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DEVICE AND METHOD FOR PRODUCING NEGATIVE IONS

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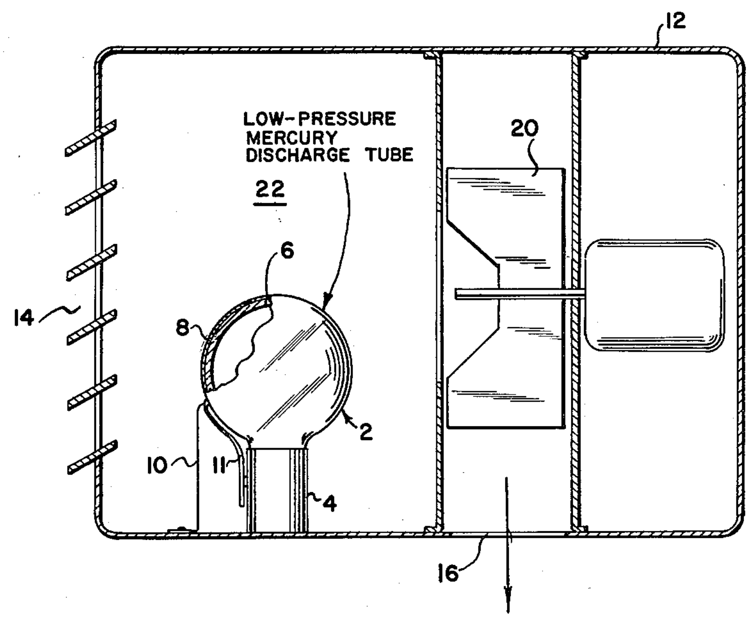

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DEVICE AND METHOD FOR PRODUCING NEGATIVE IONS

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This invention relates to the production of negative ions and the utilization thereof, and more in particular to improved methods and means for producing negative ions and for delivering them in an efficient and dependable manner to the zones of use.

An object of this invention is to provide improved methods and means for producing negative ions. A further object is to provide improved apparatus for producing negative ions in high concentration. A further object is to provide improved methods and apparatus for air purification. A further object is to provide improved therapeutic methods and apparatus. A further object is to provide for the above with apparatus which is efficient and dependable in use, compact, sturdy in construction and relatively inexpensive to manufacture, operate and maintain. These and other objects will be in part obvious and in part pointed out below.

In the drawing:

The single FIGURE is a somewhat schematic representation of one embodiment of the invention, with some parts broken away, and in section.

It has been found that negative ions have many uses, for example, in air purification and in therapeutic work. In the past, difficulties have been encountered in attempting to provide thoroughly satisfactory negative ion sources, particularly when a high concentration of negative ions is desired.

In the illustrative embodiment of the present invention, the envelope of an ultraviolet photon-emitting tube is coated with an extremely thin metallic layer of gold. This layer absorbs photons from the tube emitter onto one of its surfaces, and ejects photoelectrons from its opposite or external surface. That is, the photoelectrons are ejected from the side of the layer which is opposite the side on which the photons are absorbed. The photoelectrons are picked up by the atoms or molecules of gas surrounding the envelope. In the illustrative embodiment, this body of gas is a stream of air, and the air flow carries the negative ions to the zone of utilization.

Referring to the drawing, a tube **2** has an internal emitter at its base **4** which produces ultraviolet photons. Tube **2** has a bulb or envelope **6** of quartz or vicor which is 95% quartz and 5% glass. Upon the external surface of bulb or envelope **6** there is a thin metallic coating or layer **8** of gold. Layer **8** is grounded by a wire **10** which is held thereon by a clamp **11**, so that it is maintained at ground potential. Tube **2** is enclosed in a casing **12** which has a louvered inlet opening **14**, and an outlet opening **16** from which the air is discharged by a fan **20** driven by an electric motor. The photons pass freely through envelope **6** onto the inner surface of layer **8**. This causes layer **8** to emit electrons which pass into the zone **22** of the body of air surrounding the envelope. Particles of dust in this air may receive some of the photoelectrons. The other photoelectrons are received by atoms or molecules of the air constituents, such as the oxygen, thereby causing the air to be a source of concentrated negative ions. The fan blows the air from this zone **22** to the zone or zones of use. Hence, the air acts as means to carry negative ions from zone **22** at tube **2**.

