No. 894,654. PATENTED JULY 28, 1908.

F. E. IVES.

COLOR METER.

APPLICATION FILED OCT. 22, 1907.

2 SHEETS—SHEET 1.

Fig. 1.

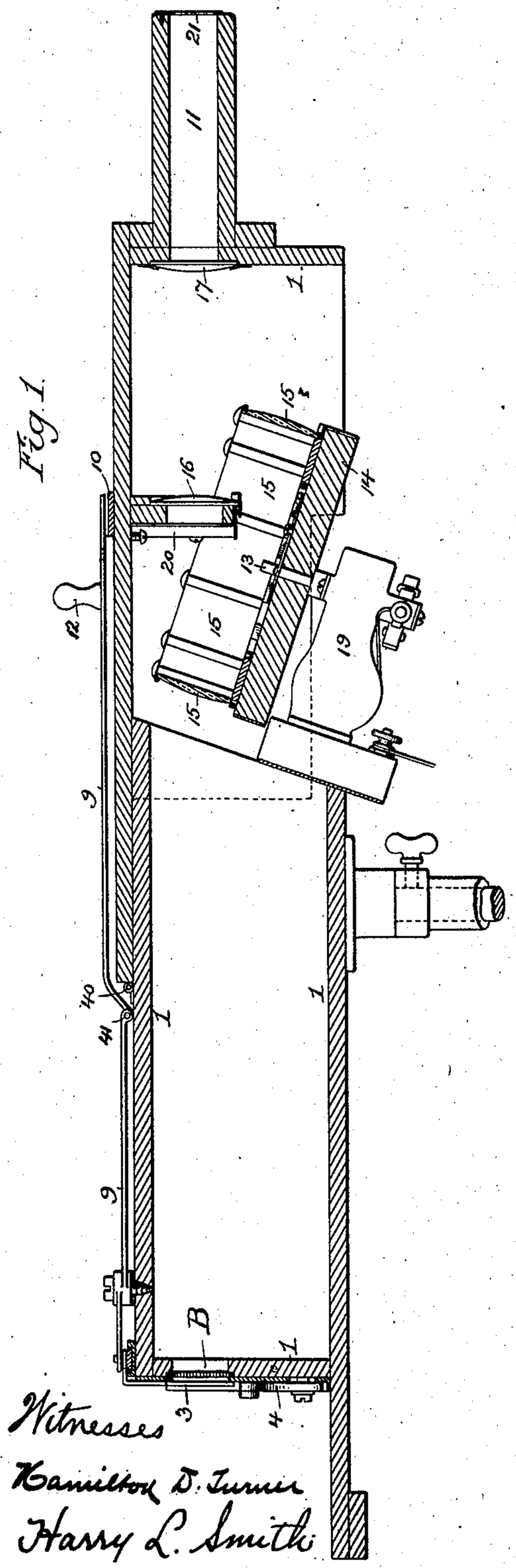
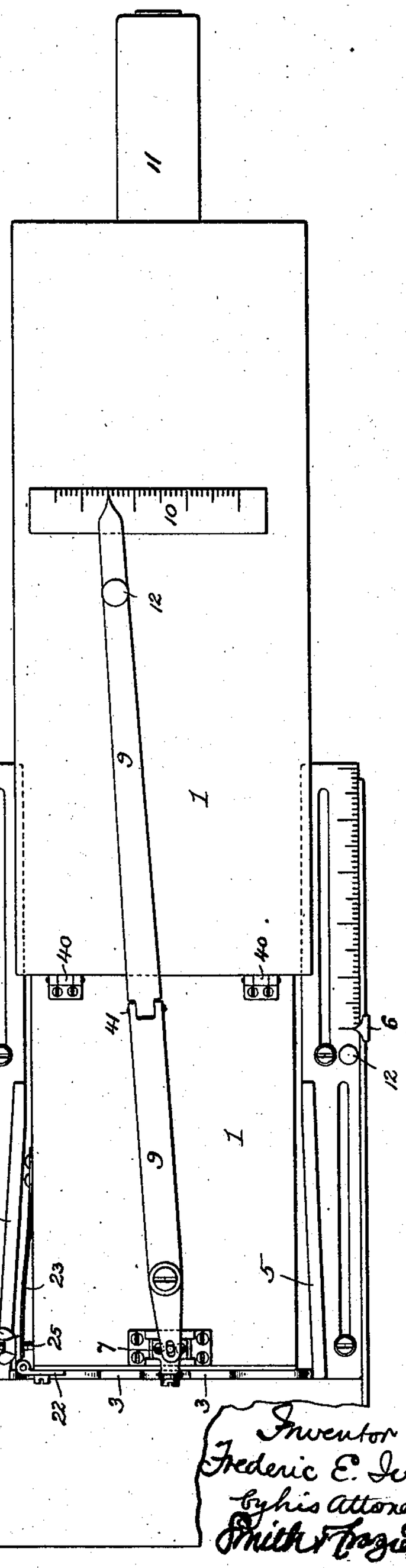


