T. FUJITA.
UNIVERSAL PHOTOMETER.
APPLICATION FILED FEB. 1, 1909.

961,852. **Patented June 21, 1910.**

2 SHEETS—SHEET 1.

Fig. 1.

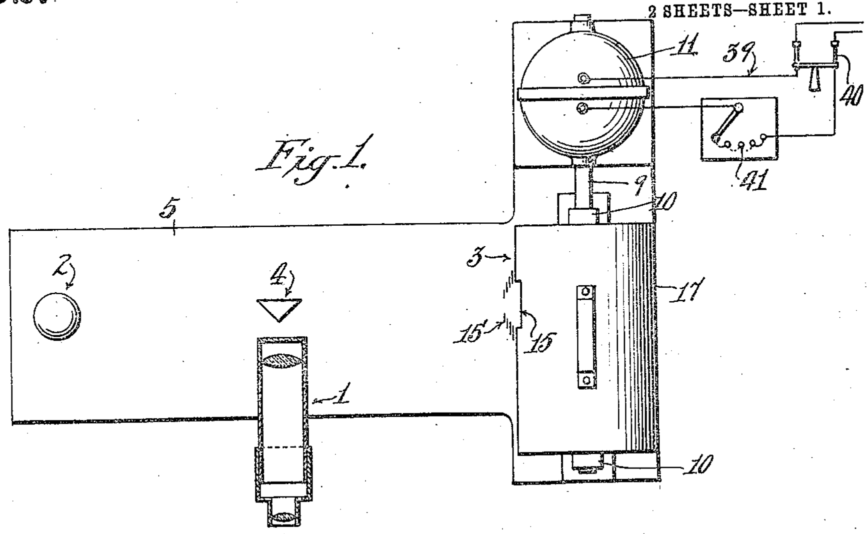


Fig. 2.

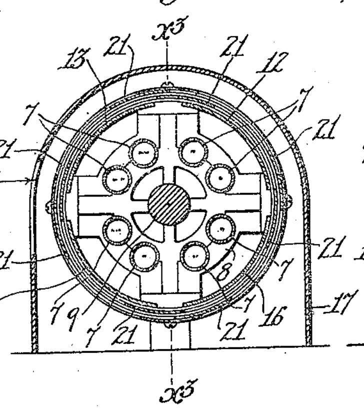


Fig. 3.

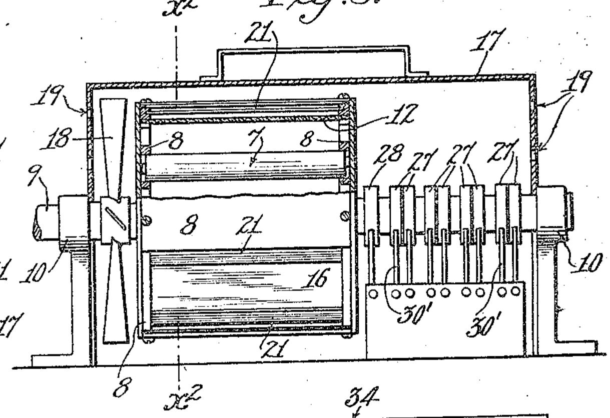
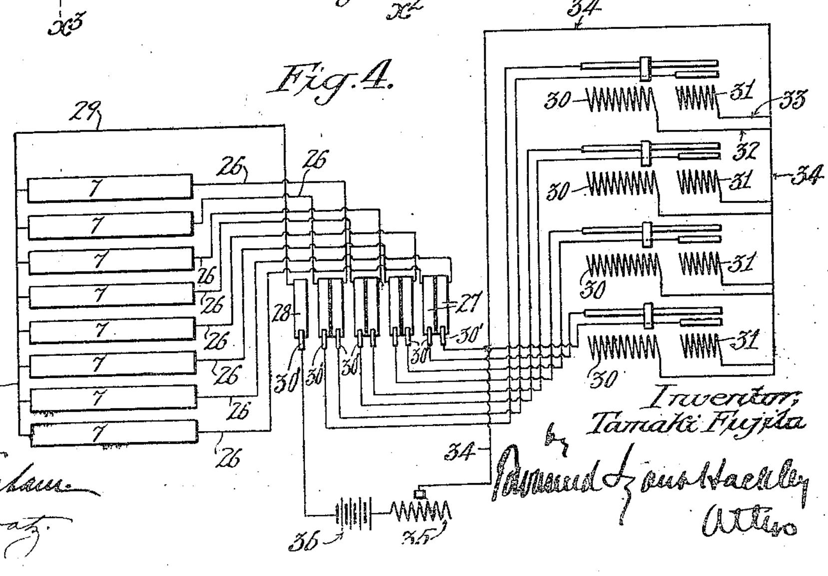


