

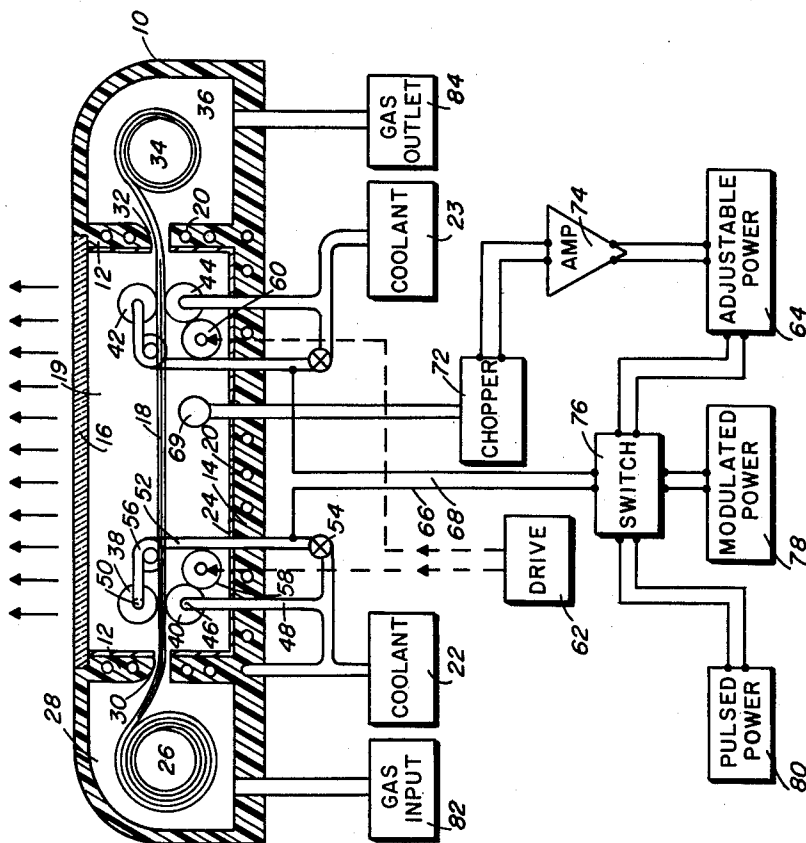
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INFRARED RADIATING SOURCE

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INFRARED RADIATING SOURCE

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The present invention relates to the generation of infrared radiation and, more particularly, to infrared emitting devices for use in scientific and industrial application, for example, in conjunction with spectrometers, searchlights and the like. Such devices in the past have been characterized by conduction or discharge regions of relatively restricted area. The present invention contemplates such devices in which are provided radiation generation regions of unusually large area.

The primary object of the present invention is to provide, in an infrared emitting device of the foregoing type, a large area source in the form of a graphite fabric section capable of converting applied electrical energy to infrared radiation with high efficiency. This graphite fabric section is mounted by fluid cooled graphite connectors which support the graphite fabric section and apply an electrical current thereacross. The graphite fabric section is immersed in a suitable housing having an inert atmosphere therewithin and a window through which radiation from the graphite fabric section may be emitted. Physical-chemical details of preferred graphite fabric, a preferred manner by which the graphite connectors are cooled, a preferred technique for maintaining the infrared radiation constant and a preferred technique for modulating the infrared radiation all constitute features of the present invention.

Other objects of the present invention will in part be obvious and will in part appear hereinafter.

For a fuller understanding of the nature and objects of the present invention, reference should be had to the following detailed description, taken in connection with the accompanying drawing, wherein there is shown a partly mechanical, partly electrical view of a device embodying the present invention.

Generally, the illustrated device comprises a housing providing a window through which infrared radiation may be transmitted, a sheet of graphite fabric which may be energized to any selected black body temperature, a plurality of graphite connectors by which the graphite fabric may be both mounted and energized, an inert atmosphere which tends to minimize deterioration of the graphite fabric, a detector for measuring minor variations in the infrared emission of the graphite fabric in order to stabilize the current therethrough when desired and a modulator for varying the current through the graphite fabric in a predetermined manner when desired.

