Dec. 30, 1969 A. J. CUSSEN 3,487,217

ELECTROMAGNETIC RADIATION EMISSION DEVICE FOR GENERATING BLACK BODY ELECTROMAGNETIC RADIATION

Filed Jan. 17, 1966

Fig. 1

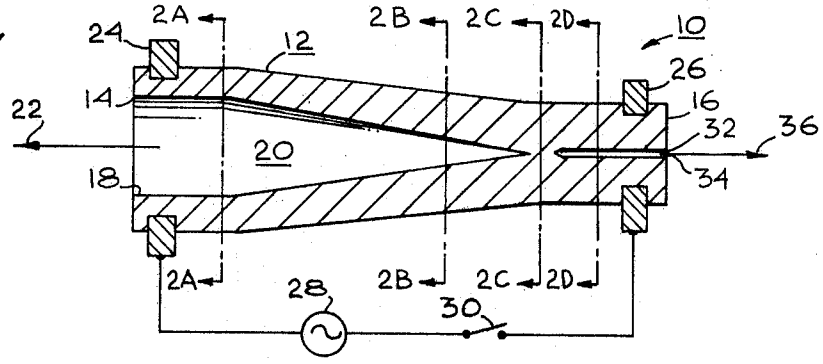


Fig. 2A

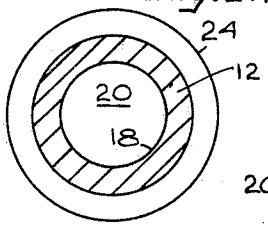


Fig. 2B

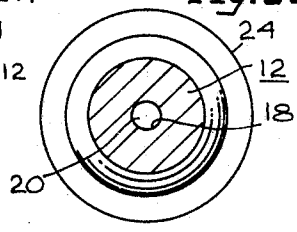


Fig. 2C

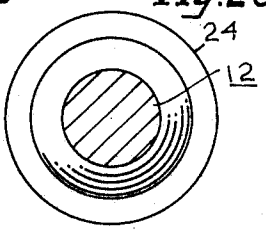


Fig. 2D

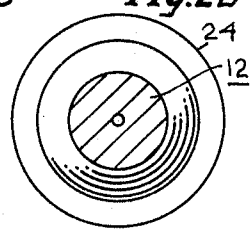
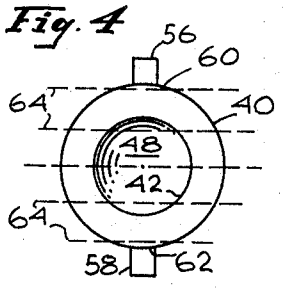


