

Dec. 5, 1967

J. F. RENDINA

3,355,982

APPARATUS FOR SIMULATING DAYLIGHT AND ARTIFICIAL LIGHT

Filed Oct. 2, 1963

2 Sheets-Sheet 1

FIG. 1

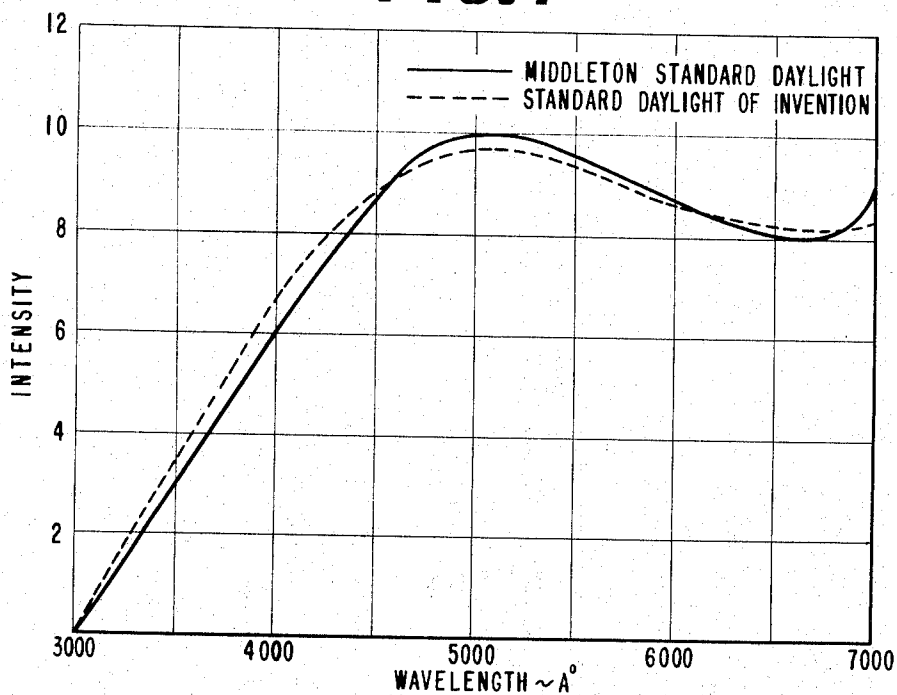
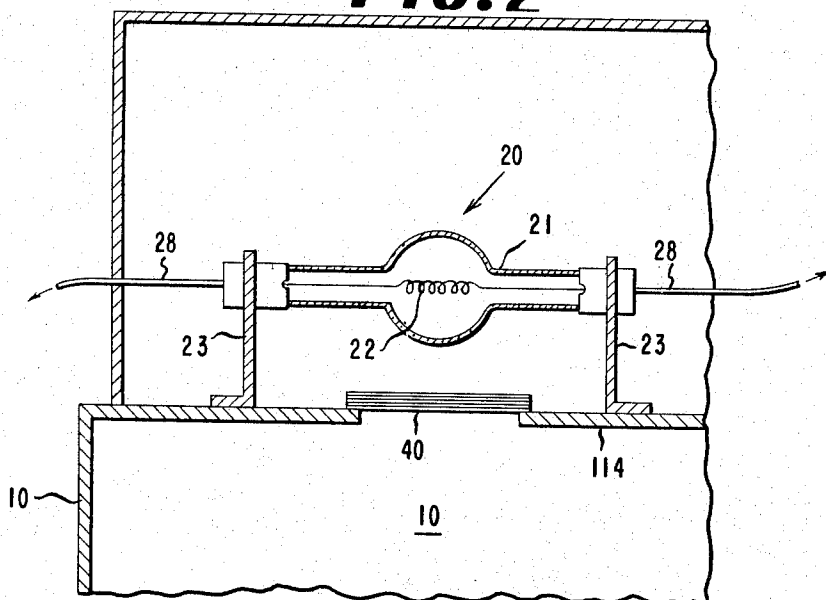