A preferred graphite fabric is woven from fibers of high purity graphitic carbon having a tensile strength of from 50,000 to 100,000 p.s.i. The fibers themselves may be produced by processing carbonaceous materials at temperatures up to 5400° F. Such graphite fibers have high thermal conductivity and good electrical conductivity. Chemically, such graphite fibers are composed of approximately 99.9%+ carbon and approximately 0.04% ash containing magnesium, aluminum, calcium, iron, manganese, silicon, boron, copper, nickel and sodium. This material sublimes at approximately 6600° F. (3650° C.) without melting. The filaments have an average diameter ranging from 0.00005 to 0.001 inch. The fabric has a thread count per inch ranging from 20 to 30, a gage ranging from 0.01 to 0.04 and a filament count per ply ranging from 1 to 2000. The infrared transmitting window is a vitreous transparent material, such as Pyrex, vicor or quartz, which has a good heat and shock resistance. The

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graphite connectors for supporting the graphite fabric section are themselves supported by cooling tubes for flowing water continuously therethrough in order to control heat transmission from the graphite cloth to the housing while enabling a flow of electricity through the cloth. The inert atmosphere in which the graphite fiber is disposed, for example, is a noble gas such as argon, or a stable non-oxidizing gas such as nitrogen. The pressure of the gas preferably ranges from slightly above atmospheric to approximately 75 p.s.i. In practice, the fabric is supplied with from 200 to 15,000 watts per square inch of fabric in order to produce a suitable black body transmission curve wherein the bulk of the radiation is infrared. In infrared optical applications, the peak transmission ordinarily ranges from one to six microns.

With reference now to the drawing, the illustrated device comprises a housing 10 within which the operating components of the device are mounted and enclosed. Housing 10 includes a series of upright panels 12, a transverse panel 14 and a transverse window 16 for enclosing a section of graphite fabric sheet 18 within a chamber 19. Panels 12 and 14 are composed of a suitable insulating material, such as a phenolic thermosetting resin, and are provided with conduits 20 for the flow of a liquid coolant, such as water, from a supply 22. Window 16 is composed of a suitable infrared radiation transmitting material of the type described above, capable of withstanding extremely high temperatures. Panels 12 and 14 are provided with a reflective coating 24, composed for example of aluminum for the purpose of directing as much infrared radiation as possible from within housing 10 through window 16.

Graphic fabric sheet 18 extends from a supply roll 26 in a compartment 28 through a passage 30 into chamber 19 and from chamber 19 through a passage 32 to a takeup spool 34 in a compartment 36. Graphite fabric sheet 18 is supported within chamber 19 by fluid cooled and electrically energized mounts now to be described. At opposite extremities of chamber 19 are pairs of graphite rollers 38, 40 and 42, 44 of relatively thick cross-section in relation to the relatively negligible cross-section of graphite rollers 38, 40 and 42, 44 of relatively thick cross-section in relation to the relatively negligible cross-section of graphite fabric section 18. Roller 40 is rotatably mounted upon a transverse conduit 46, which is supplied with fluid from coolant supply 22 through a vertical conduit 48. Roller 38 is journaled from rotation on a transverse conduit 50 which is supplied with a fluid from coolant supply 22 through a conduit 52 having a vertically extending section that is pivotally connected to coolant supply 22 at 54 and that is provided with a helical spring section 56 which causes graphite roller 38 to bear resiliently against graphite roller 40 when conduit 52 is pivoted into its extreme counter-clockwise position. Rollers 42 and 44 are mounted in the manner of rollers 38 and 40, respectively, being supplied with a coolant from a coolant supply 23. Rollers 40 and 44 are in engagement with friction rollers 58 and 60, respectively, which may be rotated when desired by a suitable drive 62. It is apparent that drive 62, when actuated, rotates pairs of rollers 38, 40 and 42, 44 to advance graphite fabric sheet 18 therebetween and to present successively fresh sections of sheet 18 for electrical energization as needed.

