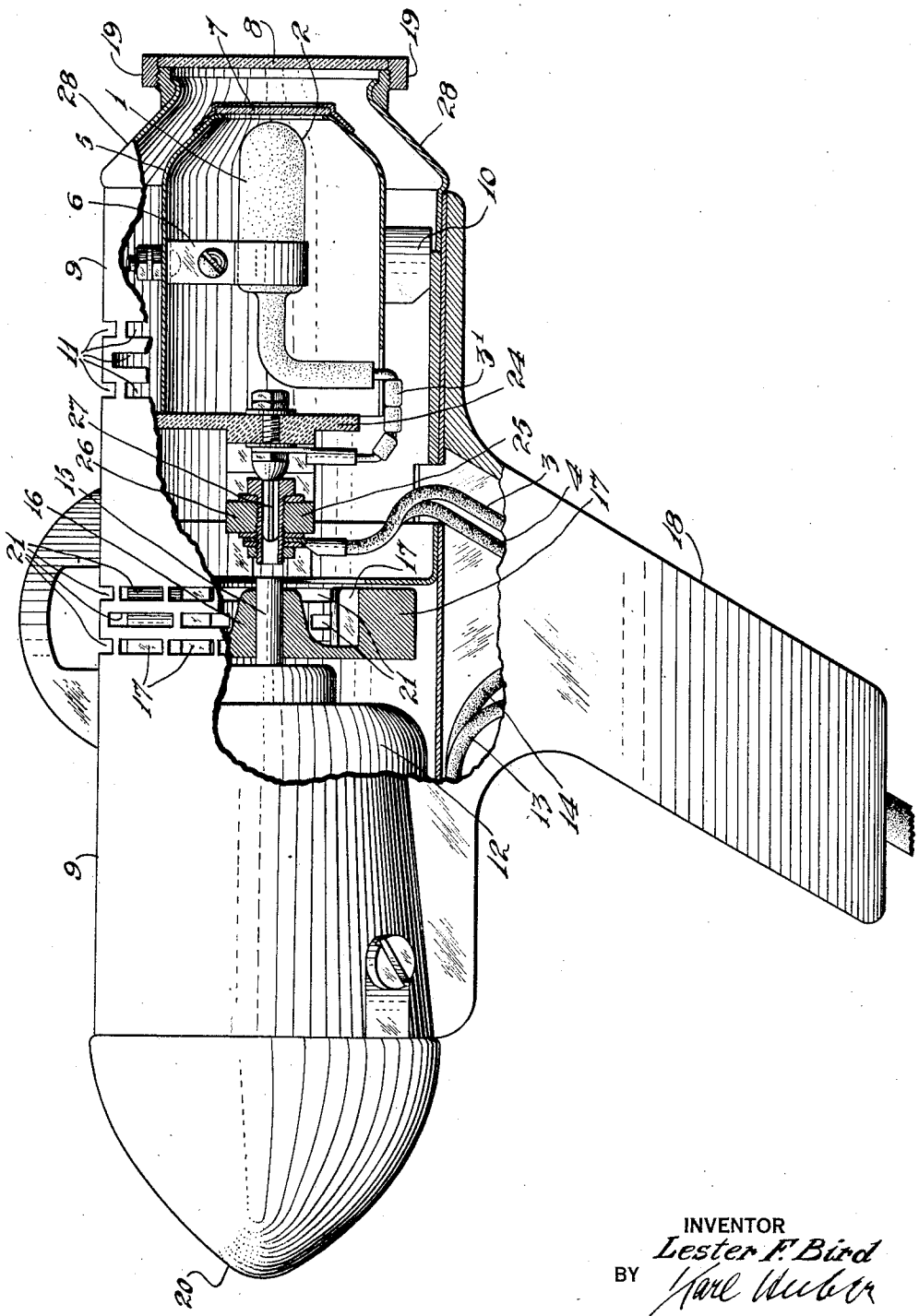
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ULTRAVIOLET IRRADIATOR

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ULTRAVIOLET IRRADIATOR

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This invention relates in general to ultra-violet irradiators and is concerned in particular with ultra-violet irradiators for use in close proximity to or in contact with the surface of the object to be irradiated.