FIG. 2



INVENTOR
JOHN F. RENDINA

BY

Harry C. Braddock
ATTORNEY

Dec. 5, 1967

J. F. RENDINA

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FIG. 3

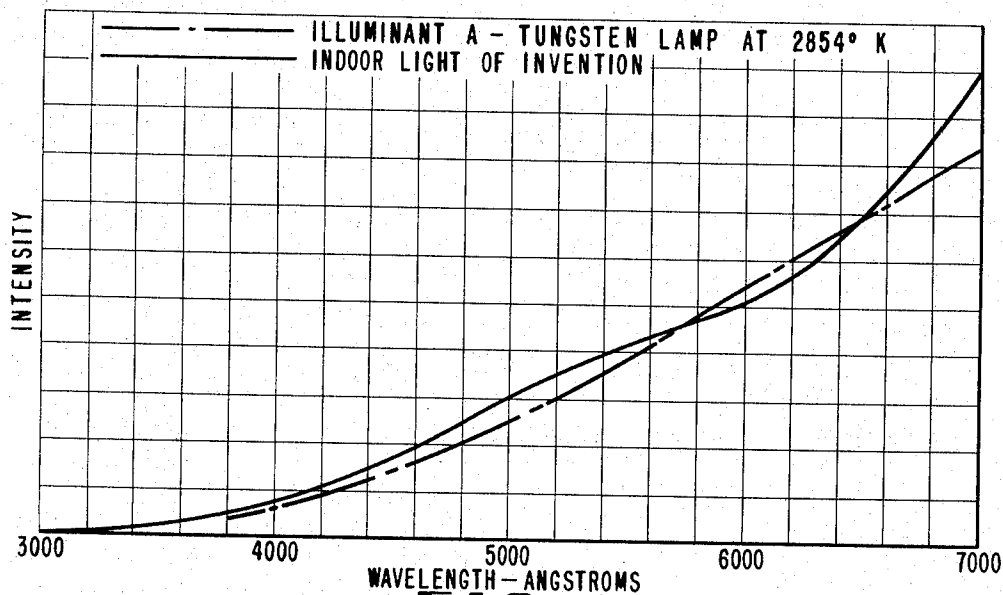


FIG. 4

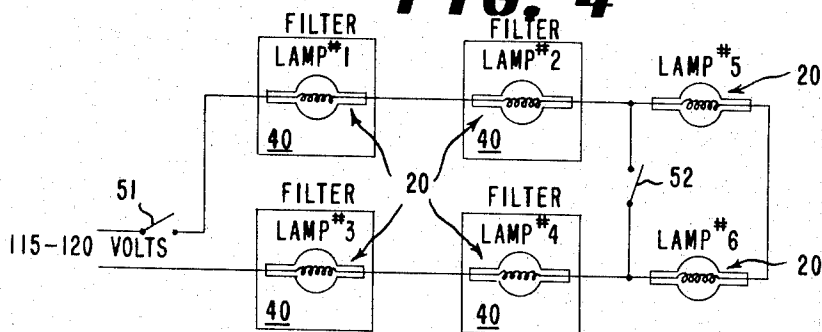
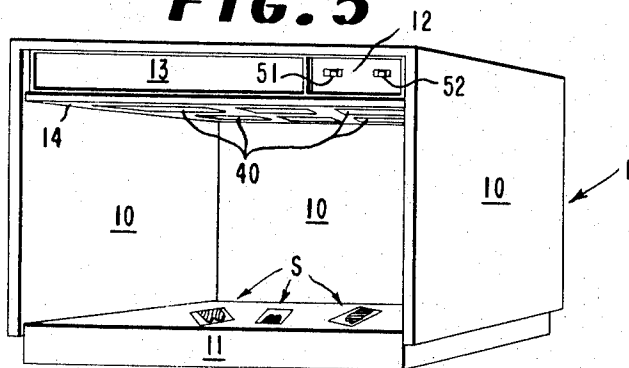


FIG. 5



INVENTOR
JOHN F. RENDINA

BY

Harry C. Buddick
ATTORNEY

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3,355,982

APPARATUS FOR SIMULATING DAYLIGHT AND ARTIFICIAL LIGHT

John F. Rendina, Wilmington, Del., assignor to E. I. du Pont de Nemours and Company, Wilmington, Del., a corporation of Delaware

Filed Oct. 2, 1963, Ser. No. 313,337

1 Claim. (Cl. 88—14)

ABSTRACT OF THE DISCLOSURE

An apparatus for selectively consecutively subjecting colored samples to a first condition simulating normal daylight and a second condition simulating indoor artificial lighting, the apparatus having two groups of light source units arranged so that one group is used to produce both conditions with simple switching arrangement to add or subtract the other group, the units being arranged so that a single switch action not only adds or subtracts the necessary light source units but controls the voltage necessary for operating the light source units at the desired temperature level.