Fig. 4.



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2 SHEETS—SHEET 2.

Fig. 5.

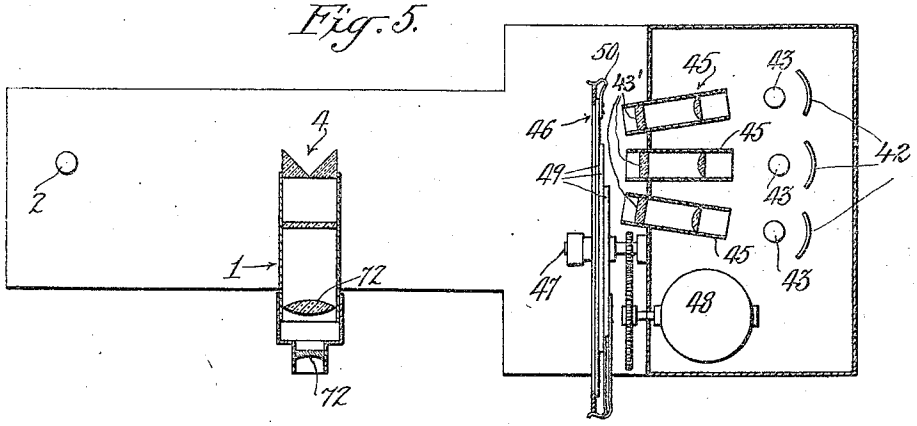


Fig. 6.

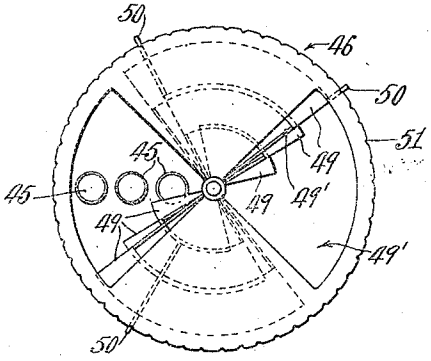


Fig. 9.

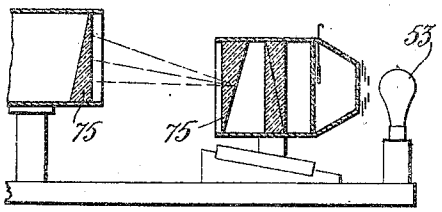


Fig. 10.

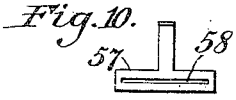


Fig. 7.

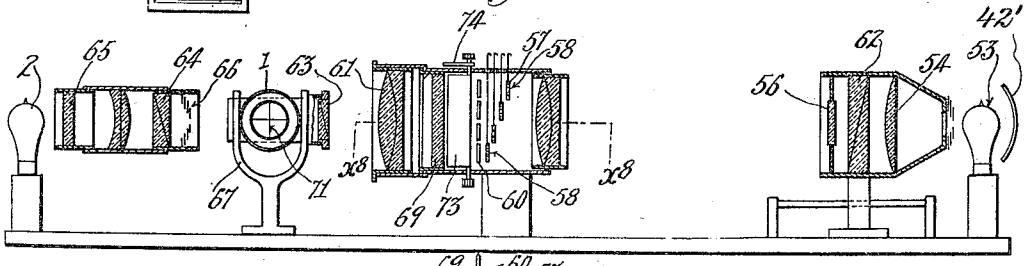
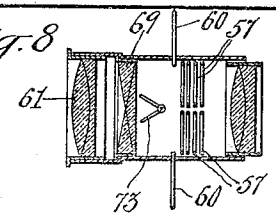


Fig. 8.



