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PHOTOCELLS

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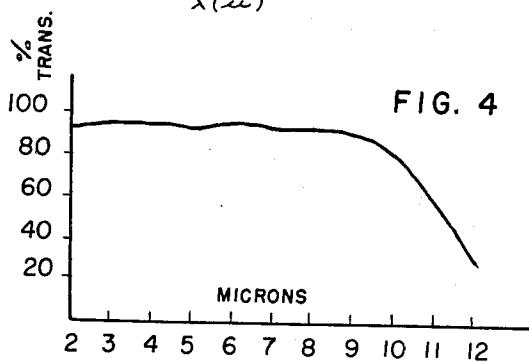
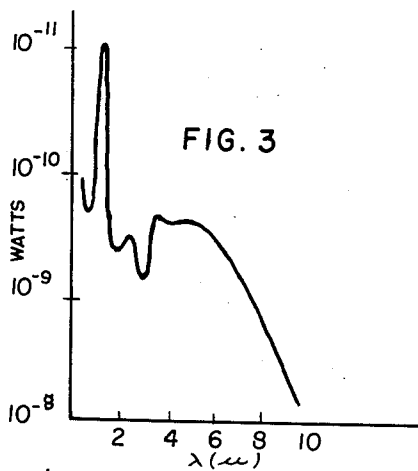
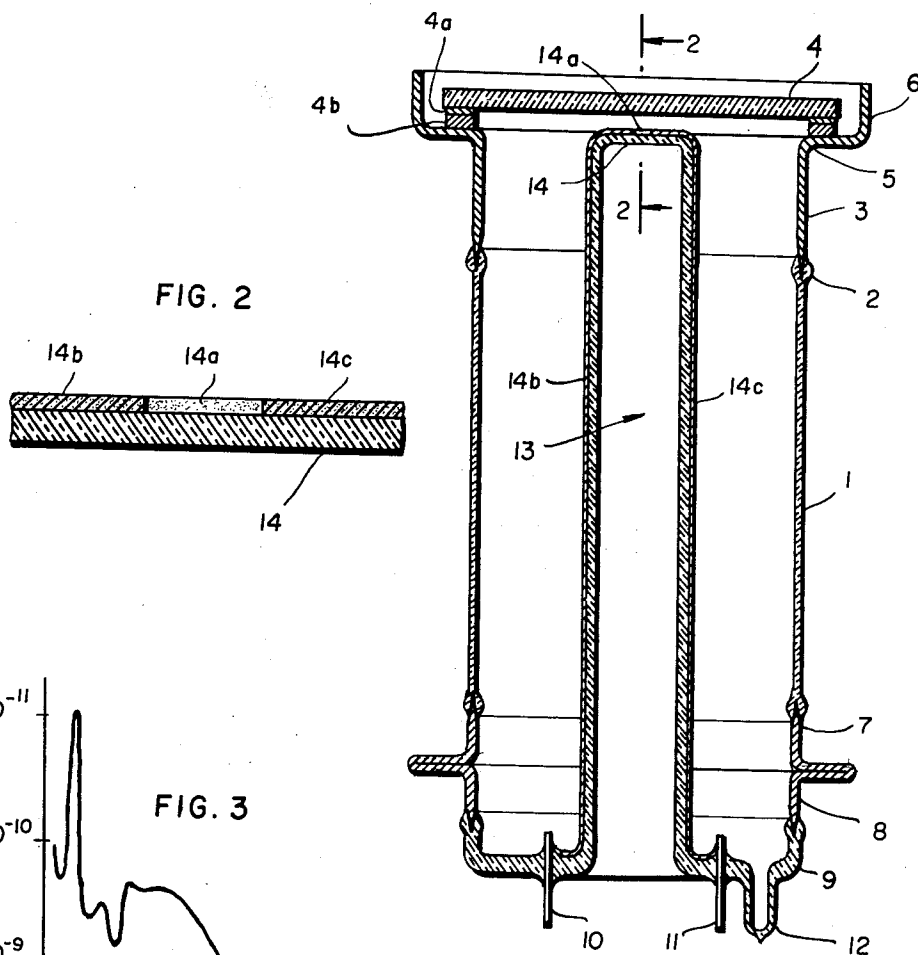


FIG. 1

FIG. 4

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This invention relates to photocells and is particularly directed to a hermetically sealed envelope with a window of a material which has high transmissivity in the infra-red regions of the spectrum.

Glasses of all known types absorb infra-red energy in large proportions and have generally been eliminated as window material for infra-red light sources. Many inorganic compounds have been investigated for possible window uses but many have been eliminated for various mechanical and chemical reasons.

While calcium fluoride, CaF_2 , is mechanically weak and has a large thermal coefficient of expansion, calcium fluoride has excellent infra-red transmissivity, is not soluble in water, and is in general an excellent window material for photocells intended for use in the two to ten microns wavelength region of the spectrum. Unfortunately, the coefficient of expansion of calcium fluoride crystals is so high (of the order of seven times that of glass) it cannot be sealed into glass or metal envelopes in the usual way.