This invention relates generally to the field of matching colors. More specifically, it involves an improved apparatus for producing simulated daylight and also simulated light representative of ordinary artificial indoor lighting for obtaining a visual color match or comparison of desired materials under the two conditions of lighting. This arrangement is of special interest and benefit in handling materials which have been treated with the so-called "white dyes," or optical brighteners, to produce a fluorescent effect. These "white dyes," or optical brighteners absorb light in the ultraviolet spectrum and fluoresce in the blue part of the spectrum to produce an actual emission of blue light from the dyed material which light is added to the light reflected from the material. The reflected light, of course, is the light returning from the dyed material after absorption of certain of the spectral components of the incident light by other component dyes present in the material. These "white dyes," also known as "whitening agents," are widely used to improve the appearance of textile and paper. An important need exists with manufacturers and consumers of such products for a suitable method for determining the color quality and relative whitening efficiency of the various fluorescent whiteners. This type of comparison is conventionally accomplished by visual examination. In general, no reliable device for qualitative visual examination, or comparison, of materials treated with these "whitening agents" has been developed. Ordinarily, a comparison of this sort is made by directing light on samples of the dyed materials from a light source having the same ultraviolet spectral energy distribution as daylight, and then viewing and comparing the reflected and fluorescent light from the samples.

However, although commercial ultraviolet light sources are available which will cause these dyed materials to fluoresce, in most of these available sources the visible spectral component of light has been filtered out and removed by an enclosure or envelope surrounding the source. This renders such light sources unsatisfactory as means for simulating natural light. In addition, it has been established that it is generally necessary to check any color match, or comparison, under the light from two different sources, one representing a standard daylight spectral distribution, and the other representing some standard indoor or artificial lighting spectral distribution, so that the color relationship is maintained under both indoor and outdoor lighting. This approach is

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made necessary due to the fact that most materials exhibit a property known as metamerism which is the apparent change in color due to a change in spectral distribution of the illumination applied.

It is an object of this invention to provide a single improved apparatus for convenient and efficient comparison of color samples under light of a "standard" daylight spectral distribution and also under light of some standard indoor or artificial spectral distribution.

It is another object to provide such an apparatus combination which utilizes simplified and improved light sources for the production of "standard" daylight spectral distribution and for the production of the "standard" indoor, or artificial, spectral distribution.

It is yet another object to provide in such a combination an improved arrangement and simplified electrical circuitry for actuating the same to produce the desired comparison.

Yet another object is the provision of such a color sample apparatus or device which is simple and economical to manufacture, operate, and maintain; yet effective and reliable in its functioning.

These objects are accomplished in an apparatus which generally comprises a supporting or housing structure defining a chamber for receiving color samples for comparison, said apparatus further comprising a lighting system for selectively sequentially subjecting samples in the chamber to light having a first spectral distribution corresponding to ordinary daylight and to light having a second spectral distribution representing or corresponding to the other lighting conditions to which the samples would be subjected, said lighting system comprising in combination a first plurality of electrically actuated light source units which under first given voltage conditions produce the simulated daylight according to the Middleton spectral distribution, and a second plurality of electrically actuated light source units, which under second given voltage conditions and in cooperation with said first plurality of light source units, produce light having the second spectral distribution, and electrical means operatively connected and cooperating with said light source units for selectively operating said units to produce said two types of light.

Other objects and advantages will appear from the following detailed description of the apparatus provided in accordance with the above objects, and the appended claims, considered in conjunction with the accompanying drawings in which:

FIGURE 1 is a graphical representation of wave length versus energy of light representing average daylight spectral distribution as determined by the "Middleton" skylight (W. E. Knowles Middleton of the National Research Council of Canada) and of the light approximating this "Middleton" daylight as produced by the apparatus of the present invention.

