Aug. 26, 1941. R. N. FALGE ET AL 2,253,615

HEAD LAMP

Filed Oct. 31, 1938 4 Sheets-Sheet 1

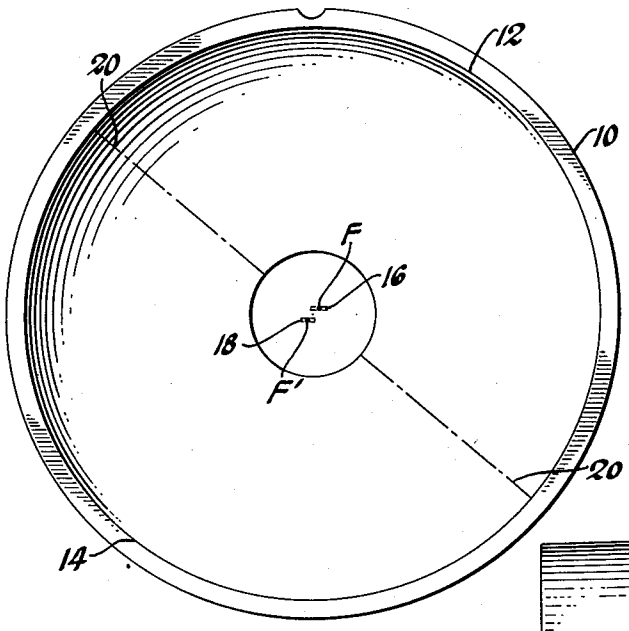


Fig. 1

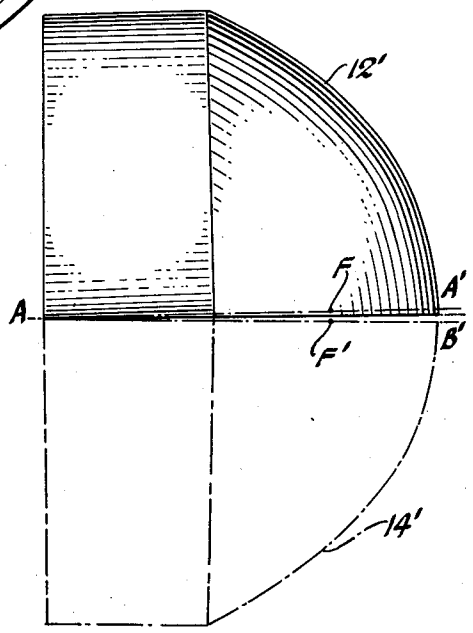


Fig. 2

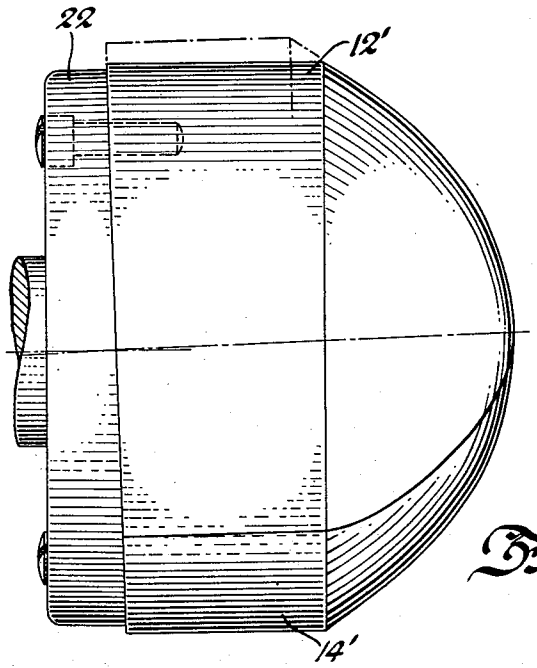


Fig. 3

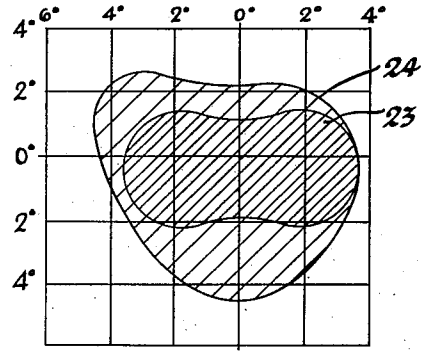
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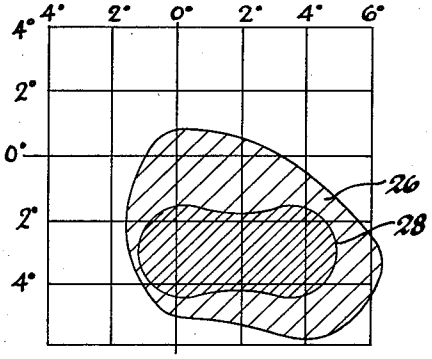
HEAD LAMP

