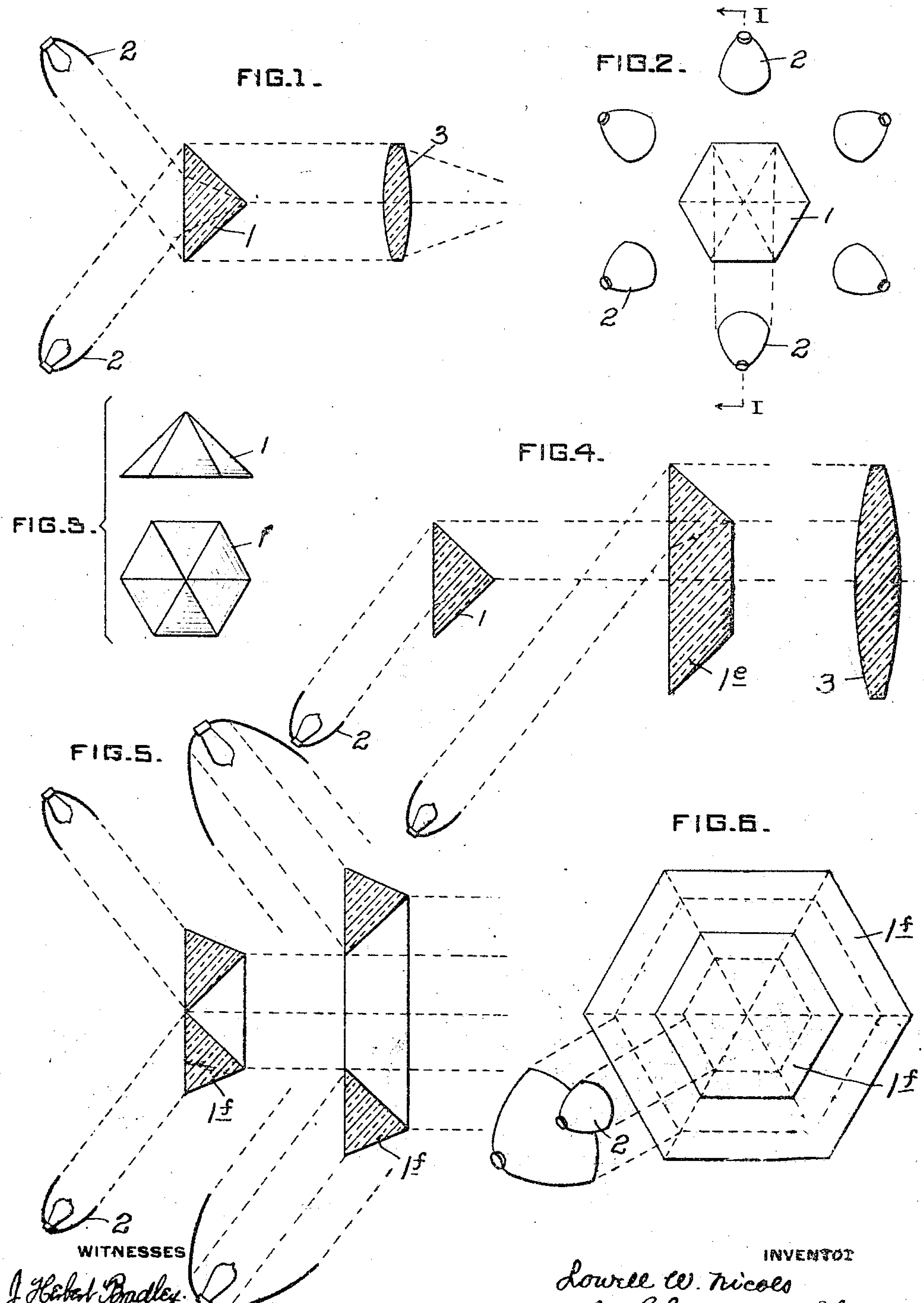
L. W. NICOLS.

LANTERN.

APPLICATION FILED APR. 5, 1917.

1,298,084. Patented Mar. 25, 1919.

3 SHEETS—SHEET 1.



WITNESSES

J. Herbert Bradley

Francis J. Tomasson

INVENTOR

Lowell W. Nicols

by Christy and Christy

his attorneys

L. W. NICOLS.

LANTERN.

APPLICATION FILED APR. 5, 1917.

1,298,084.

Patented Mar. 25, 1919.

3 SHEETS—SHEET 2.

FIG.7.

