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DENTAL OPERATING LAMP CONSTRUCTION

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2 Sheets-Sheet 2

Fig. 3

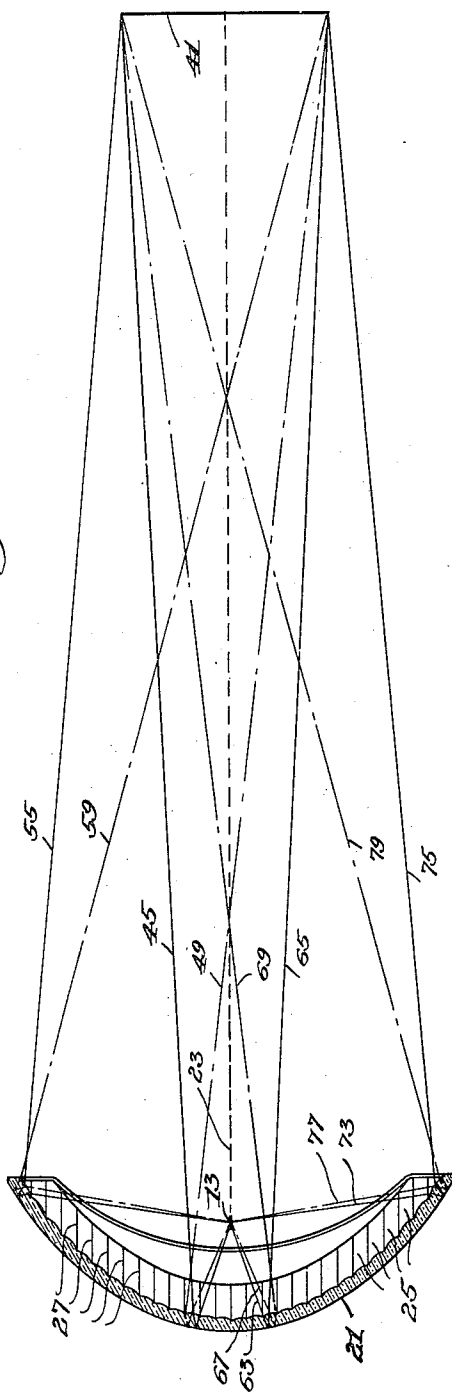
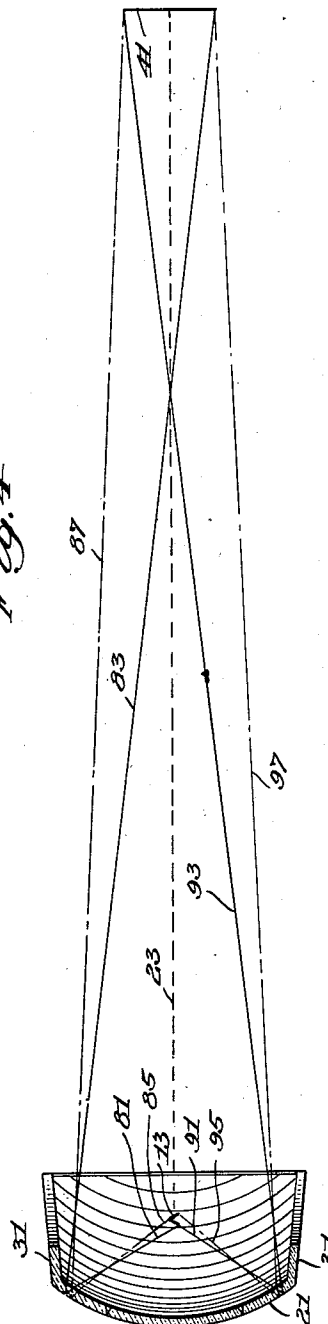


Fig. 4



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DENTAL OPERATING LAMP CONSTRUCTION

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This invention relates to the construction of a dental operating lamp.

