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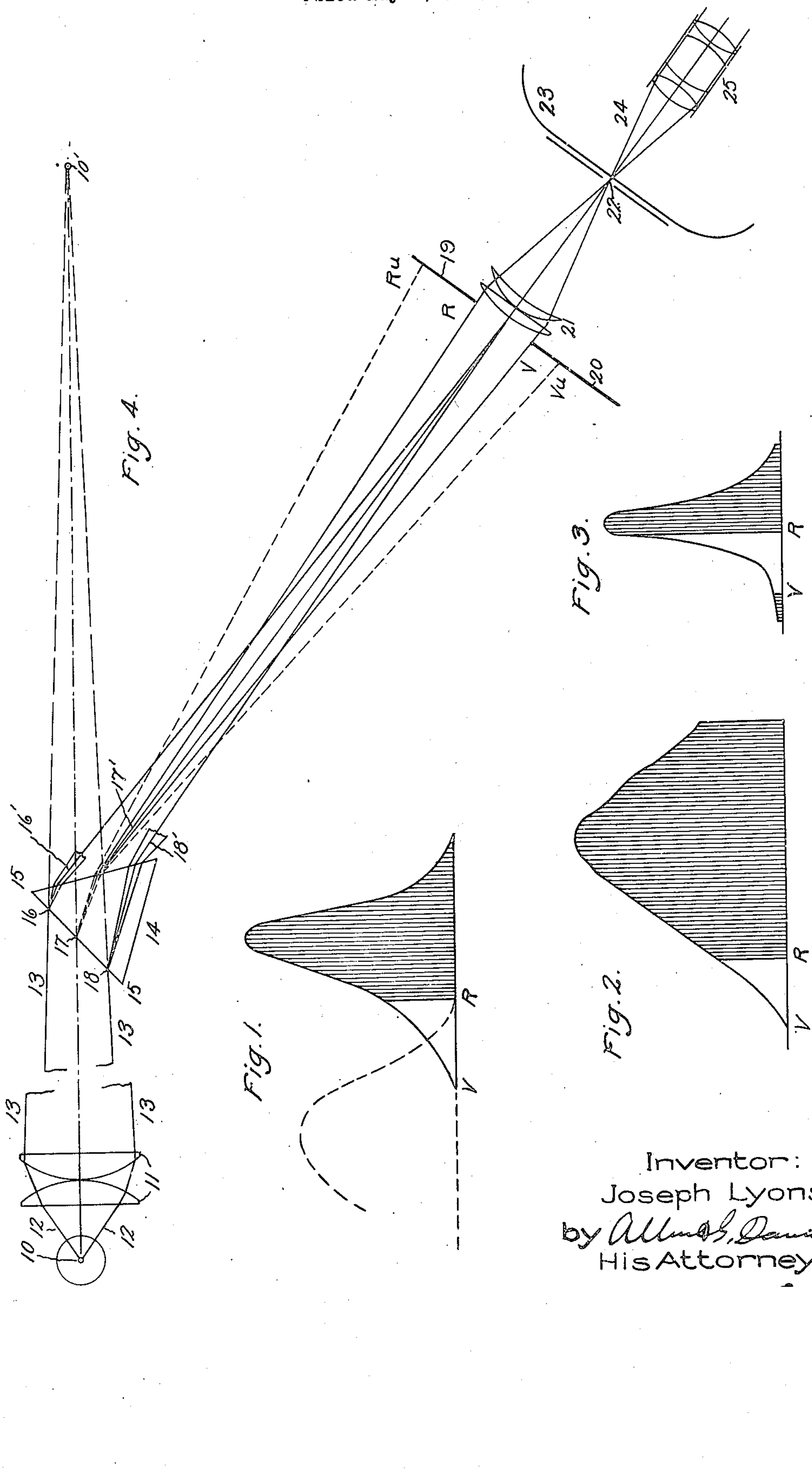
METHOD AND APPARATUS FOR PRODUCING COOL LIGHT