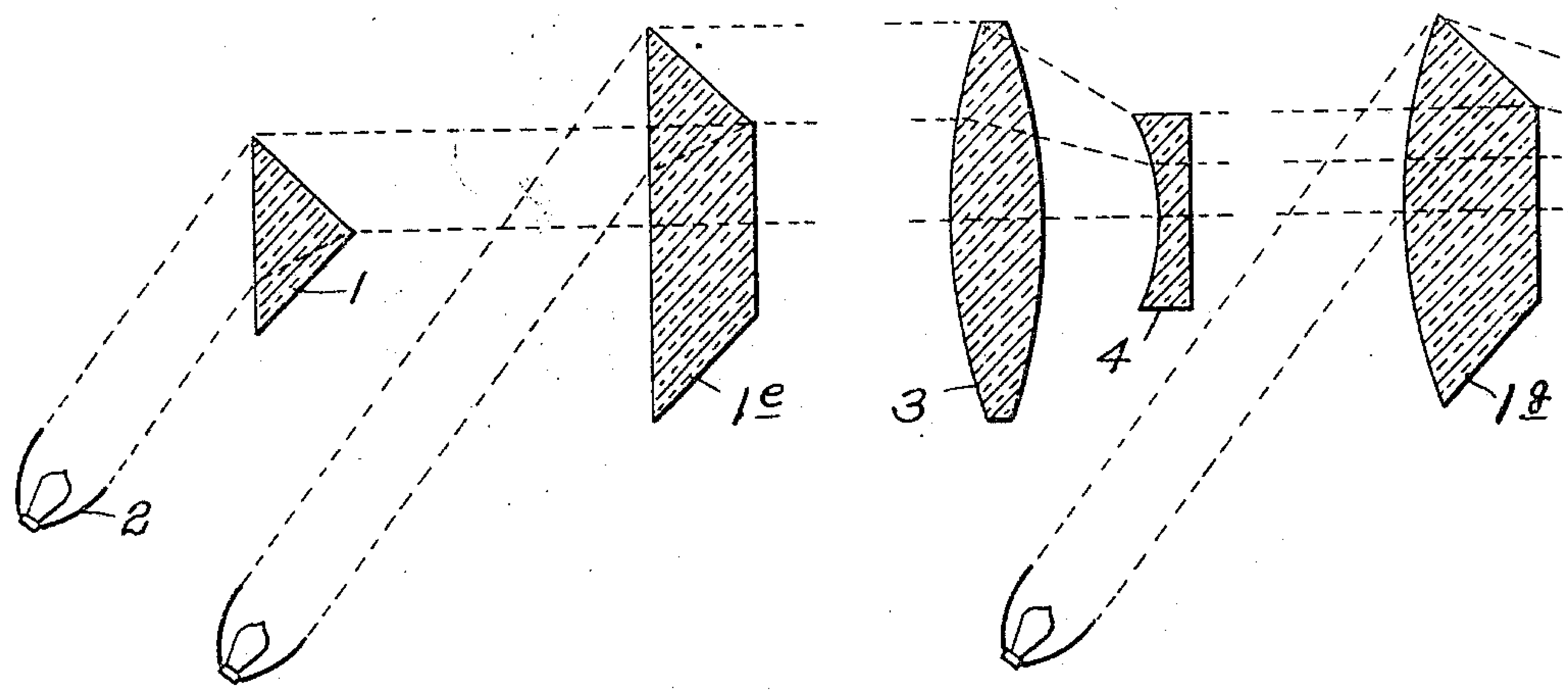


FIG.8.

