

April 23, 1940.

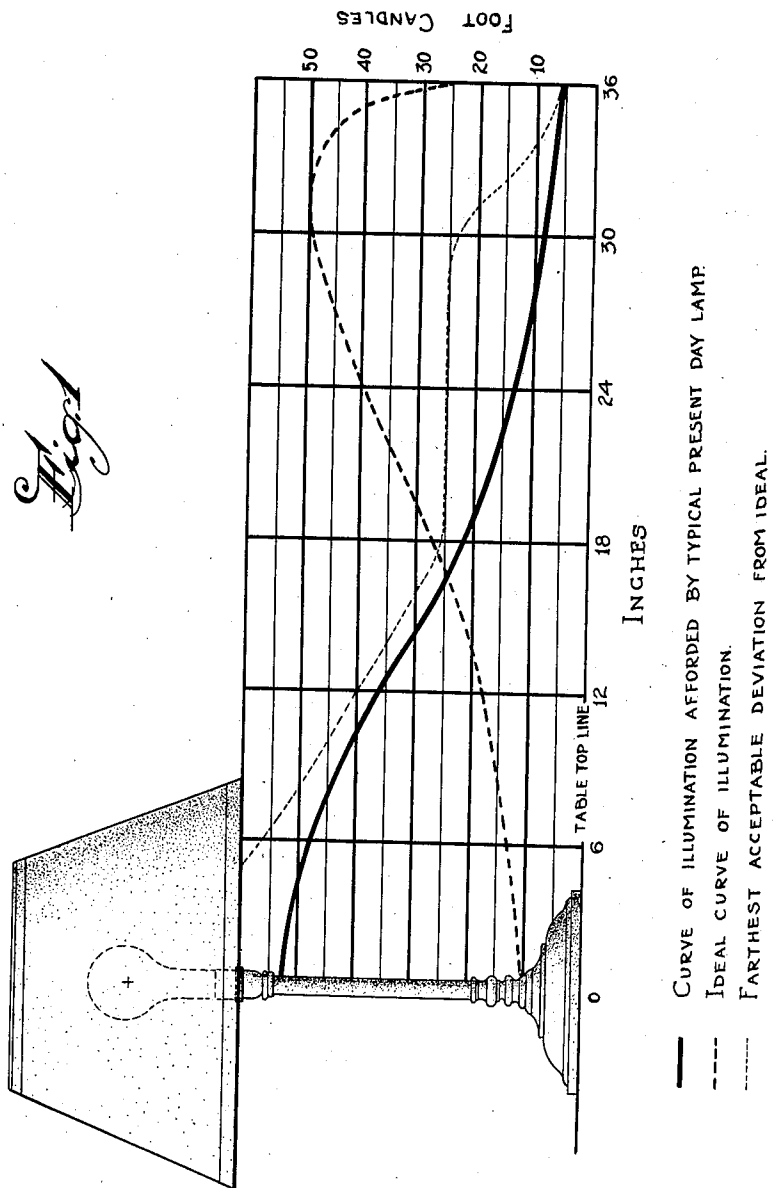
A. J. SWEET

2,198,097

LAMP

Original Filed Nov. 27, 1936

3 Sheets-Sheet 1



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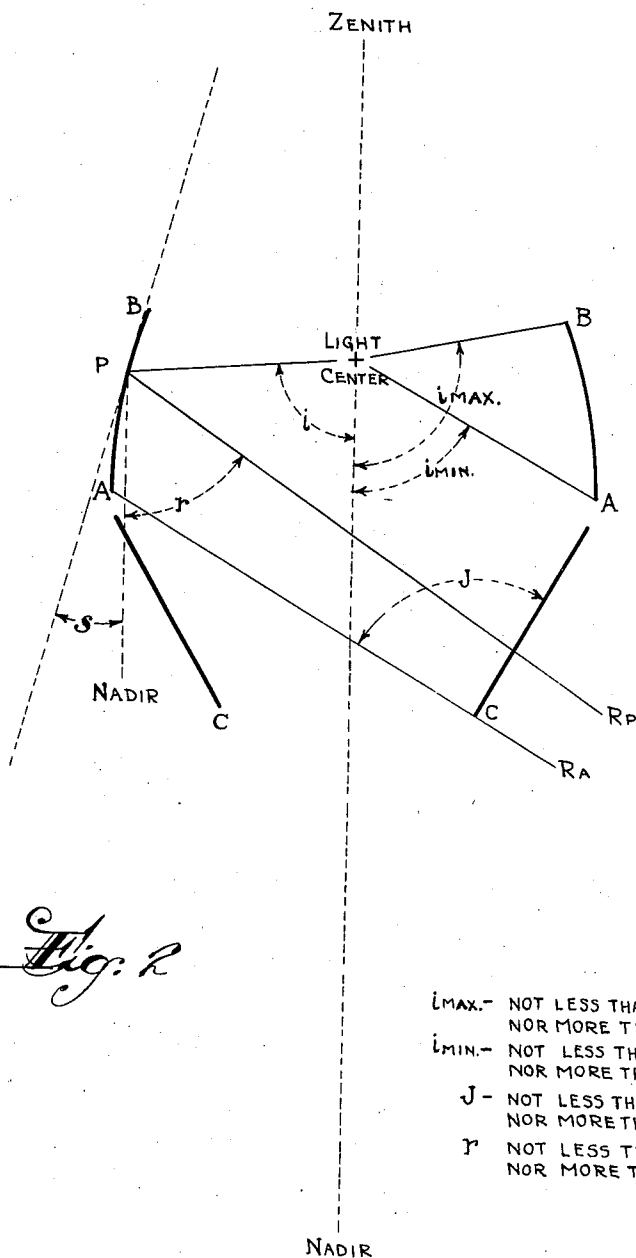


Fig. 2

- iMAX.- NOT LESS THAN 90°
NOR MORE THAN 135°
- iMIN.- NOT LESS THAN 55°
NOR MORE THAN 65°
- J- NOT LESS THAN 45°
NOR MORE THAN 135°
- r NOT LESS THAN 46°
NOR MORE THAN 65°