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LOWER FILAMENT HIGH BEAM
WITHOUT LENS

Fig. 4



UPPER FILAMENT - LOW BEAM
WITHOUT - LENS

Fig. 5

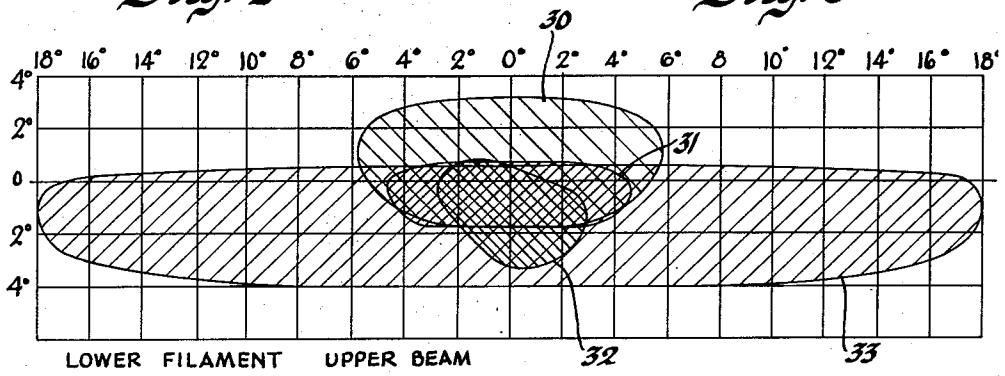


Fig. 10

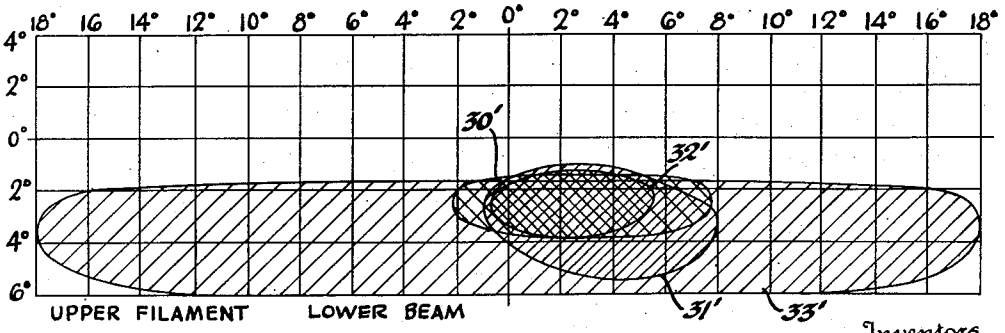


Fig. 11

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HEAD LAMP

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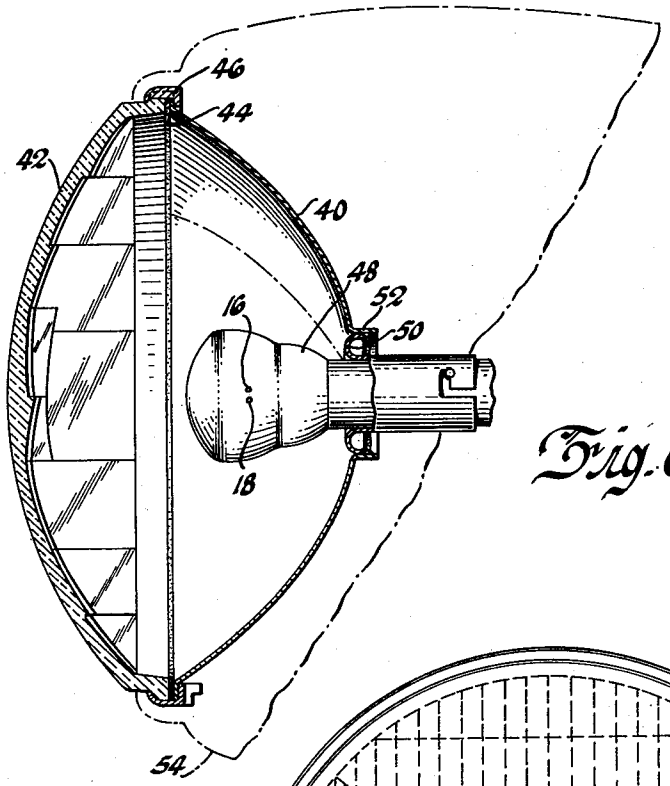


