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RADIATION-SENSITIVE DEVICE

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FIG. 1

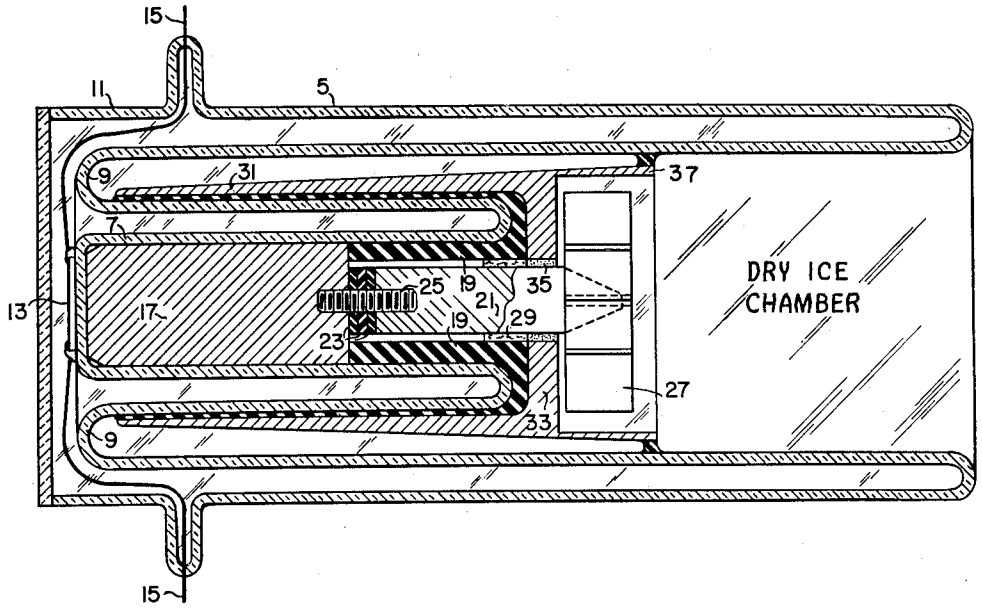
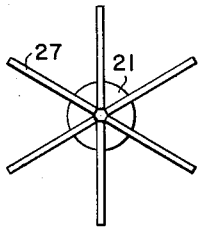


FIG. 2



INVENTOR
E. C. THOMSON

BY Jean C. Thomson

ATTORNEY

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RADIATION-SENSITIVE DEVICE

Elihu Craig Thomson, Wellesley, Mass., assignor to Electronics Corporation of America, Cambridge, Mass., a corporation of Massachusetts

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9 Claims. (Cl. 201—63)

This invention relates to radiation-sensitive devices and more particularly to radiation-sensitive devices in which the sensitive element is a photoconductor.

It is well known that some photoconductors increase their sensitivity to radiation when they are operated at low temperatures. In order to take advantage of this physical property of photoconductors, cells have been built in which a photoconductive layer was cooled by packing the cell with Dry Ice. In such cells, the Dry Ice is in direct contact with the wall on which the photoconductive layer is deposited. This method of cooling the photoconductive layer does not result in a completely uniform temperature all over the photoconductive layer. As heat is absorbed by the Dry Ice, a gaseous film is caused to form between the Dry Ice and the wall, and this gaseous film changes the thermal conductivity at the point where it forms so that the flow of heat is unsteady. When Dry Ice is held against the wall, it makes contact with the wall at several points, heat is absorbed at these points, and the solid Dry Ice turns into a vapor thereby breaking mechanical contact at these points. Then a new set of contact points is established, and the process is repeated so that the net result is to have a constantly changing thermal flow from the photoconductive layer to the Dry Ice as radiation is received by the photoconductive film. This effect is normally completely negligible except when extremely high sensitivities are desired, in which case this fluctuation in temperature can cause the conductivity of a photoconductor to fluctuate enough to constitute a noise signal comparable with the radiation signal received.

It is an object of the present invention to provide a radiation-sensitive device having a very high sensitivity to radiation and very good noise characteristics.

It is another object of the present invention to provide a cell construction by means of which a radiation-sensitive element may be maintained at uniform temperatures within limits of the order of $\frac{1}{1,0000}$ of a degree for periods extending over several minutes.