Filed May 5, 1922 2 Sheets-Sheet 1



Inventor:
Joseph Lyons,
by Allen G. Davis
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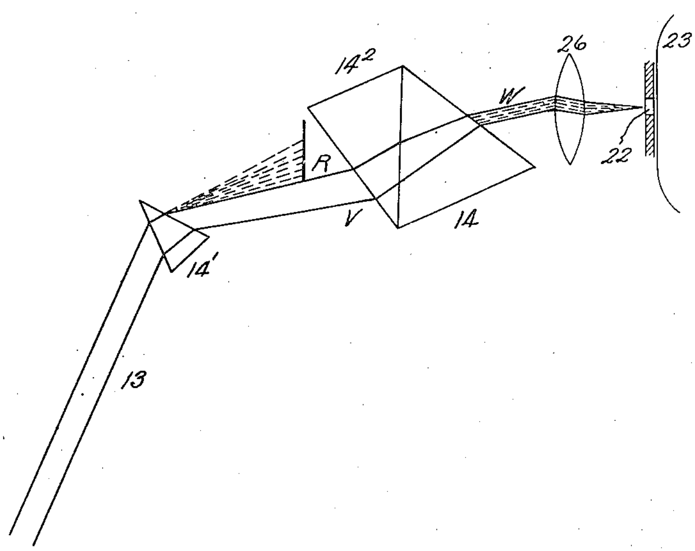
Fig. 5.



Inventor:
Joseph Lyons,
by Albert G. Davis
His Attorney.

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UNITED STATES PATENT OFFICE.

JOSEPH LYONS, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

METHOD AND APPARATUS FOR PRODUCING COOL LIGHT.

Application filed May 5, 1922. Serial No. 558,601.

To all whom it may concern:

Be it known that I, Joseph Lyons, a citizen of the United States, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Methods and Apparatus for Producing Cool Light, of which the following is a specification.

My invention relates to the production of beams of light primarily derived from artificial sources of any multichromatic and especially substantially white light, that shall be free of the invisible infra red heat rays and, if so desired, also of the invisible, highly actinic ultra violet rays. The elimination of these rays is, in accordance with my invention, effected by intercepting these rays or by diverting them from the course of the original beam into directions where they can do no harm, the object of the invention being to obtain comparatively cool light, or light that is not markedly actinic, or light that is neither hot nor markedly actinic. A beam of light thus deprived of its dark heat rays is especially useful in connection with motion picture apparatus where hot rays have been found to be sources of danger to the inflammable picture film, and beams deprived of the greater part of its actinic rays may be directed without harm to exposed parts of persons as in medical examinations or surgical operations, or to delicate organic objects in microscopy.

In accordance with my invention a beam from an ordinary source of substantially white light is first resolved into its elementary constituent rays by dispersion into a spectrum; the invisible parts of the spectrum are then either intercepted or are diverted from the course of the visible rays, and the latter are then recombined to substantially white light. The white light thus obtained would still contain an inconsiderable amount of heat rays, and if so desired, these may be eliminated by their absorption by certain transparent media; but this additional purification is ordinarily not necessary and forms no part of my present invention.

The practicability of the process thus broadly indicated is due to the fact that in the pure spectrum of any multichromatic beam of light derived from an artificial source the visible part is sharply defined and recognized without effort and is thus clearly marked off from the infra red and the ultra violet portions. In the case of sunlight the spatial separation of the invisible from the visible rays of the spectrum is not quite so well defined, but it is still sufficiently defined for the practice of my invention with a certain degree of utility.

In the following detail description reference is had to the accompanying drawing, in which, Fig. 1 is a diagram showing the distribution of rays in the spectrum of a beam from a carbon arc; Fig. 2 is a similar diagram of distribution of rays in the spectrum of incandescent metal; Fig. 3 is a similar diagram of the spectrum of a unifilament incandescent lamp; Fig. 4 is a diagram of one arrangement of apparatus for the practice of my invention; and Fig. 5 is a diagram of another arrangement of apparatus for the same purpose.

In order to convey an approximate appreciation of the practical utility of my invention, the distribution of the luminous and dark rays in the spectra of beams from different sources of artificial light should be noted. In Fig. 1, the solid line abscissa marks the width of the explored portion of the spectrum of a beam from the crater of a carbon arc, while the ordinates mark the heat energy observed at the various points. From the violet margin V the heat energy increases toward and beyond the red margin R. The space between V and R is the region of the visible rays, which in the drawing is not shaded, while the shaded space to the right of R is the region of the infra red, invisible rays. A glance at this figure of drawing conveys an idea of the extent to which a beam of light is cooled if the infra red rays are diverted from the same. The curve in dotted lines is intended to convey an idea of the distribution of actinity in this spectrum; it is not based upon accurate measurements and is therefore only a rough approximation. It is, however, well known that from the red end of the spectrum, where the actinity is practically zero, the chemical energy increases toward and far beyond the violet end; and this only is intended to be conveyed by the dotted curve.