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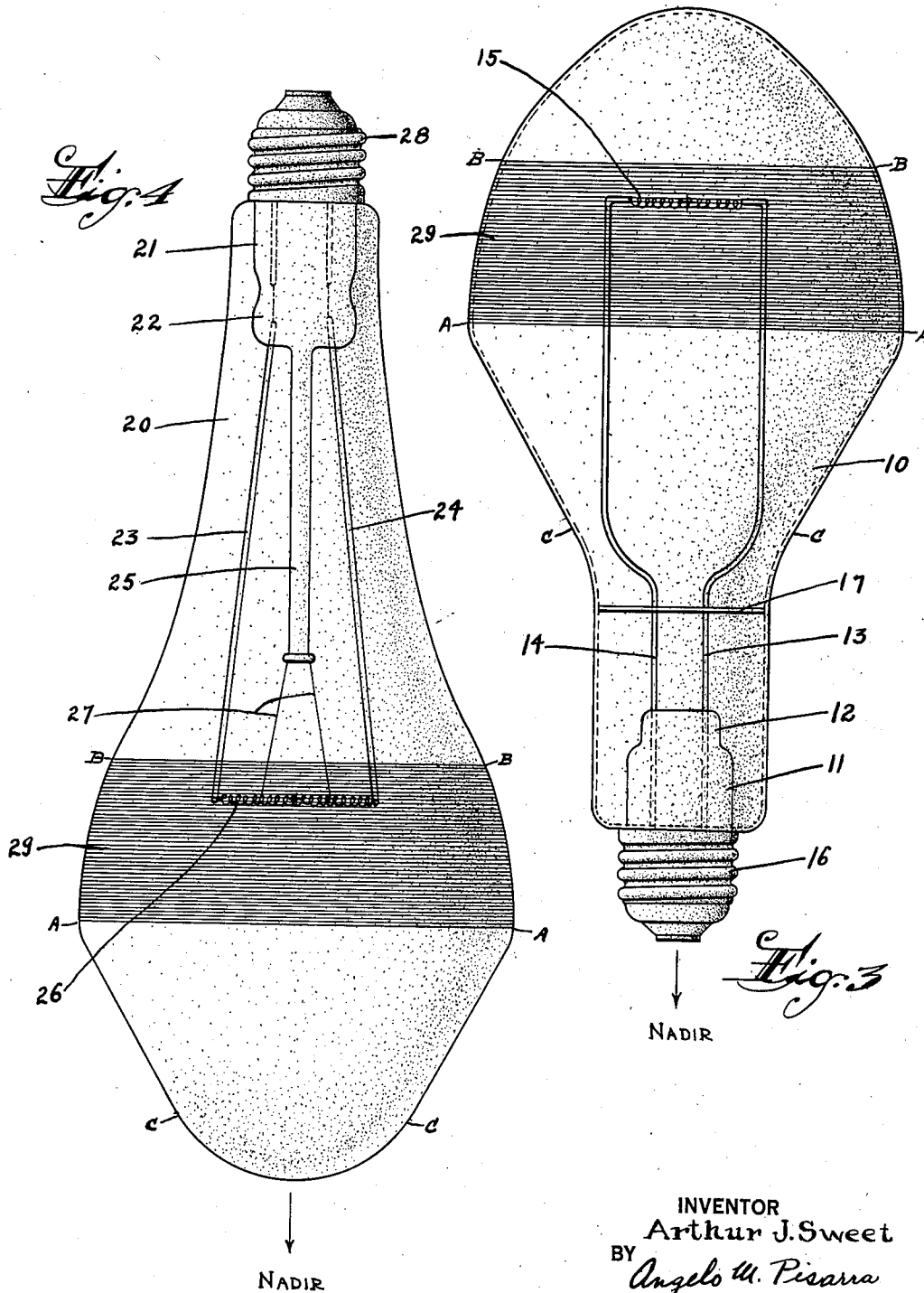
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UNITED STATES PATENT OFFICE

2,198,097

LAMP

Arthur J. Sweet, New York, N. Y.

Application November 27, 1936, Serial No. 112,866
Renewed November 14, 1938

7 Claims. (Cl. 176—34)

This invention relates to illumination, and more especially to lamps in which an incandescent or arc source is contained within a bulb. In its more specific aspect the invention is directed to the design and construction of lamps for use as elements of portable electric table and floor lamps.

One of the chief defects of portable electric table or floor lamps as heretofore available on the market has been that the illumination on the horizontal working plane has been disproportionately high at points near to the axis of the portable lamp and disproportionately low at points relatively distant from the axis of the lamp. Thus the common 100 watt incandescent lamp in a typical portable lamp supporting the light center at a height of 18" above the working plane provides an illumination approximately as follows:

37 ft.-c. at 12 inches from the axis
22 ft.-c. at 18 inches from the axis
13 ft.-c. at 24 inches from the axis
8 ft.-c. at 30 inches from the axis

Similar relationships, all exemplifying a considerable decrease in intensity of illumination as horizontal distance from the axis of the portable lamp increases, characterize all types of portable lamps to-day available on the market.

It is the consensus of competent opinion that 20 ft.-c. to 25 ft.-c. represents the lower limit of what is hygienically proper for the average reading task. Long-continued reading or similar use of the eyes at intensities on the work materially lower than this involves an undue strain on the muscular system of the eye, a strain which will eventually cause permanent impairment of eye-sight.