Either an alternating or direct current flow through graphite fiber section 18 is produced from a suitable variable power supply 64 through leads 66 and 68, one of which is electrically connected to rollers 40, 38 and the other of which is electrically connected to rollers 44, 42. A detector 69 in the form of a pyrometer or bolometer within chamber 19 determines the instantaneous infrared radiation emanating from graphite fabric section 18 to provide an electrical signal. This signal is converted into

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an alternating current output by a suitable chopper 72. The output of chopper 72 is fed back through a suitable amplifier 74 to the control of variable power supply 64 in order to instantaneously adjust the output of variable power supply 64 to produce a constant infrared radiation output. This control is effected through a switch 76 which is capable of replacing the signal from amplifier 74 with either modulated power from a suitable source 78 or pulsed power from a suitable source 80. The modulated power, in one form, is a sinusoidal carrier wave that is amplitude or frequency modulated. The pulse power, in one form, is provided intermittently by a transient circuit including a capacitor which discharges through the fabric section when it has acquired a predetermined charge.

In a specific arrangement of the foregoing type, the graphic fabric weighs approximately 7.5 ounces per square yard, the count of the graphite fabric is approximately 27 x 25 threads per inch, the gage of the graphite fabric is approximately 0.0001, the denier and ply of the graphite cloth is 950/1, the filaments per ply are 1440, the filament diameter is approximately 0.9. With an input of approximately 1200 watts per square inch, the peak of the infrared radiation output is at approximately 2.8 microns.

In operation, a fresh section of graphite fabric 18 may be positioned between pairs of rollers 38, 40 and 42, 44 by actuating drive 62. Thereafter, while cooling fluid is directed from coolant supplies 22 and 23 through the conduits within rollers 38, 40 and 42, 44, electrical current is applied between the pairs of rollers. Detector 69 provides a signal which indicates the radiation flux and thereby controls the output of variable power supply 64 in order to maintain the flux constant. The flux is concentrated by reflecting coating 24 and emitted through window 16. Nitrogen gas is directed from a suitable supply 82 communicating with chamber 28 through passage 30 into chamber 19 and from chamber 19 through passage 32 to an exhaust 84 communicating with chamber 36. The nitrogen gas serves to isolate graphite web 18 from any possible residual oxygen and, at the same time, maintains a gradient by which the walls of the chamber are insulated from the intense heat generated by graphite fabric section 18.

The illustrated device thus constitutes an infrared radiation source of extremely large area and a stable output flux that may be varied in peak wavelength in a simple way. Since certain changes may be made in the above described device without departing from the scope of the invention herein involved, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted in an illustrative and not in a limiting sense.

What is claimed is:

1. A source of infrared radiation comprising a housing

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providing a chamber, at least one wall of said chamber being an infrared radiation window and remaining walls of said chamber being coated with a reflecting metal, at least a pair of graphite mounts in said chamber, a graphite fabric sheet carried by said mounts, fluid conduits composed of metal supporting said mounts for transmitting a coolant therethrough, electrical supply means for directing an electrical current through said conduits and said mounts across said sheet, supply means, takeup means, means for advancing said web from said supply means to said takeup means in order to position fresh sections of said web between said mounts, said chamber having an inert atmosphere, a detector for receiving radiation from said sheet, and means for varying the electrical supply of current across said sheet in response to a signal received from said detector.

2. A source of infrared radiation comprising a housing providing a chamber having a window, infrared radiation transmitting means affixed to said housing in said window, infrared radiation reflecting means affixed to said housing, and carbon fabric stratum affixed in predetermined configuration in said housing between said infrared radiation transmitting means and said infrared radiation reflecting means.

3. The source of claim 2 wherein said carbon fabric stratum is composed of graphite filaments.

4. The source of claim 3 wherein said filaments range from 0.00005 to 0.001 inch in diameter.

5. A source of infrared radiation comprising a housing providing a chamber having a window, infrared radiation transmitting means affixed to said housing in said window, infrared radiation reflecting means affixed to said housing, a mount affixed in said housing including an electrically conducting, cooling fluid conduit means, and a carbon fabric stratum carried in taut condition by said mount between said infrared radiation transmitting means and said infrared reflecting means.

6. The source of claim 5 comprising, additionally, means for delivering across said electrically conducting, cooling fluid conduit means an electrical current ranging from 200 to 15,000 watts per square inch of said carbon fabric stratum.

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