Ultra-violet contact irradiators are used particularly in the therapeutic treatment of human skin. High intensity ultra-violet irradiators which are most useful for the purpose develop, however, considerable heat incident upon the generation of ultra-violet rays and cannot, therefore, be used as such as contact irradiators where such heat is objectionable, as for instance in the treatment of the skin or other sensitive parts of the human body. A high intensity ultra-violet irradiator suitable for contact irradiation comprises an electrical discharge device of the mercury pool electrode type surrounded by a quartz jacket which is cooled by a constant flow of water, a device which is subject, however, to various disadvantages in that it is rather cumbersome and expensive, causes a great deal of operating trouble, and forces the ultra-violet rays to travel through a layer of water whereby the full transmission of the ultra-violet rays is often interfered with due to the inherent nature of the water or the precipitation on the jacket or the exit window of impurities and dissolved matter, and further in that the existence of the liquid electrodes makes the discharge device extremely sensitive to motions.

It is, therefore, the prime object of my invention to provide a high intensity ultra-violet irradiator suitable for use in close proximity to or in contact with the surface to be irradiated, such as the skin, mucous membranes or other sensitive surface parts of the human body, wherein the heat developed incident to the production of the desired ultra-violet rays is prevented from exercising an undesirable effect upon the surface to be irradiated or from causing discomfort to the patient. It is a further object of my invention to provide an irradiator of the type described wherein the full transmission of the ultra-violet rays shall not be interfered with. A still further object of my invention is the provision of a high intensity contact irradiator which shall be simple, economical and easy to handle.

The chief feature of my invention resides in the cooling as hereinafter described of a high intensity electrical discharge device provided with activated electrodes. Such electrical discharge devices consist in essence of an envelope of vitreous material permeable to ultra-violet rays, such as quartz or certain glasses, containing a filling of inert gas, such as argon, and a metal vapor, such as mercury, the electrical discharge taking place within the envelope between two solid electrodes at least one of which consists of an activated cathode. In such electrical discharge devices the amount of vaporizable metal in vapor form remains substantially constant for which reason the temperature at any part of the envelope must not fall during effective operation. The device with which I am particularly concerned is one of the general type described but in which during operation all vaporizable metal is in vapor form and the vapor pressure is near to or in excess of one atmosphere, for instance about three to four atmospheres, which device is known as "dosed high pressure" electrical discharge device. If the temperature at any part of the envelope of the electrical discharge devices described falls so as to produce condensation of metal vapor, whereby the vapor pressure is decreased, the characteristics of the metal vapor arc and of the ultra-violet rays are adversely affected. As cooling of such electrical discharge devices is not possible the elimination of heat from the immediate neighborhood of the entire device is difficult. The term "constant pressure electrical discharge device" as used hereinafter shall mean such electrical discharge devices having solid electrodes at least one of which is an activated cathode, and provided with a filling of inert gas and a metal vapor, the latter being in operation at a substantially constant pressure, and the term "dosed high pressure electrical discharge device" shall mean a constant pressure electrical discharge device wherein the metal vapor pressure shall be high.

I have found that the heat produced by the high intensity constant pressure electrical discharge device described can be prevented from reaching the surface to be irradiated by enclosing the irradiator in a heat retaining vessel having a window of material permeable to ultra-violet rays, said vessel being placed within a surrounding housing also provided with a similar window, wherein at least the window of the surrounding housing and preferably both windows are cooled by a constant flow of air.

The nature and accomplishment of my invention are best illustrated by reference to the accompanying drawing, forming part hereof, and representing a vertical longitudinal elevation, partly in section, of my contact irradiation device.

The ultra-violet rays emanate from the constant pressure electrical discharge device 1 having an envelope 2 of quartz or the like ultra-violet ray permeable material, which may have, as shown in the drawing, the conventional U-shaped form. Electrical current is provided by the inleads 3, 3' and 4. The ultra-violet electrical discharge device is surrounded by the vessel 5 in which it is held in any suitable manner, for instance by the support 6. The vessel 5 may be constructed of any suitable material, such as nickel, copper, steel or refractory non-metallic material. The temperature prevailing within the vessel 5 is such that the desired vapor pressure within the electrical discharge device 1 is not interfered with.