Fig. 2.



Witnesses

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Fig. 3.

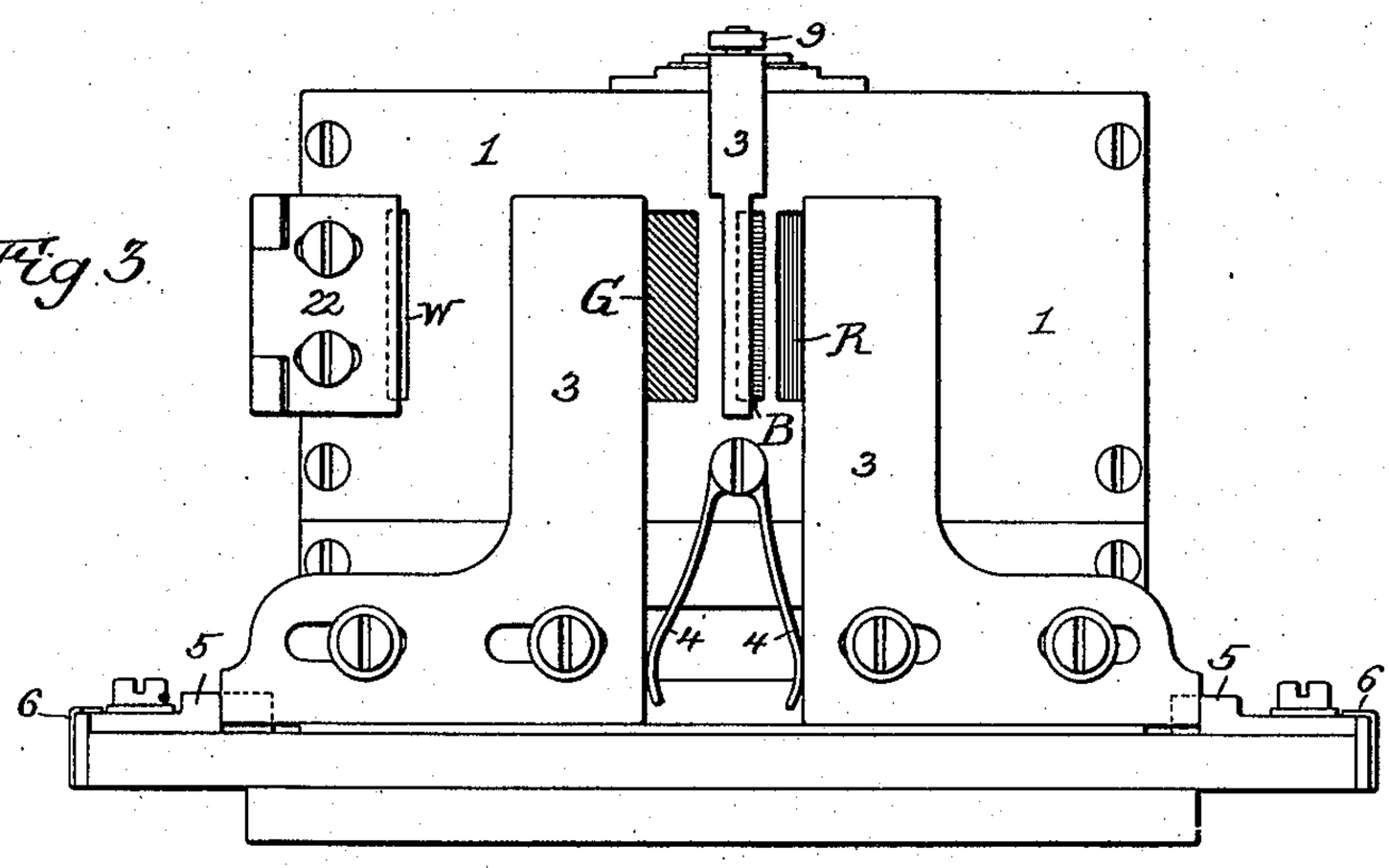


Fig. 4.

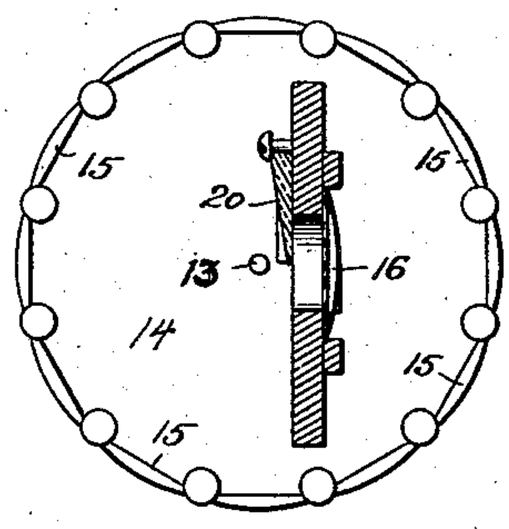


Fig. 5.