Fig. 4



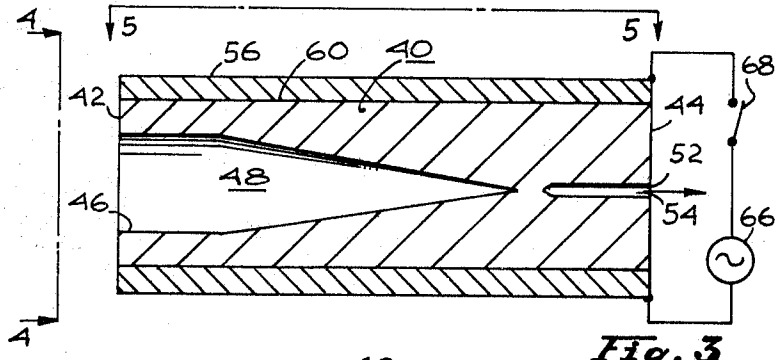


Fig. 3

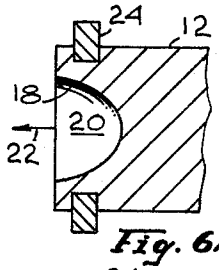


Fig. 6A

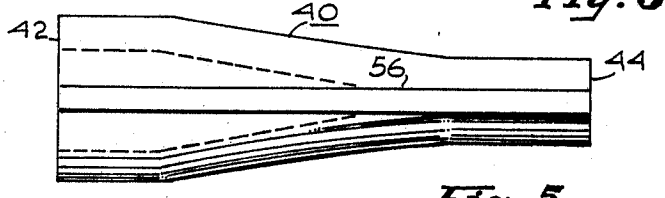


Fig. 5

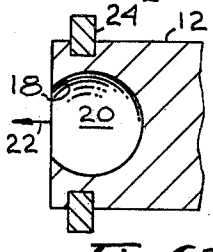


Fig. 6B

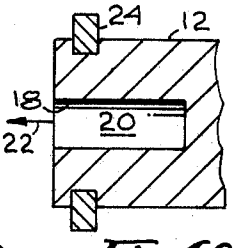


Fig. 6C

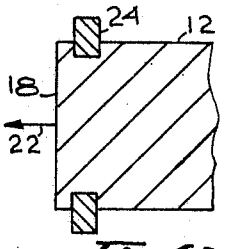


Fig. 6D

INVENTOR.
ARTHUR J. CUSSEN
BY
Don Finkelstein
ATTORNEY

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ELECTROMAGNETIC RADIATION EMISSION DEVICE FOR GENERATING BLACK BODY ELECTROMAGNETIC RADIATION

Arthur J. Cussen, Santa Barbara, Calif., assignor to Electro-Optical Industries, Inc., a corporation of California

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Int. Cl. H01j 35/00; H05b 1/02
U.S. Cl. 250—85 10 Claims

ABSTRACT OF THE DISCLOSURE

There is disclosed herein an improved electromagnetic radiation emission device for generating substantially black body electromagnetic radiation. In this invention, a cavity electromagnetic radiation emission source is provided in a body member. The body member is fabricated from a material resistant to the flow of electrical energy therethrough so that upon the flow of electrical energy through the body member, it is heated. Electrical leads are connected at preselected spaced apart locations on the body member, so that as the electrical energy flows between the connections, the entire body member, including the walls defining the cavity, are heated in a predetermined pattern. The electrical cross-section of the body member between the electrical connections is preselected to give a predetermined heating characteristic, and, therefore, radiation emission characteristic from the cavity.

This invention relates to the electromagnetic radiation emission art and more particularly to an improved electromagnetic radiation emission device.

In the calibration, testing and utilization of many electromagnetic radiation emission responsive systems, such as various infrared systems and the like, there is often a requirement for providing a source of electromagnetic radiation emission having predetermined spectral content. Often, it is desired that such an electromagnetic radiation emission device be adapted to emit electromagnetic radiation at a high temperature in order to provide a comparatively large amount of energy in any given electromagnetic radiation band width.

Prior art electromagnetic radiation emission devices, as far as applicant is aware, have generally required external heating means such as a coil, induction heater or the like, in order to heat the body member containing generally, a cavity type electromagnetic radiation emission source. Since these devices are, more or less, indirectly heated, they have not always been able to provide the desired electromagnetic radiation emission pattern distribution in certain applications or a precise temperature control.

Accordingly, it is an object of applicant's invention herein to provide an improved electromagnetic radiation emission device.

It is another object of applicant's invention herein to provide an electromagnetic radiation emission device in which the temperature of the radiating surface may be provided to obtain any pre-selected electromagnetic radiation pattern distribution.

It is yet another object of applicant's invention herein to provide an electromagnetic radiation emission device in which secondary heating means are not required to provide a high temperature for the emission of electromagnetic radiation.

The above and other objects are achieved, according to one aspect of applicant's invention, by providing a body member fabricated from an electrically conductive

mixture adapted to withstand high temperatures and remain intact throughout comparatively long operating times at such high temperatures. To the best of applicant's knowledge, no such utilization of the materials, as hereinafter set forth, has heretofore been made.

The body member is preferably made from a mixture of for example, aluminum oxide in a range of 10% to 90% by weight and a material such as may be selected from the class consisting of Kanthal metal, Nichrome, platinum, carbon, silicon carbide, silicon and germanium. Ceramic materials may also be utilized in the place of aluminum oxide, if desired. While ceramic-metal combinations, commonly called Cermets have been known in the past, applicant knows of no application where they have been utilized for this particular application providing an electrically conductive body member in an electromagnetic radiation emission device.