The problems involved in the design of dental operating lamps are quite different in many respects from those met in any other type of lighting fixture. First, the lamp should be so designed that light comes to the patient's mouth in a wide bundle of rays converging toward a given point in the patient's mouth from many different directions, so as to eliminate or reduce as much as possible any shadow from a dental implement or other object in the path of the light beam. Second, the bundle of rays or beam of light, approaching the patient's mouth in an approximately or roughly horizontal direction, should be spread laterally to a substantial extent so as to provide a field of illumination which will include the mouth as the patient turns his head from side to side, without necessitating readjustment of the light fixture after each turning movement. Third, the light beam should be compressed or restricted in a vertical direction so that, while it illuminates the mouth region adequately, it does not shine into the patient's eyes and so that the patient is not subjected to unpleasant glare. Fourth, the light beam should have a color value of high fidelity in comparison to natural daylight, so that the dentist may more accurately observe the color characteristics of various portions of the patient's mouth, to detect pathological conditions and for other purposes.

Fifth, the infra-red rays usually emitted by most light sources should be reduced as much as possible, in order to produce no unpleasant sensation of heat in the patient's mouth. Sixth, the lighting fixture should be relatively small and compact so as to offer the least possible interference to free movement of the dentist in the immediate vicinity of the patient's face, it being borne in mind that the lighting fixture must be placed within a few feet of the patient's face in order to obtain an adequate degree of illumination with a light source of reasonable power. Seventh, if any part of the lighting fixture is of material normally considered fragile (such as glass, for example) such part should be so designed that the likelihood of breakage is reduced practically to zero. Eighth, and by no means least, the lighting fixture should be of pleasing and attractive appearance. In connection with the appearance of the lamp as well as the matter of possible breakage and some of the other features above mentioned, it must be borne in mind that a dental operating lamp is

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used at a time when the patient in the dental chair is ordinarily extremely sensitive and ill at ease, and when it is of great importance that the most favorable impression be made upon the patient in every way, so that even little things such as the appearance of a lighting fixture, which might ordinarily go unnoticed, are unduly magnified in the mind of the oversensitive and uncomfortable patient and are likely to produce an unfavorable reaction upon the patient. The breakage of a part of the structure a few feet in front of the patient's face would be especially unfavorable, and in the case of a particularly apprehensive patient might even cause hysteria.

Some of the foregoing considerations apply also to illuminating units or lighting fixtures of other types, such as surgical operating lamps, but nowhere except in the field of dental operating lamps are all of these factors together found to be applicable, at least to the same high degree.

The primary object of the present invention is, therefore, to provide an improved operating lamp construction which combines, in one simple structure, a very high degree of compliance with all of the requirements above mentioned, and which provides an extremely satisfactory and favorable dental operating lamp.

Another object is the provision of a dental operating lamp of a simplified construction having fewer parts than other dental operating lamps heretofore used, this improved construction eliminating many of the separate parts heretofore used without sacrificing the lamp's compliance with the requirements above listed.

A further object is the provision particularly of an improved reflector for a dental operating lamp, so designed and constructed that the reflector accomplishes not only a pure reflecting function but also the functions of several other parts heretofore used in dental operating lamps, thus enabling the elimination of such parts without sacrifice to the satisfactoriness of the lamp as a whole.

These and other desirable objects are accomplished by the construction disclosed as an illustrative embodiment of the invention in the following description and in the accompanying drawings forming a part hereof, in which:

Fig. 1 is a front elevation of a reflector constructed in accordance with a preferred embodiment of the invention, diagrammatically illustrating also a source of light in the form of an incandescent filament;

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Fig. 2 is a top plan view of the reflector, with parts broken away and parts shown in horizontal section, diagrammatically illustrating the path of certain light rays;

Fig. 3 is a horizontal section through the reflector on a smaller scale than Figs. 1 and 2, showing diagrammatically the path of the light rays to illustrate the horizontal spread of the light beam; and

Fig. 4 is a vertical section through the reflector likewise diagrammatically illustrating the path of certain light rays to illustrate the restricted vertical spread of the light beam.

The same reference numerals throughout the several views indicate the same parts.