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UNITED STATES PATENT OFFICE.

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UNIVERSAL PHOTOMETER.

961,852. Specification of Letters Patent. Patented June 21, 1910.

Application filed February 1, 1909. Serial No. 475,508.

To all whom it may concern:

Be it known that I, TAMAKI FUJITA, a subject of the Emperor of Japan, and residing at Los Angeles, in the county of Los Angeles and State of California, have invented a new and useful Universal Photometer, of which the following is a specification.

This invention relates to photometric devices and its main object is to provide a photometer by which the relative color intensity of any light or source of illumination can be gaged as well as the absolute intensity thereof, with respect to a predetermined standard.

Other objects of the invention will appear hereinafter.

The accompanying drawings illustrate the invention.

Figure 1 is a plan of the apparatus. Fig. 2 is a vertical section on the line x^2—x^2 in Fig. 3. Fig. 3 is a longitudinal section on the line x^3—x^3 Fig. 2. Fig. 4 is a diagram of the circuit connections. Fig. 5 is a plan of another form of the invention. Fig. 6 is an elevation of the rotating shutter of Fig. 5. Fig. 7 is a vertical section of another form of the invention. Fig. 8 is a section on line x^8—x^8 of Fig. 7. Fig. 9 is a partial section of another form of the invention. Fig. 10 is a face view of one of the light obstructing plates shown in Fig. 7.

The apparatus comprises a comparator 1 of any usual or suitable construction, means for supporting at a standard distance therefrom a lamp 2 or other luminous source whose intensity is to be measured, and a device 3 for producing a comparative illumination whose intensity and color may be varied at will, the comparator consisting of a telescope, a reflector 4 being provided whereby the illumination from the source 2 and the measuring source 3 are both directed into the comparator 1 for comparative inspection. The above named parts may be mounted on a base 5.

The means 3 for producing the regulable illumination comprises a plurality of sets of electric lamps 7 carried by a cage or frame 8 fastened to a horizontal shaft 9 to rotate on a horizontal axis, said shaft being journaled in bearings 10 and operated by a suitable driving means, such as electric motor 11, by which the cage 8 and the lamps 7 carried thereby can be revolved at any desired speed. Said cage may carry at the outside of the circular series of lamps 7, screens 12, 13, 14, and 16 of glass or other transparent material, said screens being mounted for example on the cage concentrically with the axis of the cage. A case 17 incloses the cage and devices carried thereby, said case being of opaque material and having a window 15 with suitable means of regulating and measuring its area provided, say, by an iris diaphragm 15′ at one side, so that the light from the lamps within the cage passing through this window may fall on the reflector 4 and be directed thereby into the comparator.

18 designates the ventilating means consisting of a fan fastened on the shaft 9 and adapted to blow a current of air through the cage, the ends of the casing 17 being perforated as shown at 19 to allow such ventilation. The series of lamps or illuminating devices 7 should comprise at least three sets, one set for each of the three primary colors, the colors being selected as crimson, yellow and blue, or red, green and violet, according to requirements. The differentiation of the sets may be effected by either the color of the lamps or by means of the screens 12, etc. In the form shown where there are four screens, one screen 12 may be crimson, another screen 13 may be yellow, and a third screen 14 may be blue. Means are also preferably provided for producing white light for diluting or tinting the colored light produced by the several sets, aforesaid. Such means consist of lamps 7 with a plain or uncolored glass 16 in another quadrant of the cage, this blank glass being put in for mechanical balance.

Adjustable shutters 21 are provided in each of the quadrants for the respective sets of lamps to cut off more or less of the light from such set so as to control or vary the amount of light of each color.

