

July 7, 1959

H. MOHN

2,894,166

HEAT RADIATION DEVICES

Filed May 18, 1955

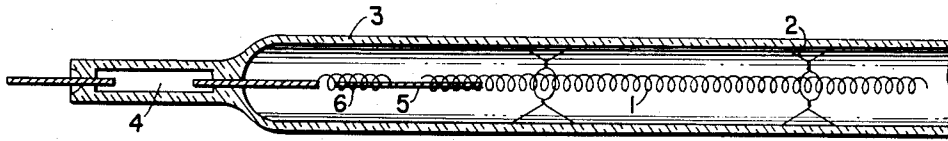


FIG. 1

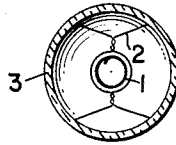


FIG. 2

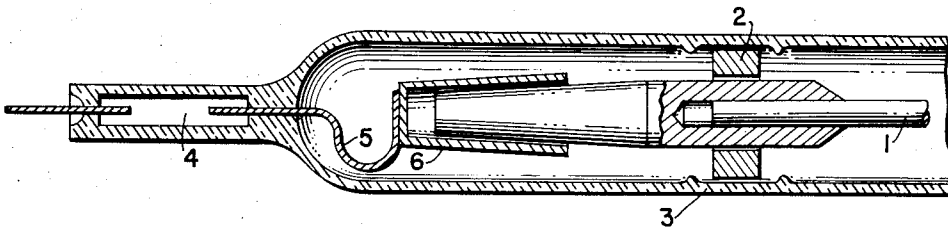


FIG. 3

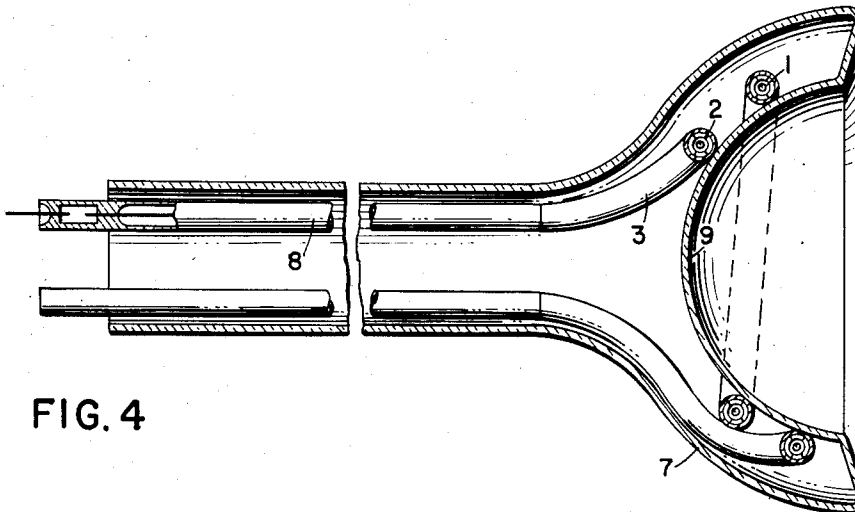


FIG. 4

INVENTOR
HEINRICH MOHN

BY

Alvin Hart
ATTORNEYS

1

2,894,166

HEAT RADIATION DEVICES

Heinrich Mohn, Hailer, Kreis Gelnhausen, Germany, assignor to W. C. Heraeus G.m.b.H., Hanau (Main), Germany, a German body corporate

Application May 18, 1955, Serial No. 509,335
In Germany April 2, 1949

Public Law 619, August 23, 1954
Patent expires April 2, 1969

9 Claims. (Cl. 313—221)

The present invention relates to heat radiation devices and has for an object to provide improved heat radiation devices adapted to radiate at least 1.5 watts per square centimetre of the surface of the apparatus. A further object is to provide heat radiation devices capable of radiating more than four watts per square centimetre, in some cases for example up to 12 watts per square centimetre.