Considerations of cost have generally deterred the average user from providing a larger bulb than 100 watts, or its equivalent in two or more bulbs of smaller size. To provide a hygienically-adequate intensity of illumination, therefore, it has been necessary to hold the reading matter or other work within a distance of approximately 18" from the axis of the lamp. Under average or typical conditions of work this is just beyond the border of convenience, 18" to 30" being the range within which it is most convenient to place the work in the case of the desk or table lamp and 24" to 38" being the corresponding range in the case of the floor lamp. Convenience, therefore, generally impels the user to place his work at a point where the illumination is more

or less inadequate, with resultant excessive ocular fatigue and eventual impairment of eye-sight.

Adequate intensity of illumination at all distances between (say) 18" and 30" might, of course, be provided by employing a lamp of sufficiently large light generating power. However, such practise would not only involve a cost which the average user regards as prohibitive, but it would produce an undesirably-brilliant illumination at points close to the axis of the portable lamp. Such over-bright illumination adjacent to the work area reduces the efficiency with which the eye functions and increases the burden placed upon the muscular system of the eye.

Attempts have been made to correct this inherent deficiency of existing types of incandescent lamp by employing, in the construction of the portable lamp, auxiliary light-controlling equipment. Such attempts have thus far been successful in correcting the above defect in only a very limited and inadequate degree.

The most serious barrier to the correction of the above defect by the employment of auxiliary reflectors has been interference produced by the lamp bulb itself to the reflected light. In order to provide the required lighting results, such reflected light has to be thrown back upon the lamp bulb and to pass through it. With current shapes of bulb, a considerable portion of the reflected light impinges upon the bulb at such an angle with the glass surface as to be partially reflected therefrom, with consequent interference with the production of proper illumination results. While such bulb interference may be minimized by optimum optical design, there is at present no known means of reducing it to the point where it becomes of little or no practical importance.

It becomes highly desirable, therefore, to produce a lamp which, when mounted with light center 15" to 18" above the working plane, will provide at a distance of 30" from the axis an illumination substantially as great as that provided at a distance of 18". Indeed, it is desirable that the illumination at 30" be considerably greater than the illumination at 18", say twice as great: for if the printed paper or other object of vision be more or less specular, not entirely matte, the same illumination will be less effective, with respect to providing visibility, at 30" than at 18".

Expressing these requirements in terms of light distribution, the desirable incandescent lamp for portable table or floor lamp use will be one which emits at least 3 times, and desirably 6 to 8 times,

as much light at an angle of 60° from the nadir as it does at an angle of 45° from the nadir. Previous to my invention no such lamp has been devised.

One additional requirement of portable table or floor lamp service calls for comment.

Table and floor lamps are frequently used without any other source of illumination within the room. If the illumination afforded by such portable lamp were provided exclusively on the work or adjacent thereto, the general surroundings in the room would be illuminated only by light reflected by the work and adjacent areas, and hence would be but very dimly illuminated. Competent opinion is unanimous that extreme contrasts between the brightly lighted work and very dimly lighted surroundings is hygienically undesirable. The desirable incandescent lamp for portable table or floor lamp use must, therefore, emit at least 20%, more typically 40%, and under occasional conditions of service as much as 60% of its light in a generally upward direction where it will serve to afford a general illumination of the room interior.

With these general requirements in mind, the nature of my invention will be made clear from the following description and drawings wherein:

Figure 1 is a graph showing the typical illumination on the plane of the work afforded by existing types of incandescent lamp when used, without auxiliary light-controlling equipment, in table or floor lamp service, as compared with the ideal illumination and with the farthest deviation from the ideal that can be considered hygienically acceptable.

Figure 2 is a constructional diagram showing the significant elements and characteristics which are involved in application of my invention.

Figure 3 is an application of my invention to a lamp designed for burning with base down (i. e., toward the nadir).

Figure 4 is an application of my invention to a lamp designed for burning with base up (i. e., toward the zenith).