FIGURE 2 is a partial vertical sectional view taken through the apparatus of FIGURE 5 to illustrate one of the light source units for producing the "standard" daylight spectral distribution according to Middleton.

FIGURE 3 is a graphical representation of wave length versus energy of light representing the "standard" indoor artificial spectral distribution (Standard C.I.E. illuminant A—an unfiltered tungsten filament source operating at 2854° K.) and of light approximating this "standard" indoor spectral distribution as produced by the apparatus of this invention.

FIGURE 4 is a schematic diagrammatic showing of the arrangement of light source units and associated circuitry of the apparatus embodying the present invention.

FIGURE 5 is a perspective view of the apparatus of the present invention showing the light source units and

location of color samples being compared or matched.

Since the measurements made by W. E. Knowles Middleton, National Research Council of Canada, of the daylight spectral distribution extending over the ultraviolet and visible portion of the spectrum are believed to represent the most reliable and complete set of data available to date, these measurements, as indicated generally in FIGURE 1, have been adopted as a basis for light having the "standard" daylight spectral distribution used in the present invention. The dotted line in FIGURE 1 indicates the "standard" daylight spectral distribution of light produced by the apparatus of this invention. For the standard indoor, artificial lighting spectral distribution used in the apparatus of this invention, the standard C.I.E. illuminant A, which is represented by an unfiltered tungsten filament source operating at 2854° K., has been adopted. The "standard" C.I.E. illuminant A distribution and that produced by the apparatus of this invention are indicated in FIGURE 3.

The improved apparatus provided in accordance with the above objects of the invention is illustrated in FIGURES 2, 4 and 5 of the drawings and comprises a housing formed by side wall elements 10, a bottom or base element 11 and a top member 13 which contains the light source units, and associated electrical means for actuating and controlling these units. The color samples S are shown in position for examination and comparison.

There are two groups of light source units, a first group which alone produces light having the "standard" daylight spectral distribution; and a second group which together with the other group jointly produce the light having the "standard" indoor or artificial light spectral distribution. The light source units of the first group are designated as lamps No. 1, No. 2, No. 3 and No. 4, one of which is shown in an enlarged view in FIGURE 2. Light source units of this first group each comprises a lamp 20 provided with a tungsten filament 22 which is heated to incandescence and operated at 3100° K. by electric current through conductors 28. The filament 22 is maintained in a sealed evacuated quartz envelope 21 which also contains a small amount of iodine which combines with the tungsten that is deposited in the envelope 21 during operation to form a tungsten iodide vapor which subsequently breaks down into the original iodine and original tungsten as it comes in contact with the hot filament 22. Lamp 20 is used in combination with a filter element 40 which will pass the ultraviolet and blue portion of light generated by the lamp but which will pass relatively smaller amounts of yellow and red.

It has been found that a commercially available bulb of the type made by the General Electric Company and identified by Catalog No. 6.6A/T4Q/CL-200W in combination with a filter of the type made by the Corning Company and identified as Corning glass filter 1-64, in a thickness which is about 0.15× to about 0.5× of stock thickness cooperate to produce the Middleton "standard" daylight spectral distribution as shown in FIGURE 1. These light source units of the first group are positioned as shown in FIGURE 5 to give even application of light over samples S positioned on the base element 11. The voltage required for each lamp 20 of the first group units to produce the "standard" Middleton daylight spectral distribution (tungsten filament at 3100° K.), is between 28.75 and 30 volts which can conveniently be achieved by connecting the four light producing units in series with a 115-120 volt source as indicated in FIGURE 4 by closing switches 51 and 52.

The light source units of the second group, which together with the first group units produce the indoor artificial light spectral distribution, each comprise the same lamp units as used in the first group units but without the filter elements. By adding two of these unfiltered lamps in series with four of the lamps of the first group units to give a voltage for each lamp of from 18-20 volts (for instance by opening switch 52 and maintaining

switch 51 closed in the circuit of FIGURE 4), a spectral distribution matching or corresponding to the C.I.E. illuminant A (standard indoor lighting; tungsten filament at 2854° K.), is produced. Thus with this relatively uncomplicated structural arrangement and electrical connections, and with simple switch actuation, two "standard" spectral distributions of light can be applied to sets of material or color samples to give a comparison for matching the samples at each of two commonly encountered lighting conditions. Other lighting conditions to be encountered could also be duplicated by using additional groups of suitably different light producing units.