Means are provided for causing any one or more of any one or plurality of the sets of lamps or illuminating devices to be energized or illuminated with any desired intensity, such means consisting, for example, of the electric circuits shown in Fig. 4. Each of the lamps 7 is connected at one end by a wire 26 with one of a plurality of collector rings 27. An additional collector ring 28 is provided connected by the wire 29 to the further end of all of said lamps. Brushes 30′ bear on said collector rings 27 and are connected to regulating or rheostatic

devices. In the present case two lamps are shown in each set and each set of rheostatic devices comprises two resistances 30, 31, connected by wires 32, 33, to a common return wire 34 leading to a rheostatic device 35 and to one side of a battery 36, the other side of the battery being connected to the brush for collector ring 28. An electric operating circuit 39 is provided for the motor 11 and includes a switch 40 and a rheostat 41 for controlling the operation of the motor.

The operation is as follows: The lamp or source of light to be tested is placed at 2 or by other suitable means the light from any source is directed onto one side of the comparator 4, the shutters 21 having been adjusted to provide for proper ratio of brightness of the lamps, for example, by previous calibration, the motor 11 is set in operation at such speed that the several sets of lamps will pass the window 15 in rapid succession, preferably at a rate greater than 16 revolutions or complete cyclic changes of color per second so that at the comparator the successive flashes produced by the several sets of lamps will appear as a single continuous color sensation. By means of the several switches or rheostatic devices 30, 31, 35, the total intensity of illumination and the comparative or relative intensity of the composing colors are varied or adjusted until the ray delivered by the light generator appears to be identical in intensity and color with the light from the source 2 to be tested. The reading is then taken according to the position of the several rheostatic devices and according to a table as determined by the previous calibration of the apparatus and thus the color and intensity of the source can be referred to any given standard of illumination.

Figs. 5 and 6 show a form of the invention wherein the light for comparison is produced by fixed sources or lamps 43 which are electric lamps whose intensity is controlled and regulated by means of the above operating circuits and rheostats, as above described, said lamps being made to produce light of different colors as by providing colored bulbs therefor or by providing colored screens or glass plates 43′ in the path of the light from said lamps, and means are provided for directing the light from all of said sources into the comparator 1 for comparison with the lamp or source 2 to be tested said means consisting of a condensing lens or device 45 and reflectors 42 for each lamp for focusing the parallel ray or beam from each lamp 43, said devices 45 being provided with the colored screens 43′ aforesaid, the several beams passing across the plane of a rotary intercepting device 46 at different distances from the center thereof. Said rotary intercepting device is mounted on a shaft 47 driven by a motor 48 and provided with a plurality of shutters 49 which are relatively adjustable on said shaft as by means of spring arms or catches 50 connected to said shutters and engaging in notches in a rim 51 connected to one of said shutters, so that all of said shutters may be brought to register or they may be caused to cover more or less completely the radial space through which the beam of only one lamp 43 is directed, the several shutters 49 being cut away, as at 49′, to provide for passage of light at the different radial zones according to the angular adjustment of the shutters. The device is used as with the form above described, the shutters 49 being adjusted in calibration and the testing being performed by adjustment of the rheostatic devices. In the present case, however, there being only three lamps for, say, three primary colors, the testing for tint or the mixture of white light is performed by composition of the primary colors only.

It is not essential to the invention that a rotary or mechanically operated intermittent cut-off be provided for the light. Thus, as shown in Fig. 7 the source of light 53 is caused by means of the condensing lens 54 and reflector 42′ to direct a beam or ray of light on a diffraction grating 56, producing a spectrum which is intercepted by plates 57 provided with slits 58, whereby segments of illumination may be selected from the different parts of the spectrum corresponding to, say, three primary colors, said plates 57 being adjustable to control accurately the color selected. Regulating shutters 60 are provided which are movable to control the amount of light passing at each slit 58, and a focusing lens 61 serves to superpose the rays of light passing through the several slits onto the comparator 1. A set of Nicol prisms may be provided, the polarizer 62 being between the source 53 and the diffraction grating, and the analyzer 63 being provided at the comparator, the former member of said set being fixed to send the light in a given plane of the oscillations and the latter member being rotatable to regulate for the total intensity. A rotatable polarizer 64 may also be provided in the path of the rays from the source 2 to be measured, to determine the plane of polarization of such rays. An iris diaphragm 66 may also be provided for regulating the intensity of the light received from such source.