As shown in Figure 3, the lamp comprises a light-permeable or vitreous envelope 10 having a stem 11 integral therewith and terminating in a press 12 in which are embedded a pair of rigid supporting conductors 13 and 14. The distance between the outer portions of said conductors is preferably as great as practical. A ring type coiled filament 15 is connected to the ends of the conductors 13 and 14 and is supported thereby. A base 16 is connected to one end of the envelope and is electrically connected to said conductors 13 and 14. A mica disc 17 has a pair of spaced openings therein about the size of the cross section of said conductors 13 and 14 which extend therethrough. Said disc is mounted in the neck of said envelope and has a diameter approximately equal to the internal diameter of said neck to aid in maintaining said conductors in proper position.

As shown in Figure 4, the lamp comprises a light permeable or vitreous envelope 20 having a stem 21 integral therewith and terminating in a press 22 in which are embedded a pair of rigid supporting conductors 23 and 24. A vitreous arbor 25 is integral with said stem and extends approximately along the longitudinal axis of said lamp. A coil ring type filament 26 is secured to the outer ends of said conductors 23 and 24. A plurality of anchor wires 27 are embedded in the outer end of said arbor and are secured to said

filament 26 to help support the same. A base 28 is connected to the envelope and is electrically connected to the conductors 23 and 24.

The foregoing elements are old in the art, the essential features of my invention are being hereinafter set forth.

Referring equally to Figure 2, Figure 3, and Figure 4, my invention involves a contour of lamp bulb between a lower limit, A, not less than 55° nor more than 65° in position and an upper limit, B, not less than 90° nor more than 135° in position, all these angular values being measured from the nadir with the center of the light source at the apex of the angle. This contour of lamp bulb, A to B, is integral with a specular reflector 29 located on either its inner or its outer surface. The inner surface of said reflector 29 being specular and the outer surface being either specular or non-specular, reflecting or non-reflecting. This specular reflector 29 may extend completely around the bulb in a surface of revolution having the lamp axis as its axis, or it may extend only a quarter of the way around the bulb, or it may extend to any degree intermediate between these two values.

In any event the reflector must be so located with respect to the envelope or bulb that its specular or reflecting surface is located at least as close to the source of light as the outer surface of said envelope or in other words the specular or reflecting surface of the reflector is located no further from the source of light than the outer surface of said envelope.

Outside the above angular limits within which the contour of the lamp bulb must, to fall within the scope of my invention, be shaped as later herein set forth, the lamp bulb may take substantially whatever shape may best be adapted to considerations of satisfactory operation of the lamp with minimum deterioration in light-emitting qualities. However, that section of the bulb, C to A, lying above the point where the internally reflected ray, R_a from the lowest edge of the designed contour, A to B, passes out of the lamp bulb, should desirably be within 45° of perpendicular to the said reflected ray, R_a save for such minimum distance below A as may be required to pass from the contour B to A to the contour A to C without involving undesirable strains within the structure of the glass.

It will be noted that my invention involves a specific contour of a portion of the light bulb in conjunction with a definite position of light source rather than any particular contour considered apart from such definite position of light source.

Proceeding to an exact definition of the reflector which is preferably a portion of the bulb contour and which is the definitive element of my invention, the following symbols are employed:

s is the angle, measured in degrees from the nadir with apex at P, of the nadir segment of a line drawn tangent to the reflecting contour at any point, P.

i is the angle, measured in degrees from the nadir with apex at the center of the light source, of a line drawn from the center of the light source to the point P.

r is the angle, measured in degrees from the nadir with apex at P, of the line along which it is desired to reflect the light.

Employing the above symbols, the portion of bulb contour which is the definitive element of my invention is afforded by the formula

$$s = \frac{1}{2}(i - r)$$

in which i will successively have values varying from a minimum value not less than 55° nor more than 65°, both inclusive, to a maximum value not less than 90° nor more than 135°, both inclusive; in which, at the minimum value of i , r is approximately equal to i and in which, at the maximum value of i , r has a value not less than 46° nor more than 52°; and in which, when r is greater than i , s is measured in a direction from the apex—nadir line opposite that in which i is measured.