In accordance with the illustrated embodiment of the present invention, heat is extracted from a photoconductive layer by means of a metallic slug in intimate contact with the surface upon which the photoconductive layer is deposited. Heat is extracted from this metallic slug through a path of limited conductivity and into a set of cooling fins which are designed to be immersed in powdered Dry Ice or another coolant. The effect of this construction is to smooth out the flow of heat away from the photoconductive layer by means of a thermal filter which is analogous to an RC filter in an electrical circuit.

Other and incidental objects of the present invention will be apparent to thoes skilled in the art from a reading of the specification and an inspection of the acompanying drawings in which:

Figure 1 shows a cross section of a radiation-sensitive device constructed in accordance with the present invention, and

Figure 2 is a detailed view of the cooling fins which are a part of the device shown in Figure 1.

Referring now to the drawing, there is shown a sealed evacuated glass envelope 5 which forms a central column 7, a hollow ring 9 around column 7, and an outside wall 11 surrounding ring 9. A radiation-sensitive element which may be a photoconductive layer 13 of lead sulfide is positioned at the top of the central column 7 and inside the sealed envelope 5. A pair of metallic leads 15 is connected in a conventional manner to the photoconductive layer 13 through the outside wall 11 of the sealed envelope 5. A metallic slug 17, preferably made of a metal of high heat capacity and conductivity, such as copper, is positioned inside the central column 7 and is placed in intimate contact with the end of the hollow column 7 upon which the photoconductive layer 13 is located. This metallic slug 17 is shorter than the central column 7 and is prevented from sliding by means of plastic filler 19 which is secured to the wall of central column 7. A second metallic slug 21, preferably made of copper, is inserted partly into the central column 7 and spaced from metallic slug 17 by means of washers 23 of a material of low thermal conductivity such as a phenolic plastic. A metallic piece 25 having a cross section which is smaller than the cross section of the smaller of slugs 17 and 21 links metallic slugs 17 and 21. This metallic piece 25 is preferably threaded so that the thermal conductivity between metallic slugs 17 and 21 may be easily adjusted by changing the number of washers 23. A set of cooling fins 27, also preferably made of copper, is mounted on the part of slug 21 which is positioned outside the central column 7. The cooling surfaces of the fins 27 are parallel to the direction of motion of the Dry Ice as it sublimates.

Part of the space between the metallic slug 21 and the plastic filler 19 may be filled with packed cotton 29 to prevent moisture from collecting inside the central column 7. A radiation shield 31 which may be made of aluminum is inserted into hollow ring 9 and secured to the innermost wall of hollow ring 9 by means of plastic filler 19. This radiation shield 31 has a flanged portion 33 extending towards metallic slug 21 and spaced slightly from metallic slug 21, this space being filled with silicone grease 35. This flanged portion 33 is perpendicular to the direction of travel of the Dry Ice as it sublimates. The radiation shield 31 comprises also an extension 37 which is sealed to the outermost wall of hollow ring 9 to prevent Dry Ice from going into the hollow ring 9.

Figure 2 shows the cooling fins 27, six of which are mounted on the metallic slug 21.

The operation of the radiation-sensitive device of Figure 1 is as follows: the device is aimed so that the photoconductive layer 13 faces the source of radiation to be detected. Dry Ice is packed from the open end of the device into the device between the cooling fins 27 and is held against flange 33 by a spring-operated plunger (not shown). The surfaces of these fins are parallel to the direction of motion of the Dry Ice as it sublimates, and a gaseous film forms between the surface of the fins 27 and the packed Dry Ice. A minimum amount of actual contact takes place between the fins 27 and the packed Dry Ice, with the result that almost all of the heat is transferred through a gaseous film. However, as the area of the fins 27 is quite large, an efficient heat transfer nevertheless takes place. The fins 27 are mounted on the end of the small metallic slug 21 and are capable of extracting heat from this small slug 21 and of transferring this heat to the Dry Ice at a much higher rate than the rate at which heat can pass through the small metallic piece 25 between metallic slug 17 and metallic slug 21. Thus the rate of heat flow is determined by the fixed conduc-

tivity of washers 23 rather than by the fluctuating conductivity of the film between vanes 27 and the Dry Ice. This has the effect of smoothing out the flow of heat from the photoconductive layer 13 to the packed Dry Ice.

