Jan. 15, 1929. 1,698,905

J. T. BEECHLYN

APPARATUS FOR PROJECTING LIGHT

Filed Nov. 12, 1923

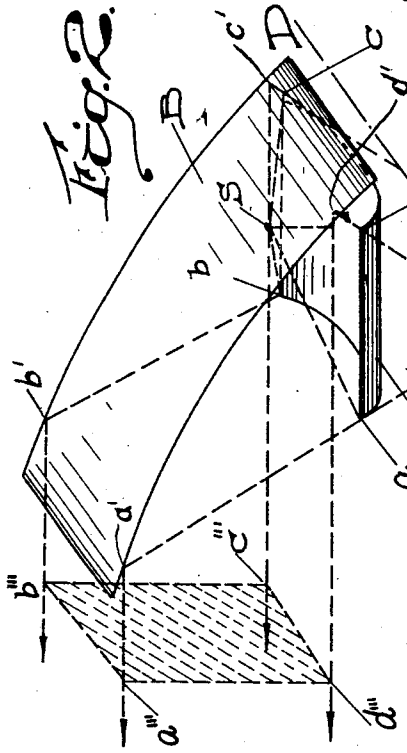


Fig. 2.

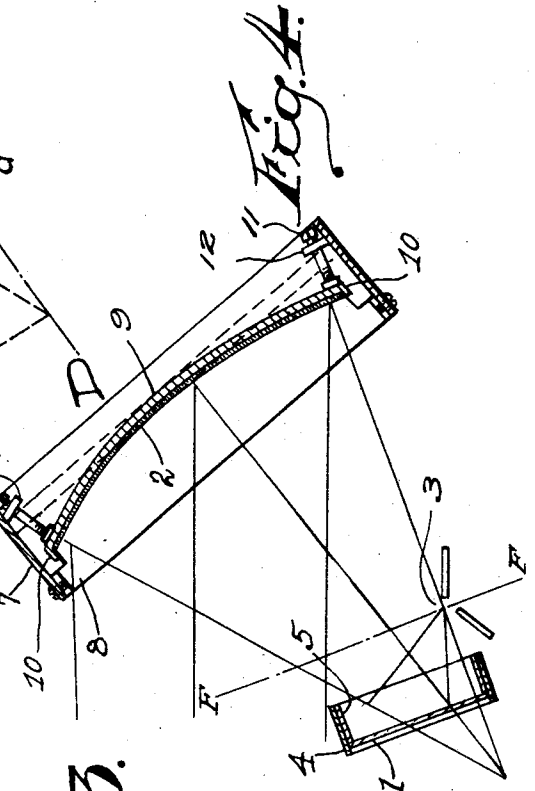


Fig. 4.

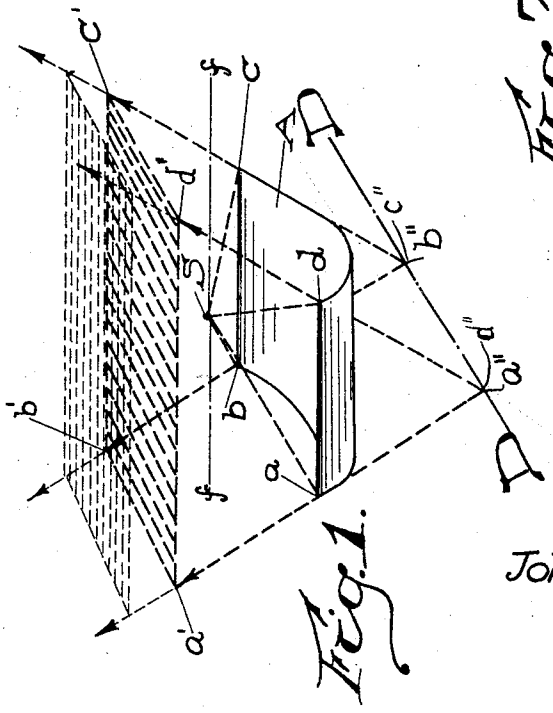


Fig. 1.

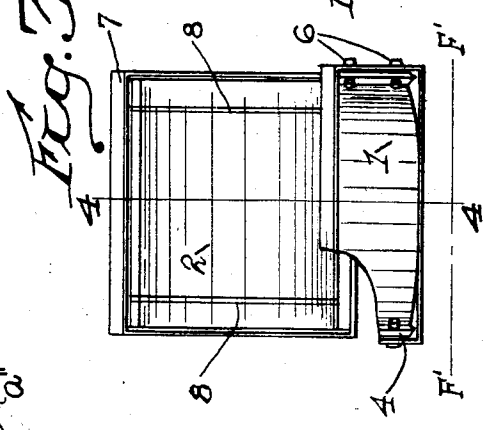


Fig. 3.

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Patented Jan. 15, 1929. 1,698,905

UNITED STATES PATENT OFFICE.

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APPARATUS FOR PROJECTING LIGHT.

