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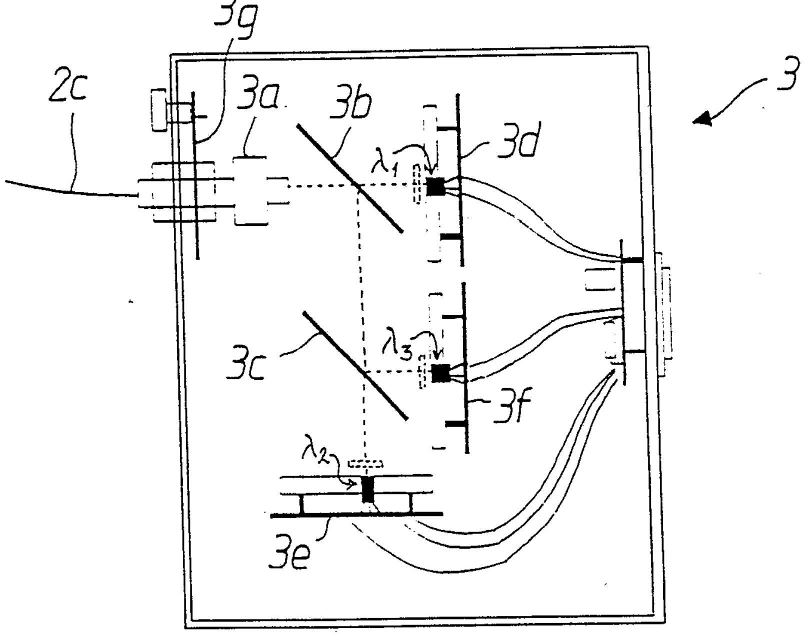

(57) Abstract

In a method for measuring the temperature of fuel particles within a fluidized bed, at the same time with two measurement wavelengths (λ_1, λ_3) additionally a third measurement wavelength (λ_2) is used. By means of the information obtained with the latter and by means of the information obtained with said two measurement wavelengths, the surface temperature (T_c) of the fuel particles is calculated in such a fashion that the ratio of the emissivities of the fuel particles and the other fluidized bed material is a non-assumed value in the calculation operation. The apparatus comprises a measuring part (3) outside the fluidized bed combustor, comprising three detectors (3d, 3e, 3f) for measuring the thermal radiation at the three measurement wavelengths.

* See back of page

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Method and apparatus for measuring of surface temperature of fuel particles in a fluidized bed

The present invention relates to a method for measuring of temperature of fuel particles in a fluidized bed, comprising determining the surface temperature of the fuel particles by measuring the intensity of thermal radiation emitted at the same time by the fuel particles and the other fluidized bed material within the fluidized bed at two different measurement wavelengths, and calculating the surface temperature of the particles by means of the obtained measurement data. The invention also relates to an apparatus for measuring of temperature of fuel particles within a fluidized bed, comprising a receiver of thermal radiation mountable inside a fluidized bed and connected with detectors provided for detection of the intensity of the thermal radiation emitted at the same time by the fuel particles and the other fluidized bed material within the fluidized bed at two different measurement wavelengths, the apparatus further comprising a data processing unit for processing the measurement data given by the detectors and for calculating the temperature of the fuel particles by means of the measurement data.

One of the techiques developed especially for combusting solid fuels is the so-called fluidized bed combustion. In this method the fuel is burned in a bed consisting of solid material. During the burning, air or any other oxygen-containing mixture is introduced to the combustor from below the bed. The rate of the gas feed is controlled so as to make the bed in a sort of way to float above the gas cushion. Some commonly known advantages are obtained by means of the fluidized bed combustion.

Many factors associated with the fluidized bed technology depend on the temperatures present during the burning. It is therefore essential that a fluidized bed combustor is used at a proper temperature. Within the combustor there are several points in which the temperature must be measured and also controlled. In addition to the temperature of the bed and the free gas space above the bed, the surface temperature of the burning fuel particles is an important parameter.

A popular method to measure the surface temperature of the particles is to measure the thermal radiation emitted by them using optical pyrometry, because the method is based on a contact-free principle. In addition, several materials allowing the measurement by means of a probe inserted in the combustor are available. However, in performing the measurement and processing the measurement signal, methods and apparatuses not giving fully reliable measuring results have been used heretofore, owing to some assumptions which are inevitable when processing the measurement data.