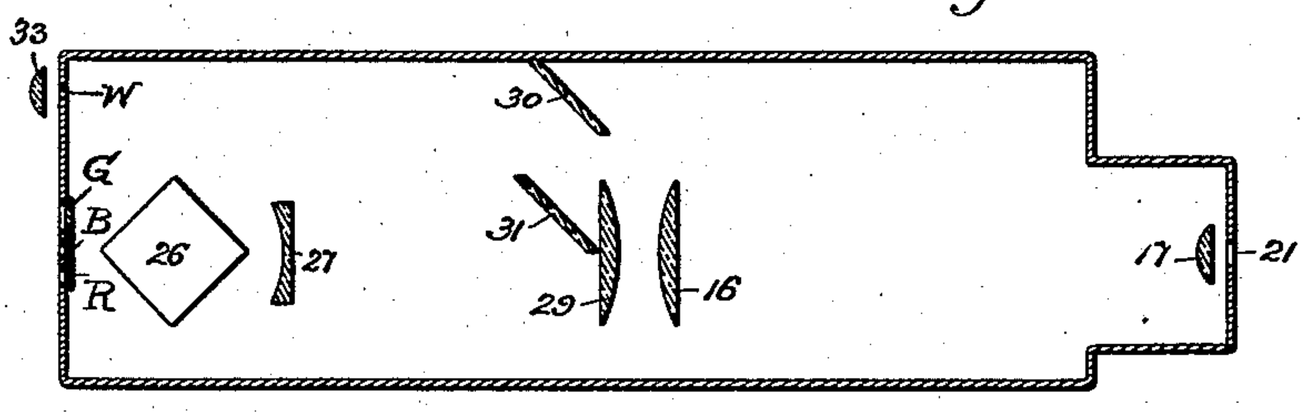
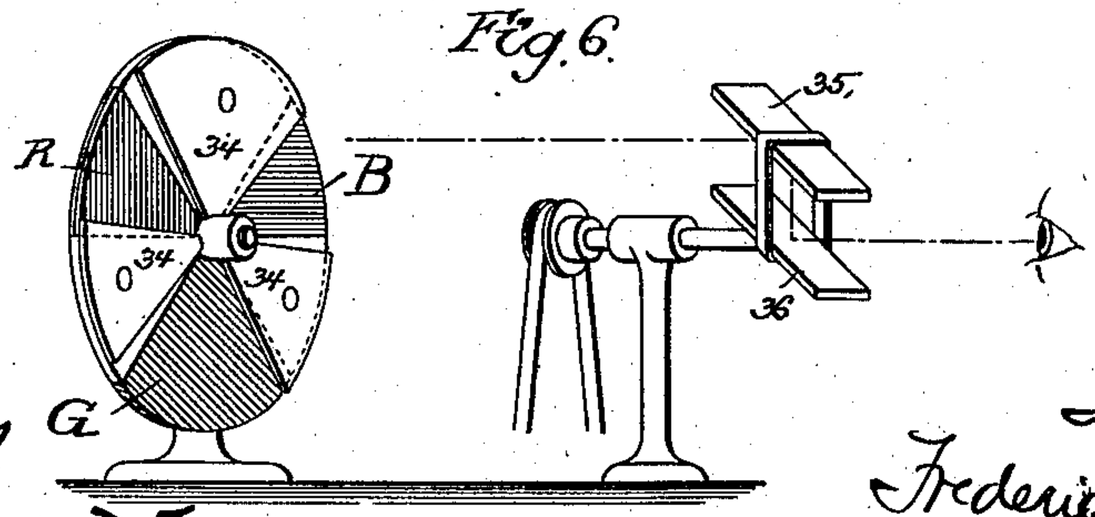


Fig. 6.



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FREDERIC E. IVES, OF WOODCLIFFE-ON-HUDSON, NEW JERSEY.

COLOR-METER.

No. 894,654. Specification of Letters Patent. Patented July 28, 1908.

Application filed October 22, 1907. Serial No. 398,544.

To all whom it may concern:

Be it known that I, FREDERIC E. IVES, a citizen of the United States, residing in Woodcliffe-on-Hudson, New Jersey, have invented a certain Improved Color-Meter, of which the following is a specification.

The object of my invention is to provide a color meter whereby every color to be found in the arts and industries can be quickly and accurately matched, measured in terms of three definite spectrum hues, recorded by three numbers, and reproduced for observation or matching at any time by simply setting the instrument to the recorded numbers and directing it to a background of standard white. This object I attain in the following manner, reference being had to the accompanying drawings, in which

Figure 1 is a vertical, longitudinal, sectional view of a preferred form of color meter embodying my invention; Fig. 2 is a plan view of the same; Fig. 3 is a front view; Fig. 4 is a view showing the relation to each other of certain parts of the instrument, and Figs. 5 and 6 are views of a diagrammatic character, illustrating modifications of my invention.

Referring in the first instance to Figs. 1, 2, 3 and 4 of the drawings, 1 represents a box or casing mounted upon a suitable standard, preferably in such manner that it can be adjusted vertically and secured in any of its various positions of vertical adjustment. In the front of this box or casing are four apertures, three of which are juxtaposed and are provided, respectively, with red, green, and blue-violet color screens, indicated respectively, by the letters R, G, and B, in Fig. 3, the red representing the spectrum between Fraunhofer lines A and C, the green a narrow band over *b*, and the blue-violet between F, 1/2 G and H. The fourth aperture W has no screen and is intended for the passage of clear light or of light rays passing through or reflected from the object whose color is to be matched.