Application filed November 12, 1923. Serial No. 674,249.

My invention relates to apparatus for projecting light from any suitable source in such a manner that the light rays emanating from the source, will be collected and projected in a beam in which all of the rays of light are substantially parallel.

It is well known to those skilled in the art, that a reflector, having the form of a true paraboloid, possesses the property of projecting the rays of light emanating from a source located at its focal center, in a beam in which the projected rays are substantially parallel. Such reflectors have been developed to a high degree of perfection for use in connection with search lights, and other similar apparatus, in which it is desired to project the light great distances. The illuminating power of any such light projecting device, however, depends upon the effective area of the reflector, and the manufacturing difficulties encountered in producing paraboloidal reflectors of large diameter or other reflectors which are not developable into a plane surface have imposed serious limitations on the ultimate power of light projecting apparatus of this type. Another inherent defect in light projecting apparatus employing a reflector having the form of a true paraboloid, arises from the fact that the source of light must necessarily be located at the focal center of the reflector, and as a consequence, the light source with its associated and often complex mechanism, is always directly in the projected beam where it is difficult of access.

The object of the present invention is to provide an improved apparatus capable of projecting the light emanating from a source in a parallel beam, by the use of a novel arrangement of reflectors relatively simple and inexpensive to manufacture, by reason of the fact that each reflector is developable into a plane surface. Also with my improved arrangement the light source can be disposed outside of the beam. My invention further contemplates an improved method, by the practice of which, reflectors having the form of a parabolic cylinder can be readily and cheaply manufactured by the flexure of ordinary plate glass, originally having a plane surface. The above and other advantageous features of my invention will hereinafter more fully appear, reference being had to the accompanying drawings, in which

Fig. 1 is a diagrammatic view illustrating the principle underlying my invention.

Fig. 2 is a diagrammatic view showing the arrangement of reflectors contemplated by my invention.

Fig. 3 is a view in front elevation of a light reflecting device embodying my invention.

Fig. 4 is a view in vertical section of the device shown in Fig. 3, the section being taken along the line 4—4.

Like reference characters refer to like parts in the different figures.

Referring first to Fig. 1, there is shown a reflector A, the concave reflecting surface of which is that of a parabolic cylinder having a focal line *f f*. It is known that if a point light source S be placed on the focal line *f f*, then the rays of light reflected from the reflector A will all be parallel to a plane containing the focal line *f f* and the apex of the cylinder. A number of rays reflected from A are indicated in dotted lines at *aa'*, *bb'*, *cc'*, *dd'*, and it is apparent that while these rays are parallel to each other in one plane, yet all these rays will have divergence with respect to a plane at right angles thereto. The reflected light is therefore in the form of a generally wedge-shaped beam having a thickness equal to the width of the reflector A, and a spread determined by the length of the reflector A and the position of the source S. In such a beam it is apparent that the rays coming from the source S, such as S^a, S^b etc., are directed by the reflector A as if coming directly from points *a''*, *b''* etc., located on a line DD which is the directrix of the parabolic section of the reflector A with respect to source S.

In carrying out my invention I employ a reflector A, which, as shown in Fig. 2, is disposed substantially in the same manner as shown in Fig. 1. I also employ a second reflector B having a concave reflecting surface which is also in the form of a parabolic cylinder having its focal line at right angles to the focal line *f f* of the reflector A. In carrying out my improved arrangement, the focal line of the reflector B is made to coincide with the directrix line DD of the reflector A, and the reflector B is assumed to have been swung about the line DD until it intercepts all of the rays *aa''*, *bb''* etc., coming from the reflector A. The points at which the reflected rays from the reflector A strike the reflector B are designated as *a'*, *b'*, *c'* and *d'*.

Since the rays *aa'*, *bb'* etc., are already parallel to a plane perpendicular to the surface of the reflector B, they will remain paral-

lel when reflected by B. Furthermore, the divergence existing between the rays aa', bb' etc., will now be annulled because these rays have their apparent origin on the focal line of the reflector B, that is, the directrix DD. Consequently, the rays $a'a'''$, $b'b'''$ etc., coming from the reflector B, will have been rendered parallel in two planes at right angles to each other, and so will form a beam in which all the rays of light will be substantially paralell to each other. Assuming a point source S, the beam will be rectangular in cross section, in accordance with the outline of the reflector B. With a source of finite dimensions, the cross section of the beam at a point remote from the source will be determined by the relative focal lengths of the reflectors A and B.

From the foregoing it is apparent that by my invention I have provided an improved light projecting apparatus capable of projecting the light emanating from a source in a substantially parallel beam by a novel arrangement of reflectors, each having the form of a curved surface that is developable into or from a plane surface. Inasmuch as the principles underlying the application of my invention are purely mathematical, it is more or less immaterial just what specific form of reflectors are employed in carrying out the invention. It is obvious that the curvature and dimensions of the reflectors may be varied from the proportions shown in Fig. 2, and also that the angular relation between the reflectors A and B can be varied so long as the focal line of the reflector B is made to substantially coincide with a directrix of the reflector A.