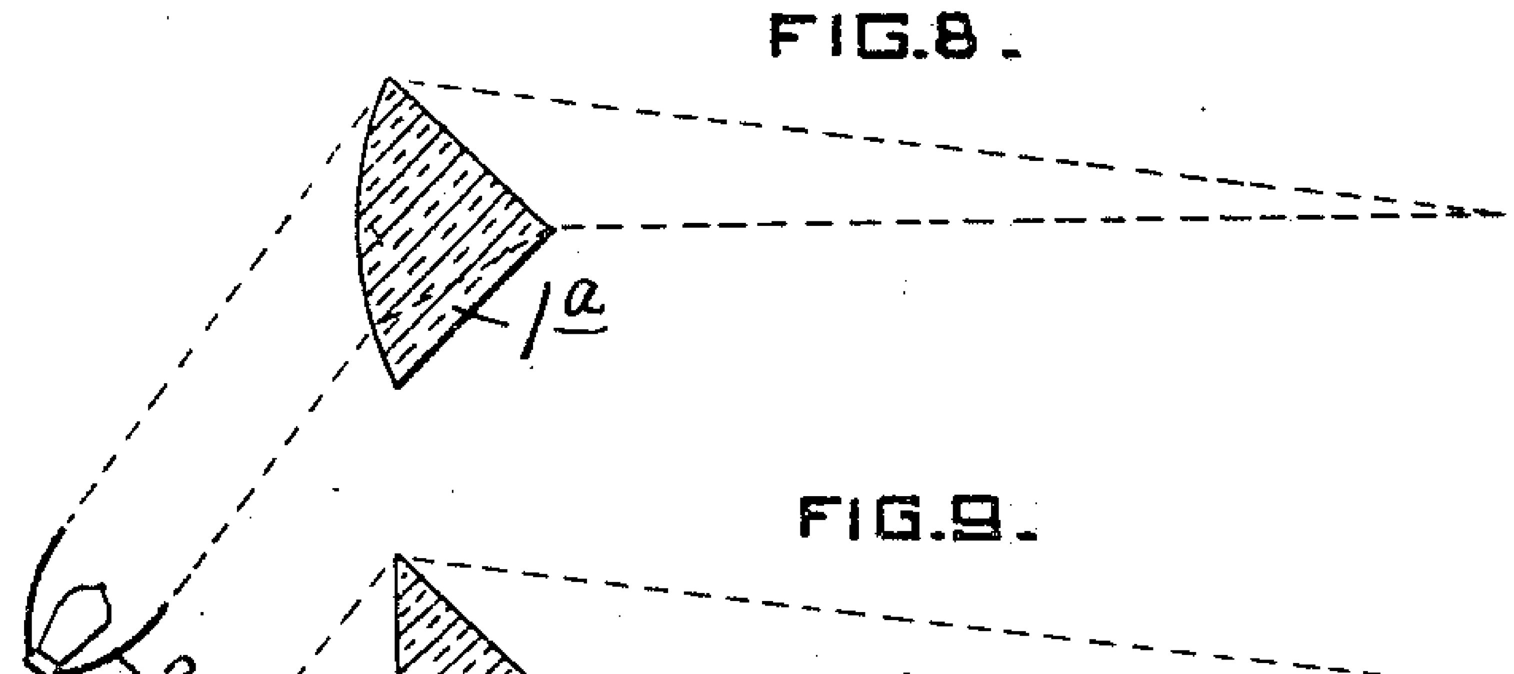
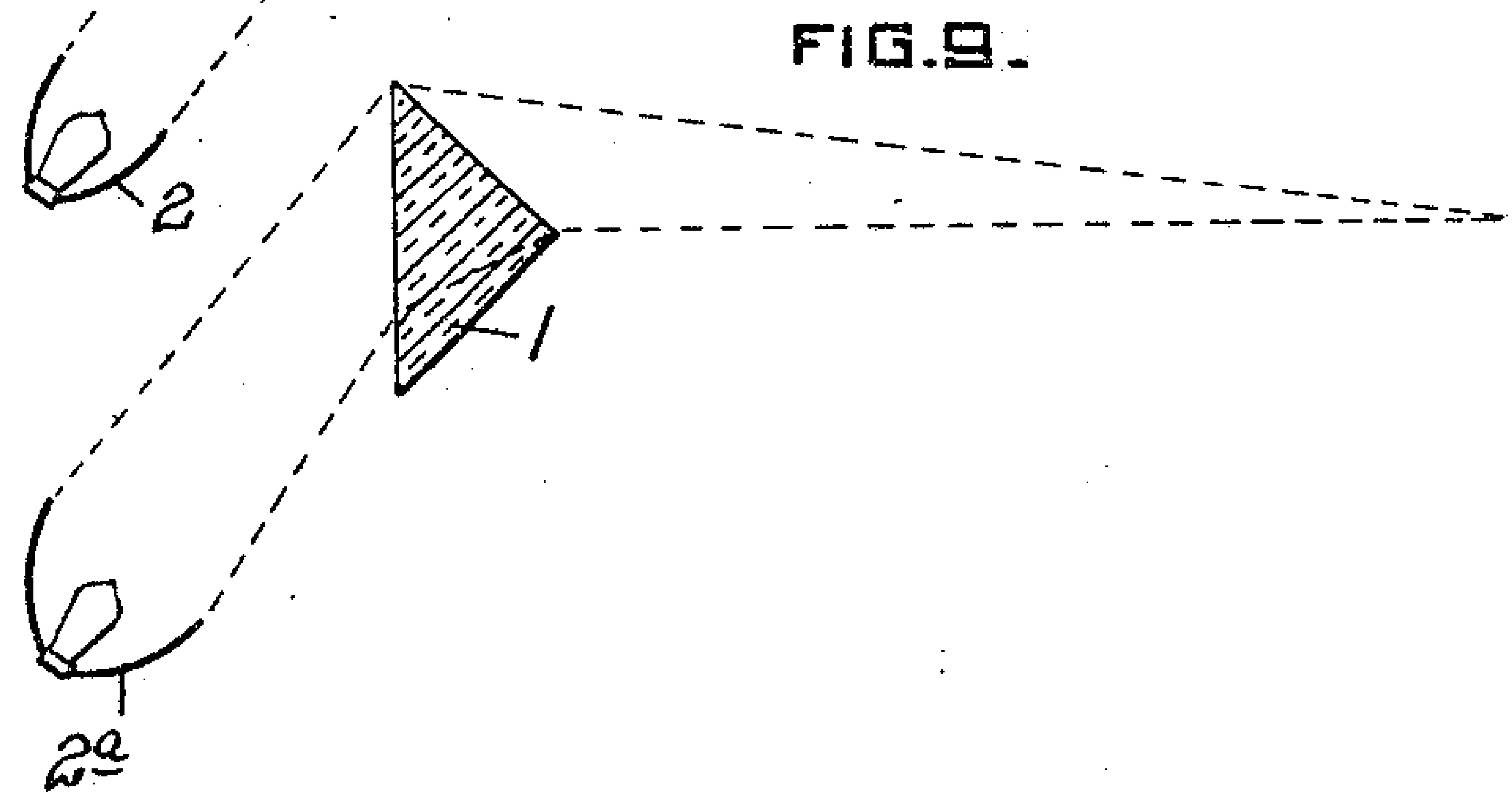


FIG.9.



WITNESSES

J. Herbert Bradley.

Francis J. Tomasson

INVENTOR

Lowell W. Nicols

by Christy and Christy

his attorneys

L. W. NICOLS.
LANTERN.
APPLICATION FILED APR. 5, 1917.

1,298,084.

Patented Mar. 25, 1919.
3 SHEETS—SHEET 3.

FIG.10.