In heat radiation devices which are intended for therapeutic and industrial uses it is important to obtain high intensity of radiation, while the ranges of wavelengths comprised by the radiation are also of importance. Thus for example in medical therapy the depth of penetration of heat radiation has been found to increase considerably towards shorter wavelengths i.e. with increasing temperature of the radiating element. Experience has shown that the radiation of a heating conductor at 1000° K. penetrates into the organism to a depth of approximately 0.5 to 1 mm., while that of a radiating element at 2000° K. penetrates into the organism, e.g. the human body, to a depth of approximately 3 mm. In many industrial processes, for example in drying processes, an increase of the effect towards shorter wavelengths is also observed, although in many cases an optimum is obtained at a predetermined wavelength, for example in certain drying processes when using radiators having a temperature of 1800° to 2000° K. It is also an object of the present invention to provide with simple technical means heat radiating devices of comparatively high output which more particularly will emit radiation of relatively short wavelengths.

Various embodiments of heat radiation devices according to the invention are illustrated in Figs. 1 to 4 of the accompanying drawing. According to the present invention the heat radiation devices are prepared in a simple manner by enclosing an electric heating conductor the dimensions of which ensure the required temperature and intensity of radiation, by an envelope of silicon dioxide, without the use of radiation absorbing intermediate layers or embedding masses. The silicon dioxide may for example be employed in the form of transparent quartz glass, or preferably of a semi-transparent or milky-translucent quartz glass, or of quartz ware, for example of quartz ware produced by a centrifugal process and known under the registered trade mark Rotosil. The invention utilises the fact that quartz glass combines resistance to high temperatures with a good permeability for heat radiation.

It is essential for obtaining the great advantages of the invention that the envelope of silicon dioxide, which surrounds the electric heating conductor, is sealed in a gas-tight manner and is filled with an inert gas instead of air. The gas filling preferably consists of 85 to 99% of rare gases, the remainder being nitrogen, which latter may if desired be replaced by hydrogen or by a mixture of nitrogen and hydrogen. The total gas pressure is above 500 mm. Hg, preferably more than 1 atmosphere, and may for example be up to 3 atmospheres. The content of

2

rare gases in the gas mixture is preferably between 93 and 97%, the percentages figures herein and throughout this specification relating to volumes. Amongst the rare gases argon and to an even greater extent krypton, due to its high molecular weight, have proved particularly advantageous. By the provision of a filling consisting of these inert gases the evaporation of the heating conductor is reduced to a minimum, and in addition parasitic discharges between the two ends, i.e. the points of the highest potential, are suppressed. The current supply through the gas-tight sealed envelope of silicon dioxide is effected in a known manner by means of foils or wires melted or squeezed into the material.

It is also important for the heat radiation device according to the invention that no insulating components are arranged between the heating conductor and the envelope of silicon dioxide, and that the heating conductor itself, which for example may be formed as a heating wire, does not rest in a bedding mass but is extended freely or is simply wound upon a refractory carrier member. In the arrangement according to the invention the radiation is transmitted direct to the envelope; when using transparent quartz glass the radiation passes through the envelope substantially unaltered; in the case of translucent quartz glass or of quartz ware a certain amount of diffusion is additionally obtained which effects the desired uniform distribution in space in the case of unilateral irradiation in conjunction with a reflector. On the other hand both quartz glass and quartz ware have, in contrast to ordinary glass, adequate temperature resistance for satisfying the requirements of such a heat radiation device.

The electric heating conductor may consist of materials generally known in the art, for example of one of the well known metallic heating wires, or of non-metallic heating conductors, more particularly graphite or silicon carbide.