The comparator 1 is provided with the necessary means for adjustment and is preferably revolubly mounted in a frame 67, as shown in Fig. 7, so that the comparator may be revolved to any angle found most convenient.

Cross hairs, indicated at 71, are provided in the comparator between the reflecting prisms and the eye piece lenses. The eye piece lenses are indicated at 72 in Fig. 5, which also shows a preferred construction

of the reflecting prisms of the comparator, said prisms being adapted to reflect the light by internal reflection. The light receiving surface of said prisms may be frosted or plain according to the method of operation desired.

By using quartz for the bulbs, screens, prisms and lenses in place of glass I am enabled to provide for using differential combinations of the ultra-violet rays. The device may also be used to produce interference of two or more ultra-violet rays to produce the visible images corresponding to the difference of vibrations of the component rays on a translucent screen or on the plane of the cross hairs of the comparator microscope, for comparing the result with an image in the same plane, of properly blended standard colored rays. The means for simultaneously varying the intensity of the several colored rays selected regulates the proportion of the constituent rays in such a way that the proportionate variations in intensity of the respective constituent rays are inversely proportionate to the intensities themselves.

When arranged as shown in Fig. 7, the diffraction grating will produce two spectra, respectively, above and below the center line with a white band in the middle. Two sets of slit adjusting and shutter devices are provided for these two spectra, and the selected components are superposed at the comparator by the condensing lens or equivalent device.

The shutters may be duplicated at each side as shown in Fig. 8 so that by different adjustments at the two sides, two beams of different colors may be selected from the same spectra and may be thrown on the comparator as separate images by a panchromatic prism 69, for purposes of comparison. Hinged shutters 73 may be provided having pointers 74 to indicate their angular position, said shutters extending over the range of the spectrum to harmonically control the intensities of all selected colors simultaneously, these shutters being arranged at the mid line of the instrument and cutting off the light by spreading outwardly, and being regulated independently of each other.

Instead of the diffraction grating the spectrum may be produced by means of a set of refracting prisms 75 indicated in Fig. 9.

Rock salt, alum; or any other suitable optical substances can be used instead of glass or quartz for screens, prisms, lenses, and grating.

Any reflecting polarizers can be substituted for the Nicols, and a reflecting grating for the transmitting one as usual.

A fluorescent screen 65, say of zinc sulfid, may be provided at the source 2 for measuring or ascertaining any X-rays or other rays capable of producing fluorescence on such a screen.

What I claim is:

1. In a photometric apparatus, means for producing rays of light of different color, means for separately and independently varying the amount of the differently colored rays, and means for directing the differently colored rays of light onto a comparator producing the effect of a blended light for comparison with light from another source.

2. A photometric apparatus comprising means for producing differently colored rays of light, means for independently adjusting the amount of such differently colored rays of light, a comparator, and means for directing upon said comparator the differently colored rays of light to produce at the comparator the usual effect of a light composed of such different rays.

3. A photometric apparatus comprising means for producing differently colored rays of light, means for independently varying the amount of such differently colored rays of light, means for simultaneously varying the intensity of all of such differently colored rays of light, a comparator, and means for directing the differently colored rays of light onto the comparator to produce at the comparator the blended effect of said rays.

4. A photometric apparatus comprising means for producing differently colored rays of light, means for independently varying the amount of such differently colored rays of light, means for producing white light, means for varying the intensity of such white light, a comparator, and means for directing onto the comparator the differently colored and white lights, as above set forth.

5. In a photometric apparatus, means for producing rays of light of different color, intercepting means for cutting off a variable portion of the light of each color, and means for directing said rays onto a comparator to blend the effects of the differently colored rays of light for production of the effect of a composite light for the purpose stated.

In testimony whereof, I have hereunto set my hand at Los Angeles, California, this 26th day of January, 1909.

TAMAKI FUJITA.

In presence of—
ARTHUR P. KNIGHT,
FRANK L. A. GRAHAM.