As previously stated, one of the advantageous results attained by my invention is the provision of an improved light reflecting device in which the reflectors may be manufactured with much less expense than the paraboloidal reflectors heretofore employed. Another way of stating the proposition is that by my invention it is possible to project light by utilizing two reflectors having curved surfaces of the first order in the same manner as light has been heretofore projected by a single curved surface of the second order. Generally speaking it may be stated that a curved surface of the first order is developable into a plane surface, while a curved surface of the second order, such as a paraboloid or sphere is not so developable. It therefore follows that the reflectors employed in carrying out my invention are adapted to be made from material having a normally plane surface which is capable of being flexed into the form of a parabolic cylinder, and in Figs. 3 and 4, I have illustrated a practical embodiment of my invention, and my improved method of forming reflectors.

Referring to Figs. 3 and 4, my device is therein illustrated as comprising a reflector 1 having the form of a parabolic cylinder with a focal line F—F, and a second reflector 2, also having the form of a parabolic cylinder and a focal line F'—F'. A suitable light source 3, here shown as an electric arc, is located on the focal line F—F, and is so positioned with respect to the reflector 1 that it is located entirely outside of the rays of light reflected from the source by the reflector 1. The focal line F'—F' of the reflector 2 coincides with the directrix of the reflector 1, and it is apparent from the foregoing discussion with respect to Figs. 1 and 2, that the rays of light from the source 3 which are reflected by the reflector 2 will be parallel in two planes.

As best shown in Fig. 4, the smaller reflector 1 is in the form of a sheet, either of plate glass or metal, having a suitable reflecting surface thereon, which sheet is received in a rectangular frame 4. Templets 5, 5 are also carried by the frame 4, each templet having one edge thereof curved in the form of a portion of a parabolic cylinder. The reflector 1 is flexed into engagement with curved edges of the templets 5, and is held in its flexed position by means of set screws 6 engaging the back of the reflector 1.

The larger reflector 2 is preferably formed of plate glass having a suitable reflecting surface, which plate is received in a frame 7. The frame 7 is provided with templets 8, 8, each having a curved surface having the form of a portion of a parabolic cylinder. In order to flex the plate glass to the form of the templets 8, I employ an improved means, whereby this flexure may be accomplished without danger of cracking the glass, as will now be described.

A metallic backing 9 is applied to the back of the reflecting surface of the flat glass plate 2, the backing 9 being in the form of a separate sheet, or being applied to the plate 2 by electrolytic deposit, as desired. The backing is extended around the edges of the plate, as shown at 10. The front face of the glass plate 2 is then placed against the templets 8, as indicated in dotted lines, after which pressure is applied along the bent-over edges 10 of the backing 9, as indicated by the arrows. When this occurs the metalllic backing 9, and with it the plate 2, are bent into the form of the templets 8, in the absence of relative surface movement between the backing and plate. Practically all the forces acting on the glass are compressive by reason of the fact that the forces applied to the backing 9 are transmitted to the plate 2 through the bent-over edges 10, and as the glass bends, the backing 9 itself exerts pressure over the back of the plate 2. Consequently, there will be but little chance to crack the glass, the strength of which, under compression, is substantially twelve times the

strength under tension. After the plate 2 has been bent to shape it is held in contact with the templets 8 by means of set screws 11 coacting with lugs 12 carried by the frame 7. By carrying out the above described procedure, it has been found possible to flex a plane mirror, or reflector, several times beyond the point where fracture thereof would occur, should the glass be bent while unsupported.

From the foregoing, it is apparent that by my invention I have provided an improved apparatus for projecting light in a parallel beam by a novel arrangement of reflectors, each having the form of a developable curved surface, such as a parabolic cylinder. With this arrangement of reflectors, it is possible to employ a source of light located entirely outside of the reflected beam, a distinct advantage when using a light source requiring complicated mechanism, such as a high intensity electric arc. Obviously, an arc mechanism located outside of the beam is capable of ready adjustment without, in any way, obstructing the beam. Furthermore, my improved method of flexing a plane reflector into the form of a parabolic cylinder, greatly reduces the cost of manufacturing reflectors for carrying out my invention.

I claim:

1. In a light projecting device, the combination with a reflector having the form of a parabolic cylinder, and a source of light located on the focal line of said reflector, of a second reflector having the form of a parabolic cylinder and so arranged as to intercept rays of light reflected from said source by the first named reflector, the focal line of said second named reflector coinciding with the directrix of the rays of light coming from said first named reflector.

2. In a light projecting device, the combination with a source of light, of a reflector having a developable surface curved as a parabolic cylinder so as to bring rays of light from said source towards parallelism in one plane, and a second reflector having a developable surface curved as a parabolic cylinder with its axis at right angles to the first reflector so as to bring the previously collected rays towards parallelism in a plane substantially at right angles to the first plane.

Dated this second day of November, 1923.

JOHN T. BEECHLYN.