The requirements of my invention would, indeed, be met if, at the minimum value of i , r had a value not less than 46° nor more than 52° and if, at the maximum value of i , r had a value approximately equal to the minimum value of i , the formula remaining valid and unchanged. However, such alternative values of r would produce a bulb form more difficult of manufacture and more liable to internal strains within the structure of the glass than would the preferred values.

The exact minimum value of i , lying between 55° and 65° inclusive, is determined by the maximum distance, measured in the working plane perpendicular to the axis of the lamp, at which it is desired to provide illumination from the lamp and by the distance, measured along the axis of the lamp, of the light center from this working plane. This minimum value of i is given by the formula

$i =$

$$\tan^{-1} \frac{\text{Maximum distance of work from axis}}{\text{Distance of light center from working plane}}$$

The exact maximum value of i , not less than 90° nor more than 135°, is determined by the relative proportions of the generated light which it is desired to emit on each side of a plane perpendicular to the lamp axis and passing through the light center. It is never desirable to deliver more than 60% of the emitted light on the side of the plane opposite to that in which the reflecting contour A to B delivers its light; a value of 40% approximately represents the most generally desirable condition; while a value of 20% is the minimum. The exact determination of this percentage depends upon the relation which it is desired to provide between intensity of illumination on the work and average intensity of illumination of the room surroundings. The optimum value of this relation will vary as between the office and the home, the large room and the small room, the light-finished room and the dark-finished room, and will also be materially influenced by the size of the lamp employed. In general, the larger the room of typical use, the darker the finish, or the larger the size of lamp employed, the greater should be the percentage of light emitted on the side of the plane opposite to that in which the reflecting contour A to B delivers its light.

The above percentage of light having been decided upon, it becomes a simple matter for one versed in the art so to locate the point B—that is, so to determine the maximum value of i —that the amount of light emitted between the maximum value of i and the zenith equals the desired percentage.

The maximum and minimum values of i having been determined as set forth above, a photometric test of the light-emitting element mounted at the center of a spherical bulb will afford the data from which can be computed the

amount of light which will fall upon the reflecting surface A to B. This amount of light will be expressed in lumens.

The reflecting efficiency of the surface A to B being known, the amount of light which will be reflected by the surface may now be computed.

The ring-shaped section of the horizontal working plane within which it is desired to provide illumination is now divided into a series of concentric rings. It is most convenient to choose the division points either 1° or 2° apart, depending upon the accuracy of design desired. The area of each of these concentric rings is now computed and expressed in square feet or decimal fractions thereof.

The amount of direct light from the light-emitting element which falls upon each of the above concentric rings is now computed from the photometric test data referred to above. This amount of light will be expressed in lumens. The lumen sum for the entire group of concentric rings is next determined.

The illumination, expressed in foot candles, which it is desired to produce at the center of each concentric ring is now multiplied by the area of the ring, the product expressing the number of lumens which will be required to produce the desired illumination. The sum of these products will be the total amount of light required to produce the desired intensity of illumination at all points within the working area.

The sum of the direct lumens, obtained as specified above, and of the reflected lumens, obtained as specified above, gives the theoretical lumens available to produce illumination in the working area. Were the light source a true point source, these theoretical lumens would correspond with the actual available lumens. Because the light source is not a true point source, there will be a certain "spill" at both the inner and outer edges of the ring-shaped area. The theoretical available lumens are therefore multiplied by a constant of the general order of magnitude of .9 to give the computed available lumens.

If the computed available lumens are greater or less than the required lumens, determined as specified above, the requirements must be suitably modified or the lamp size altered, so as to bring the two values into substantial agreement.

These initial steps having been taken, the designer is now in a position to determine exactly the contour A to B.

The zone A to B is divided into subzones each desirably about 4° wide.

Starting at the middle of the subzone whose lower limit is A, a point is taken which will provide a bulb of the desired diameter. It will of course be understood that the diameter at this point is very slightly less than the maximum bulb diameter.