The pyrometric measurement is based generally on the relationship between the thermal radiation from a hot body and its surface temperature for a given wavelength. However, an exact measurement result can be obtained only if it is sure that the radiation is coming from one body only and its emissivity is known exactly. In the practice, however, there is the problem that within the fluidized bed inside the combustor, in which the measurement is carried out, there are in addition to the burning fuel particles also other bed material consisting of mineral material, like sand for example. In this case two different measurement wavelengths have been utilized in order to eliminate said uncertainty by utilizing a sufficient number of intensity values obtained at these two measurement wavelengths when making the calculations. In this well-known technique, however, the emissivities of both the fuel particles and the other bed material, or more precisely the ratio of the emissivities, have continued to be a problem. When calculating the temperature, tabular values have been a common recourse, which involves the drawback that, owing to the circumstances within a fluidized bed combustor, the real values may deviate from those measured in laboratory conditions. Therefore up to now a method and apparatus for measuring the surface temperature, being operational and reliable and eliminating the above-mentioned uncertainty, has not been available.

It is an object of the present invention to eliminate the drawbacks referred to hereinabobe and to provide an apparatus for determining the surface temperature of burning fuel particles of a fluidized bed combustor, using a relatively simple method, which can be easily applied industrially. For achieving said purpose the method according to the invention is mainly characterized by using a third measurement wavelength in the measurement at the same time with said two measurement wavelengths, and by calculating the surface temperature of the fuel particles by means of the information obtained with said third measurement wavelength and said two measurement wavelengths in such a fashion that the ratio of the emissivities of the fuel particles and the other fluidized bed material is a non-assumed value in the calculation operation. The additional information given by the third measurement wavelength can be used in various calculational particle temperature equations for eliminating the emissivity ratio previously taken unknown. The intensity of the thermal radiation emitted by the other fluidized bed material can be measured continuously, and the surface temperature of the material is calculated on the basis of the information obtained at at least two different measurement wavelengths. Said value is utilized in calculating the surface temperature of the fuel particles on the basis of the intensity data obtained at three measurement wavelengths. The procedure is possible, because the instants when the intensity to be measured originates solely from the other bed material can be identified, thus making it possible to use two measurement wavelengths for determining its surface temperature, the so-called colour temperature of the fluidized bed material.

The methods according to the invention comprise also some advantageous alternatives associated with monitoring and processing the signals and with the selection of the measurement wavelengths, all of which are to be described hereinafter.

The apparatus according to the invention is characterized by that it comprises also a detector which is provided for measurement of the intensity of the thermal radiation emitted by the fuel particles and the other fluidized bed material within the fluidized bed at a third measurement wavelength as well, said detector being connected with the data processing unit containing a program for calculating the surface temperature of the fuel particles on the basis of the information obtained at said measurement wavelengths in such a fashion that the ratio of the emissivities of the fuel particles and the other bed material is a non-assumed value in the calculation operation. The apparatus in its simplest form is so assembled that the thermal radiation is received at all the three measurement wavelengths by a common receiver of thermal radiation, the apparatus further comprising separating means, preferably dichroic mirrors, for distributing the intensity coming in at different wavelengths to the respective detectors. An accurate apparatus being at the same time applicable to an industrial scale can be realized by incorporating photodiodes in the detectors, the photodiodes being connected to electronics having means for converting the intensity coming in at the measurement wavelength to a corresponding voltage signal.

The invention will be described more closely in the following with reference to the accompanying drawings, wherein

Fig. 1 shows schematically the measurement arrangements in the method of the invention

Fig. 2 shows a longitudinal section of a member mounted inside the fluidized bed combustor for receiving thermal radiation

Fig. 3 shows schematically the measuring part located outside the combustor

Fig. 4 shows an example of the field of view of the member receiving thermal radiation

Fig. 5 illustrates the dependence of a calculatable parameter on the temperature at the different emissivity ratios of two materials

Fig. 6 shows as an example a continuous signal obtainable at one vawelength, and

Fig. 7a and 7b exemplify the determination of the temperature in a manner according to the invention.

Fig. 1 shows the measuring arrangements of the method in accordance with the invention. The figure also illustrates schematically the apparatus according to the invention. Inside a fluidized bed combustor 1 there is placed a member 2 receiving thermal radiation emitted by the material within the combustor. The member 2 conducts the thermal radiation to the outside of the combustor to a measuring part 3 to be described more closely hereinafter. The intensity signals obtained at three different wavelengths are transferred through A/D converters into a data processing part 4, in which the signal processing takes place and the calculation of the surface temperature of burning fuel particles is carried out on the basis of the information given by the signals, by using a suitable algorithm.