The radiation device is preferably made in tube form, the heating wire being extended or, in the case of greater power, wound upon a carrier, generally in the form of a coil, said carrier itself consisting of highly refractory material, for example of aluminium dioxide or of zirconium oxide. The envelope is placed as closely as possible around the heating wire or heating bar; thus the width of the gap between the carrier of the heating wire and the inner surface of the protective tube is in the case of a load of 4 watts per square centimetre approximately 8 mm. or less. In other cases it may be between a few mm., for example 3 mm., and 10 mm. or more. In this manner greater powers combined with a more uniform width radiation, are obtained, as compared with the use of the reflectors hitherto used, for example in the art of drying, which are fitted with spherical incandescent bulbs. The heat radiation devices according to the invention, while using simpler means, permit higher temperatures and thus shorter radiation wavelengths to be obtained than with known heat radiation devices. It is an important feature that due to the use of an inert filling gas, which may even be applied under a pressure of 1 to 3 atmospheres, the length of life of the heat radiation device is considerably increased. Owing to the fact that the radiation device consists of a tubular envelope which closely surrounds the electric heating conductor, the quartz glass may be stressed by higher pressure than for example in an envelope body made in the form of an electric bulb.

Thus in the heat radiation device according to the invention various effects cooperate in providing an apparatus which surprisingly combines the advantage of high intensity of radiation, high temperature and great length of life.

Referring now to the accompanying drawings, which

3

illustrate embodiments of the heat radiation device according to the invention by way of non-limitative examples, the device illustrated in Fig. 1 comprises a heating helix of high melting-point wire 1, each end of which is plugged upon a mandrel 5 conductively mounted in a wire coil 6, made for example of high melting materials such as tungsten, tantalum and molybdenum. The latter is welded to the current supply member 4, which is formed as a molybdenum foil. The heating coil itself is supported at short distances, in wire members 2 which ensure uniform spacing from the wall of the tube. The interior of the tube 3, which is made of quartz glass, is evacuated and filled with an inert gas as above specified.

Fig. 2 is a cross-section showing the wire member 2 by the centre of which the incandescent helix 1 is supported against the tubular envelope 3.

Fig. 3 shows a modified embodiment, in which the heating element is constituted by an incandescent bar 1 made of graphite or of silicon carbide and mounted longitudinally displaceably in two end pieces of greater diameter made of the same material, or similar material; the distance from the wall of the tube is ensured at each end by a distance ring or spacer ring 2 which is prevented from longitudinal displacement by two dimples pressed out of the wall of the tube. Current is supplied through a tapered sleeve 6 having as small an amount of taper as practicable, which is fitted on to the thickened end of the heating conductor. Welded to this cone is a multi-strand wire 5 made of high-melting material, which in turn is welded to the current supply terminal 4. The interior of the tubular envelope 3, which is made of silicon dioxide, for example of quartz glass or of quartz ware, is filled with an inert gas as specified further above, as in the case of the arrangement of Fig. 1.

Fig. 4 illustrates an embodiment in which a heating conductor constructed according to the principles explained with reference to Fig. 1 is incorporated in an immersion hood or bell. This immersion hood or bell has an outer wall 7 consisting of high-melting glass, for example silicon dioxide, and an inner wall 9 made of quartz glass pervious to heat radiation, that is to say, if possible of transparent or translucent material. The current supply terminals are arranged in two protective tubes 8 which are fused to the evacuated heat radiation device proper 3; the construction of this latter device corresponds to that described with reference to Fig. 1. The maximum of radiation in the illustrated examples lies according to the temperature of the heating conductor, between 1μ and 3μ .

Heat radiation devices according to the invention may be used with advantageous results in therapeutics, for example by being embodied in the well known kind of heat radiation device which is used for the production of hyperaemia, and for the treatment of anaemia and for the mitigation of pain. They may also be advantageously employed for fitting in light boxes.