Fig. 6

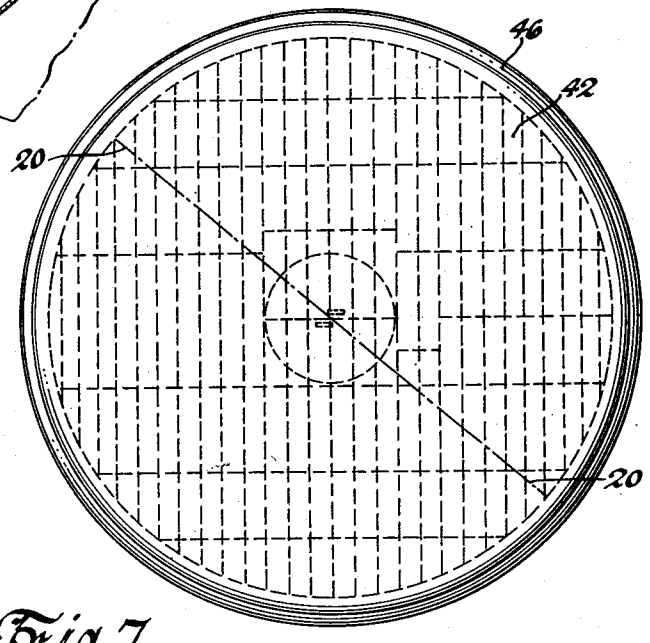


Fig. 7

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Filed Oct. 31, 1938 4 Sheets-Sheet 4

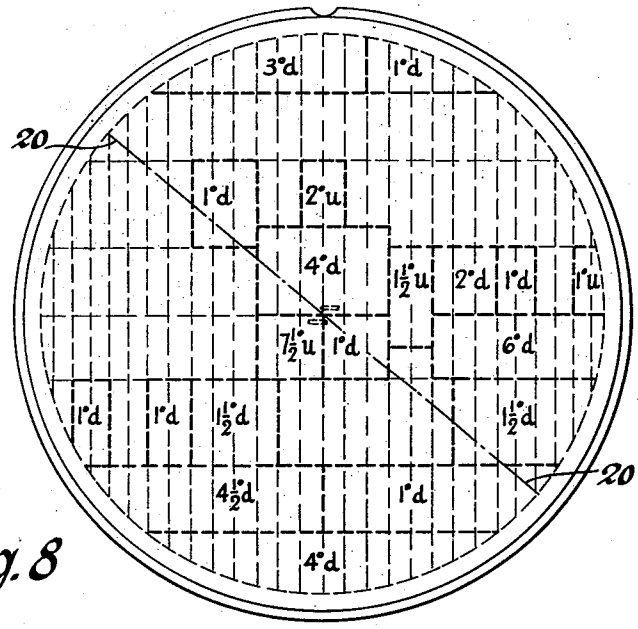


Fig. 8

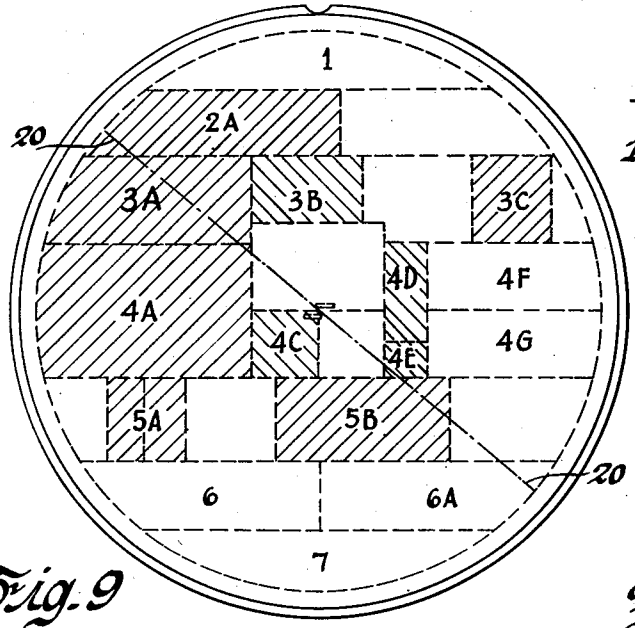


Fig. 9

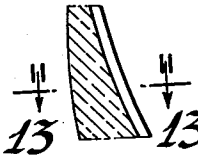


Fig. 12



Fig. 13

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Patented Aug. 26, 1941 2,253,615

UNITED STATES PATENT OFFICE

2,253,615

HEAD LAMP

Robert N. Falge and George W. Onksen, Jr., Anderson, Ind., assignors to General Motors Corporation, Detroit, Mich., a corporation of Delaware

Application October 31, 1938, Serial No. 237,994

4 Claims. (Cl. 240—41.25)

This invention has to do with headlamps of the type designed to produce different beams by shifting from one filament to the other.