Electrical terminals are provided on the body member in a spaced apart relationship, for example, at a first end and a second end thereof. The first end of the electrically conductive body member in this embodiment has walls defining a cavity extending a preselected distance into the electrically conductive body member. In this embodiment of applicant's invention, the electrical cross-section area contour of the electrically conductive body member between the electrical terminals is preselected so that a given pattern distribution of electromagnetic radiation will be emitted from the walls defining the cavity. Thus, for example, the electrical cross-sectional area contour between the two electrical terminals may be constant, that is, the cross-sectional area throughout the length of the body member is constant. In other embodiments of applicant's invention, the electrical cross-sectional area contour may be varied to provide any desired temperature distribution along the walls defining the cavity. However, applicant has found that, in general, to achieve black body radiation, it is generally preferable to have the electrical cross-sectional area contour constant between the two electrical terminals.

Electrical energy is then supplied to the two electrical terminals and since the electrical body member, is itself a conductor, there is a current flowing in the electrically conductive body member. However, the electrical properties of the electrically conductive body member are such that it is heated by the passage of the electric current thereto. Thus, the electrical energy may be supplied for as long as is necessary to heat the electrically conductive body member to any desired temperature for the emission of electromagnetic radiation from the walls defining the cavity.

In other embodiments of applicant's invention, the electrical terminals are supplied along oppositely disposed external peripheral longitudinal locations and the electrical cross-sectional contour is then provided in longitudinally disposed cross-sections between the two electrical terminals.

The above and other embodiments of applicant's invention may be more readily understood from the following detailed description taken together with the accompanying drawing wherein similar reference characters refer to similar elements throughout and in which:

FIGURE 1 and FIGURES 2A, 2B, 2C and 2D illustrate on embodiment of applicant's invention;

FIGURES 3, 4 and 5 illustrate another embodiment of applicant's invention; and

FIGURES 6A, 6B, 6C and 6D illustrate other embodiments of applicant's invention.

Referring now to FIGURES 1 and 2A, 2B, 2C and 2D, there is shown one embodiment of applicant's invention for an improved electromagnetic radiation emission device generally designated **10**. As shown, the electromagnetic radiation emission device **10** has a body member **12**

with a first end **14** and a second end **16**. The first end **14** has walls **18** defining a cavity **20** extending a preselected distance into the body member **12**. The walls **18** defining the cavity **20** comprise a cavity electromagnetic radiation emission source adapted to emit electromagnetic radiation therefrom as indicated by the arrow **22**. While shown as a conical cavity, it will be appreciated that any desired cavity shape may be utilized.

A first electrical terminal **24** and a second electrical terminal **26** which, in this embodiment of applicant's invention, comprise ringlike members, are coupled to the electrically conductive body member **12** and the first electrical terminal **24** is adjacent the first end **14** thereof and a second electrical terminal **26** is adjacent the second end **16**, of the electrically conductive body member **12**. The first electrical terminal **24** and the second electrical terminal **26** are powered by a source of alternating current **28** which, for example, may be conventional 115 volt, 60 cycle alternating current, and power to the electrically conductive body member **12** through the electrical terminals **24** and **26** is controlled by a switch means **30**. It will be appreciated that this is a schematic representation of one means of controlling the electrical current passing through the electrically conductive body member **12** and that the precise means for controlling this current is not part of applicant's invention herein.

In the embodiment of applicant's invention shown in FIGURE 1, the electrically conductive body member **12** has a preselected electrical cross-sectional area contour between the first electrical terminal **24** and the second electrical terminal **26**. The contour may be selected to provide any desired pattern of heating of the walls **18** and, for example, the contour may be substantially a constant electrical cross-sectional area so that electromagnetic radiation **22** is emitted in a substantially black body pattern distribution. FIGURES 2A, 2B, 2C and 2D illustrate the cross-sectional area of the electrically conductive body member **12** at various cross-sectional points thereof, as indicated. Thus, the cross-sectional area shown in FIGURES 2A, 2B, 2C and 2D is substantially constant and at all points the cross-sectional area of body member **12** between the electrical connector **24** and the electrical connector **26** is equal. Applicant has found that this provides a substantially uniform temperature for the walls **18** to provide a closely controlled electromagnetic radiation emission **22** in a substantially black body pattern distribution. It will be appreciated, however, that any other electrical cross-sectional area contour may be selected to provide any radiation pattern distribution from the walls **18** that may be required.