The radiation shield 31 is provided so that the thermal filter comprising slugs 17 and 21, washers 23, and fins 27 does not receive radiation through the side walls of the envelope. This radiation shield 31 is also cooled by the Dry Ice. The cooling surface for the radiation shield 31 includes its flanged portion 33 which has a cooling surface perpendicular to the direction of motion of the Dry Ice as it sublimates. Consequently, the mechanical contact between the Dry Ice and the surface of flange portion 33 is subject to the fluctuations mentioned above. However, this is of no importance as there is no mechanical contact between the radiation shield 31 and the thermal filter inside central column 7 except through materials having a very high insulating value. The radiation shield 31 makes contact with the innermost wall of hollow ring 9 through a very thin film of insulating plastic filler 19, and therefore the radiation shield 31 also acts as a conductive path for heat to be extracted from the glass walls of the device, this heat being that which flows in from heat conduction along the glass walls from the outside wall 11 of the device. The radiation shield 31 may be slightly above the temperature of the Dry Ice due to inefficient cooling by the Dry Ice and due also to the fact that it absorbs a considerable amount of heat from conduction and radiation. However, it acts as an efficient radiation shield, since the transfer of heat by radiation between the radiation shield 31 and the thermal filter is exceedingly small in view of the small temperature difference between them. The inside walls of the device may be silvered to reduce further the transfer of heat by radiation.

I claim:

1. A radiation-sensitive device comprising a sealed envelope forming a hollow central column and an outside wall surrounding said column, a radiation-sensitive element positioned on said column and inside said envelope, and a metallic slug positioned inside said column and outside said envelope.

2. A radiation-sensitive device according to claim 1 wherein there are provided cooling fins in mechanical contact with said slug.

3. A radiation-sensitive device comprising a sealed envelope forming a hollow central column, said envelope also forming a hollow ring around said column and an outside wall surrounding said ring, a radiation-sensitive element positioned at one end of said column and inside said envelope, and a radiation shield positioned within said hollow ring.

4. A radiation-sensitive device comprising a sealed envelope forming a hollow central column, said envelope also forming a hollow ring around said column and an outside wall surrounding said ring, a radiation-sensitive element positioned at one end of said column and inside said envelope, and a metallic slug positioned inside said column and outside said envelope.

5. A radiation-sensitive device comprising a sealed envelope forming a hollow central column, said envelope also forming a hollow ring around said column and an outside wall surrounding said ring, a radiation-sensitive element positioned at one end of said column and inside said envelope, a radiation shield positioned within said hollow ring, and a metallic slug positioned inside said column and outside said envelope.

6. A radiation-sensitive device comprising a sealed envelope forming a hollow central column, said envelope also forming a hollow ring around said column and an outside wall surrounding said ring, a radiation-sensitive element positioned at one end of said column and inside said envelope, a metallic slug positioned inside said column and outside said envelope, and cooling fins in mechanical contact with said slug.

7. A radiation-sensitive device comprising a sealed envelope forming a hollow column around a central axis, said envelope also forming a hollow ring around said column and an outside wall surrounding said ring, a radiation-sensitve element positioned at one end of said column and inside said envelope, a metallic slug positioned inside said column and outside said envelope, and cooling fins in mechanical contact with said slug, said cooling fins having cooling surfaces parallel with said central axis.

8. A radiation-sensitive device comprising a sealed envelope forming a hollow central column, said envelope also forming a hollow ring around said column and an outside wall surrounding said ring, a radiation-sensitive element positioned at the top of said column and inside said envelope, a first metallic slug positioned inside said column and outside said envelope, a second metallic slug one part of which is positioned inside said column, cooling fins mounted on the part of said second slug which is positioned outside said column, spacers of low conductivity between said first and second slugs, and a metallic piece linking together said first and second slugs and having a cross section which is smaller than the cross section of the smaller of said slugs.

9. A radiation-sensitive device according to claim 8 wherein said metallic piece is threaded.

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