In prior designs of such headlamps it has been customary to locate one filament at or near the focus of the reflector and the other filament above the focus. Upon changing from the filament at focus to the filament above focus the light from the central zone of the reflector, which is sensitive to changes in vertical position of the light source, is depressed and the insensitive light from the top and bottom zones is at all times directed below the tops of the beams by inclining these portions of the reflector downwardly or by providing down-bending prisms on the corresponding sections of the lens. It is thus possible to secure a high beam from the lower or focal filament and a low beam from the upper filament.

A disadvantage inherent in this design arises from the fact that the upper filament is appreciably out of focus so that the low beam is less concentrated than the high beam and the distribution of light in it is much less satisfactory. Efforts to improve the beam tend to make the high beam worse so that in all such designs compromise is necessary and the result is frequently a good driving or upper beam and a much less satisfactory lower or passing beam.

We have found it possible by the use of a special reflector, preferably in combination with a suitable lens, to obtain an improved low beam in combination with an improved high beam. Our design avoids to a considerable degree the losses necessitated by compromise in conventional headlighting equipment.

According to our invention we employ a reflector consisting of a plurality of sections, each preferably substantially half of a paraboloid, arranged one above the other with vertically spaced foci and converging axes, and we arrange one filament at the focus of one section of the reflector and the other filament at the focus of the other section. We aim the headlamp with the axis of one section at or near horizontal and with the axis of the other section downwardly inclined.

In order to obtain depression of the beam upon going from one filament to the other it is necessary, as in the conventional two-beam design previously referred to, to give a permanent downward tilt to the light from those portions of the reflector that are insensitive to vertical changes in position of the source of light. In our preferred design this is done by means of suitable down-bending prisms on the lens although the corresponding portions of the reflector may be tilted downwardly if preferred. In the present instance we prefer to employ down-bending prisms as hereinafter disclosed.

In the preferred form of our invention in which the lower section of the reflector is aimed straight ahead and the lower filament is at its focus, while the upper filament is at the focus of the upper section, with the lower filament energized all of the light from the lower half of the reflector except the bottom zone may be directed straight ahead to form the top of the high beam. All of the light from the upper half of the reflector except the top zone may be directed substantially straight ahead by giving to this half of the reflector a downward tilt sufficient to overcome or substantially offset the upward inclination given to the rays by the fact that the lower filament is below the focus of the upper half of the reflector. With greater inclination of the upper reflector section this light may, of course, be thrown further down in the beam. The light from the top and bottom zones is used for widespread illumination nearer the car.

Upon energizing the upper filament, the light from the upper section of the reflector is directed downwardly by the inclination given to this section while the light from all but the bottom zone of the lower section is directed downwardly because the upper filament is above the focus of this section. Top and bottom zones provide foreground illumination as before.

An objection to the employment of reflectors such as described consisting of sections of paraboloids or the like having spaced foci is that, as ordinarily produced, there is a step between the sections of the reflectors. We have found it possible to avoid this step by making the reflector punch of two identical paraboloidal sections. Each section consists of slightly more than a semi-paraboloid and terminates in a parting line lying in a plane slightly inclined to the axis of the paraboloid and intersecting the axis forwardly of the focus. When two such paraboloids are placed together they fit exactly since their meeting sections are identical. From a punch of this description reflectors may be drawn showing no step or line between the paraboloidal sections of which they are composed.

In the preferred embodiment of our invention the beam coming from one of the filaments is directed both downwardly and to the right with respect to the beam coming from the other filament. To accomplish this in our preferred con-

struction referred to above and at the same time obtain compact beams with high intensity hot spots at the top, it is necessary to design the reflector with the focus of the upper half not only above but also to the left of the focus of the lower half. While this could be done by rotating the upper half about a vertical line connecting the foci, a break or step would be formed between the parting lines of the sections or else a curved parting line would be obtained from the intersection of the paraboloids. Steps and curved parting lines are objectionable in that they introduce complications in manufacture. These may be avoided by rotating the preferred form of composite reflector above described about the axis of the lower section until the lateral displacement of the foci is sufficient to give the desired amount of lateral shift to the beam in combination with the desired amount of downward shift resulting from vertical displacement of the foci.