The angular distance from the nadir of the center of the outermost concentric ring of the work area with respect to said point as the apex of the angle is now determined. This angle is the value of r in the design formula above given, with respect to determining the slope in the subzone whose lower limit is A. The corresponding value of i is afforded by the angular distance from the nadir of said point, the light center being the apex of the angle.

Proceeding from A toward B subzone by subzone, the above process is continued. When sufficient reflected lumens have been provided in the outermost concentric ring to produce, in con-

junction with the direct lumens, the desired illumination, the angle r is varied to conform to the center of the next inner concentric ring. This process is continued until the innermost concentric ring and the subzone adjacent to B are coincidentally reached. It will be found conducive to accuracy of design to make the subzones near B half the angular width of the subzones employed over the larger part of the zonal area A to B.

The above design method provides a bulb contour and associated filament position entirely novel in the art of lamp manufacture. When this bulb contour A to B is provided with a specular reflecting finish, the resultant lamp produces a light distribution entirely novel, a distribution highly useful in certain specialized fields, such as that represented by portable table and floor lamps.

I do not, however, wish to be limited to the single application of portable table and floor lamp service. Incandescent lamps made in accordance with my invention will, used inverted, find useful application in certain indirect lighting service. In such applications the ceiling becomes the working plane and the light emitted on the opposite side of the light center from that in which the reflected light is emitted is used for direct, downward lighting. There are other applications in which a lamp made in compliance with my invention will be found uniquely useful.

The effectiveness of my invention is enhanced by making the incandescent filament or other source of light of as small over-all physical dimensions as possible, that is, of as close an approximation as practical to a point source. This is particularly true of the vertical dimension. I prefer that the horizontal dimension does not exceed three-quarters of an inch and the vertical dimension does not exceed one-quarter of an inch. These approximate over-all values presuppose a lamp bulb having a diameter of approximately four inches, and will change proportionately with changes in bulb diameter.

In the preferred form of my invention I etch, frost, sand-blast or roughen all bulb areas not furnished with a specular reflecting finish. Such bulb areas may, however, be left smooth without violating the principle of my invention.

It is preferable though not essential to my invention to leave the center of the lamp bulb, on that side of the light center chiefly traversed by the reflected rays, free from any obstruction such as the glass "arbor" commonly used for mechanically supporting the filament in the ordinary construction of incandescent lamp. Instead, I prefer to use a single L-shaped support or a multiple of such L-shaped supports, the shorter bar of the L being adjacent to the light center and mounted approximately perpendicular to the axis of the lamp. Or, alternatively, I mechanically support the filament by the customary "arbor" construction but support that arbor from the opposite side of the light center from that chiefly traversed by the reflected rays.

Although my invention has been described in detail it is not to be limited thereby but only by the prior art.

What is claimed:

1. A lamp comprising a light-permeable envelope, a source of light located therein and a reflector, said reflector being integral with said envelope, the inner surface of said reflector being in contact with the outer surface of said en-

velope, the lower limit of the major portion of said reflector being not less than fifty-five degrees nor more than sixty-five degrees and the upper limit of the major portion of said reflector being not less than ninety degrees nor more than one hundred and thirty-five degrees, all of said angles measured from the nadir with the apex of each angle at the center of said source of light, the contour of said reflecting surface and its position with respect to said source being such that the illumination on a horizontal plane produced by the light so reflected is substantially non-decreasing as the horizontal distance from a vertical axis through the center of the light source increases until reaching the maximum working distance for which the lamp is designed, beyond which distance said illumination rapidly decreases.

2. A lamp comprising a light-permeable envelope, a source of light located therein and a reflector, the inner surface of said reflector being specular and located at least as close to the center of said light source as the outer surface of said envelope, a limit of the greater part of said specular surface being not less than fifty-five degrees nor more than sixty-five degrees and another limit of said greater part of said specular surface being not less than ninety degrees nor more than one hundred and thirty-five degrees, all of said angles measured from the nadir with the apex of each angle at the center of said light source, the contour of said reflecting surface and its position with respect to said source being such that the illumination on a horizontal plane produced by the light so reflected increases as the horizontal distance from the vertical axis through the light source increases until the maximum working distance for which the lamp is designed is reached, beyond which distance said illumination rapidly decreases, the greater part of that portion of the envelope in the paths of the reflected rays and on the opposite side of the envelope being not less than forty-five degrees nor more than one hundred and thirty-five degrees to the paths of said rays as they strike said portion.