The lamp of the present invention comprises essentially a reflector indicated in general by the numeral 11, and a source of light such as an incandescent bulb having a filament 13, together with suitable supporting structure for the reflector and for the incandescent bulb socket, which supporting structure may be of any known form and which is, accordingly, not here illustrated. The filament 13 of the bulb is preferably of small size, so as to be somewhat approaching a theoretical "point source" of light, but actually may be in the neighborhood of one-eighth inch to one-quarter inch in length, arranged conveniently in a V or inverted V form as shown in Fig. 4.

The reflector itself is of special and unique construction, so designed that the lamp as a whole has all of the desirable characteristics above listed. Preferably the reflector is molded from a single integral piece of glass, of a special composition mentioned below. In shape, the reflector is curved in general in both a vertical plane and a horizontal plane, and acts both as a reflecting and a refracting unit; in other words, a catadioptric unit.

The rear surface or reflecting surface 21 of the reflector is, both vertically and horizontally, of the shape of a segment of an ellipse, and preferably is a surface of revolution formed by revolving a segment of an ellipse about its major axis, which also is the optical axis of the system, and is indicated in the drawings by the line 23. In other words, the rear surface is a portion or segment of what is technically known as an ellipsoid of revolution, or, more specifically, a prolate spheroid. The light source 13 is placed substantially at the nearer focus of the spheroid. The rear surface is silvered so as to form a good reflecting surface.

The front surface of the reflector may be thought of as being basically a series of parallel convex flutes superimposed on a theoretical or imaginary smooth prolate spheroid surface at an approximately uniform distance in front of the prolate spheroid surface forming the rear face of the reflector. The flutes are indicated at 25 in the drawings, and are so arranged that the junction lines 27 between successive flutes lie in planes parallel to each other and to the major axis 23 of the spheroid. In cross section, the front face of each flute is approximately a small arc of a circle.

Only a small segment of a complete spheroid surface is used as the reflector, the segment being, when viewed in a direction along the major axis or optical axis 23, of generally rectangular shape with somewhat rounded ends, as in Fig. 1. The segment employed is preferably symmetrical with respect to the major axis, the vertex of the spheroid being at the center of the reflector. The two shorter sides of the reflector (that is, the

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ends) are preferably curved on arcs of a circle having its center on the optical axis 23, such curvature resulting from cutting or truncating the prolate spheroid by an imaginary plane perpendicular to the axis 23 and somewhat in front of the focus of the spheroid (at the filament 13) as seen in Fig. 2. The two longer sides of the reflector (which may conveniently be called the top and bottom) are approximately straight when viewed in the direction of the optical axis, as seen in Fig. 1, and are reinforced or strengthened by forwardly projecting ribs or flanges 31, of substantial width at the center and tapering to zero width at the ends, these ribs or flanges being arranged in planes which diverge slightly from the optical axis 23, in a forward direction, as seen in Fig. 4, the planes of these ribs being approximately perpendicular to the planes of junction lines 27 between the flutes. This particular shape of reflector is of pleasing and attractive appearance, and is easy to mount in a simple supporting structure. The body of the reflector, including the flutes 25 and the flanges 31, is pressed, moulded, or otherwise formed as a single integral piece of glass of the special composition disclosed below.

The following illustrative dimensions are offered as an example of the preferred size and shape of the reflector, having been found exceedingly satisfactory in use, but are not intended as a limitation upon the invention, for changes in dimensions may obviously be made without departing from the principles of the invention. In the preferred example of the invention, the rear or reflecting surface is formed or generated, in the geometrical sense, by the rotation about its major axis of an ellipse having a major axis of about thirty-eight inches, a minor axis of about twenty-one and five-sixteenths inches, and a distance from the focus to the adjacent vertex of about three and nine-thirty-seconds inches; the flutes 25 are each about one-half inch in width; the total width of the unit, measured as a diameter from one of the curved ends to the other, is about fourteen inches; the total height of the unit, between the top and bottom flanges 31, is about eight inches; and the thickness of the glass body, measured from the silvered reflecting surface to the bottoms of the valleys between the flutes, is about five-sixteenths of an inch.