The operation of the apparatus in carrying out examination and comparison of color samples is believed to be clear from the above description.

The samples S are placed in suitable locations in the chamber defined by the wall elements 10, the top element 13 and bottom elements 11, and in the desired sequence the lamps No. 1, No. 2, No. 3 and No. 4 representing the first group light producing units for generating the standard daylight or Middleton spectral distribution, are actuated by closing switches 51 and 52, and then all the lamps No. 1, No. 2, No. 3, No. 4, No. 5 and No. 6 are actuated by closing switch 51 and opening switch 52 to give the standard indoor lighting (C.I.E. illuminant A) spectral distribution. These steps can be accomplished in any desired sequence.

This sequential examination and comparison of samples will quickly and effectively indicate whether or not a color match exists under each of the representative lighting conditions. The variation in the voltage drop across the lamps 20 occurring with the change in circuit conditions associated with opening switch 52 while switch 51 is closed, is sufficient to alter the characteristics of the first group of light producing elements such that in conjunction with the second group the second desired light conditions are produced directly. The lowered voltage across each lamp produces a lower filament operating temperature and in conjunction with the added number of unfiltered lamps produces the C.I.E. illuminant A spectral distribution in a very simple operation.

It is believed to be clear that a novel, useful, and improved apparatus for examination and comparison of color samples has been provided in accordance with the objects of the invention.

Although a preferred embodiment of the invention has been described in detail in accordance with the patent statute, it will be obvious to those skilled in the art that modifications may be made in this apparatus without departing from the spirit of the invention and such are considered to fall within the scope of the following claim.

I claim:

An improved simplified apparatus for examining samples of material to determine their color under a first condition simulating normal daylight and under a second condition simulating indoor artificial lighting, said apparatus comprising a housing structure, said housing structure defining a chamber for receiving and supporting samples of material for examination, said apparatus further comprising a lighting system for selectively sequentially subjecting samples positioned in said chamber to light having a first spectral distribution corresponding to ordinary daylight and also to light having a second spectral distribution representing artificial indoor lighting to which the material of the samples would be subjected, said lighting system consisting solely of, in combination, a first plurality of identical electrically actuated light source units which under a first voltage condition produce in said chamber the simulated daylight, a second plurality of electrically actuated light source units, said units being identical with the units of said first plurality which under a second voltage condition, and in cooperation with said first plurality of light source units, produce in said chamber light representing artificial indoor lighting conditions, and electrical means adapted to be connected to a 115-120 volt source of

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electrical voltage and operatively connected with said light source units for selectively operating said units to produce alternately light of said two spectral distributions, said units of said first plurality each consisting of a lamp having a tungsten filament sealed in an evacuated quartz envelope in combination with a filter which passes blue and ultraviolet light but limits a significant portion of red and yellow light applied thereto, said units of said second plurality each consisting of an unfiltered lamp having a tungsten filament sealed in an evacuated quartz envelope, said electrical voltage source and electrical means being arranged to supply selectively a voltage directly solely to said units of said first group in series sufficient to operate said filaments at 3100° K. which provides radiation corresponding to standard daylight, or alternatively directly to the units of both groups in series to operate said filaments at a significantly lower temperature which provides radiation corresponding to standard (C.I.E. illuminant A) indoor lighting, said first plurality of units consisting of four lamps in series, each lamp having an operating voltage of from 28.75 to 30.0 volts when supplied directly and solely by said source and said second plurality of units consisting of two lamps each having an operating voltage of 18-20 volts when connected in

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series with each of said lamps of said first plurality across said voltage source, said electrical means comprising a switch device for alternately connecting either the units of said first plurality in series across said source or all of the units of both pluralities in series across said source, the units and switch device arranged so that a single actuation of the switch device also directly and instantly controls the voltage as necessary to achieve the desired filament operating temperature level for the units in each condition.

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JEWELL H. PEDERSEN, *Primary Examiner*.W. A. SKLAR, *Assistant Examiner*.