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[54] APPARATUS FOR GENERATING ULTRA VIOLET LIGHT

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[51] Int. Cl. H01j 5/16

[58] Field of Search 250/84, 86, 88; 313/225, 228; 350/1, 290

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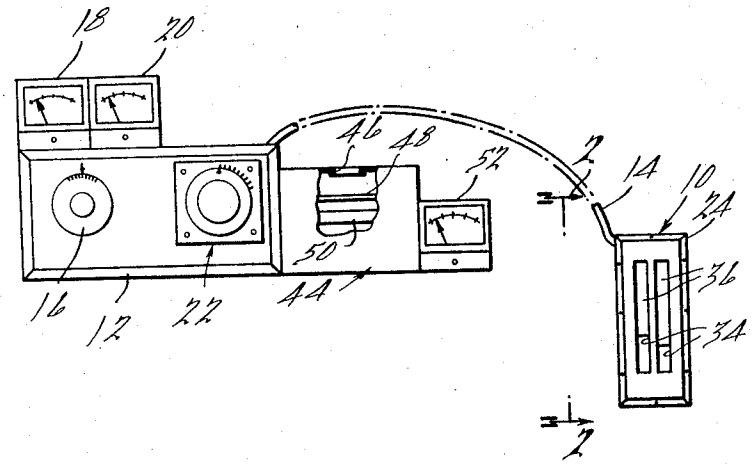
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[57] ABSTRACT

Apparatus for generating ultra-violet light which can be controlled to provide a controlled erythemal effect.

1 Claim, 6 Drawing Figures



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SHEET 1 OF 2

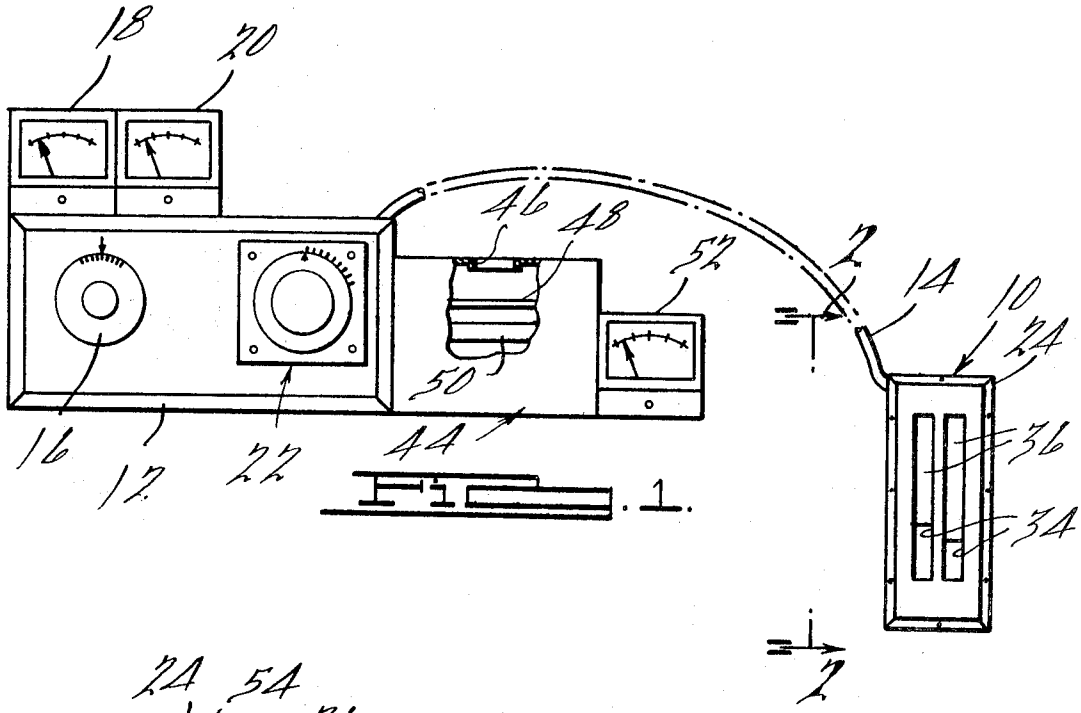


FIG. 1.