In Fig. 2 there is shown the construction of the probe 2 inserted into the combustor 1 more closely. The probe is enclosed by a protective tube 2a made of steel, the end of which has a ceramic cover glass 2b, through which the thermal radiation from a predetermined "angle of view" can pass further into an optical fibre 2c extending inside the probe and conducting the radiation outside the combustor to the measuring part 3.

The measuring part shown in Fig. 3 comprises a lens 3a having a short focal length and a good illuminating efficiency and being provided for focusing the light from the optical fibre 2c to form a beam directed towards a dichroic mirror 3b, which reflects the infrared light and permits the visible light to pass through. In the case of Fig. 3 the mirror will permit the shorter wavelengths to a detector 3d and will reflect the longer wavelengths to a second dichroic mirror 3c, which in turn passes the shortest of the long wavelengths reflected by the first dichroic mirror 3a through further to a detector 3e and reflects the longest wavelengths of all to a detector 3f. By using dichroic mirrors it is possible to effect a good distribution of different wavelengths to the different detectors without any great losses, and they can act at the same time as prefilters. The measuring part also includes a shutter 3g associated to the lens 3a, making it possible to measure the dark signal.

The detectors 3d, 3e, 3f comprise an interference filter (denoted schematically by dashed lines in Fig. 3), a silicon photodiode located thereafter as well as an amplifier. Instead of separate components, it is also possible to use a hybrid component as a detector in the measuring part. The current signal given by the photodiode is converted to a more easily measurable voltage signal by passing said current to a resistor.

The algorithms serving as the basis for the measurement and the processing of the signals obtained by means of the detectors at different wavelengths of measurement will be discussed below.

Fig. 4 illustrates the sources of signals obtainable by means of the field of view of the probe. As shown by the figure, the field of view of the probe is covered by a burning fuel particle within a part X x A and by the other fluidized bed material within a part (1 - X) x A. The burning fuel particles pass the field of view in a very short time causing pulses in the measurement signals. The pulses will be discussed more closely hereinafter.

The determination of the temperature of the fuel particles within a fluidized bed using two wavelengths has not been free of problems, owing to the unknown emissivities ratio of the bed and the particles subjected to the measurement. A particle to be measured emits thermal radiation at two wavelengths in the following manner:

$$I_1 = \epsilon_b\ (1-X)\ F_1(T_b) + \epsilon_c\ X\ F_1(T_c) \qquad (1)$$

$$I_2 = \epsilon_b\ (1-X)\ F_2(T_b) + \epsilon_c\ X\ F_2(T_c) \qquad (2)$$

wherein

T_c, T_b are the temperatures of the fuel particle and the bed, respectively.

X is the portion of the field of view covered by the fuel particle ($0 \leq X \leq 1$).

ϵ_{ci}, ϵ_{bi} are the emissivities of the particle and the bed, respectively, at the measurement wavelengths.

$F_i(T)$ are the signals given by the detectors when measuring a black body covering the whole field of view at temperature T.

The functions F_i can be calculated based on Planck's law and the characteristics of the apparatus:

$$F_i(T) = C_1 \int_0^\infty \frac{f_i(\lambda, T)\, d\lambda}{\lambda^5 \, (\exp(C_2/\lambda T) - 1)} \qquad (3)$$

The apparatus-dependent functions $f_i(\lambda, T)$ contain the effect of optical filtration of the measuring device, the electrical amplification and also the possible non-linearity of the detectors. It is, however, unnecessary to measure the functions $F_i(\lambda, T)$ accurately if the detector responses to the thermal radiation of a black body (functions $F_i(T)$) are measured directly. Thus, in the method according to the invention, the measuring device is calibrated with a black radiator prior to the measurement. T_c is solved with Equations 1 and 2, and X representing the relative portion of a fuel particle within the field of view of measurement is eliminated.

$$\alpha = \frac{I_2(X) - I_2(0)}{I_1(X) - I_1(0)} = \frac{I_2(0)}{I_1(0)} \cdot \frac{\left(\frac{\epsilon_c}{\epsilon_b}\right)_2 \cdot \frac{F_2(T_c)}{F_2(T_b)} - 1}{\left(\frac{\epsilon_c}{\epsilon_b}\right)_1 \cdot \frac{F_1(T_c)}{F_1(T_b)} - 1} \qquad (4)$$

$$R = \left(\frac{\epsilon_c}{\epsilon_b}\right)_1 = \left(\frac{\epsilon_c}{\epsilon_b}\right)_2 \tag{5}$$

Also in the case of grey objects to be measured, the emissivities ratio (denoted herein by R) has had an assumed value. When the temperature of a particle shall be measured, some value of α will be determined and the value is compared with the calibrated temperature curves shown in Fig. 5. The problem in this case is that it is uncertain which curve should be the exact basis for the temperature determination. Morover, if R is definitely or in all probability below 1,0, the temperature can not be explicitly determined based on parameter α. Even a low noise may increase the value of α and result in failure in determining the temperature using a chosen curve.