The heat retaining vessel 5 is provided with a window 7 of material permeable to ultra-violet rays, such as fused quartz, and is located in front of the constant pressure irradiator 1. The vessel 5 containing the irradiator 1 is placed within but spaced from an outer housing 9 of suitable metal, such as nickel or stainless steel, to which it is secured in any suitable manner, such as by support 10, the support consisting preferably of a material of relatively poor heat conductivity, such as refractory non-metallic materials, for instance porcelain, alundum or the like, or thin strips of metal, or the like.

The outer housing 9 is provided on one side with openings 11 connecting with the space left between the housing 9 and the inner vessel 5. The front end of the housing 9 is provided with a window 8 of ultra-violet ray permeable material such as fused quartz, crystal quartz or suitable glass. At the other end of housing 9 I provide an electric motor 12, with conductors 13 and 14 for the supply of electric power. Mounted on the shaft 15 of the motor 12 is a fan which may consist advantageously of body 16 and rectangular blades 17. Attached to the bottom part of housing 9 I may provide a handle 18 serving to conveniently hold by hand the entire device, and to hold within its interior the various electrical conductors. The outside housing 9 may be conveniently of cylindrical shape with a tapering end 20, and the window 8 may be protected, when the device is not in use, by a cover, not shown.

In the drawing I have shown a construction wherein the inner vessel 5 is removably secured to the outer housing 9. The removability of vessel 5 including the irradiator 1 is further facilitated by mounting the entire vessel on a plate 24 closely fitted to the inner wall of housing 9, and by connecting the inlead conductors 3 and 4 with the electrodes of the electrical discharge device 1 by means of a spring contact, as shown for instance in the case of lead-in 3 connected to receptacles 25 and 26 holding spring contact 27 from which lead-in wire 3' leads to its electrode within the envelope 2. Where the vessel 5 and the electrical discharge device 1 are thus secured removably to the outer housing 9 it is convenient to provide the front part 23, including window 8, of the outer housing as an integral part of the inner vessel 5, rather than of the outer housing 9.

The window 8 may be fitted to the front end of the device in such mannner that it can be removed, for instance by fitting it within brackets 19 screwed to the front end of the outer housing.

My contact ultra-violet irradiator operates in such manner that the motor 12 and the electrical discharge device 1 function at the same time. The cool air is drawn through the openings 11 into the space around the inner heat retaining vessel 5 and flows past windows 8 and 7 and around the vessel 5 toward the fan blades 17, whereafter the now hot air is expelled through exit openings 21.

As pointed out before the temperature within the inner heat retaining vessel 5 is such that the metal vapor pressure of the constant pressure electrical discharge device 1 is not interfered with, the construction being such that no air current comes into contact with the envelope 2. For the same reason the vessel 5 is preferably substantially insulated, as far as heat conductivity is concerned, from the outer housing 9, as by making the supports 10 of material having low heat conductivity, by constructing the mounting plate 24 of refractory non-metallic material, and by constructing, if desired, the entire vessel 5 of a similar refractory material. Such insulation of the vessel 5 from the outer housing 9 further has the advantage that no substantial amount of heat is conducted to the outer housing.

The outside surface of vessel 5 will usually be at an elevated temperature and heat is radiated from it into the space between vessel 5 and the outer housing 9 and between window 7 and window 8, and will be radiated to window 8.

The sucking or drawing action of the fan blades 17 draws away from the above mentioned space the hot air contained therein, and replacement by cool air takes place through openings 11, whereby a constant flow of cool air is obtained, cooling in particular windows 8 and 7. With the flow of air at suitable velocity the window 8 will constantly be at such temperature that its outer surface can be brought into close proximity to and contact with sensitive surfaces such as human skin, where the maximum permissible temperature for metal objects in contact therewith is about 45° C. Since room temperature often approaches 35° C. the maximum temperature of 45° C. at the contact surface allows only a temperature rise of 10° C. I have found that the cooling by flow of air in my contact irradiator decreases the temperature of several hundred degrees C. prevailing at the outside of the envelope 2 of the electrical discharge device 1 to less than 45° C. on the outside of the outer housing 9 and the window 8.