The three color screens R, G, and B should be such as to transmit exclusively, but with sufficient freedom, the respective colors to which they correspond. These screens are preferably made by dyeing gelatin films on glass, the red by a combination of naphthol red and naphthol yellow, the green by a combination of naphthol green, naphthol yellow and neptune green, and the blue-violet by a combination of deep cobalt blue and peacock blue, although good effects are possible by the use of colored glasses in place of dyed films where suitable colored glasses are obtainable. An important feature of this part of my invention consists in preparing a green screen which limits the transmission of spectrum green rays to a narrow and sharp band about *b* in the spectrum without too much damping of the dominant ray. Green light of this hue and degree of purity is used in order that it may mix with the pure red to match undegraded orange reds and yellows and yet mix with the blue-violet to match rich peacock blues. Heretofore, in order to meet this requirement, it has been necessary to resort to spectroscopic analysis, but I find that by a combination of the colors before mentioned I am enabled to produce a color screen which admirably answers its intended purpose.

Each of the color screen apertures is provided with a sliding shutter 3, whereby the area of such aperture may be varied at will, the shutters for the red and green screens being suitably mounted on the front of the casing, so as to fit snugly thereto, and being pushed outwardly by a suitable spring or springs, such, for instance, as is represented at 4, and moved inwardly by means of a longitudinally guided wedge 5 mounted upon the projecting base of the box at one side of the same, each of these wedges being preferably provided with a scale coöperating with a fixed pointer 6 on the base, whereby the adjustment of either of the shutters can be accurately noted and recorded. The shutter 3, coöperating with the blue color screen, is carried by a laterally guided slide 7 on the top of the box, and is operated by a lever 9, coöperating with a scale 10, whereby said shutter can be conveniently adjusted by the observer at the eye piece 11 at the rear end of the box, knobs or handles 12 being provided upon the lever 9 and upon the wedge-carrying slides to facilitate movement of the same. If the rays of light from these three color screens are caused to pass rapidly across the field of vision, they will be mixed or blended by persistence of vision. Any desired means, either vibrating or rotating, may be employed, within the scope of my invention, in order to effect this result, a rotating device being preferred. I therefore mount upon a rotatable shaft 13, within the box or casing 1, a wheel or disk 14, having upon it an annularly arranged series of juxtaposed convex

lenses 15, and within the circle of these lenses is fixedly mounted a convex field lens 16, which directs a cone of rays to the eye piece aperture, in front of which is mounted a focusing lens 17.

The shaft 13 may be rotated in any available way. In the present instance it constitutes the armature shaft of a small electric motor 19, rigidly mounted upon the box or casing 1.

In front of the lens 16, and partially covering the same, is a wedge prism 20, which serves to deflect, into that part of the lens which it covers, the rays of light from the clear aperture W.

The lens-carrying wheel or disk 14 is mounted obliquely in order that its lenses may be in the plane of the lens 16 when crossing in front of the same, and below said plane when crossing in the rear of the lens, whereby they will not interfere with the transmission of the rays of light from said lens 16 to the eye piece, this construction being adopted in order to avoid the use of mirrors or prisms to deflect the rays from the lenses 15 to the lens 16, as would be necessary if the wheel or disk 14 rotated about a vertical axis.

Slow movement of the lenses 15 in front of the field lens 16 will cause that portion of said field lens which is not covered by the wedge prism 20, to appear, as seen from the eye piece aperture 21, successively filled with or crossed by horizontally moving vertical bands of red, blue and green light, but when the lens wheel 14 is rapidly rotated, these colors will be evenly mixed or blended to the eye by persistence of vision, and, supposing that the shutters of the three color screens are set at the 100 points of their respective scales, the uncovered portion of the field lens 16 should show a clear white light corresponding with that shown on the covered half of the lens to which the rays of light are transmitted from the clear aperture W, said rays being bent into the axis of the meter by the prism 20 and spread across their respective portion of the field by the action of the moving lenses 15.