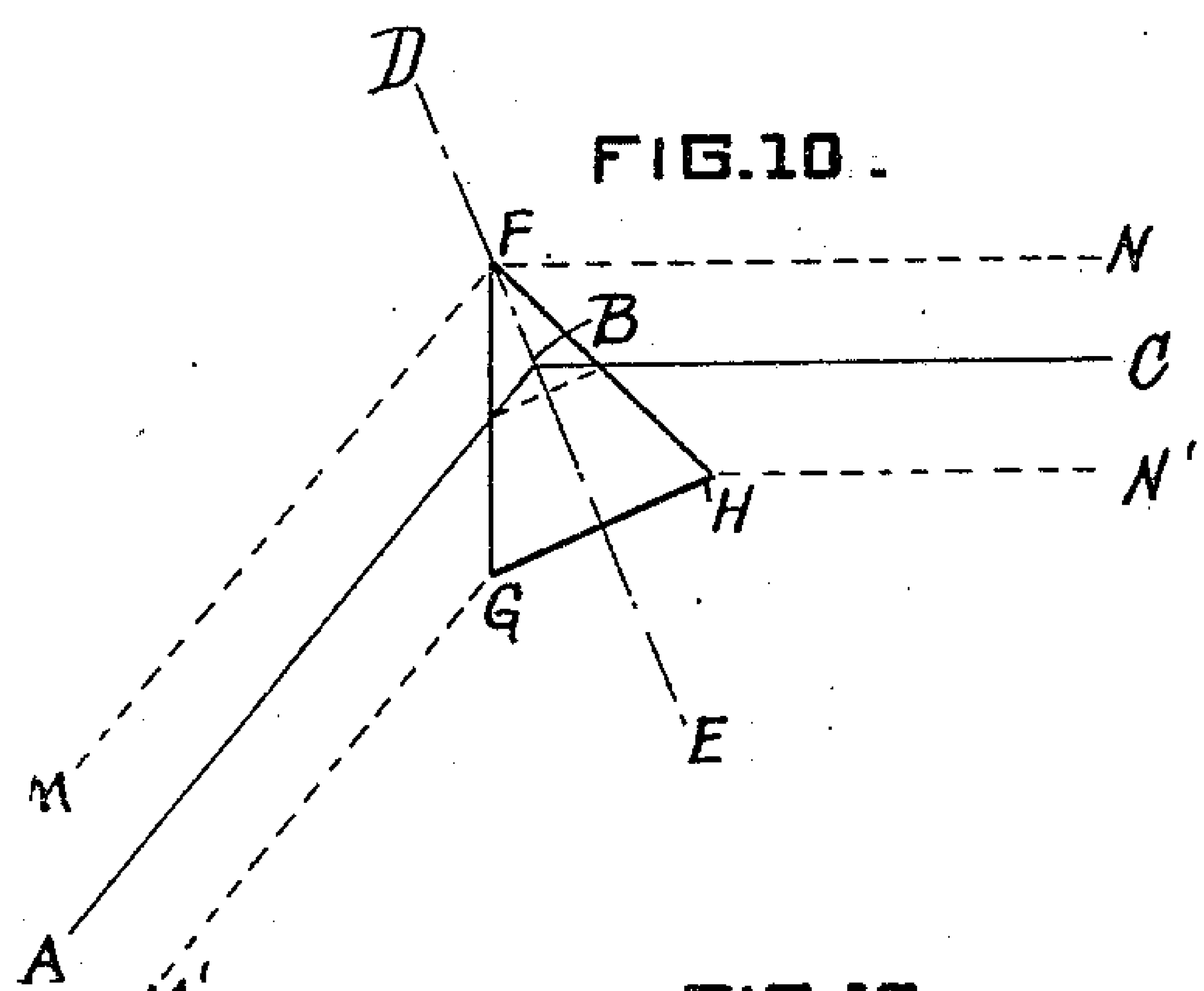


FIG.11.