It is one preferred feature of my device that the windows 7 and 8, or at least one of them, is constructed of material capable of absorbing infrared rays while yet freely transmitting ultra-violet rays, such as pure quartz or specially designed glasses, thus aiding in providing as low a temperature as possible on the outside of the window 8 which is in direct contact with the human skin or other contacted surface.

A further preferred feature of my device is a construction substantially as shown in the drawing whereby the first of the incoming air, i. e. the as yet cool air, is directed against the inner surface of the contact window 8 and also over the outer surface of the inner window 7. As the radiation of heat is particularly concentrated on the windows 7 and 8 the direction of the incoming cool air against the inner surface of window 8 and to some extent also against the outer surface of the inner window 7 is particularly effective in producing cooling, because cooling air is more efficient in removing heat when applied to a small hot area rather than to a larger relatively less hot area.

It has been established that with the cooling by a flow of air in accordance with my invention an

irradiation device is provided which utilizes the ultra-violet radiation of high intensity constant pressure, especially dosed high pressure, electrical discharge devices provided with activated electrodes and which permits the use of such rays in close proximity to sensitive surfaces, as in the therapeutic treatment of human skin. The device according to my invention is extremely simple in construction and does not require rubber hoses or other disturbing appurtenances, thus being highly flexible in use. The transmission of the ultra-violet rays is not interfered with and the full benefit of the radiation is thus retained. The wattage input to my air cooled irradiator can be less than the input to the water cooled type due to the higher efficiency of my air cooled irradiator. Also my air cooled irradiator permits a more concentrated arc stream in the electrical discharge device than is the case with the water cooled irradiators. The more concentrated arc stream also increases the efficiency of applicators serving to conduct the ultra-violet rays to specific areas or to surfaces within orifices or serving to intensify the ultra-violet rays on a limited area.

What I claim is:

1. A high intensity ultra-violet contact irradiator comprising a constant high pressure electrical discharge device provided with solid electrodes at least one of which is an activated cathode, a heat retaining vessel spaced from and completely enclosing and surrounding said electrical discharge device and containing a substantially still atmosphere, an outer housing for said vessel and being spaced therefrom, said vessel and said housing having juxtaposed windows of ultra-violet permeable material, whereby ultra-violet rays from said electrical discharge device are transmitted through said windows, and means associated with said housing to provide a flow of cool air through the space between said vessel and said housing at least between said juxtaposed windows.

2. A high intensity ultra-violet contact irradiator comprising a constant high pressure electrical discharge device provided with solid electrodes at least one of which is an activated cathode, a heat retaining vessel spaced from and completely enclosing and surrounding said electrical discharge device and containing a substantially still atmosphere, an outer housing for said vessel and being spaced therefrom, said vessel and said housing having juxtaposed windows of infra-red absorbent vitreous material permeable to ultra-violet rays, whereby ultra-violet rays from said electrical discharge device are transmitted through said windows, and means associated with said housing to provide a flow of cool air through the space between said vessel and said housing at least between said juxtaposed windows.

3. A high intensity ultra-violet contact irradiator comprising a constant high pressure electrical discharge device provided with solid electrodes at least one of which is an activated cathode, a heat retaining vessel spaced from and completely enclosing and surrounding said electrical discharge device and containing a substantially still atmosphere, an outer housing for said vessel and being spaced therefrom, said vessel and said housing having juxtaposed windows of ultra-voilet permeable material, whereby ultra-violet rays from said electrical discharge device are transmitted through said windows, and a motor driven fan within said housing to provide a flow of cold air through the space between said vessel and said housing at least between said juxtaposed windows.

4. A high intensity ultra-violet contact irradiator comprising a dosed high pressure electrical discharge device provided with solid electrodes at least one of which is an activated cathode, a heat retaining vessel spaced from and completely enclosing and surrounding said electrical discharge device and containing a substantially still atmosphere, an outer housing for said vessel and being spaced therefrom, said vessel and said housing having juxtaposed windwos of infra-red absorbent vitreous material permeable to ultra-violet rays, whereby ultra-violet rays from said electrical discharge device are transmitted through said windows, and means associated with said housing to provide a flow of cool air through the space between said vessel and said housing at least between said juxtaposed windows.

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