This reflector or, more properly, this catadioptric unit, is mounted in a tiltable manner so that the dentist may adjust the beam of light relative to the mouth of the dental patient, but in any adjusted position the optical axis 23 is normally horizontal or approximately horizontal, and the width of the unit (from one curved end to the other) is also horizontal or approximately horizontal, the ribs or flanges 31 being at the top and bottom. For convenience and brevity of description, directions mentioned hereinafter will be understood as referring to the directions when the optical axis is horizontal and when the width of the unit extends horizontally.

With a catadioptric unit having approximately the characteristics above mentioned, and using as a source of light an incandescent filament 13 as previously described, located substantially at one focus of the ellipsoid, the beam of light rays emanating from the device will have the characteristics set forth in the first, second, and third requirements listed at the beginning of this specification. The illuminated field may be considered as a plane perpendicular to the optical axis 23 and placed at about 42 inches away from the catadioptric unit, this dimension represent-

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ing the approximate distance at which the illuminating unit is usually placed from the face of the dental patient. The plane of the illuminated field is indicated diagrammatically by the line 41 in Figs. 3 and 4. Light rays emanating from the filament 13 will be reflected from all parts of the catadioptric unit so as to illuminate the field 41 throughout an area which is fairly wide in a horizontal direction and rather narrow in a vertical direction, as indicated. The light rays from the source 13 passing to any one of the flutes 25, will be refracted as they enter the flute, then be reflected from the rear silvered surface 21, then be refracted again as they pass out through the flute toward the field to be illuminated. The refracting effect of the flutes, upon both the entering ray and the emergent ray, is such as to spread the emergent beam of light laterally in a horizontal direction, so that the field will be brightly illuminated throughout a lateral extent of about seven inches (or about three and a half inches on each side of the optical axis 23) when the catadioptric unit is of the preferred form and dimensions above mentioned.

Although the flutes 25 will have the effect of spreading the emergent light beam laterally, they will not cause any spreading thereof vertically, however. The bundle of rays passing toward the field 41 will be relatively compressed in a vertical direction, and the tendency will be (so far as a vertical plane only is concerned) for the rays originating at one focus of the ellipsoid to be reflected through the other focus thereof, which is located somewhat in front of the field 41 (that is, between the field 41 and the light source). However, there will be a certain amount of vertical spread to the emergent rays, by the time they reach the field 41, this spread being due in part to the size of the light source 13, so that rays originate from a substantial area rather than from a theoretical point, and being due in part to the placing of the field of illumination beyond the other focus of the ellipsoid so that the rays from the upper and lower parts of the reflector tend to cross each other in the region of the other focus, and then to diverge or spread vertically by the time they reach the field of illumination. The combined effects produced by these two causes result in a vertical spread of the light beam at the field of illumination 41 (when the other dimensions are the preferred dimensions given above as an example) of about three or four inches, which is adequate to illuminate the oral cavity without shining into the eyes of the patient, and which thus satisfies the third requirement listed at the beginning of this specification.

The first requirement previously listed is satisfied by reason of the general size and shape of the catadioptric unit. In the preferred form, as already mentioned, it has a total width of about fourteen inches and a height of about eight inches, so that any given point on the field of illumination 41 is illuminated simultaneously by an infinite number of rays approaching that point from different angles, some approaching from one lateral edge of the reflector, others approaching from the other lateral edge fourteen inches away, others approaching from various points in between, as indicated diagrammatically in Fig. 3 of the drawings, while some rays approach from the top portion of the catadioptric unit, others approach from the bottom portion, and still other rays approach from various other portions intermediate the top and bottom of the catadioptric unit, as indicated diagrammatically in Fig. 4.

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The result of all these rays approaching any given point on the field of illumination from a variety of angles or directions, is that an almost shadowless illumination is provided, well fulfilling the first requirement listed at the beginning of this specification.