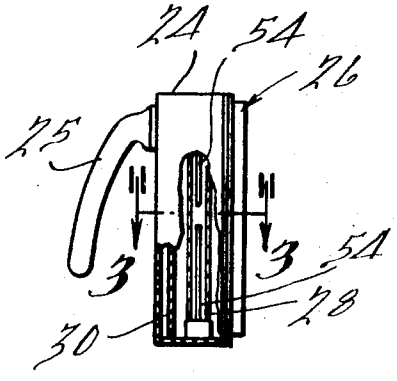


FIG. 2.

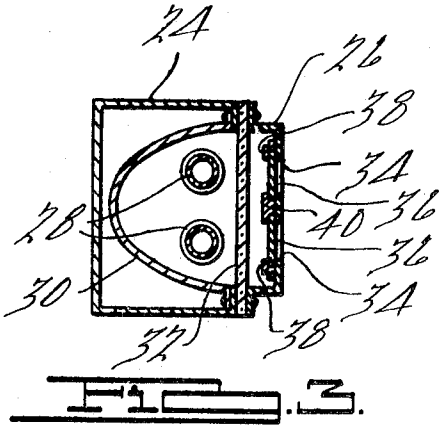


FIG. 3.

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FIG. 4A.

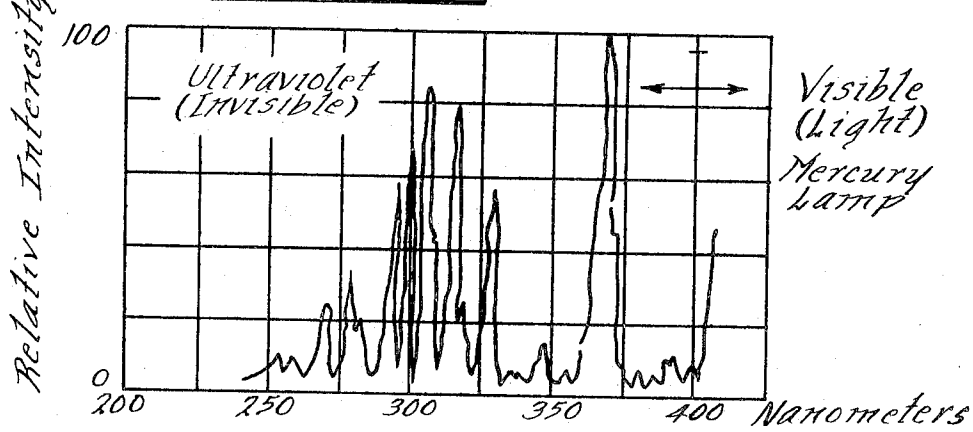
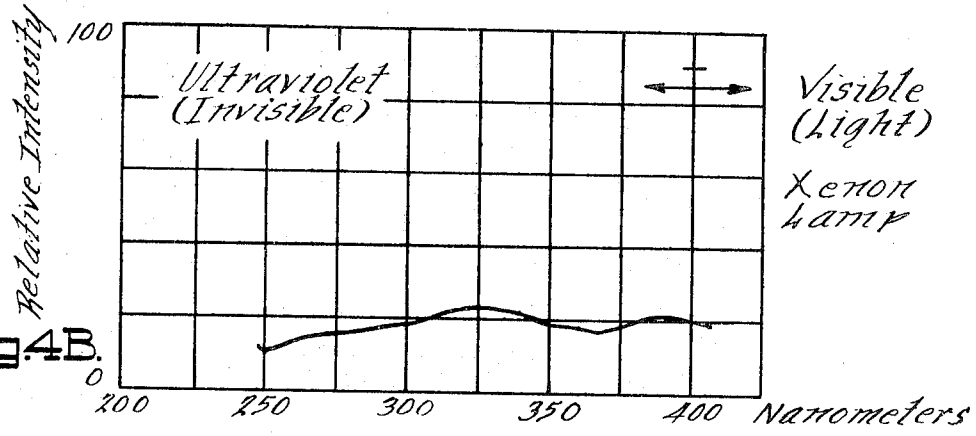


FIG. 4B.