The additional information obtainable at the third wavelength of measurement can be utilized for eliminating the unknown emissivities ratio in the equation defining the particle temperature. Equation 4 can be used for solving the emissivities ratio R:

$$R = \frac{\beta_{12} - 1}{\beta_{12}\dfrac{F_1(T_c)}{F_1(T_b)} - \dfrac{F_2(T_c)}{F_2(T_b)}} \tag{6}$$

$$\beta_{12} = \frac{I_2(X) - I_2(0)}{I_1(X) - I_1(0)} \cdot \frac{I_1(0)}{I_2(0)} \tag{7}$$

wherein α and the bed signal $I_1(0)/I_2(0)$ are incorporated into parameter β_{12}. The same equation can be written for the wavelengths 1 and 2 used previously, and in the present case, also between the new wavelength 3 and the wavelength 2, for example. In the case of grey bodies the value of R must in each case be the same, thus yielding the temperature T_c in the following manner:

$$\frac{\beta_{12} - 1}{\beta_{12}\dfrac{F_1(T_c)}{F_1(T_b)} - \dfrac{F_2(T_c)}{F_2(T_b)}} = \frac{\beta_{32} - 1}{\beta_{32}\dfrac{F_3(T_c)}{F_3(T_b)} - \dfrac{F_2(T_c)}{F_2(T_b)}} \qquad (8)$$

The left and right sides of the equation above can be denoted e.g. by $L_{12}(T_c)$ and $L_{32}(T_c)$.

When using two wavelengths it is advisable to select these to be as far from each other as possible in order to increase the sensitivity. The third wavelength must therefore be selected in the wavelength band between the two previously chosen ones.

For illustrating the matter, Fig. 7a shows the dependence of the formulae or functions L_{ij} on variable T_c (temperature of fuel particles) for two additional wavelengths of 800 nm and 1000 nm when the temperature of the bed is 1000 K and the values of β have been measured without noise in respect of a particle of 1050 degrees. The emissivities ratio R is 1.0 and the wavelengths 1 and 2 are 600 and 1050 nm, respectively. The continuous curve represents formula L_{12} and the dashed line represents formula L_{32} as the third wavelength is 800 and 1000 nm. The temperature is determined by finding a point where function L_{12} intersects the value of a known emissivities ratio or constant function R (in the shown case the value of R is 1,0 and the point of intersection is at 1050 K). When three wavelengths are used, the temperature of a particle will be found by locating the point of intersection of functions L_{12} and L_{32}. If the third wavelength becomes longer, the difference of the derivatives of the L-functions at the point of measurement will increase, and the sensitivity of the determination of particle temperature to errors in measurement parameters β, caused by noise, will consequently decrease. Moreover, lengthening of the third wavelength reduces the noise of the measurement signal strongly and results in a further reduction of accidental error. The difference of the derivatives of the L-functions is, however, in this case smaller than the difference of the derivatives of L_{12} and the constant function R (emissivities ratio), and the sensitivity to noise is consequently higher.

As the emissivities ratio R is below 1,0, the advantages of the new method are most apparent. Fig. 7b shows the L-functions for the ratio R = 0.85 and, as hereinabove, the temperatures of the bed and the particle are 1000 and 1050 K respectively. In addition to the exact temperature determination, the difference between the derivatives of the L-functions is now even higher than the difference of the derivatives of function L_{12} and the constant function R! Owing to this fact the noise sensitivity is also low in a situation which would make the exact determination of temperature impossible in the practice if two wavelengths were used.

The optimum wavelengths of measurement depend on the characteristics of the measuring device, among other things. The shortest wavelength, that is wavelength 1, is not greater than 700 nm and the longer wavelengths, that is wavelengths 2 and 3, are not below 700 nm.

The measuring device must wait for a particle passing the measuring point close enough to carry out the temperature determination. In such events it is capable of detecting pulses differing from the relatively even background caused by the rest of the fluidized bed material within the used measurement bands. The pulses are illustrated in Fig. 6 showing said case at one wavelength.