While filaments of conventional V-shape may be employed in our improved headlamp we have found it best to use horizontal coiled filaments so as to obtain a hot spot of minimum depth.

The reflector designed as described is used in combination with a lens the principal function of which is to spread the light across the road for the reflector itself takes care of a large part of the vertical and lateral tilt which must be given to light from various parts of the lamp to get the desired result. Lateral spreading of light is accomplished by flutes on the lens in accordance with usual practice. However, we have also found it advantageous to provide the lens with down-bending prisms where necessary or desirable to improve the beam pattern. We have also employed some side-bending prisms here and there to smooth up the beams. Road tests point toward the desirability of providing light above the cutoff in the upper beam to illuminate the highway for a greater distance ahead when cars are not approaching and to provide better illumination in hilly country. We have provided light above the cutoff from regions of the reflector where the images move through a considerable number of degrees in response to changes in vertical position of the light source so that this light will fall below the top of the lower beam. Where necessary up-bending prisms are employed to bring this fast-moving light above the normal cutoff of the upper beam.

Details of the invention as well as various modifications are described in the following specification taken in connection with the accompanying drawings in which:

Figure 1 is a front view of our improved reflector showing the position of the bulb and its filaments.

Figure 2 is a side view showing the two halves of the reflector punch fitted together and with their axes in a vertical plane.

Figure 3 is a side elevation of the punch rotated to bring the axes of the sections in the desired inclined plane and with the punch sections secured to a mounting plate ready for use in the press.

Figure 4 shows the beam patterns obtained from the reflector shown in Figure 1 with the lower filament energized.

Figure 5 shows the beam patterns obtained from the same reflector with the upper filament energized.

Figure 6 is a vertical section through our complete headlamp.

Figure 7 is a front view of the headlamp.

Figure 8 is a view of the lens with the dividing line between the reflectors indicated in dotted line and with the lens sections marked to show the upward or downward tilt given by the prisms incorporated in them.

Figure 9 is a diagrammatic view showing by suitable legends the approximate portions of the lens and reflector used to provide the hot spot in upper and lower beams and the light above the cutoff in the upper beam.

Figure 10 shows the upper beam pattern from the complete headlamp.

Figure 11 is a similar view showing the lower beam pattern.

Figure 12 is a side view of one of the optical elements making up the lens.

Figure 13 is a section on line 13—13 of Figure 12.

10 indicates a reflector comprising an upper paraboloidal segment 12 having its focus at F and a lower paraboloidal segment 14 having its focus at F'. 16 indicates a horizontal coiled filament centered on the focus F and 18 indicates a similar filament centered on the focus F'. The parting line between the segments is shown dotted at 20—20 in Figure 1 for it is substantially invisible when the lamp is not lighted. This parting line is indicated in a similar way in Figures 7 to 9 inclusive.

The punch shown in Figures 2 and 3 is made from two like paraboloidal sections indicated at 12' and 14'. The focus of paraboloidal section 12' is indicated at F and that of 14' is indicated at F'. The axis of paraboloidal section 12' is indicated by dotted line A—A' and the axis of paraboloidal section 14' is indicated by line A—B'. It will be noted that the plane in which parting line 20—20 lies bisects the angle between the axes A—A' and A—B' of the reflector sections and is at right angles to a line connecting the foci F and F'. Since the paraboloidal segments 12' and 14' are identical, their meeting faces are identical and fit each other exactly.

There is, however, a very slight depression adjacent the parting line since the apexes of the reflector sections lie on opposite sides of the parting line. This depression is very small and in drawing reflectors out of metal with the use of the punch the metal is stretched across the depression, merging the sections into each other without perceptible interruption of either surface.

In Figure 3, 22 indicates the plate on which the punch sections are mounted for use in the press. It will be noted that the face of the plate which receives the punch is machined off at an angle and the face of the punch is machined to fit it. This angle is determined by the requirement that with the punch sections mounted in the position shown in Figure 3 the axis of the section 14' must be aimed substantially horizontally and straight ahead. As a consequence the axis of the upper section 12' is tilted downwardly and to the right.

In the illustrated embodiment of our invention the reflector has a focal length of 1¼" and the spacing between filaments is on the order of ⅛". In general, in order to obtain two satisfactory concentrated beams with our design of headlamp it is desirable that the distance between the foci should be not in excess of 15% of the focal length of the reflector. The minimum distance between foci is, of course, determined by limitations of incandescent lamp design.

In the illustrated embodiment the angle between the axes of the reflector sections is on the

order of 3°. In general it will be found that best results in the use of our invention are obtained where the angle between these axes is not in excess of 5° for with greater angles it is no longer possible to obtain two smooth, concentrated beams.