By varying the area of the apertures of the different color screens these colors ma be mixed in different proportions, so as to produce upon the field of vision any desired color or shade of color, and hence the color of any object exhibited upon that half of the field corresponding to the clear aperture W may be matched by a suitable adjustment of the shutters of the color screens, the adjustment of each shutter, and the consequent proportion of each color in the mixture, being indicated by the respective scales, whereby an accurate record of the mixture can be preserved and such mixture reproduced at any desired time by a corresponding adjustment of the three shutters.

Where the object whose color is to be matched is transparent the light may pass through the same before passing through the aperture W, and where the object is opaque it may be exposed in front of said aperture, a suitable lens (see Fig. 5) being employed in order to form in the respective half of the field an image of such object, which is seen at the eye piece aperture 21 as if in a telescope. It is therefore only necessary to project an image of any colored object into its respective half of the field of the color meter in order to match its color in the other half of the field by so adjusting the shutters of the three color screens that the color in both halves of the field appears alike.

Assuming that the light which reaches the color screens is ordinary white light of the same quality that illuminates the colored object, the white formed by the admixture of the red, blue, and green colors should exactly match that coming through the clear aperture W. If they are not alike they can be made so by altering the absolute or relative size of the color screen apertures, equalization of luminosity being conveniently effected by means of a sliding shutter 22, suitably mounted on the front of the box and carried by a spring arm 23, which can be adjusted by means of a thumb nut 24 on a bolt 25 passing through said spring arm, as shown in Fig. 2.

In that modification of my invention shown in Fig. 5, I use, in place of the rotating lens wheel, a rotating glass cube 26, having vertical sides and mounted upon a vertical axis in the rear of the color screens. When this cube is revolved with sufficient rapidity the effect is to spread the colors across the line of vision, and produce a strip white in the middle and tinted with color at both ends, and, by taking as the source of light for illuminating the field of the color meter that part of the strip which appears white, the field can be changed to any color whatever by suitably varying the areas of the apertures of the color screens, and a percentage measurement of these apertures will give a record. An objection to this particular optical mixing device is that the speed of movement of the color bands across the field varies with the distance laterally from the optical center, necessitating the use of differential scales to indicate true numerical values.

In connection with the revolving cube 26 I employ a concave lens 27, which serves to make the mixture of colors alike in all parts of the field, and I place in front of the field lens 16 a collecting lens 29 for parallelizing a cone of rays from the middle of the band of light spread out horizontally across the axis when the glass cube 26 is rapidly revolved. In this construction, also, in place of the wedge prism 20, I use a pair of opaque mirrors 30 and 31, the mirror 30 receiving the rays of light from the aperture W, or from

the image-forming lens 33, and reflecting them onto the mirror 31, which, in turn, reflects them through a portion of the collecting lens 29 and field lens 16.

In that modification of my invention shown in Fig. 6, the color screens R, B, and G are shown as sectors, whose area can be varied by adjustment of sector-shaped shutters 34, the light passing through the color screens being received upon and reflected by a pair of mirrors, prisms, or other reflectors, 35 and 36, mounted so as to rotate about an axis concentric with the center of the mirror 36, whereby the mirror 35 will receive, successively, rays of light from the red, blue, and green screens, and will reflect these rays onto the mirror 36, which in turn reflects them to the eye of the observer, persistence of vision making the transmitted light appear white if the colors are mixed in suitable proportion, or of any other color whatever by suitably modifying the area of the apertures of the color screens. The same result could be obtained by employing revolving color screen sectors in connection with stationary reflecting mirrors or prisms, but the use of such revolving sectors is to be avoided because their apertures cannot be altered without first bringing them to rest, unless exceptionally delicate and complicated mechanism is employed.