Datapairs making it possible to calculate the above-described parameter β_{12} and parameter β_{32} of Equations 6 and 7 respectively can be calculated at the pulses at wavelengths 1 and 2, and 3 and 2. The parameter can be determined by means of linear regression with a number of datapairs taken at a sufficiently high frequency. In a corresponding manner the so-called bed signals $I_1(0)$, $I_2(0)$ and $I_3(0)$ representing the intensity level of the thermal radiation solely from the bed material at measurement wavelengths 1, 2 and 3, respectively, can be determined for Equations 6 and 7 within the signal level outside said pulses.

In the practice the signal is so processed that the voltage readings measured by the A/D converter at different wavelengths are stored in the memory of a computer. For the measured signals it must be first determined which part of this signal data originates from the fluidized bed material only in order to be able to calculate the surface temperature of the fluidized bed material by utilizing the information obtained at two different wavelengths. The thermal radiation emitted solely by fluidized bed material can be calculated by dividing a pair of sample lines obtained by the computer at two different wavelengths within a prescribed period in for example twenty groups, this arrangement being illustrated in Fig. 6. The average values of the signals in the groups can be sorted in the order of magnitude, by means of which values the average signal level can be calculated. The effect of the pulses caused by hot fuel particles, as well as the effect of the particles which are colder than usually can thus be eliminated. The method is based on the fact that in a time scale the portion of the pulses caused by hot fuel particles is short compared with the length of the whole measurement period, and the signal emanating solely from the fluidized bed material can be known for certain.

Samples out of the detector signals are taken at the frequency of 27500 Hz by means of the computer in order to reach a sufficient time resolution. The storage of all these data in the computer memory is, however, unpractical, even impossible. Hence, after the signal emanating solely from the fluidized bed material has been determined, and on the basis of the obtained data, the temperature of the other fluidized bed material has been calculated, the measuring computer can shift to a state of readiness, in which it continuously monitors the level of the signals which are to be measured without storing the signals. If it is detected that the signals contain a sufficiently high deviation from the level of the signal normally emitted by the bed, the detected pulse will be stored at all the three measurement wavelengths and the calculations can be carried out according to the algorithms of Equations 6, 7 and 8.

Prior to the measurement, it is advisable to calibrate the photodiodes serving as the detectors with a black radiator at the used wavelengths.

The invention is applicable in the measurement of the surface temperatures of all non-metallic materials (the so-called "grey radiators") present in fluidized bed combustion. For these materials, the dependence of the emissivities on the wavelength is negligible as to the accuracy of the measurement. It can thus be summarized that the introduction of a third measurement wavelength is a decisive improvement for the accuracy of the measurement without too complicated and expensive a method and device in the practice.

Claims:

1. Method for measuring the temperature of fuel particles within a fluidized bed, comprising determining the surface temperature of fuel particles by measuring the intensity (I_1, I_3) of thermal radiation emitted at the same time by fuel particles and the other fluidized bed material within the fluidized bed at two different measurement wavelengths (λ_1, λ_3), and calculating the surface temperature of the particles by means of the obtained measurement data, **characterized** in that at the same time with said two measurement wavelengths (λ_1, λ_3), additionally a third measurement wavelength (λ_2) is used in the measurement, and by means of the information obtained with the latter and and by means of the information obtained with said two measurement wavelengths, the surface temperature (T_c) of the fuel particles is calculated in such a fashion that the ratio of the emissivities of the fuel particles and the other fluidized bed material is a non-assumed value in the calculation operation.

2. Method as claimed in Claim 1, **characterized** in that the intensity ($I(0)$) of the thermal radiation emitted by the other fluidized bed material is measured continuously and the surface temperature (T_b) of the material is calculated on the basis of the information obtained at at least two different measurement wavelengths (λ_1, λ_3), and the value so obtained is utilized in calculating the surface temperature of the fuel particles on the basis of the intensity information (I_1, I_2, I_3) obtained at the three measurement wavelengths (λ_1, λ_2, λ_3).

3. Method as claimed in Claim 2, **characterized** in that in the measuremnt of the intensity emitted by the fuel particles and the intensity emitted by the

other fluidized bed material, a common continuous measurement signal is used, and when the signal is relatively unchanged, the surface temperature (T_b) of the other fluidized bed material is calculated by means of the intensity levels (I_1, I_3) obtained at two different measurement wavelengths (λ_1, λ_3), the points at which the thermal radiation emitted by a fuel particle causes a change in said intensity levels are identified, and the intensity values obtained at these points at three different measurement wavelengths are utilized in calculating the surface temperature (T_c) of the fuel particles.