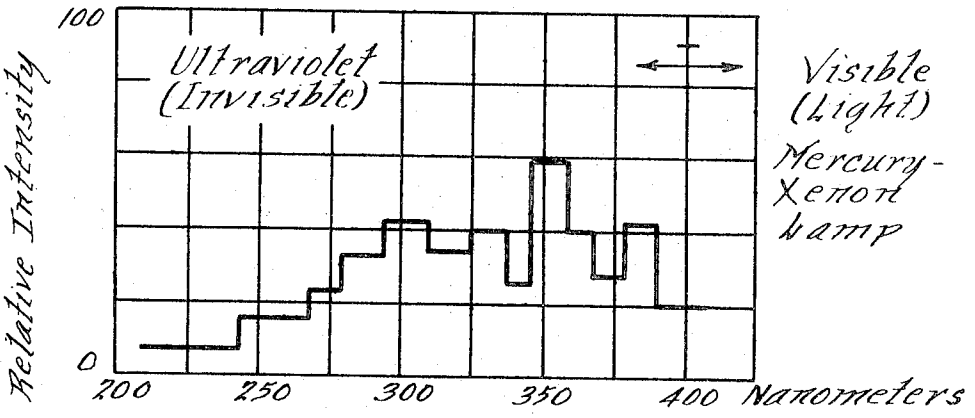


FIG. 4C.

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APPARATUS FOR GENERATING ULTRA VIOLET LIGHT

SUMMARY BACKGROUND OF THE INVENTION

The present invention relates to apparatus for generating ultra-violet light and more particularly to apparatus for providing a controlled output of ultra-violet light.

It would be desireable to be able to provide a source of ultra-violet which could be controlled in such a manner as to provide a known output. In this way various effects of light in the ultra-violet range could be utilized and/or analyzed. For example it would be desireable to determine the erythemal effect on human skin of various pigmentations as caused by sunlight. In this regard it is known that certain wave lengths of ultra-violet are more effective than others as to erythemal effect. To facilitate the occurrence of erythemal effect it would be desireable to have a source of ultra-violet which is rich in the desired wave lengths and could be controlled such as to provide a known output at those wave lengths. Prior devices and apparatus were unreliable in that they either were deficient in the desired spectral region or such extreme variations in output between similar devices occurred as to make their use literally impractical.

Therefore it is an object of the present invention to provide apparatus for providing ultra-violet light which can be controlled to provide a known output over various spectral regions.

It is another object to provide apparatus for providing a controlled erythemal effect.

It is another object to provide novel apparatus generating and utilizing ultra-violet light.

Other objects, features, and advantages of the present invention will become apparent from the subsequent description and the appended claims, taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a pictorial view depicting a system utilizing features of the present invention;

FIG. 2 is a side elevational view with some parts broken away of the generating device of FIG. 1 taken generally in the direction of the arrows 2—2;

FIG. 3 is a sectional view, to increased scale of the apparatus of FIG. 2, taken generally along the line 3—3; and

FIGS. 4 A—C are curves of relative intensity versus wave length for different ultra-violet light generating tubes.

Looking now to the drawings, FIG. 1 shows a lamp assembly **10** electrically connected to a variable power supply **12** via conductors **14**. The supply **12** is provided with a suitable dial actuated element **16** whereby the voltage to the lamp assembly **10** can be selectively varied. A voltmeter **18** and ammeter **20** are connected to the power supply **12** to provide an indication of the magnitude of voltage and current to the lamp assembly **10**. The output from power supply **12** can be controlled by a timer **22** whereby the time interval for energization of the assembly **10** can be selectively varied. The timer **22** could also provide an audible signal for operator control or could be connected to actuate a shutter structure (such as defined below by straps **36**, etc.)

