United States Patent [19]

Pusch

[11] **3,875,408**

[45] **Apr. 1, 1975**

[54] **METHOD AND DEVICE FOR ASCERTAINING THERMAL CONSTRASTS**

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[22] Filed: **July 9, 1973**

[21] Appl. No.: **377,710**

[30] **Foreign Application Priority Data**

July 10, 1972	Germany	2233870
July 10, 1972	Germany	2233820

[52] **U.S. Cl.** **250/339,** 250/338

[51] **Int. Cl.** **G01j 3/28**

[58] **Field of Search** 250/338, 340, 341, 342, 250/349, 350, 352, 339

[56] **References Cited**

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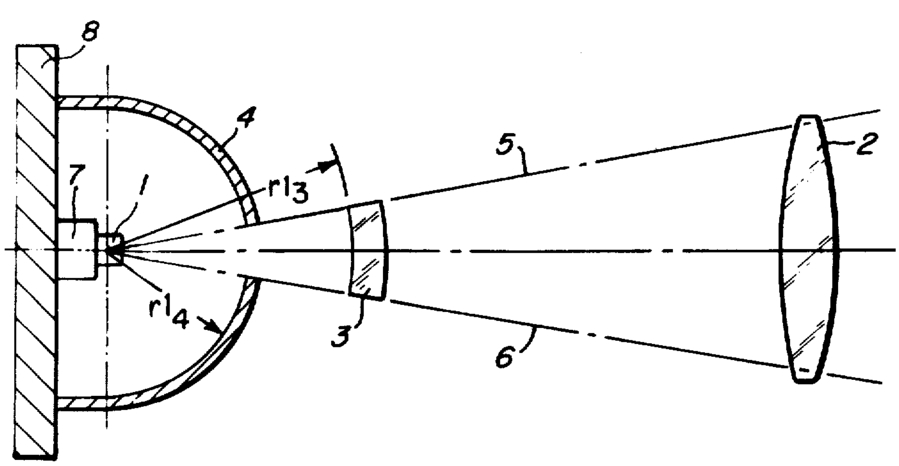
[57] **ABSTRACT**

A method of and device for ascertaining thermal constrasts, according to which the reception of thermal radiation is limited to the through passage region of an atmospheric window.