The thin layer **8** of metal is deposited on the tube envelope **6** by vacuum evaporation, and this permits accurate control of the thickness of the metallic layer, and it also insures uniform thickness of the layer throughout the envelope surface. In the illustrative embodiment, the metallic layer is gold of the thickness of the order of 75 to 400 Angstrom units, and certain tests have indicated that the preferable thickness is near the lower limit of this range.

Layer **8** is thick enough to permit the absorption of the photons, and thin enough to permit the escape of photoelectrons.

In the illustrative embodiment, tube **2** is a low-pressure mercury discharge bulb which emits 90% of its energy at the line of 2537 Angstrom units. The tube is rated at 3.5 watts, with an ultraviolet photon output of .1 watt. As has been indicated, the gold layer **8** was deposited by vacuum evaporation and, during the depositing of this layer, the tube was rotated constantly between two gold vapor sources. The ground wire **10** is mechanically clamped to layer **8**.

The invention contemplates that other metals and other photon sources may be used in place of those of the illustrative embodiment. Photoelectrons will not be emitted from the layer unless the photons are of sufficiently high energy. In general, only photons below a certain wave length will produce photoelectrons for a given metallic coating. The maximum wave length for a particular metallic coating may be calculated from the photoelectric function of the metal by the relationship

$$\frac{hc}{\lambda \text{ max.}}=W$$

where W is the work function in electron volts, h is Planck's constant; c is the velocity of light; and λ max. is the maximum wave length photon which will produce a photoelectron. The following are the values of W and λ max. for some metals:

	W	λ Max., A.
Gold	4.82	2,552
Cesium	2.84	4,331
Mercury	4.53	2,715
Nickel	5.01	2,455
Lead	4.0	3,075
Silver	4.73	2,600
Tungsten	4.5	2,733

If a light emitting tube is covered with a thin layer of metal, photoelectrons will be given off if all of the following conditions obtain:

(1) The wave length of some of the emitted light is below the critical maximum for the metallic coating;

(2) The photoelectrons can escape from the metallic coating; and,

(3) The metal film does not become positively charged, thus stopping the escape of further photoelectrons.

Condition (1) can be obtained by selecting a suitable source of emission spectra for the bulb, and a suitable metallic coating. In this connection, note that the alloys frequently have lower work functions than the pure metal. Normal tungsten bulbs emit light down to 3000 A. Mercury arc tubes emit light down to 1849 A.

Condition (2) can be obtained by having a sufficiently thin metallic film. In this connection, two factors must be balanced—the probability of absorbing a photon increases with the thickness of the film, while the probability that the photoelectron will escape decreases with the thickness of the film. In general, the optimal thickness cannot be predicted theoretically, but should be determined experimentally. This is because we do not have accurate range energy curves for electrons of very low energy.

Condition (3) is overcome by providing a grounding wire in contact with the metallic film.

In the illustrative embodiment, a single tube has been shown, and the metallic coating is substantialy spherical. The invention contemplates that more than one tube may be used operated in a parallel or series electrical circuit, and that tubes of other types and shapes may be used. While the drawing and the description are somewhat schematic it is understood that the tube is provided with auxiliary components, including a switch, ballast and wire for connection to a suitable source of electricity.

As many possible embodiments may be made in the above invention and as many changes might be made in the embodiments above set forth, it is to be understood that all matter hereinbefore set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in the limiting sense.

I claim:

1. In a device for producing negative ions, the combination of, a source of photon radiation, a non-metallic envelope for said source having an envelope wall which is adapted to permit photons to pass therethrough, a thin metallic layer coated upon the side of said wall opposite said source, said layer being of a thickness which is great enough to stop a substantial portion of photons which have passed through said wall but being thin enough to permit the escape of photoelectrons from the side of said layer opposite said wall.

2. A device as described in claim 1, which includes means to maintain said metallic layer at a substantially stable potential.

3. A device as described in claim 1, wherein said source of photon radiation is a low-pressure mercury discharge tube and wherein said metallic layer is a layer of gold with a thickness of the order of 75 to 400 Angstrom units.

4. A device as described in claim 1, wherein said source of photon radiation is a low-pressure mercury discharge tube and wherein said metallic layer is a layer of gold with a thickness of the order of 75 Angstrom units.

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