The lamp assembly **10** is readily portable and includes a housing **24** which has a handle **25** mounted at its rearward side. The housing **24** has an open forward face which is generally closed by a cover assembly **26**. A pair of gas lamps **28** (the details of which are to be described) are supported in the housing **24** with an arcurately shaped reflector **30** supported behind. A suitable filter system **32** (the details of which are to be described) is located between the lamps **28** and the cover assembly **26**. The cover assembly **26** has a pair of side by side slots **34** which when open will, of course, transmit the light energy from the lamps **28** as enhanced by the reflector **30**. A pair of strap members **36** are slidably supported in guides **38** and **40** and can be selectively moved relative to the slots **34** whereby the area of light transmission through the slots **34** can be selectively varied.

It has been indicated in some prior literature that a wave length of 296.7 nanometers provides maximum erythemal effect on human skin. However, it is believed that substantial erythemal effect can be obtained at other wave lengths. Therefore it would be desireable to have a device capable of generating a significant output over the entire UV range such that any desired wave length could be (by proper filtering) selected and effectively utilized. Such a device could have substantial clinicial and domestic use. With prior UV apparatus mercury vapor tubes have been used to generate ultra-violet (UV) light. The output from a mercury vapor tube, however, in the UV range is erratic and generally composed of a series of peaks and valleys (see FIG. 4A). In fact the mercury vapor tube output could have a minimum output point at the desired wave length; for example 296.7 nanometers. A xenon gas tube in the UV range (see FIG. 4B) has a relatively uniform output. It has been found that by adding a relatively small percent of xenon to a mercury vapor tube that the relative intensity of the resultant tube over the UV range will be quite smooth when compared to the tube with mercury without xenon (FIG. 4A); of especial significance is the fact that the valleys or minimal output points are substantially eliminated. The result is a tube or lamp which can be effectively used at generally any desired wave length in the UV range. It should be noted that mercury - xenon lamps have previously been used for street lighting. Xenon alone will provide a high relative intensity in the visible light range and also a high relative intensity in the infra-red range. For lighting, a large quantity of xenon is used to enhance the visible light output. At the same time, of course, a considerable amount of heat is generated as a result of the high infra-red (IR) output of xenon. For devices utilizing the UV range it is desireable to minimize the generation of IR. It was found by limiting the percent of volume of xenon in the tube, e.g. to a maximum of between around 4 to 6 percent, the desired results can be obtained without undue heat generation. In a preferred form good results were obtained with a mercury vapor tube doped with 4 percent by volume of xenon with the tube at a pressure of around 3.5 atmospheres; of course, the tube could also include some argon which aids the firing of the tube.

The desired wave length can be obtained by proper selection and design of the filter **32**. While the filter **32** is shown as a single glass element it should be understood that in actual practice a plurality of such elements may be utilized. The apparatus as shown in FIG. 1 is for clinical use to test erythemal effect on human skin. In such a case the filter **32** is designed to be relatively sharp cut at the desired UV wave length such as 296.7 nanometers. The device would be used by contacting the test patient's body with the front cover **26**. This will automatically locate the skin a preselected distance from the tubes **28**. Next the tubes **28** can be energized for a fixed time by the timer **22**. By moving the straps **36** the exposed skin area can be selectively varied. In this manner erythemal effect at different wave lengths (by changing filter **32**) and for different time intervals can be selected. The apparatus would be useful for determining the effectiveness of various sun tan lotions, etc., which purport to be effective against crythemal effect (sunburn) from the sun. Note that in minimizing the magnitude of IR generation heat problems are minimized and discomfort to the patient is avoided. Some air cooling, via a small fan (not shown) could be provided to cool the filter **32**.