14 Claims, 3 Drawing Figures



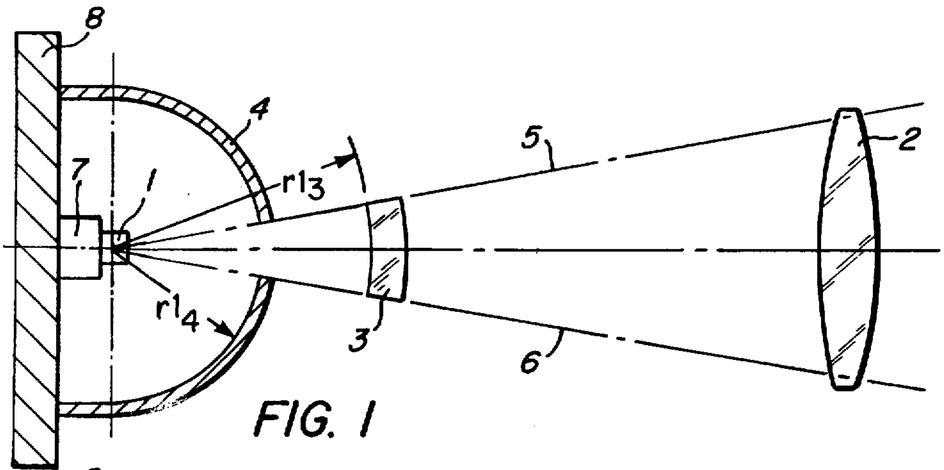


FIG. 1

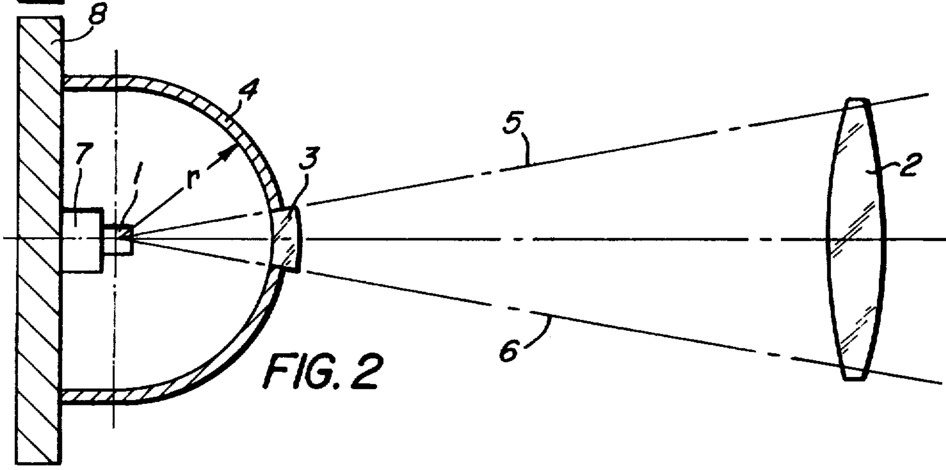
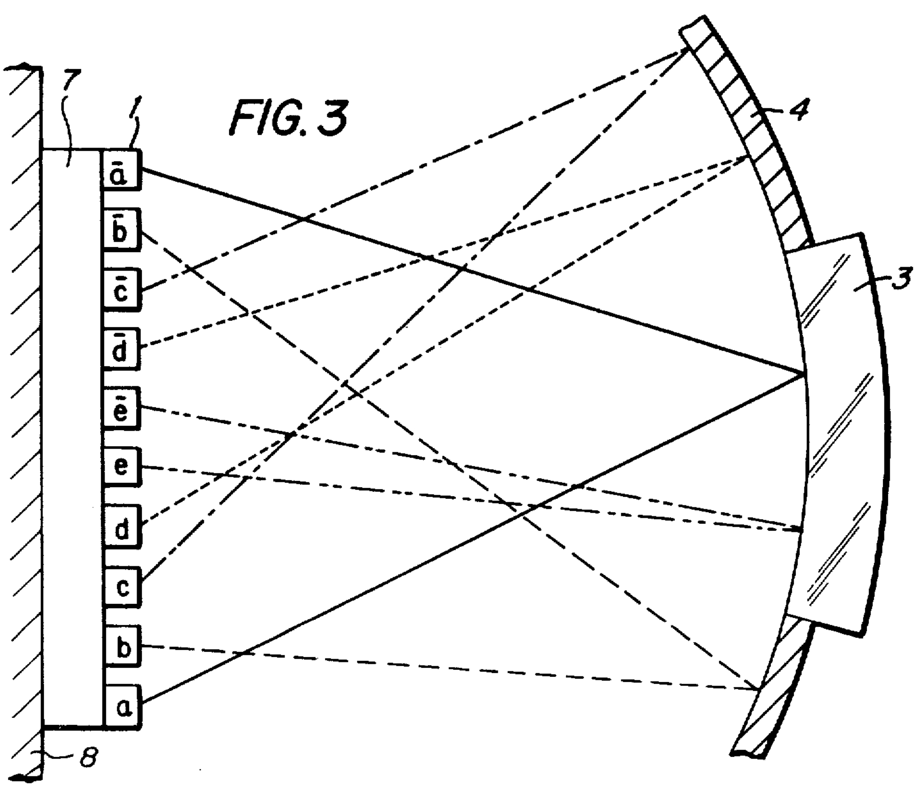


FIG. 2

FIG. 3



METHOD AND DEVICE FOR ASCERTAINING THERMAL CONSTRASTS

The present invention relates to a method and device for ascertaining thermocontrasts with which the thermodisturbing radiation of the atmosphere is not received outside an atmospheric window.

The now-a-days employed methods make use above all in atmospheric windows of from 3.3 to 4.2 μm wave length of detectors which have a considerably wider reception range than corresponds to the width of this window while their sensitivity has its maximum at approximately 5 μm. With these detectors, in particular the disturbing radiation of the carbon dioxide occurring above 4.2 μm and of the water steam content of the atmosphere is received additionally. Heretofore, it has not been clearly recognized that with longer transmitting distances in the atmosphere, the absorbing gas, similar to a black body emits disturbing radiation of the corresponding gas temperature into the heat receiver.

The mentioned disturbing radiation of the absorbing gases, however, results in a considerable reduction in the thermoconstrast sensitivity of corresponding devices. This also applies to detectors which operate in atmospheric windows of 5 to 14 μm when their sensitivity exists beyond the atmospheric window.

It is, therefore, an object of the present invention to provide a method and a device which will to a major extent avoid this disturbing radiation and will thereby bring about an increase in the thermocontrast sensitivity of heat detecting devices.