In order to monitor the electromagnetic radiation emitted from the electrically conductive body member **12**, applicant may provide a test electromagnetic radiation emission source **32** defined by wall portions **34** in the second end **16** of the electrically conductive body member **12**. Electromagnetic radiation **36** emitted from the wall portions **34** in a direction substantially opposite to the direction of emission of electromagnetic radiation **22** from the cavity **20** may be monitored and detected and utilized to control the amount of electrical energy flowing into the electrically conductive body member **12** from the electrical terminals **24** and **26** in a manner described in my copending patent application, Ser. No. 521,045, filed concurrently herewith on Jan. 17, 1966. Further, appropriate shielding in the way of thermally insulating sleeves, apertures, and the like, as shown, for example, in the above-mentioned copending patent application may also be utilized, as desired, in arrangements incorporating applicant's invention herein.

While the walls **18** which emit the electromagnetic radiation are shown as defining a conical cavity, it will be appreciated that any other desired geometric shape may be utilized as the surface for emitting radiation. For example, the shape defined by the walls **18** may be hemispheric as shown in FIG. 6A, hyperhemispheric, as shown in FIG. 6B, cylindrical, as shown in FIG. 6C or even flat, as shown in FIG. 6D.

As noted above, applicant utilizes in this invention an electrically conductive body member **12**. That is, the body member itself is at least partially electrically conductive and, preferably, is a comparatively poor electrical conductor in order that it may more readily heat upon the passage of an electric current therethrough. Further, since applicant's invention herein is often utilized to provide electromagnetic radiations and comparatively high temperature surfaces, it is desirable that the body member **12** remain intact and structurally integral over comparatively long extended periods of operation at comparatively high temperatures. Therefore, applicant has found that the body member **12** when specifically designed to be operable at high temperatures is preferably fabricated from a mixture comprising between 10% and 90% by weight aluminum oxide and between 90% and 10%, correspondingly, of a conductor or semi-conductor of electricity which may be selected from the class consisting of Kanthal metal, Nichrome, platinum, carbon or the semiconductors such as silicon carbide, silicon or germanium. When the electrically conductive body member **12** is fabricated from these materials in the proportions listed, applicant has found that the electrically conductive body member **12** rapidly heats upon application of an electric current and remains substantially intact at even comparatively high temperatures.

In the embodiment shown above on FIGURES 1 and 2A, 2B, 2C and 2D, it is seen that the electric current flows substantially axially, that is, along the long dimension of the cavity **20**, which cavity may, if desired, be substantially conical in form, or in the forms shown on FIGURES 6A, 6B, 6C or 6D.

Applicant has found, however, that applicant's invention herein may also be practiced with other configurations of the body member **12** and positioning of the electrical terminals **24** and **26**. It is only necessary in practicing applicant's invention that the body member have a preselected electrical cross-section area contour between the two electrical terminals. FIGURES 3, 4 and 5 illustrate another embodiment of applicant's invention, wherein the electric current flows at substantially right angles to the long axis of a cavity. In this embodiment of applicant's invention shown in FIGURES 3, 4 and 5, there is a preselected electrical cross-sectional area contour between the two electrodes, but it is not necessarily constant.

As shown therein, there is a body member **40** which may be fabricated from the same material as described above for the electrically conductive body member **12**. Electrically conductive body member **40** has a first end **42** and a second end **44**. The first end **42** has wall portions **46** defining a substantially conical cavity **48**, which may, if desired, be in any other geometric shape, such as, for example, the shapes shown in FIGS. 6A, 6B, 6C and 6D, and the wall portions **46** are adapted to emit electromagnetic radiation **50** in a preselected direction. The second end **44** may, if desired, be provided with wall portions **52** defining a test electromagnetic radiation source **54** that may be utilized in the control of the temperature of the body member **40** as described in my copending patent application, Ser. No. 521,045, filed concurrently herewith on Jan. 17, 1966.

In this embodiment of applicant's invention, there is provided a first electrical terminal **56** and a second electrical terminal **58** coupled to the electrically conductive body member **40**, along opposite external peripheral longitudinally disposed surface portions **60** and **62** of the electrically conductive body member **40**.