The UV output from the assembly **10** can be calibrated by calibration apparatus **44**. The apparatus **44** can include a photosensitive element **50** and may or may not utilize an additional filter **48** to attenuate the output from the assembly **10**. The intensity of the transmitted UV light can be read upon a meter **52** and can then be adjusted to the desired magnitude by manipulation of the voltage output from the power supply **12**. In this way tests can be repeated at the desired wave length for a selected time at a selected intensity.

To improve the efficiency of the assembly **10** the reflector **30** was designed to have a parabolic curvature. In addition it was found that the type of surface finish was significant. It was found that a dull, matte like finish resulted in a substantially higher percentage reflectance than a polished finish. Thus an

aluminum reflector polished, e.g. to have a micro finish of from around 5 to 20 micro inches, and subsequently sand blasted with fine grain sand to dull the finish will have a higher percentage of reflectance in the UV range than a polished, shiny reflector. A magnesium oxide coat, applied by electrodeposition to a polished surface, also provides a dull finish having higher reflectance than the polished reflector; the same is true of a polished surface which has been dulled by chemical etching. Thus the reflector **30** constructed to have a dull, matte like finish improved the efficiency of the assembly **10** in the UV region.

While some discussion has been made with regard to mercury street lights which use a substantial amount of xenon, it is significant to note that conventional mercury sun lamps do not use xenon. Such lamps, in order to increase the UV output, locate the electrodes a substantial distance apart, i.e. in some lamps around 1.75 inches, requiring higher operating voltages. These lamps also, at the higher voltages, have a substantial IR output or heat generation. In the mercury - xenon tube of the present invention the UV output is enhanced (by the xenon) and as a result the operating voltage need not be as high. This permits the electrodes **54** to be spaced relatively close to each other. The result is an efficient UV generator with less heat (IR) generation for a given output in the UV range. In one form, the electrodes were located 0.75 inch apart.

The more proximate location of the electrodes **54** provides an added advantage. With conventional sun lamps in order to maintain the arc pressure (and hence the arc), supplemental heat to the tube is required; it has been the practice to locate the ballast near the tube and to use its heat generation as the source of supplemental heat. This, of course, results in a cumbersome design. In the present invention, with the electrodes **54** located so close the internal local temperatures are more readily maintained at the necessary level to maintain arc pressure (and hence the arc) and as a result no supplemental heat source is required. Thus the ballast can be located remotely from the lamp assembly **10** permitting the design of a readily, portable device.

Note that the tubes **28** have an output characteristic (see FIG. **4C**) which encompasses not only those wave lengths causing erythemal effect but also in the germicidal range. Hence the tubes **28** could be used effectively for sterilization of clinical instruments, control of bacteria, molds, and other micro-organisms.

While it will be apparent that the preferred embodiments of the invention disclosed are well calculated to fulfill the objects above stated, it will be appreciated that the invention is susceptible to modification, variation and change without departing from the proper scope or fair meaning of the invention.

We claim

1. Apparatus for providing a controlled light output in the ultra-violet range to provide an erythemal effect, comprising: lamp means for generating a generally continuous output for substantially the ultra-violet range, said lamp means comprising a housing having an opening at one end, at least one lamp mounted in said housing for transmitting light towards said opening, filter means connected to said housing over said opening for providing a filtered output from said lamp over a selected wave length range whereby the filtered output can be used to provide an erythemal effect, and calibration means separate from said lamp means for determining the intensity of the filtered output over said selected range, variable power supply means selectively actuable for varying the power to said lamp and hence for selectively controlling the intensity of the filtered output whereby the erythemal effect can be controlled, said lamp comprising a mercury vapor gas lamp with the gas doped with a small quantity of xenon being no greater than around four percent of the gas by volume, said lamp having closely spaced electrodes being spaced no greater than around 0.75 inch.

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