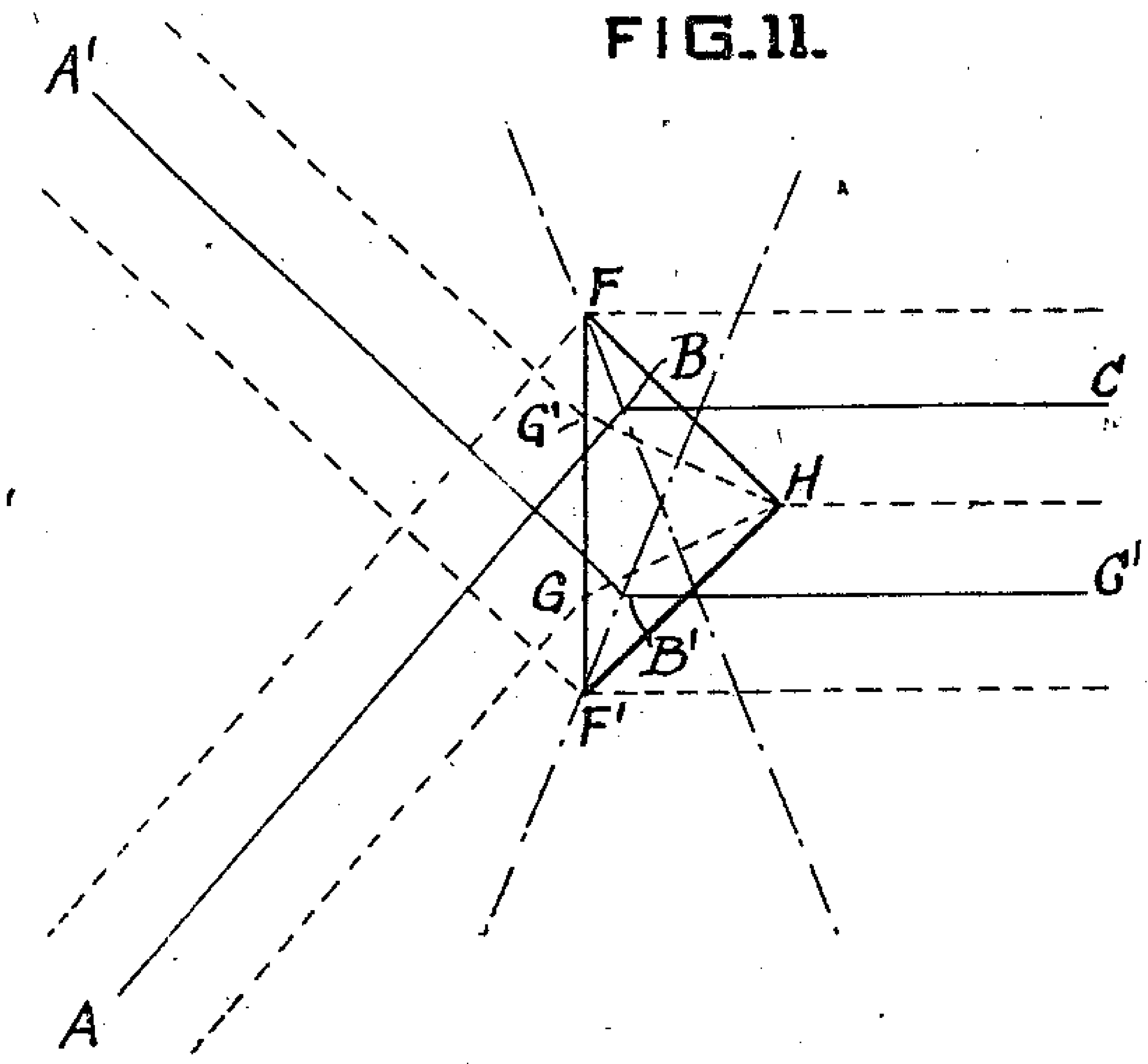
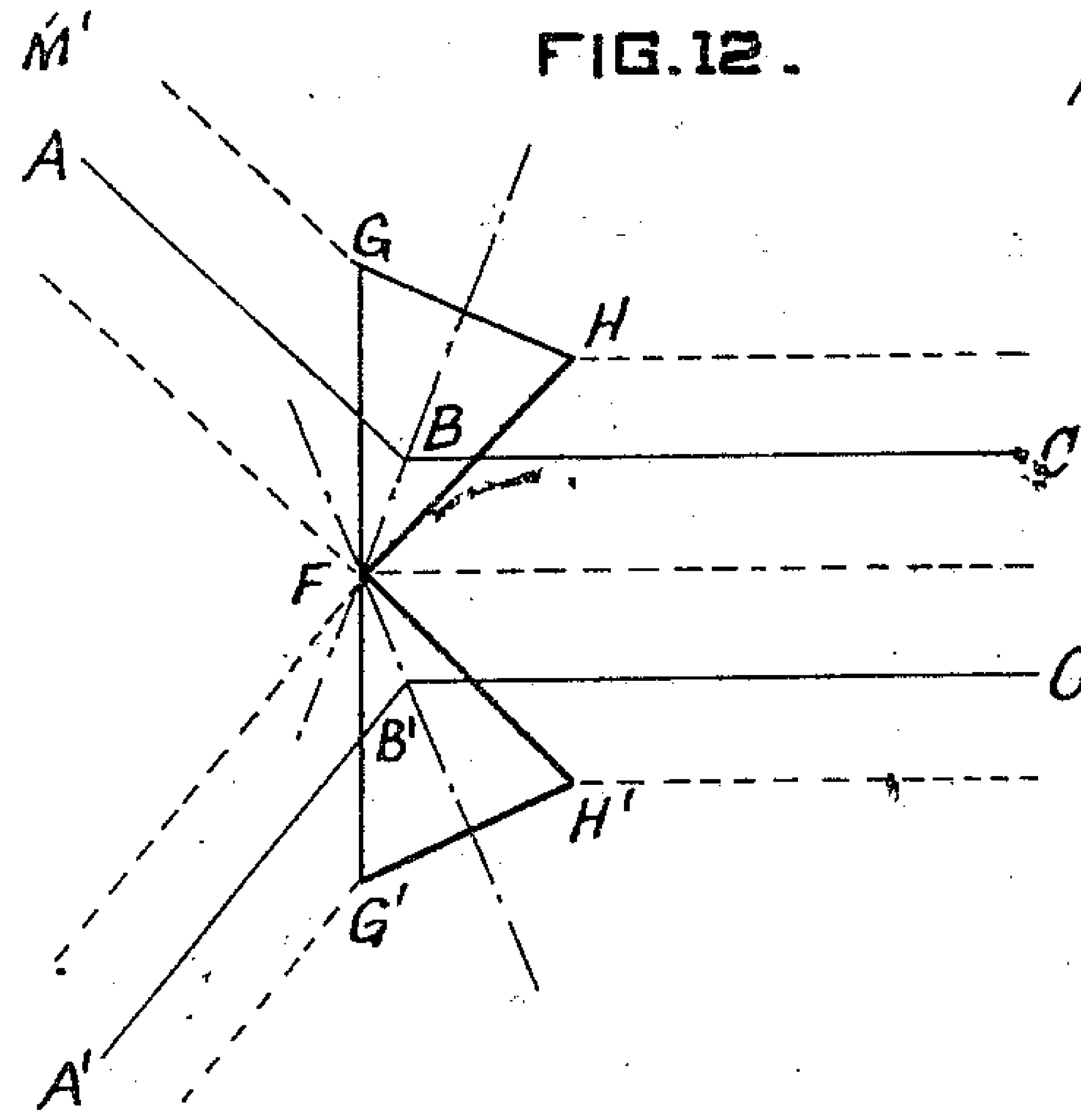


FIG.12.