In order to permit ready access to the lenses 15, 16 and 17 and the prism 20 of the instrument shown in Fig. 1, the casing 1 is made in two parts, the top of the rear portion overlapping that of the front portion and being hinged thereto, as shown at 40 in Figs. 1 and 2, the rear section of the case being open at the bottom so that it can be swung upward in order to uncover the rotating wheel 14 and its lenses, ready access to the lenses 16 and 17 and prism 20 being also possible when the rear section of the case is thus raised. In order to permit of this movement of the rear portion of the casing without interference therewith by the lever 9, the latter is also made in two parts, hinged together as at 41, in Figs. 1 and 2.

I claim:—

1. A color meter having three color screens, means providing a light-transmitting aperture for each screen, means for varying the area of said aperture, and means for causing the rays of light from these screens to pass in rapid succession across the axis of vision.

2. A color meter having three color screens, means providing a light-transmitting aperture for each screen, means for varying the area of said aperture, and a rotating device for causing the rays of light from these screens to pass in rapid succession across the axis of vision.

3. A color meter having three stationary color screens, means providing a light-transmitting aperture for each screen, means for varying the area of said aperture, and means for causing the rays of light from said screens to pass in rapid succession across the axis of vision.

4. A color meter having three stationary color screens, means providing a light-transmitting aperture for each screen, means for varying the area of said aperture, and a rotating optical device for causing the rays of light from said screens to pass in rapid succession across the axis of vision.

5. A color meter having three color screens, means providing a light-transmitting aperture for each screen, means for varying the area of said aperture, means for causing the rays of light from said color screens to pass in rapid succession across the field of vision, and means for projecting uncolored light rays over a portion of said field of vision.

6. A color meter having three color screens, means providing a light-transmitting aperture for each screen, means for varying the area of said aperture, means for causing the rays of light from said color screens to pass in rapid succession across the field of vision, means for projecting uncolored light rays over a portion of said field of vision, and means for varying the area of the aperture through which said uncolored rays pass.

7. A color meter having three color screens, means providing a light-transmitting aperture for each screen, means for varying the area of said aperture, means for causing the rays of light from said color screens to pass in rapid succession across the field of vision, and means for projecting rays of light from an exposed object onto a portion of said field of vision.

8. A color meter having three color screens, means providing a light-transmitting aperture for each screen, means for varying the area of said aperture, a rotating optical device for causing the rays of light from said color screens to pass in rapid succession across the field of vision, and means for directing uncolored rays of light onto a portion of said field.

9. A color meter having three color screens, means providing a light-transmitting aperture for each screen, means for varying the area of said aperture, a rotating optical device for causing the rays of light from said color screens to pass in rapid succession across the field of vision, means for directing uncolored rays of light onto a portion of said field, and means for varying the area of the aperture through which said uncolored rays pass.

10. A color meter having three color screens, means providing a light-transmitting aperture for each screen, means for varying the area of said aperture, a rotating optical device for causing the rays of light from

said color screens to pass in rapid succession across the field of vision, and means for directing rays of light from an exposed object onto a portion of said field.

11. A color meter having three color screens, means providing a light-transmitting aperture for each screen, means for varying the area of said aperture, means for causing the rays of light from said color screens to pass in rapid succession across the axis of vision, a convex field lens, and an eye aperture, disposed in the order named.

12. A color meter having three color screens, means providing a light-transmitting aperture for each screen, means for varying the area of said aperture, a rotating optical device for causing the rays of light from said color screens to pass in rapid succession across the axis of vision, a convex field lens, and an eye aperture, disposed in the order named.

13. A color meter having, in combination, three color screens, means providing a light-transmitting aperture for each screen, means for varying the area of said aperture, a series of juxtaposed lenses, and means for moving the latter successively across the rays of light from said color screens.

14. A color meter having, in combination, three color screens, means providing a light-transmitting aperture for each screen, means for varying the area of said aperture, a series of juxtaposed lenses, and a rotating carrier whereby said lenses are caused to pass successively across the rays of light from the color screens.

15. A color meter having, in combination, three color screens, means providing a light-transmitting aperture for each screen, means for varying the area of said aperture, a series of juxtaposed lenses, a rotatable carrier whereby said lenses are successively carried across the rays of light from said color screens, and a field lens interposed between said lenses and the eye aperture.