These and other objects and advantages of the invention will appear more clearly from the following specification, in connection with the accompanying drawings, in which:

FIG. 1 diagrammatically illustrates a detector according to the invention with a spherical apertured partition, or aperture, and with a reflection filter preceding same.

FIG. 2 shows the structural combination of the apertured partition and the reflection filter.

FIG. 3 illustrates the arrangement of a series detector.

The method according to the present invention is characterized primarily in that the reception of the thermoradiation is limited to the through passage range of an atmospheric window. If this is effected, the disturbing radiation of the absorbing gases (CO_2 and H_2O), the wave length of which exceeds 5.2 μm is automatically excluded from being received.

The method may be practiced in various manners. Thus, according to a further development of the invention by means of a suitable composition of the detector material, the maximum of the sensitivity of an IR detector can be placed into the atmospheric window itself. It is even possible to permit the drop of the sensitivity above the window to follow approximately the same stiffness as the through passage curve of the window. In view of the newest technological developments, above all CdHg:HgTe — detectors are suggested.

Inasmuch as the composition of the detector material in conformity with the present state of the art can be varied only within certain tolerance limits, the through passage curve of the window will not always or only approximately be obtainable, which fact brings about a more or less strong reception of residual disturbing radiation of the atmosphere.

According to a further feature of the invention, the detector is preceded by an optical high or band-pass filter which forms a unit with the detector and is transparent only in the atmospheric window. The marginal line of the filter is expediently so designed that it has at least on one side, preferably on the long wave side, approximately the same drop characteristic as the atmospheric window.

It is known from the literature to arrange cooled filters ahead of the detectors inasmuch as the self-emission of the filter brings about a disturbing radiation. In conformity with the invention, the filters are designed as reflection filters, which in the stop-band range have the properties of reflecting surfaces. If such filter is designed spherically and if the detector is located in the center of this sphere, it will by auto-collimation see itself and thus its own temperature. By this step it will be possible also to employ noncooled filters.

It is further known to have a cooled orifice preceding the detector. In conformity with the invention, this orifice is designed as spherical orifice having the detector arranged in the center thereof so that the detector will be in auto-collimation. In this instance, a cooling of the orifice may be omitted.

Preferably, the spherical reflection filter is built into the opening of the orifice so that reflection filter and orifice will in the stop-band range form a reflecting ball cup.

In many instances, a series detector is employed as receiving element, which series detector comprises a major portion of individual detector elements. With such an arrangement, it is possible to bring each detector element precisely to auto-collimation. According to a further feature of the invention, in this instance the detector row is adjusted symmetrically to the center point so that detector elements located in the stop-band range of the filter located symmetrically to the center point will form an image to each other and will see their mutually same temperature. With an arrangement according to which reflection filters and spherical apertures are located on a common ball cup, according to the present invention, in the through passage range of the filter, the inner disturbance radiation of the device is likewise eliminated because the detector elements can form an image to each other only through the spherical aperture and thereby cannot receive the inner disturbing radiation of the device.

A considerable advantage of the invention consists in that the presently customary cooled apertures and filters will be avoided. It will be realized that the outer disturbing radiation of the atmosphere as well as the inner disturbing radiation of the devices cannot reach the detector. This, however, brings about a considerable increase in the contrast sensitivity of the devices. If, as detector material, there is used CdHg:HgTe, in the window of 4 μm,, with this detector, a thermoelectric cooling to approximately −40°C will be satisfactory. Furthermore, this detector material has the advantage that by suitable selection of the composition it can be displaced in the spectral range in an optimum manner.

If for technological or optical structural reasons it appears necessary as filter to use an absorption filter, it is known that these absorption filters will in the block band region radiate with the temperature specific thereto. For this reason, these absorption filters have to be cooled. This cooling may, in conformity with the present invention, be effected by the same thermoelectric cooler by means of which the detector itself is being cooled.

If a plurality of detectors are arranged closely adjacent to each other, for instance in series, the temperature increases easily bring about an overspeaking of one detector to the adjacent detector. This causes inaccurate indications which falsify the final result of the measurement.

According to a further feature of the invention, with an arrangement of detectors as set forth above, the mirror arrangement is so selected that a non-sharp picture is obtained of the detector, which lack of sharpness, however, is not greater than the detector. It is still better when the size of the non-sharp zone corresponds to the cooled surface on which the detector is located. If a plurality of detectors are combined to a group, for instance to form a series, expediently the non-sharp zone is expanded to the cooling surface of the entire detector group. In view of this new arrangement, with detectors combined to a group, especially with series detectors, an overspeaking of one detector to an adjacent detector will be prevented or at least greatly reduced.