Since the electrical terminals **56** and **58** are longitudinally disposed with respect to the long axis of the cavity **48**, in this embodiment of applicant's invention, it is preferred that there be a predetermined electrical cross-sectional area contour between the electrical terminals **56**

and 58. Thus, as shown on FIGURE 4, the electrical cross-sectional area, for example, as indicated by the dotted lines 64 should have this preselected electrical cross-sectional area contour. For example, the contour may be selected so that the cross-sectional area along each of the planes indicated by the lines 64 is substantially constant, or it may vary in any desired predetermined manner. In any event, the particular preselected electrical cross-sectional area contour that is determined for the body member 40 is such that the electromagnetic radiation 50 emitted from the wall portions 46 has a predetermined pattern distribution.

In the operation of applicant's invention as shown on FIGURES 3, 4 and 5, electrical energy is supplied from a source of alternating current 66 which, for example, may be conventional 115, volt, 60 cycle alternating current, and it is controlled by, for example, a switch means 68 so that electrical current flows between the electrical terminals 56 and 58 for a time period sufficient to heat the body member 40 to any desired temperature. It will be appreciated that the showing of the switch 68 and the source of electrical energy 66 is a more or less conventional representation and that applicant's invention may equally well be utilized with more sophisticated control systems for controlling the temperature of the electrically conductive body member 40.

This concludes a description of applicant's invention of an improved cavity electromagnetic radiation emission device. Those skilled in the art may find many variations and adaptations of applicant's invention herein and the following claims are intended to cover all such variations and adaptations falling within the true scope and spirit of applicant's invention.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. An electromagnetic radiation emission device comprising in combination;

an electrically conductive body member having a first end and a second end;

said first end of said electrically conductive body member having walls defining an electromagnetic radiation emitting surface having a preselected geometric shape;

a first and a second electrical terminal coupled to said body member in a spaced apart relationship;

and said body member having a preselected electrical cross-section area contour between said first and said second electrical terminals whereby electrical energy is supplied to said electrically conductive body member from said terminals for heating said body member and said walls thereof to provide electromagnetic radiation emitted therefrom in a predetermined pattern distribution.

2. The arrangement defined in claim 1 wherein said predetermined cross-sectional contour of said electrically conductive body member is constant, said preselected shape is conical and said electromagnetic radiation emitted from said walls defining said surface is emitted in a substantially black body pattern distribution.

3. The arrangement defined in claim 2 wherein said first and said second electrical terminals comprise ring like members engaging said electrically conductive body member adjacent to said first end and said second end, respectively.

4. The arrangement defined in claim 2 wherein said first and said second terminals comprise means engaging said body member in oppositely disposed external peripheral longitudinally aligned locations.

5. The arrangement defined in claim 1 wherein said electrically conductive body member is comprised of between approximately 10% and 90% aluminum oxide and between approximately 90% and 10%, correspondingly, of material selected from the class consisting of Kanthal metal, Nichrome, platinum, carbon, silicon carbide, silicon and germanium.

6. The arrangement defined in claim 5 wherein said first and said second electrical terminals comprise ring-like members engaging said electrically conductive cylindrical body member adjacent said first end and said second end thereof, respectively.

7. Arrangement defined in claim 5 wherein said first and said second electrical terminals comprise means engaging said body member in oppositely disposed external peripheral locations, and said preselected electrical cross-sectional area contour comprises cross-sectional areas parallel thereto.

8. The arrangement defined in claim 6 wherein said predetermined cross-sectional contour is constant, said preselected geometric shape is conical and said electromagnetic radiation emitted from said cavity is emitted in a substantially black body pattern distribution.

9. The arrangement defined in claim 7 wherein said preselected electrical cross-section contour is constant and said electromagnetic radiation emitted from said walls defining said cavity is emitted in a substantially black body pattern distribution.

10. The arrangement defined in claim 1 wherein said preselected electrical cross-sectional contour provides substantially constant temperature throughout said walls defining said electromagnetic radiation emission surface.

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RALPH G. NILSON, Primary Examiner

S. C. SHEAR, Assistant Examiner

U.S. Cl. X.R.

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