In Figure 4 we have shown the beam patterns produced by energizing the lower filament in our reflector. The patterns are laterally elongated because the filament is laterally elongated. The pattern 23 is projected by the lower reflector section. It is aimed straight ahead with the top slightly above the horizontal. The pattern 24 comes from the upper reflector section. This pattern is less concentrated than pattern 23 because the lower filament is not at the focus of this section of the reflector. The pattern extends higher above the horizontal for the same reason and also because the lower filament is below the focus of the upper section of the reflector.

In Figure 5 are shown the beam patterns produced by energizing the upper filament. Pattern 26 is produced by the lower reflector section. The pattern 26 is larger than pattern 23 of Figure 4 because the upper filament is not at the focus of this section of the reflector. The top of pattern 26 is but very little lower than the top of pattern 23 because the light from the bottom zone changes but little in direction in going from one filament to the other. Some of this top light is also due to the tilting of filament images from parts of the reflector near the parting line. It will also be noted that pattern 26 is displaced to the right of pattern 23 as a consequence of the upper filament lying to the left of the lower filament.

Pattern 28, Figure 5, is produced by the upper reflector section. It is compact because the upper filament is at the focus of this section. It is depressed below horizontal because the upper reflector section is tilted downwardly. The pattern is displaced toward the right because this reflector section is aimed in that direction as well as down.

By providing our reflector with conventional properly designed spreading flutes it would be possible to obtain two horizontally spread beams, each having a well defined hot spot, the hot spot of the lower beam being from 1½ to 2° below the hot spot of the high beam and displaced toward the right. The provision of good hot spots in both beams is an important advantage of our design. Such a low beam, however, would have the objection that the top of the beam is higher than is desirable for passing. Such a high beam would also lack the desired light above the cut-off for fast driving or driving in hilly country. More light is also desirable in the foreground and it is also necessary to provide a smooth graduation of intensity in both beams both laterally and vertically. While this could be done by properly shaping the reflector this is difficult to do in practice and it is preferred to accomplish the desired shift in the light by employing a lens having flutes and prisms to accomplish the desired result.

The details of the lens design are shown in Figures 8 and 9. In Figure 8 the dotted lines define sections of the lens provided with prisms to give the approximate vertical tilts indicated. The remaining sections have little or no tilt.

Referring to Figure 9 the hot spot of the high beam is made up of light from the sections of the lamp indicated by the following reference characters: 2A, 3A, 3C, 4A, 5A and 5B. These parts are distinguished on the drawing by similar crosshatching. It will be noted that all of these sections lie in the central zone of the reflector so that upon going to the upper filament the light from them is depressed. It will also be noted that sections 4A, 5A, 5B and the lower part of section 3A lie over the lower half of the reflector so that the light passing through them when the lower filament is energized is directed straight ahead. The remaining hot spot sections 2A, 3C and part of 3A lie over portions of the upper half of the reflector. The light from these portions goes to the top of the beam because the effect of the downward tilt given to this section of the reflector is overcome by the effect of the location of the lower filament beneath the focus of the upper reflector section. By reference to Figure 8 it will be observed that these high beam hot spot sections are given little or no up or down tilt by prisms on the lens. The light from these hot spot sections is likewise given but slight spread, varying from 0° to 16° so as to concentrate the light down the center of the road.

Sections 2A and 3C, Figure 9, provide the hot spot in the low beam. The light from these sections is projected downwardly below horizontal when the upper filament is energized because of the downward tilt given to the upper half of the reflector.

Light is provided above the horizontal in the upper beam from sections 3B, 4C, 4D and 4E which are given like crosshatching on Figure 9. It will be noted that these sections lie close to the filaments so that the light from them is shifted a considerable number of degrees in going from one filament to the other. To bring light from section 4C above the horizontal in the high beam it is necessary to give it a substantial upward tilt by means of prisms on the lens. This tilt may be on the order of 7½° as indicated on Figure 8. Sections 3B, 4D and 4E lie over the upper reflector section and the light from these sections is projected above horizontal because the lower filament is below the axis of this section. However, it will be found desirable to provide some of these sections with upbending prisms as shown in Figure 8 to throw light further above the cutoff.

The light from these sections is given but little spread, preferably on the order of 10° so that this high light may be confined to the distance roadway.

The light from the remainder of the lamp that is, the portions not crosshatched in Figure 9, is employed to illuminate the road nearer the car and to provide a gradual change in the illumination between the hot spot and the rest of the beam both laterally and vertically. To accomplish this these sections are provided with flutes giving a wider spread to the light, for example, on the order of from 24° to 38°.