WITNESSES
J. Herbert Bradley
Francis J. Tomasson

INVENTOR
Lowell W. Nicols
by Christy and Christy
his attorneys

UNITED STATES PATENT OFFICE.

LOWELL W. NICOLS, OF SEWICKLEY, PENNSYLVANIA, ASSIGNOR TO H. C. FRY GLASS COMPANY, OF ROCHESTER, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

LANTERN.

1,298,084. Specification of Letters Patent. Patented Mar. 25, 1919.

Application filed April 5, 1917. Serial No. 159,927.

To all whom it may concern:

Be it known that I, LOWELL W. NICOLS, residing at Sewickley, in the county of Allegheny and State of Pennsylvania, a citizen of the United States, have invented or discovered certain new and useful Improvements in Lanterns, of which improvements the following is a specification.

My invention relates to improvements in lanterns. The immediate object which I have in mind is to produce a light for the projection of motion pictures which shall be at once brilliant, steady, and economical to employ; but it will be understood, on reading the ensuing specification, that my improved lantern is widely applicable, where bright and concentrated light is desired: in spot-lights for theaters, for example, in lighthouses, and in many other specific uses.

Electric light is of all kinds of illumination the simplest and most satisfactory for the user to handle; and of electric lamps the two forms available for concentration are the arc lamp and the incandescent lamp. Until quite recently, the incandescent lamp has been so far inferior to the arc in intensity that it has scarcely been considered for such service as motion-picture projectors and spot-lights in theaters. Of late years, however, with the invention of filaments of new materials and the discovery of the good effects of maintaining the filament in an atmosphere of inert gas such as nitrogen, rather than in vacuum, the candle-power practically attainable in incandescent lamps has been vastly increased. The arc lamp has still one notable superiority over the incandescent, when it comes to projecting beams of intense light: the light emanates from a source of small dimensions—practically from a point—and may accordingly be focused and directed without serious difficulty; but the light-giving source in an incandescent lamp is very appreciably extended, it is of practically considerable dimensions, and the higher the power of the lamp the larger the source of light. When, therefore, one comes to deal with high-power incandescent lamps, the factor of the actual size of the light-emitting body becomes a matter of difficulty; the light cannot be focused and projected in sharply defined and properly confined pencils — at least, not easily. On the other hand, there are serious objections and difficulties attending the use of the arc lamp for purposes such as I have indicated. The nature of some of these objections and difficulties may be indicated: In a spot-light, for instance, it is desirable that substantially all the light emanated from the source be gathered and projected in a narrow pencil. To accomplish this a mirror must be provided, and this mirror must be placed near the source of light. But the arc gives off vapors, and these, condensing and solidifying on the mirror surface, corrode and dim it and diminish its effectiveness. The consequence is that a mirror with an arc light (if provided at all) is of relatively little value, and, economically considered, the lamp is very wasteful of light. Again, the arc light requires relatively great current strength, and is, on this account too, uneconomical. For motion-picture work the arc may not be produced by an alternating, but only by a direct, current; and at best it is noisy; the light flickers; and there is need for an attendant constantly. For another thing, the fire risk attendant on the use of an open arc is high.

By my invention I make the incandescent lamp available, avoiding the difficulties just mentioned, incident to the use of the arc lamp. In my use of the incandescent lamp, instead of building it of large size (with the attendant difficulty already noted), I multiply the number of small-sized lamps, until I gain the candle-power desired, and I provide means for bringing together into one common pencil the light emanating from all of them. Since the actual dimensions of the light-source of each small-sized lamp are small, and within limits practically permissible, I may focus and direct the pencils as I will, and unite them in a single shaft of light, which also is wholly within control for practical purposes.

In the accompanying drawings, Figure 1 shows in longitudinal section the essential parts of the lantern of my invention; Fig. 2 is an end elevation of the organization shown in Fig. 1; Fig. 3 shows in side elevation and in plan the light-deflecting member of Figs. 1 and 2; Fig. 4 is a view in longitudinal section of the essential parts of another lantern, embodying the fundamental invention which is present also in the lantern of Fig. 1, and embodying also refinements upon that fundamental invention. Figs. 5 and 6 are views in longitudinal section and in end elevation of the essential parts of still another lantern embodying my invention; and Fig. 7 is a view in longitudinal section of still another lantern. Fig. 8 shows in longitudinal section the essential parts of a lantern in which the light-deflecting member is modified in form; Fig. 9 is a like view of another lantern in which the peculiar ends attained in the lantern of Fig. 8 (as compared with those of Figs. 1, 4, and 7) are attained in another way. Figs. 10—12 show diagrammatically the theory of my invention, as it is embodied in the lanterns of Figs. 1, 4, and 7.