To explain more fully the path of the light rays, and particularly the spread of the rays in a horizontal direction, reference may be made to Fig. 2. The line 43 diagrammatically represents a light ray starting from the filament 13 and entering one of the flutes 25 near the center of the catadioptric unit, while the line 45 diagrammatically represents the same ray as it emerges from the unit after being reflected and twice refracted. The line 47 represents another entering ray similar to the ray 43 but entering the same flute 25 at a point farther away from the optical axis, and the line 49 represents the corresponding emergent ray after it is reflected and twice refracted. It will be seen that, due to the refracting action of the flutes, the ray 49 is inclined more toward the optical axis 23 than the ray 45, although the corresponding entering rays 43 and 47 have the reverse relationship, the ray 47 being at a greater angle away from the optical axis than the ray 43. The same relationship holds for rays entering other flutes 25. For example, the line 53 represents a ray from the filament 13 entering near one edge of a flute at the extreme lateral edge of the catadioptric unit, while the line 55 represents the corresponding emergent ray. The line 57 represents another ray entering a different portion of the same flute 25, while the line 59 represents the corresponding emergent ray, and it is seen, as before, that the two emergent rays 55 and 59 cross each other after emerging.

These entering rays and emergent rays 43 to 59 are indicated by the same reference numerals in Fig. 3 of the drawings, while other similar entering and emergent rays on the other side or half of the catadioptric unit are indicated by the numerals 63 to 79 inclusive. As seen from the diagram, each of the flutes 25 is so designed as to spread the rays emerging from that flute over the entire desired width of the illuminated field 41, so that the entire width of this field (in a horizontal direction) will be illuminated by separate bundles of rays coming from each of the separate flutes.

The spread in a vertical direction is obtained, as already explained, not from the flutes but from the appreciable size of the filament 13 together with the crossing effect of the rays of light at the other focus of the ellipsoid, which crossing effect also aids in the spread of the illuminated field in a horizontal direction. Referring now to Fig. 4 for a diagrammatic representation of the vertical spread, the line 81 represents a ray of light from one end of the incandescent filament 13, entering the catadioptric unit near the upper edge thereof, and the line 83 represents the corresponding emergent ray, which reaches the illuminated field 41 near the lower edge thereof. The line 85 represents another ray of light from the other end of the filament 13, passing to substantially the same point on the reflecting surface, and the line 87 represents the corresponding emergent ray, which passes to the upper part of the illuminated field 41. The spread between the emergent beams 83 and 87 is due to the angularity between the entering rays 81 and 85, which in turn is due to

the size of the incandescent filament 13. Rays from intermediate points on the filament will, of course, follow similar paths and will fall on the field 41 at intermediate points in the height thereof.

Light passing from the filament to any other part of the catadioptric unit will similarly emerge in a beam illuminating the entire height of the field 41. For example, the line 91 represents an entering ray from one end of the filament, passing to the lower part of the reflector, and the line 93 represents the corresponding emergent ray, which in this instance passes to the upper edge of the field 41. The line 95 represents an entering ray from the other end of the filament likewise passing to the lower part of the reflector, and the line 97 represents the corresponding emergent ray which passes to the lower part of the field 41.

The fact that the catadioptric unit is of less height than width aids somewhat in restricting the vertical spread of the emergent beam of light and keeping it within the confines demanded by the third requirement listed at the beginning of this specification. The unit may be described as cut off or truncated at top and bottom, in comparison to its lateral extent or dimension. It is seen that a construction having the shape and proportions above described admirably fulfills the first, second, and third requirements previously listed.