As previously pointed out, it is necessary to give the light from bottom zone of the lower half of the reflector a substantial downward tilt for the light from this section is insensitive to vertical changes in the filament position and would not shift down upon going to the upper filament. Consequently, as shown in Figure 8, this zone is given a substantial downward tilt, preferably on the order of 4°, by means of prisms on the lens. The zone next above is likewise preferably given a substantial downward tilt. It has been found desirable to give a greater degree of downward

tilt to zone 6 than to zone 6A in order to smooth up the beams.

It will be noted that a substantial amount of downward tilt is given to the zone 1 of the reflector to bring this insensitive light into the lower part of the beam.

Attention is also called to the substantial downward tilt about 6° given to zone 4G of the reflector. This light would otherwise fall between the hot spot of the high beam and the top of the light above the horizontal and so would make the top of the hot spot less well defined and thereby interfere with aiming in service. Hence it was found desirable to use prisms to place this light further down in the beams.

Figure 10 illustrates how the light from the various sections of the lamp, as just described, cooperates to produce the desired high beam. The light pattern 30 providing light above the cutoff, comes from sections 3B, 4C, 4D and 4E as described. The hot spot light 31 from the lower section of the lens comes from sections of the lamp marked 4A, 5A, 5B and part of 3A on Figure 9. The hot spot 32 from the upper section of the lens comes from sections of the lamp indicated at 2A, 3C and part of 3A on the same figure. The remaining wide spread pattern 33 comes from the remaining sections of the lamp.

Figure 11 indicates the beam produced by the upper filament. The patterns 30, 31, 32 and 33 have now become patterns 30', 31', 32' and 33' respectively. It will be noted that the hot spots 31' and 32' are shifted substantially entirely to the right of the center line, and the top of the lower beam lies from 1° to 1½° below horizontal. Attention is also called to the fact that the pattern 33' is aimed lower than pattern 33 and is more concentrated. The complete lower beam provides a smooth, concentrated passing light with the hot spot depressed and aimed toward the right and has proven effective in lighting the road and avoiding glare.

In Figures 6 and 7 there is shown somewhat diagrammatically one physical embodiment of our invention. Here 40 indicates the reflector just described and 42 indicates the lens. Between the two is interposed a gasket 44 and the parts are held assembled by a suitable ring 46. 48 indicates a bulb provided with filaments 16 and 18 as previously described. The bulb is preferably provided with mounting ring 50 secured to its base in fixed relation to the filaments. The bulb with the ring 50 is carefully positioned in the reflector with the filaments in their proper optical positions and then the ring 50 is secured in the opening 52 in the reflector by soldering or other suitable means. This method of mounting the bulb in the reflector is the subject of copending application for patent filed by Robert N. Falge, under Serial No. 286,819, on July 27, 1939.

The parts shown in Figure 6 constitute a sealed headlighting unit which may be suitably mounted in housing 54 indicated in dotted lines in Figure 6.

We have not pictured the details of lens design on the drawings because of the considerable number of sectional views required instead we have shown in Figure 12 a side elevation of one of the rectangular units making up the lens, and indicated by dotted lines on Figures 7 and 8. We have chosen for this purpose one of the units making up section 4G of the lens. It will be noted from Figure 8 that this lens element includes a 6° down-bending prism and as shown in 13 it is provided with a wide spreading flute. It will be understood that the lens is made up of similar elements, each given the vertical tilt indicated on Figure 8 and the spread indicated in the foregoing description.

It has also been found desirable to incorporate side-bending prisms in certain portions of the lens providing light for the hot spots or light above the horizontal so as to insure that this light is concentrated down the center of the road. The amount of lateral bending is comparatively slight, ranging from ½° to 3°.

In general, the light from such portions over the lower half of the reflector is inclined toward the left, while the light from portions over the upper half is inclined toward the right.

Obviously, the precise amount of downward or lateral bending or lateral spread given to the light from different parts of the lamp is a matter of judgment and it is to be understood that we do not limit ourselves to any particular selection of precise angles or spreads. The important feature of our invention consists in so designing our headlamp as to provide concentrated light at the top of both beams rather than one concentrated beam and one broken-up, unconcentrated beam as is so often the result of present designs.

Our invention is capable of considerable modification. In some cases it may be desirable to employ paraboloidal sections fitted together with a step between them. This may be especially desirable where more than half of the reflector is used to provide highly concentrated light in one of the beams, for example, the high beam.