The object of this invention is to provide an improved hermetically sealed photocell containing a photoconductor responsive to radiation in the two to ten micron wavelength region, and having a window hermetically sealed in the envelope for transmitting to the photoconductor the waves of said spectral region.

The objects of this invention are attained by a crystal of calcium fluoride, CaF_2 , sealed to a silver ring in the end of a tubular envelope having a re-entrant stem carrying a photoconductor closely adjacent the window.

The above-mentioned and other features and objects of this invention and the manner of attaining them will become more apparent and the invention itself will be best understood by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawings, wherein:

FIG. 1 is a longitudinal sectional view of a photocell constructed according to this invention;

FIG. 2 is an enlarged detail view taken on line 2-2 of FIG. 1;

FIG. 3 is a graph of spectral response of one photoconductor which may be employed in the cell of FIG. 1; and

FIG. 4 is a graph of the wavelength transmissivity of calcium fluoride.

The photocell of this invention comprises the tubular envelope 1 joined by a knife-edge seal at 2 to the metal collar 3. The metal of the collar 3 is selected for its high coefficient of thermal expansion, matching as nearly as possible the expansion characteristics of the window 4. Two right-angle expansion bends 5 and 6 are drawn in the collar to relieve radial strain in the window during manufacture and use. One metal for collar 3 has been found to be silver, where the window material 4 is a crystal structure of calcium fluoride.

The opposite end of the envelope is sealed to the knife-edge of the "Kovar" ring 7 which is matched in diameter to the second "Kovar" ring 8, also with a knife-edge sealed in the header 9. Contact pins 10 and 11 are sealed in the header containing the exhaust tubulation 12. The re-entrant stem 13 extends inwardly from the header to within a short distance of the window 4 at the opposite end. The stem preferably is a one-piece glass tube with an integral flat end 14 disposed in close spaced parallel relationship with the window 4. On the flat end of the

stem is laid down a photoconductive material 14a, FIG. 2, such as gold-doped germanium, between two films 14b and 14c of metal of high electrical conductivity, such as silver. The metal films on either side of the photoconductive material are electrically connected to pins 10 and 11 as by strips of silver paste painted along opposite sides of the stem and connecting the two films, respectively, to the pins. The long hollow stem 13 receives a cooling agent, such as liquid nitrogen, for chilling the photoconductor.

In manufacture, a cut disc of calcium fluoride for the window 4 is metalized at 4a along the periphery thereof as by a strip of platinum bright baked for twenty (20) minutes at four hundred fifty (450°) degrees centigrade. The baking temperature is slowly raised and lowered to prevent thermal shock to the calcium fluoride crystal. Next the silver collar is cleaned and roughened in a thirty percent (30%) nitric acid bath. Next a paste 4b of silver chloride is employed for joining the metalized periphery of the crystal with the metal collar 3. A flat sealing junction as shown increases the sheer strength of the seal. Preferably the glass-to-metal seal at 2 has been previously made to minimize disturbing heat shock at the window end of the envelope. The header with its assembled re-entrant stem is fitted to the envelope and the peripheral edges of the flanges 7 and 8 are welded, as by "heliarc," or by low temperature braising. After degassing and exhaust, the tubulation 12 is sealed off. With the metals mentioned, commercial grades of hard glass such as "7052" should be used for envelope parts 1 and 9.

The envelope thus described may be baked at about four hundred thirty (430°) degrees centigrade and will not be cracked when splashed with liquid nitrogen. The seals will not fatigue with vibration. The cell thus made may be operated at temperatures in the region of minus 200 degrees centigrade (-200°C.) with liquid air in the stem 13 without damage to the window seal.

The spectral response of gold-doped germanium is shown in FIG. 3 where it can be seen that such a cell is quite sensitive up to about six (6) microns. In FIG. 4 it is seen that calcium fluoride has near-perfect transmissivity of this range of light frequencies, up to and beyond the sensitive range of the photoconductor.

While the principles of the invention have been described in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of the invention.

What is claimed is:

1. In a photocell having an open-ended generally tubular envelope with a photoconductive element disposed therein, a hermetic closure assembly for said envelope comprising: a collar member formed of silver and having one end sealed to the open end of said envelope; and a flat circular disc formed of calcium fluoride supported by said collar member adjacent its other end forming a window for transmitting infra-red radiation to said photoconductive element; said disc being sealed to said collar member by a metallized strip on said disc, and a layer of silver chloride joining said metallized strip to said collar member.

2. In a photocell having an open-ended generally tubular envelope with a photoconductive element disposed therein, a hermetic closure assembly for said envelope comprising: a generally tubular collar member formed of silver and having one end sealed to the open end of said envelope, said collar member having an outwardly extending annular flange portion formed at its other end with an upwardly extending tubular portion formed at the outer periphery of said flange portion; and a flat circular disc formed of calcium fluoride supported on to said collar member flange portion and forming a window for

transmitting infra-red radiation to said photoconductive elements; said disc being sealed to said collar member flange portion by an annular strip of platinum formed on said disc adjacent its outer periphery, and a layer of silver chloride joining said platinum strip to said collar member flange portion.

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