The curve shown in Fig. 2, shows the distribution of heat energy in the spectrum of a beam from incandescent platinum, and it is clear that in this case the infra red heat energy is vastly greater than that of the visible part of the spectrum.

It must be observed, however, that the heat energy curves of Figs. 1 and 2 are based upon explorations of practically pure spectra, that is to say, of spectra obtained from very small beams issuing through narrow slits, such as are habitually used by physicists in the laboratory and which would be of little practical value. In practice we have to deal with and must use beams of considerable illuminating power and in such case the spectrum obtained is compounded by a great number of pure spectra, which more or less overlap, so that the spatial separation of the visible and invisible rays is not as sharply marked as in the case of the pure spectrum and the preponderance of heat energy of the ultimate infra red region is not as great as in Figs. 1 and 2. But when a powerful source of light of the smallest practicable expanse is used, there results a spectrum, which, although still compounded, shows a large preponderance of heat in the infra red region, which, in accordance with my invention can be eliminated and the beam cooled to a remarkable and highly useful degree.

In Fig. 3, the heat energy distribution of such spectrum is indicated. The source of light in this case was a single, coiled filament incandescent lamp and the heat energy of the infra red region was found to be about 70 per cent of the total energy. The elimination of 70 per cent of heat from a beam of light used in motion picture projection effectively prevents the ignition and combustion of the ordinary picture film used in apparatus of this kind. Moreover, it is quite practicable to use an incandescent lamp with a single filament of smaller cross section and consuming more energy than the lamp which gave the energy distribution shown in Fig. 3, and thus a purer spectrum and consequently a higher percentage of eliminated invisible heat rays is obtained in accordance with my invention. Other, more powerful sources of artificial light, such as the luminous craters of arc lamps and especially of the high intensity arc lamps of the Beck system, which can be made very small, are also available.

Referring now to Fig. 4, a concentrated light source 10 of a suitable kind is shown as located a short distance beyond the focus of a system of condensing lenses 11. The rays 12 from the source are, with this arrangement, converged in the region to the right of the lens system, as indicated at 13, and if the beam passed unobstructed into the field, the image of the source would be produced at 10′. If the source of light were placed at the focus of the lens system, the rays 13 would be practically parallel and theoretically this would give the best results, but for practical reasons the rays 13, 13 are allowed to converge moderately, as indicated in Fig. 4.

In the path of the rays 13, 13 is located a prism 14, which is here shown as a 60 degree prism which should have a high index of refraction. This prism should be of a size to intercept the whole beam 13, 13, and in order to allow the use of a moderately small prism, the rays of this beam are made converging; this is the practical reason for locating the light source beyond the focal distance of the lens system.

By the prism 14 each ray 13 of the composite light incident upon its surface 15, 15 is by refraction dispersed and is thus resolved into a spectrum. For the sake of simplicity of illustration only three such composite rays are here shown, incident respectively at the points 16, 17, 18 and yielding respectively the spectra 16′, 17′ 18′. Only the marginal and the central visible, elementary rays of the spectra 16′ and 18′ are indicated in the drawing, to avoid complexity, but of the spectrum 17′ the visible marginal rays V, R as well as the central ray are indicated in solid lines, while the outer limits of the invisible ultra violet rays V_u and of the infra red rays R_i are indicated by dotted lines. These spectra partly overlap, but their combination results in a somewhat impure single spectrum extending laterally approximately between V_u and R_i; the visible part being between V and R and the invisible parts between V and V_u on one side (the ultra violet) and between R and R_i on the other side. A spectrum of this kind yielded the energy distribution curve of Fig. 3.

At a suitable distance from the prism 14, a screen 19 is placed in the path of the infra red rays; the inner edge of which is located at the edge of the visible red rays, or may slightly pass into the field of these rays. This screen must be an opaque body and may have a reflecting surface, whereby the infra red rays are either absorbed or are reflected out of the path of the visible rays. A like screen 20 is placed in the path of the ultra violet rays, if desired.