3. A lamp comprising a light permeable envelope, a source of light therein and a reflector, said reflector located not further from said source of light than the outer surface of said envelope, the contour of the inner surface of said reflector and its position with respect to the center of said source of light being in approximate conformity with the equation $s = \frac{1}{2}(i - r)$ in which S is the slope of the inner reflecting contour of the reflector at any particular point thereon measured in angular degrees from the nadir; i is the angle, measured, in degrees from the nadir, of a line drawn from the center of said light source to said particular point; the minimum value of i being between fifty-five degrees and sixty-five degrees, both inclusive, and the maximum value of i being between ninety degrees and one hundred and thirty-five degrees, both inclusive; r is the angle, measured in degrees from the nadir, at which it is desired to reflect the light, r being approximately equal to i at the minimum value of i and being not less than forty-five degrees nor more than fifty-two degrees at the maximum value of i .

4. A lamp comprising a source of light within a light-permeable envelope, the contour of said envelope between a minimum angle not less than fifty-five degrees nor more than sixty-five degrees and a maximum angle not less than ninety

degrees nor more than one hundred thirty-five degrees, said angles being measured from the nadir with apex of angle at the center of the source of light, being such that, when a specular reflecting surface is applied thereto, the illumination on a horizontal plane produced by the light reflected therefrom is substantially non-decreasing as the horizontal distance from the vertical axis through the center of the light source increases.

5. A lamp comprising a source of light, a light-permeable envelope and a specular reflector located between the light source and the envelope, the contour of said reflector between a minimum angle not less than fifty-five degrees nor more than sixty-five degrees and a maximum angle not less than ninety degrees nor more than one hundred thirty-five degrees, said angles being measured from the nadir with apex of angle at the center of the source of light, being such that the illumination on a horizontal plane produced by the light reflected therefrom is substantially non-decreasing as the horizontal distance from the vertical axis through the center of the light source increases.

6. A lamp comprising a source of light within a light-permeable envelope, a portion of said envelope having an inner-directed specular reflecting surface applied thereto and having a contour in substantial conformity with the equation $s = \frac{1}{2}(i - r)$ in which s is the slope, measured in angular degrees from the nadir, of said contour at any point thereon; i is the angle, measured in degrees from the nadir, of a line drawn from the center of said light source to said point; the minimum value of i being not less than fifty-five degrees nor more than sixty-five

degrees and the maximum value of i being not less than ninety degrees nor more than one hundred and thirty-five degrees; r is the angle, measured in degrees from the nadir, at which it is desired to reflect the light, r being never less than forty-six degrees nor more than sixty-five degrees and being so chosen that the illumination on a horizontal plane produced by the light reflected by said specular reflecting surface is substantially non-decreasing as the horizontal distance from the vertical axis through the center of the light source increases.

7. A lamp comprising a light permeable envelope, a source of light therein and a reflector, said reflector located not further from said source of light than the outer surface of said envelope, the contour of the inner surface of said reflector and its position with respect to the center of said source of light being in approximate conformity with the equation $S = \frac{1}{2}(i - r)$ in which S is the slope of the inner reflecting contour of the reflector at any particular point thereon measured in angular degrees from the nadir; i is the angle, measured, in degrees from the nadir, of a line drawn from the center of said light source to said particular point; the minimum value of i being between fifty-five degrees and sixty-five degrees, both inclusive, and the maximum value of i being not less than ninety degrees; r is the angle, measured in degrees from the nadir, at which it is desired to reflect the light, r being approximately equal to i at the minimum value of i and being not less than forty-five degrees nor more than fifty-two degrees at the maximum value of i .

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