The essential element of the lantern of my invention is a member capable of changing the direction of a pencil of light without changing the degree of concentration of the light of which the pencil is composed. This essential element is constructed to so deal with a plurality of beams of light, directed upon it from different sources, and to turn into a common path or toward a common focus, or in a common direction, the light received in such a plurality of beams. My lantern includes, associated with such an essential element, a plurality of light sources. This essential element of my invention may be a refractor, or it may be a reflector.

Referring first to Figs. 1, 2, and 3, the refractor 1 is formed of glass or of other light-refracting material; it is, as will presently appear, essentially a prism member; and it is in this instance in shape a hexagonal pyramid. About it is arranged a plurality of light sources. In this instance these light sources are shown to consist of incandescent lamps (nitrogen lamps, for example) provided with parabolic reflectors, so that each light source projects a pencil of light made up of substantially parallel rays. These light sources correspond in number to the faces of the pyramidal refractor; and, it being in this case a hexagonal pyramid, there are six light sources, as indicated in Fig. 2. The light sources are grouped symmetrically around the refractor, in a plane perpendicular to the prolonged axis of the pyramid, each directly opposite one of the six sides of the pyramid (*cf.* Fig. 2), and they project their pencils of light angularly upon the base of the pyramid (*cf.* Fig. 1). The pyramid is indeed a compound prism, including as many prism elements as there are sides to the pyramid. The glass body bounded by and between the base of the pyramid and each one of its sides becomes a simple prism for the light which comes from that particular light source, which is arranged opposite the side under consideration; the basal angle of the pyramid is the refracting angle of the prism. The hexagonal prism might indeed be cut into six parts, and might consist literally (as in effect) of six prisms. But, by combining the six prisms in one pyramid, there is manifest gain, for the glass in the central portion of the pyramid is in its effect part, not of one only, but of all six prisms. The arrangement is such that the light projected from the several sources 2 in converging paths upon the base of the pyramidal refractor 1, passing through the refractor, is turned in direction, and emerges as a compound pencil. In such compound pencil, as will readily be understood, the components may overlap or be separate; preferably, they will come into immediate contact but will not greatly overlap; they may be directed to a common focus, or in a common direction. As indicated in Fig. 1 they are turned into parallel contiguous paths.

The variables in this problem of directing the rays are, first, the quality of the glass or other refracting medium employed; second, the refracting angle—that is the basal angle of the pyramid; and, third, the angle of incidence of the light upon the base of the pyramid. These factors may be varied to effect the desired end.

It will be seen that a lantern constructed after the manner now described delivers in a single pencil the light emanating from six sources. The actual dimensions of the several light-giving elements may be small, within permissible practical limits, whereas a single lamp of sufficient size to give the total illumination which my lantern affords would of necessity have a light-giving element of dimensions too great to be practical for my intended purposes. The total volume of light which my lantern projects is of course not six times the volume emanating from each source; some light is necessarily lost; but the total so obtainable is greater than can be obtained from any single source of this nature, in condition to be directed and employed for such ends as I have indicated.

In consequence of the arrangement of the several light sources in a group around the refractor, space is afforded for a number of lamps; their number may be increased indefinitely. I have said they are arranged in a common plane; and so they are, as they are shown in Figs. 1 and 2. But their arrangement in a common plane is a correlative of their being placed at equal distances from the refractor. The essential condition is that they shall be grouped around the refractor, directing their pencils from the proper quarter and at the proper angle upon the base of the refractor.

I have said above that, in the lantern as it is shown in Fig. 1, the light emerges from the refractor 1 in a compound pencil of parallel rays. If it be desired to change the condition in this regard of the emitted light, a lens may be interposed in its path. To such end I show in Fig. 1 as part of the lantern a condensing lens 3. The effect of such a lens will be to direct the light to a focus. Figs. 8 and 9 show alternative means of attaining this same end; in Fig. 8 the base of the refractor 1^a is made lenticular, and the light is brought, in the manner diagrammatically indicated, to a focus *f*; in Fig. 9 the refractor 1 is unchanged, but the light source 2^a includes a mirror which is ellipsoidal rather than parabolic; it emits a convergent pencil, and this is brought by the refractor 1 to a focus at *f*.

Chromatic aberration is a matter which must be taken into account. By selecting glass of proper quality this aberration may be so far diminished in amount as to be negligible; or, if conditions of service make such a course desirable, the refractor may be built up in well known manner of pieces of glass of different refractive power, and so rendered achromatic.

As shown in Fig. 4, the number of refracting elements may be multiplied. The refracting elements are placed in axial alinement. The second refractor, 1^e, of Fig. 4 is, it will be seen, effective at its periphery to refract the light cast upon it from the light sources grouped immediately about it, while the light emitted through refractor 1 passes freely and without refraction through the plane central portion of refractor 1^e. Refractor 1^e is pyramidal, but is in shape the frustum of a pyramid. Indeed the central portion of this refractor 1^e might be cut away—and with advantage, for of necessity it will absorb some of the light passing through. But the cost of manufacture will be less if it be made as shown. However, the prism portion might be built up in the form of a ring or a polygonal continuous band, leaving the central space free for the passage of light. Such a multiplication of refractors manifestly provides for indefinite increase in the number of light sources.