Compliance with the fourth and fifth requirements is achieved by making the catadioptric unit from glass having both heat-absorbing and color-correcting characteristics, while compliance with the seventh requirement is achieved by using a glass which, without sacrifice of its heat-absorbing and color-correcting characteristics, also has a relatively low coefficient of thermal expansion and a high resistance to heat. Such a glass may be what is known as a borosilicate glass, containing ferrous oxide or ferrous oxalate, and cobalt, and either zinc or cadmium or a mixture thereof. A borosilicate glass is one in which boric acid is used in the glass mixture to enable a decrease in the amount of soda ash or other alkali which would otherwise have to be employed to flux the glass or make it fusible, and this reduction in the content of the soda ash or other alkali results in a lowering of the coefficient of thermal expansion of the glass, as a result of which the heat resistance of the glass is greatly increased and the likelihood of breakage due to heating and cooling is greatly decreased, thus satisfying the seventh requirement listed at the beginning of this specification. The use of iron, preferably in the form of ferrous oxalate, in combination with zinc oxide or cadmium oxide, or mixtures of zinc oxide and cadmium oxide, gives the glass great heat-absorbing properties by giving it a bluish or greenish-bluish tint so that it tends to absorb the infra-red wave lengths emitted by the incandescent light source, and the wave lengths near the red end of the spectrum, resulting in a "cool" beam of emergent light. This satisfies the fifth requirement previously listed. The use of cobalt in the glass mixture gives the glass transmission characteristics producing substantially daylight effects when used with an incandescent light source, thus satisfying the fourth requirement above listed.

The various components of the glass mixture may be used in substantially the same proportions disclosed, for example, in United States

Patent 1,924,752, granted August 29, 1933, on an application of Walter H. Rising, except that it is preferred in the present instance to increase the ratio of iron to cobalt to a considerably higher ratio than that mentioned in said Rising patent. For example, the glass batch mixture and the resulting glass after melting may conveniently be of the same compositions shown in column C of the two tables given in said Rising patent, except that a substantially smaller quantity of cobalt oxide than that there indicated is used in the glass batch, so that the resulting ratio of iron to cobalt in the glass is substantially greater than 16 to 1, and preferably is about 32 to 1.

When a dental lamp is constructed of an incandescent light bulb combined with a heat-resisting, heat-absorbing, and color-correcting catadioptric unit as above disclosed, an exceedingly satisfactory and efficient dental lamp results, satisfying all eight of the requirements listed at the beginning of this specification. The shape of the catadioptric unit is such, as above explained, as to satisfy the first, second, and third requirements. The special composition of which the catadioptric unit is made is such as to satisfy the fourth, fifth, and seventh requirements. The fact that the heat-absorbing and color-correcting characteristics are obtained from the composition of the catadioptric unit itself, rather than from a separate screen or filter used in conjunction therewith, makes the construction more compact than would be the case if a separate screen or filter were used, thus satisfying the sixth requirement, and the elimination of the necessity for any separate screen or filter results in a structure of more pleasing and attractive appearance, thus satisfying the eighth requirement, while at the same time the elimination of any separate screen or filter likewise eliminates the possibilities of breakage that would be inherent in the use of a separate screen or filter, thus aiding compliance with the seventh requirement above listed. It may also be mentioned that the obtaining of the desired heat-absorbing and color-correcting characteristics from the composition of the catadioptric unit itself results in increased efficiency in heat absorption and color correction, because each ray of light passes twice through the thickness of the glass of the catadioptric unit (once before impinging upon the reflecting surface, and then again after being reflected) so that greater heat-absorbing and color-correcting effect is produced on each ray of light, for a given thickness of glass, than would be the case if heat absorption and color correction were produced by a separate screen or filter of glass through which the light passed only once.

The device as a whole satisfies all of the requirements above listed, and is extremely satisfactory and efficient as a dental operating lamp.

It is seen from the foregoing disclosure that a construction is provided which admirably fulfills the above-mentioned objects of the invention. It is to be understood that the foregoing disclosure is given by way of illustrative example only, rather than by way of limitation, and that without departing from the invention, the construction may be varied within the scope of the appended claims.