The visible part of the spectrum is intercepted by an optical element or elements by which its elementary rays are recombined to furnish the same kind of a multi-chromatic beam as issued from the original source, usually white light. In Fig. 4 this restoring means is shown as a system of condensing lenses 21, which gather the visible part of the spectrum and concentrate the same at the aperture 22 of a motion picture apparatus and upon the picture film 23. In this manner the picture film receives substantially white light deprived of the greater part of the heat rays which it originally carried; if the screen 20 is used, the light striking the film is also deprived of the greater part of the original actinic rays. In this manner the picture film becomes a secondary source of light, and the beam 24 issuing from the same is gathered by the lens system 25 which is or may be of the kind ordinarily employed in motion picture projection apparatus and which throws the image of the aperture and of the film picture upon a more or less distant screen; the arrangement of the screen is not shown in the drawing, since it would be of the ordinary well known kind and forms no part of my invention.

In Fig. 5 a specifically different arrangement of apparatus is shown for carrying my invention into effect. In this case the original source of light is understood to be located in the focus of a condensing lens or system of condensing lenses which renders the rays 13 of the outgoing beam parallel. This beam is intercepted by the prism 14′ which has by preference a smaller refracting angle than the prism 14 shown in Fig. 4, whereby the spectrum issuing from the same attains a smaller spread, so that the violet and red marginal rays V and R become more nearly parallel. The infra red rays are intercepted by the screen 19, as shown and the ultra violet rays may, if desired, be likewise intercepted. The visible part of the spectrum (between V and R) is in this case intercepted by an achromatic prism system composed of 60 degree prism 14^1 of crown glass and a 35 degree prism 14^2 of flint glass. Such combination is well known in the art, but the refracting angles of these prisms would not necessarily be 60 degrees and 35 degrees respectively, since the suitable refracting angles of the two prisms depends upon the indexes of refraction of the two kinds of glass employed. The path of the marginal rays of the visible spectrum through the achromatic prism system is indicated in the drawing; the multichromatic rays are combined by the prism system and the light issues as a substantially white beam W, which by a condensing lens 26 is concentrated at the aperture 22 and upon the picture film 23.

It should be understood that other optical elements than those shown by way of example in Figs. 4 and 5 may be employed for the practice of my invention, without departing from the essence thereof.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. The method of illuminating a circumscribed region practically without heating the same, which consists in resolving an ordinary beam of light into an assemblage of its elementary constituent rays, diverting the dark heat rays from the assemblage and recombining the remaining rays in the region of illumination.

2. The method of cool illumination, which consists in producing the spectrum of an ordinary beam of light, diverting the infra red rays from the spectrum, and recombining the remaining rays at the region to be illuminated.

3. The mehtod of cool illumination, which consists in subjecting an ordinary, hot, polychromatic beam of light to dispersion, gathering the dispersed rays to the exclusion of the infra red rays, and recombining the gathered rays at the desired region of illumination.

4. The method of cool illumination derived from an ordinary, hot, polychromatic beam of light, which consists in projecting the spectrum of the beam into space in a desired direction, intercepting the progress of the infra red rays at a desired point and recombining the remaining rays at a desired region of illumination.

5. The method of cool illumination derived from an ordinary, hot, polychromatic beam of light, which consists in projecting the spectrum of the beam into space in a desired direction, intercepting the progress of the infra red rays at a desired point and reflecting them from the paths of the remaining rays, and recombining the remaining rays at a desired region of illumination.

6. The process of converting hot, polychromatic light flux into cool light of substantially the same polychromatic composition, which consists in resolving the hot flux into its elementary constituent rays, diverting the dark heat rays from the flux and recombining the remaining rays.

7. The process of converting hot, polychromatic, actinic light flux into cool light of reduced actinity, which consists in projecting the original flux as a spectrum in a desired direction, diverting the infra red and ultra violet rays from the path of the visible rays, and recombining the latter.

8. A light transforming apparatus comprising a source of polychromatic light, a dispersing prism, means for directing a beam of light from the source upon the prism, a shield or shields for intercepting the invisible rays from the spectrum issuing from the prism, and means for recombining the dispersed visible rays to a beam of polychromatic light at a desired region of illumination.

In witness whereof, I have hereunto set my hand this first day of May 1922.

JOSEPH LYONS.