As shown in Figs. 5 and 6 the prism elements 1^f are arranged with their refracting angles directed inwardly toward the axis of the lantern as a whole, instead of in opposite arrangement; and two things, it will be observed, are consequent upon this: first, the prism elements become conveniently separate parts, and second, the paths of the pencils of light do not cross.

Fig. 7 shows a carrying forward of the multiple-unit idea of Fig. 4, so that an indefinite number of units may be combined in tandem arrangement, while the whole is kept within reasonable and practicable dimensions. Here is involved, in addition to what is shown in Fig. 4, means for concentrating the compound pencil, as it passes from each unit in turn, and for causing the concentrated pencil to travel in parallel rays through the central part of the next succeeding unit. The first unit 1 (beginning at the left) is the unit of Fig. 1, and requires no further description. The light which it projects will be understood to be a pencil of parallel rays. The succeeding refracting elements may be such elements as 1^e of Fig. 4; so that, beyond the element 1^e, the twice compounded beam of light advances in parallel rays. But the beam is larger, of greater cross-sectional area, than the beam advancing from the first unit. In the path of this beam, beyond the element 1^e, is arranged a condensing lens 3. This lens 3, receiving the beam of parallel rays, causes the rays to converge. And then in turn, beyond lens 3, is arranged the lens 4 which, receiving the convergent pencil of light from lens 3, turns the rays divergently again, and causes the light to advance in a beam of parallel rays. But the beam is now of diminished size (though of increased concentration). It follows that the next ensuing unit need not be of the large size otherwise necessary. Ordinarily the arrangement and power of the parts thus far described will be such that the successive refracting units (excepting the first, if desired) will be duplicates. Fig. 7 shows also that, instead of the refracting unit 1^b combined with the condensing lens 3, each of these succeeding units may be such as shown at 1^g having a lenticular base. The condensing lens 3 may thus be rendered unnecessary, and may be omitted. I believe this building up of units in tandem and in indefinite number to be particularly applicable in such use as lanterns in lighthouses.

The theory underlying my invention, so far as concerns a refractor for changing the direction of the light, will be well understood on considering the diagrams, Figs. 10, 11 and 12. Consider first Fig. 10. Suppose a pencil of light composed of parallel rays to be traveling in the direction A B, from A to B, and the line A B to be the axis of the pencil; and suppose the object in view be to turn the pencil, and to cause it to travel in the direction and on the axis B—C. The medium is air and the refracting body which is to effect the turning is glass. This refracting body then will be a prism; and since, given such conditions as have been stated, refraction both of the entering and of the emerging ray will be toward the base of the prism, the arrangement will be that indicated in Fig. 10, the prism F G H being so disposed that the base G H lies on the side of the broken line A B C toward which refraction is to occur, and the summit F on the opposite side. The degree of the refracting angle G F H determines, of course, the degree of refraction. For simplicity of illustration the prism F G H is shown to be an isosceles triangle, symmetrically placed, precisely on the line D E which bisects the angle A B C. Let it then be supposed that a ray traveling in the direction A—B falls full upon the face F G of the prism. It will be refracted and be emitted from the face F H as a ray advancing in the direction B—C. This is indicated in dotted lines in Fig. 10; the pencil M—F, M′—G makes incidence on the face F G, and it is emitted from the face F H in the pencil F—N, H—N′.

The problem is to combine the pencils emitted from two light sources and to cause them to advance together in parallel rays, either side by side or overlapping (so to speak) and merged the one into the other.

Fig. 11 shows two light sources, A and A′ and two light paths with axes A B and A′ B′. The two ideal prisms F G H of Fig. 13 may be overlapped (as it were) as indicated in Fig. 11 and combined in a single refracting member F F′ H (which is the refracting member 1 of Fig. 1), or they may be separate prisms, or separate parts of a prism body, as indicated in Fig. 12. If they be arranged summit to summit the paths of light will not cross (*cf.* Fig. 5); but if they be arranged base to base, the paths of light will cross, and this is the state of the case in Figs. 1, 4, and 7. It will be observed that in all cases the several pencils initially directed to converge are turned, so that the degree of convergence is diminished, and, in the particular instance chosen for illustration, is actually reduced to zero—the refracted rays advancing in parallel lines.

I claim as my invention:

1. In a lantern, the combination of a plurality of light sources, a pyramidal prism having a base and a plurality of faces corresponding in number to the number of light sources, and means for projecting pencils of light from each source through the base and one side of the prism, the angles of incidence of the pencils of light from said several sources upon the base being acute, and the angle of refraction of all the pencils leaving the prism being substantially perpendicular to the base thereof.

2. In a lantern, the combination of a succession of light refractors, and a plurality of light sources for each refractor, the light sources for each refractor being arranged around it and projecting light convergently upon it, and the whole arranged to project in a common direction the light emanating from the several sources.

3. In a lantern the combination of a plurality of groups of light-giving units, the units of each group being arranged to project pencils of light in convergent paths, a light-directing element for each group, such element being arranged athwart the paths of light emanating from said light-giving units of the group and adapted without changing the degree of concentration of the light received, to change the direction of advance and to cause the light received from all the associated units to advance in a common direction, the several groups being alined, and a light-condensing element arranged between successive units.

In testimony whereof I have hereunto set my hand.

LOWELL W. NICOLS.

Witnesses:

BAYARD H. CHRISTY,

FRANCIS J. TOMASSON.