Referring now to the drawings in detail, the IR detector **1** is located in the center of a spherical pin hole diaphragm **4**, the aperature of which is defined by the marginal rays **5** and **6** of the objective **2**. The IR detector **1** is likewise located in the center point of the spherical reflection filter **3**, the rim of which is likewise defined by the aperature of the objective.

The aperature angle depends on the optical requirements of the concept of the device and ordinarily amounts to from 30° to 45°. The pin hole diaphragm **4** and the reflection filter **3** are, in this instance, designed separately of each other, but are located on the same optical axis.

With the arrangement of FIG. **2**, the reflection filter **3** is built into the opening of the pin hole diaphragm **4** and together with the latter forms a unitary structure.

The series detector **1** as shown in FIG. **3** carries a plurality of detector elements *a* to *e* and $\bar{a}$ to $\bar{e}$. The detector **1** is adjusted in the center of the spherical ball mirror **4** or the reflection filter **3** in such a way that a picture of the detector element *a* is formed on the element $\bar{a}$, a picture of the detector element *b* on the element $\bar{b}$, etc. and vice versa. In this way, the various detector elements see each other, and inasmuch as they are arranged on a common cooled carrier or support, they also see their own temperature. A cooler **7** is fastened to the base plate **8** while the cold side of the cooler is connected to the detector **1**. The interior of the detector housing is expediently filled with protective gas so that when the detector cools off, a humidity deposit will be avoided.

It is, of course, to be understood that the present invention is, by no means, limited to the particular showing in the drawings, but also comprises any modifications within the scope of the appended claims.

What I claim is:

1. A method of ascertaining thermal contrasts, which includes

a. the step of limiting the reception of thermal radiation to the through-passage region of an atmospheric window from 3.0 to 4.2 μm wavelength and thereby excluding the disturbing radiation of the absorbing gases (CO_2 and H_2O) from being received,

b. the further step of using a detector whose sensitivity has its maximum in that atmospheric window.

2. An IR-detector system for ascertaining thermal contrasts, which includes means for limiting the reception of thermal radiation to the through-passage region of an atmospheric window from 3.0 to 4.2 μm wavelength and a detector having maximum sensitivity in an upper region of said atmospheric window.

3. A detector system according to claim **2**, in which the composition of the material of said detector is such that the drop of the sensitivity of said detector at the **4.2**-side of said window follows approximately the same steepness as the through passage curve of said window.

4. A detector system according to claim **2**, in which the detector material is substantially CdHg:HgTe.

5. A detector system according to claim **2**, which includes an optical filter arranged in front of said detector and being transparent only in said atmospheric window, said filter having a drop characteristic which approximately equals the drop characteristic at the **4.2**-side of said atmospheric window.

6. A detector system according to claim **5**, in which said optical filter is designed as reflection filter and outside said atmospheric window has a mirroring reflection in the direction of said detector system.

7. A detector system according to claim **5**, in which said optical filter is spherical, and in which said detector is located at the spherical center of said optical filter.

8. A detector system according to claim **2**, which includes a spherical mirroring apertured diaphragm, and in which said detector is located in the center of said diaphragm.

9. A detector system according to claim **2**, which includes a spherical reflection filter, and a spherical mirroring apertured diaphragm, said reflection filter being coaxially arranged in the aperture of said diaphragm.

10. A detector system according to claim **2**, which includes a spherical optical filter and a spherical mirroring apertured diaphragm, and in which the detector is a series detector adjusted symmetrically with regard to the spherical center of said mirroring apertured diaphragm so that detector elements located in the blocking range of said mirroring apertured diaphragm mirror each other.

11. A detector system according to claim **10**, which includes a pinhole diaphragm, and in which in the through-passage region of said filter the detector elements mirror each other by means of said pinhole diaphragm.

12. A detector system according to claim **11**, in which the mirror arrangement is such that the image of said detector is unsharp.

13. A detector system according to claim **12**, which includes surface means having said detector arranged thereon, and which includes cooling means for cooling said surface means, said unsharp image of said detector not exceeding said cooled surface means.

14. A detector system according to claim **13**, in which the cooling means for cooling said detector are thermo-electric cooling means.

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