16. A color meter having three color screens, means providing a light-transmitting aperture for each screen, means for varying the area of said aperture, a rotating optical device for causing the rays of light from said screens to pass in rapid succession across the axis of vision, a convex field lens, a focusing lens, and an eye aperture, disposed in the order named.

17. A color meter having three color screens, means providing a light-transmitting aperture for each screen, means for varying the area of said aperture, a series of juxtaposed lenses, a rotatable carrier for causing said lenses to pass in succession across the rays of light from said color screens, and field and focusing lenses interposed between said rotating lenses and the eye aperture.

18. A color meter having three color screens, means providing a light-transmitting aperture for each screen, means for varying the area of said aperture, a series of juxtaposed lenses, a field lens, and a rotatable carrier for said juxtaposed lenses having its axis set obliquely in respect to said field lens.

19. A color meter having three color screens, means providing a light-transmitting aperture for each screen, means for varying the area of said aperture, a series of juxtaposed lenses, a rotatable carrier therefor, and a casing having a movable portion which can be adjusted so as to expose said carrier and its lenses.

20. A color meter having three color screens, means providing a light-transmitting aperture for each screen, means for varying the area of said aperture, a series of juxtaposed lenses, a rotatable carrier therefor, and a casing having a portion upon which said carrier is mounted and another portion mounted upon the first so as to be movable into position to expose said carrier and its lenses.

21. A color meter having three color screens, means providing a light-transmitting aperture for each screen, means for varying the area of said aperture, a series of juxtaposed lenses, a rotatable carrier therefor, a field lens, and a casing having one portion upon which said carrier is mounted and another portion carrying said field lens and movable in respect to the first so as to expose said field lens and the lenses which are mounted upon the rotatable carrier.

22. A color meter having three color screens, means providing a light-transmitting aperture for each of said screens, shutters for varying the area of said apertures, and means, each including a scale and pointer, for adjusting said shutters.

23. A color meter having three color screens, means providing a light-transmitting aperture for each of said screens, shutters for varying the area of said apertures, and means, including wedge slides, for effecting adjustment of certain of said shutters.

24. A color meter having three color screens, means providing a light-transmitting aperture for each of said screens, shutters for varying the area of said apertures, a casing carrying said screens, wedge slides at opposite sides of said casing for adjusting certain of said shutters, and a lever on top of the casing for adjusting one of said shutters.

25. A color meter having three color screens, means providing a light-transmitting aperture for each of said screens, a shutter for varying the area of the aperture of one of said screens, a casing carrying said screens and a rotating optical device for mixing the rays of light therefrom, said casing comprising two parts pivoted together, and a lever on top of the casing for adjusting said shut-

ter, said lever also having two parts pivoted together.

26. A color meter having a casing provided with three color screens, means providing a light-transmitting aperture for each screen, means for varying the area of said aperture, a series of juxtaposed lenses, a rotatable carrier therefor, and an electric motor mounted upon the casing and having an armature shaft to which said carrier is secured.

27. A color meter having red, blue, and green color screens, the green screen having a color composition which limits the transmission of spectrum green rays to a narrow band about *b* in the spectrum.

28. A color meter having red, blue, and green color screens, the green screen being a combination of naphthol green, naphthol yellow and neptune green.

29. A color meter having red, blue and green color screens, the red screen having a color composition which limits the transmission of spectrum rays to a band between Fraunhofer lines A and C, the blue screen having a color composition which limits the transmission of spectrum rays to a band between F, ½ G and H, and the green screen having a color composition which limits the transmission of spectrum rays to a narrow band over *b*.

In testimony whereof, I have signed my name to this specification, in the presence of two subscribing witnesses.

FREDERIC E. IVES.

Witnesses:
HAMILTON D. TURNER,
KATE A. BEADLE.