What is claimed is:

1. A dental operating lamp comprising an incandescent filament, and a glass catadioptric unit associated therewith, said unit having a rear surface remote from said filament silvered so as to form a reflecting surface, said reflecting surface

being substantially in the shape of a portion of a prolate spheroid with said filament substantially at the adjacent focus thereof, said unit having a front surface formed of a series of convex flutes with the valleys between successive flutes lying substantially in successive spaced planes parallel to each other and to the major axis of said prolate spheroid, so that when said lamp is oriented with said major axis extending horizontally and said planes extending vertically, the beam of light emerging from said unit will, in cross section at a substantial distance in front of said unit, be relatively spread laterally in a horizontal direction and relatively confined vertically.

2. A dental operating lamp comprising an incandescent filament and a combined reflecting and refracting unit associated therewith, said unit including a glass wall having substantially the shape of a portion of a prolate spheroid, said portion being substantially symmetrical with respect to the vertex of said spheroid and said filament being substantially at a focus thereof, the rear face of said glass wall being smooth and being silvered to form a reflecting surface, the front face of said glass wall having convex flutes arranged substantially in planes parallel to each other and to the major axis of said prolate spheroid, so that the light emerging from said unit in the general direction of the axis of said spheroid will be spread laterally in a direction perpendicular to said planes to a greater extent than in a direction parallel to said planes.

3. A dental operating lamp comprising an incandescent filament and a combined reflecting and refracting unit associated therewith, said unit including a glass wall having substantially the shape of a portion of a prolate spheroid, said portion being substantially symmetrical with respect to the vertex of said spheroid and said filament being substantially at a focus thereof, the rear face of said glass wall being smooth and being silvered to form a reflecting surface, the front face of said glass wall having convex flutes arranged substantially in planes parallel to each other and to the major axis of said prolate spheroid, the glass of which said wall is made being a sodium borosilicate glass containing zinc, cobalt, and ferrous oxide.

4. A construction as described in claim 3, in which the ratio of ferrous oxide to cobalt oxide in said glass is substantially greater than sixteen to one.

5. A dental operating lamp comprising a source of light and a combined reflecting and refracting unit associated therewith, said unit including a body of glass curved in two directions at right angles to each other, the general curvature in both directions being substantially the curvature of an ellipse having one focus located substantially at said source of light and the other located between the source of light and the face of a dental patient whose oral cavity is to be illuminated by said lamp, said body of glass also having its rear face silvered and its front face formed with a series of convex flutes extending in one of said two directions, the width of said

body in the direction of said flutes being substantially less than the width thereof in a direction at right angles thereto, so that when said lamp is pointed approximately horizontally toward the face of a dental patient with said flutes extending approximately vertically, said flutes will spread the beam of emergent light horizontally to a greater extent than the vertical spread of the beam, with the result that the mouth of a dental patient may continue to be illuminated without readjustment of the lamp as the patient turns his head from side to side, without substantially illuminating the eyes of the patient.

6. A construction as described in claim 5, in which said glass body has strengthening ribs projecting forwardly adjacent the edges thereof at right angles to said flutes.

7. A construction as described in claim 5, in which said glass body is of heat absorbing glass having relatively low coefficient of thermal expansion and containing cobalt to provide for color correction.

8. A construction as described in claim 5, in which said glass body is of sodium borosilicate glass containing cobalt, ferrous oxide, and an oxide of at least one of the metals chosen from the group consisting of zinc and cadmium.

9. A dental operating lamp comprising a catadioptric unit formed of sodium borosilicate glass containing zinc oxide, cobalt oxide, and ferrous oxide, said unit having a curved wall with a rear reflecting surface substantially in the shape of a portion of a prolate spheroid and with a front surface formed of a series of convex flutes with the valleys between successive flutes lying substantially in successive planes parallel to each other and to the major axis of said prolate spheroid, and a source of artificial light substantially at that focus of said spheroid which is nearer to said curved wall, so that when said lamp is oriented with said major axis pointing approximately horizontally toward the face of a dental patient and with said parallel planes arranged substantially vertically, said lamp will produce a beam of relatively cool color-corrected light illuminating the face of the patient throughout an area substantially wider horizontally than its vertical height.

10. A construction as described in claim 9, in which said curved wall is of substantially greater width across said flutes than its height in the direction of said flutes.

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