As pointed out above, heat radiation devices according to the invention may also be used with advantage in industry. Thus particular advantages are obtained in the drying of lacquers, paints and dyes, in the polymerisation and condensation of synthetic resins, and in the textile industry for the condensing, hardening and drying of the dyes and sizes used for spun fibres and fabrics. Evaporation and drying processes in the food industries, for example in the manufacture of yeasts or of food salts, can be carried out in a very gentle manner with the help of radiation devices according to the invention. In addition the radiation device according to the invention may be used in the home for cooking when installed as a radiation element in radiation-type hot plates. On the other hand aggressive solutions will in many cases be more advantageously concentrated by the use of these heat radiation devices than by the use of under-heat, by which sensitive solutions are liable to be overheated. Finally the heat radiation devices according to the inven-

4

tion may also be employed as immersion heaters. For this purpose the invention also provides a novel form of immersion heater, constituted by an immersion hood as it has been described above with reference to Fig. 4. When the hood or bell is immersed into the liquid to be heated, the heating elements are in contact with the air which is enclosed therein like the air in a diving bell. They accordingly can transmit heat to the surface of the liquid only by radiation provided that the back of the hood or bell is heat insulated by a cavity filled with insulating material. When vapour is developed by the liquid upon heating, and air escapes from the cavity, the transmission of heat still takes place by radiation through the enclosed gas pocket, and only when considerable temperature variations take place during the operation of the device, may the liquid rise somewhat back into the cavity. It is therefore advisable for the immersion heater bell to be so constructed that even at the inner side a zone adjacent to the lower edge is left free from heating elements. In order to protect the radiating surface from contamination by direct contact with the liquid, the radiating surface is preferably made in the form of a high drawn up dome.

The heating bell illustrated in Fig. 4 may also be used as surface radiating device for the evaporation of liquids.

I claim:

1. Heat radiation device comprising a double-walled bell having an outer wall consisting of a high-melting material and an inner wall consisting of quartz glass pervious to heat radiation, tubes of a silicon dioxide material selected from the group consisting of milky opalescent quartz and quartz ware sealed in a gas-tight manner arranged in the interior of this bell, and electric heating conductors enclosed concentrically by said tubes at a small distance from the tube walls, said tubes being filled with a gas mixture comprising 85 to 99% of rare gases, the remainder being gases selected from the group consisting of nitrogen and hydrogen, the total gas pressure being between 500 mm. Hg and 3 atmospheres, and the heating conductors being so dimensioned that 1.5 to 8 watts per square centimetre can be radiated from the surface of the said silicon dioxide tubes.

2. A heat radiation device adapted to radiate at least 1.5 watt per square centimetre of its surface, comprising an elongated electric heat conductor, a hermetically sealed tube arranged to enclose the electric heating conductor concentrically at a small distance therefrom, the tube being of a silicon dioxide material selected from the group consisting of milky opalescent quartz and quartz ware, and a gas mixture filling said tube, the gas mixture comprising 85 to 99% of rare gases, the remainder being gases selected from the group consisting of nitrogen and hydrogen, and the total gas pressure being above 500 mm. Hg.

3. The heat radiation device of claim 2, wherein the distance between the electric heat conductor and the enclosing tube is no more than 8 mm.

4. The heat radiation device of claim 3, wherein the distance between the electric heat conductor and the enclosing tube is about 3 mm.

5. The heat radiation device of claim 2, wherein the space between the electric heat conductor and the enclosing tube is free of radiation-absorbing solid masses.

6. The heat radiation device of claim 2, wherein the total gas pressure in the tube does not exceed three atmospheres.

7. The heat radiation device of claim 2, wherein said electric heat conductor is a wire coil and there is provided a carrier member of highly refractory material upon which said wire coil is wound.

8. The heat radiation device of claim 2, wherein said electric heat conductor is a non-metallic electric heating rod of a material selected from the group consisting of graphite and silicon carbide.

9. The heat radiation device of claim 2, wherein the gas mixture comprises at least 93% of rare gases.

References Cited in the file of this patent

UNITED STATES PATENTS

2,007,927 Brazelton ----- July 9, 1935

2,030,820
2,097,679
2,185,025
2,227,294
2,228,342
2,235,713
2,275,674

5

James ----- Feb. 11, 1936
Swanson ----- Nov. 2, 1937
Elenbaas et al. ----- Dec. 26, 1939
Brody ----- Dec. 31, 1940
Claude ----- Jan. 14, 1941
Lemmens et al. ----- Mar. 18, 1941
Davies et al. ----- Mar. 10, 1942