with either the contact 226 or the contact 228, the motor 214 will be energized in a corresponding direction to rotate the worm 202 for shifting the band 50 in a corresponding direction relative to the frame 40.

It may be observed that the type of control for rotatable band 50 just described, is particularly useful and is preferred by some surgeons in that it permits the surgeon, by manipulation of the foot operated pedal 230, to adjust the diameter of the illuminated area 32 to a larger or smaller magnitude at any time and regardless of the height to which the lamp assembly 28 is situated, whereas, with the control for band 50 illustrated in connection with FIGS. 1 and 3, it is normally necessary to choose a preferred size of illuminated area 32 which will then remain constant regardless of the height of the lamp assembly 28.

In FIG. 5, there is illustrated a filter generally designated 300 having a light passing portion 302 in covering relationship to the face 304 of lamp 64 applied to the lamp 64 and releasably held thereon by means of a number of resilient clamps 306 disposed peripherally of the portion 302 and extending upwardly around the contour of the lamp 64. It has been discovered that, if the filtering portion 304 is made of Aklo glass, type 5963 blue, manufactured and sold by the Blue Ridge Glass Corp. of Kingsport, Tennessee, a maximum illumination of the area 32 by light rays of useful wave length will occur with a very minimum of heating upon the illuminated area 32.

With the preferred embodiment of apparatus 10 described, it is possible to maintain a constant area 32 of illumination throughout a relatively wide range of height adjustments of the lamp assembly 28, a preferred embodiment having slots 68 providing for such consistency of size of the illuminated area 32 while the lamp assembly 28 is shifted between extreme positions from about thirty inches above the level 30 to about sixty-five inches thereabove.

It will now be apparent that the apparatus contemplated by the invention is ideally adapted for achieving all of the above-mentioned and other objects and advantages thereof. It will also be perceived by those skilled in the art, however, that certain minor modifications or changes could be made from the precise form of apparatus 10 described for illustrative purposes without departing from the true spirit or intention of the invention. Accordingly, it is to be understood that the invention shall be deemed limited only by the fair scope of the claims that follow.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. In illuminating apparatus for use in surgical operating rooms or the like, upright post means; an arm mounted on said post means for vertical swinging movement relative to the latter; a normally horizontal frame; means for shiftably mounting said frame on said arm remote from said post means, said frame shifting relative to said arm to remain horizontal as said arm is swung to raise and lower said frame; a plurality of substantially unidirectionally radiative light sources; means pivotally mounting each of said sources on said frame for swinging movement about separate, normally, substantially horizontal axes all substantially tangent to a common circle, said sources being disposed for directing the primary radiations therefrom generally downwardly along angularly converging paths; shiftable control means mechanically coupled with said means pivotally mounting each of said sources for simultaneously swinging said sources through substantially equal angles relative to said frame to vary the focus of said primary radiations; and mechanical linkage means interconnecting said post means with said control means, the connection of said linkage means with said post means being at a zone of the latter spaced from the axis of swinging movement of said arm, for shifting said control means automatically as said arm is swung relative to said post means for correlation of said focus with the vertical position of the frame relative to a subject to be illuminated.

2. In apparatus as set forth in claim 1, wherein said control means includes a follower element for and mechanically coupled with each source respectively for swinging movement with the corresponding source, and an annular member rotatably mounted on the frame and having cam surface parts engageable with each of the elements and arranged for simultaneously swinging the latter when the member is shifted.

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