In some instances it may be desirable to use reflectors of slightly different focal length in order to vary the characteristics of the out of focus light in the beam patterns. Thus, one of the filaments would be behind the focus of one section of the reflector thereby causing light from that section to be projected above the hot spot while the other filament would be ahead of the focus of the other section of the reflector thereby causing light from that section to be projected below the hot spot. Quite similar results may be obtained by using reflector sections of the same focal length but displaced axially with respect to each other.

Where one reflector section is tilted both downwardly and laterally with respect to the other it may be desirable to avoid a step between the sections by using as a parting line the natural intersection between the two paraboloids. This intersection will often be in the form of a rather wide S curve, introducing difficulties in manufacture of reflector punches but this may be offset by advantages in light utilization and distribution.

It may also in some instances prove desirable to tilt downwardly certain portions of the reflector sections such as the top and bottom zones which, in the preferred embodiment here illustrated, are provided with down-bending prisms. Similarly it may in some instances prove desirable to laterally tilt certain portions of the reflector sections instead of using side-bending prisms on the lens.

The spreading of light by means of flutes on the lens may be accomplished by flutes on the reflector as described in Sumner Brown Patent No. 1,546,281 granted July 14, 1925.

It may also be desirable to apply horizontal flutes to portions of the reflector, preferably the top and bottom zones to smooth up the beam in a vertical direction as disclosed in Patent No.

1,825,084 granted September 29, 1931, to C. A. Michel.

It will be understood that terms "parabolic" and "paraboloidal" are used in a sense to include not only these precise geometric forms but other conic sections such as paraboloids or hyperboloids or hybrid curves differing but slightly from a paraboloid and giving a similar light distribution.

Various other modifications will occur to those skilled in the art.

We claim:

1. In combination a reflector consisting of two substantially like paraboloidal segments, each segment consisting of slightly more than a semi-paraboloid and terminating in a parting line lying in a plane slightly inclined to the axis of the paraboloid and intersecting the axis forwardly of the focus, said segments being secured together with their parting lines in contact, whereby their axes intersect and their foci lie spaced from each other, said reflector being arranged with one of its axes substantially horizontal and with its parting line inclined with respect to the horizontal and with its foci spaced both vertically and laterally, a concentrated horizontally elongated source of light centered on each of said foci, and means for independently energizing said sources so that upon changing to the upper source the beam is shifted downwardly and to one side, the angle between said axes being sufficiently small so that with either source energized the beams from the two segments of the reflector overlap to produce a concentrated beam.

2. A headlamp comprising a reflector made of two parabolic segments joined together with the axis of one segment tilted downwardly and laterally with respect to the other and with the focus of such segment located above and to one side of the focus of the other, a concentrated light source at each of said foci, means for separately energizing said light sources, said headlamp including means to direct downwardly the light from the top and bottom zones so as to obtain a depressed beam with laterally shifted intensity upon going to the upper source, the angle between said axes being sufficiently small so that with either source energized the beams from the two segments of the reflector overlap to produce a concentrated beam.

3. In combination, a reflector comprising a pair of opposed, substantially semi-paraboloidal segments joined together along a line inclined to the horizontal so that substantial portions of said segments are vertically opposed to each other while the remaining portions are laterally opposed to each other, said segments having their foci vertically and laterally spaced from each other, the upper segment having a top zone extending forwardly of the focal plane, the lower segment having a bottom zone extending forwardly of the focal plane, concentrated separately energizable light sources, one at each of said foci, the spacing between foci being so slight that the light from each source is projected from each of said segments in a concentrated beam, the upper segment having its axis tilted downwardly slightly with respect to the axis of the lower segment so as to cause the beam therefrom to overlap the beam from the lower segment whichever filament is energized, said top and bottom zones being downwardly inclined so that upon shifting from the lower filament to the upper filament the beam is depressed as well as shifted toward one side.

4. In combination, a reflector consisting of two substantially identical paraboloidal segments, each segment consisting of slightly more than a semi-paraboloid, said segments being joined together along a line inclined to the horizontal so that substantial portions of said segments are vertically opposed to each other while the remaining portions are laterally opposed to each other, said segments having their foci vertically and laterally spaced from each other, the upper segment having a top zone extending forwardly of the focal plane, the lower segment having a bottom zone extending forwardly of the focal plane, concentrated separately energizable light sources, one at each of said foci, the spacing between foci being so slight that the light from each source is projected from each of said segments in a concentrated beam, the upper segment having its axis tilted downwardly with respect to the axis of the lower segment so as to cause the beam therefrom to overlap the beam from the lower segment whichever filament is energized, said top and bottom segments being downwardly inclined so that upon shifting from the lower filament to the upper filament the beam is depressed as well as shifted to one side.

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