4. Method as claimed in Claim 2 or 3, **characterized** in that the measurement wavelengths utilized in calculating the surface temperature of the other fluidized bed material are the largest and smallest wavelength (λ_1, λ_3) and the third wavelength (λ_2), which is utilized additionally in measuring the surface temperature (T_c) of the fuel particles, lies therebetween.

5. Method as claimed in any of the preceding claims, **characterized** in that one (λ_1) of the used measurement wavelengths is not greater than 700 nm, and the other two (λ_2, λ_3) are not below 700 nm.

6. Method as claimed in any of the preceding claims, **characterized** in that the member (3) provided in the method for the measurement of the intensity of the thermal radiation is calibrated with a black radiator before the measurement.

7. Apparatus for measuring the temperature of fuel particles within a fluidized bed, comprising a receiver (2) of thermal radiation mountable inside a fluidized bed and connected with detectors (3d, 3f) provided for detection of the intensity of the thermal radiation

emitted at the same time by the fuel particles and the other fluidized bed material within the fluidized bed at two different measurement wavelengths (λ_1, λ_3), the apparatus further comprising a data processing unit (4) for processing the measurement data given by the detectors and for calculating the surface temperature (T_c) of the fuel particles by means of the measurement data, **characterized** in that the apparatus comprises further a detector (3e) provided for measurement of the intensity of the thermal radiation emitted by the fuel particles and the other fluidized bed material within the fluidized bed at a third measurement wavelength, said detector being connected with said data processing unit containing a program for calculating the surface temperature (T_c) of the fuel particles on the basis of the information obtained at said measurement wavelengths in such a fashion that the ratio of the emissivities of the fuel particles and the other fluidized bed material is a non-assumed value in the calculation operation.

8. Apparatus as claimed in Claim 7, **characterized** in that the thermal radiation is received at all the three measurement wavelengths (λ_1, λ_2, λ_3) by a common receiver (2) of thermal radiation, the apparatus further comprising separating means, preferably dichroic mirrors (3b, 3c), for distributing the intensity coming in at different wavelengths to the respective detectors.

9. Apparatus as claimed in Claim 7 or 8, **characterized** in that the detectors contain photodiodes connected to electronics having means for converting the intensity coming in at the measurement wavelength to a corresponding voltage signal.

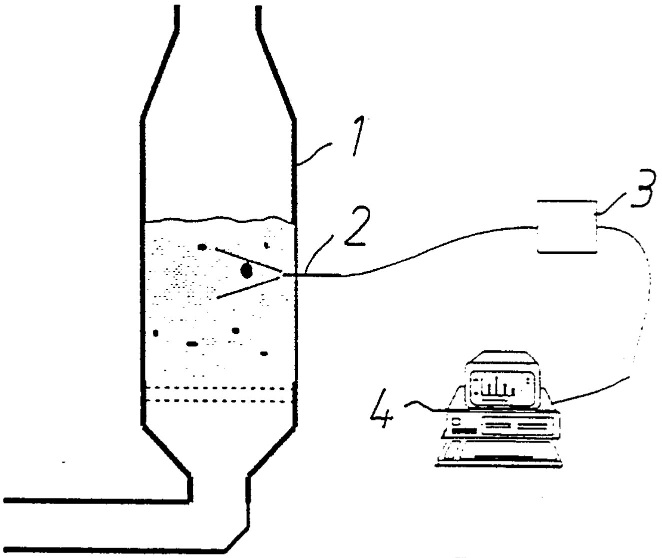

FIG.1

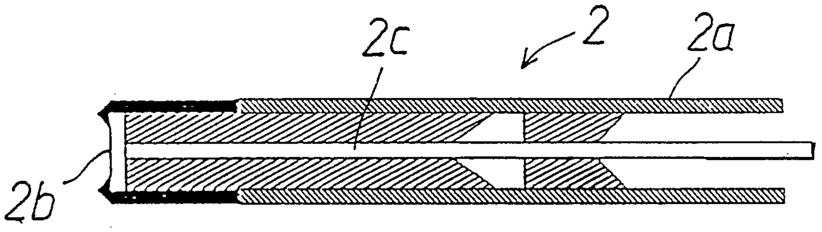

FIG.2

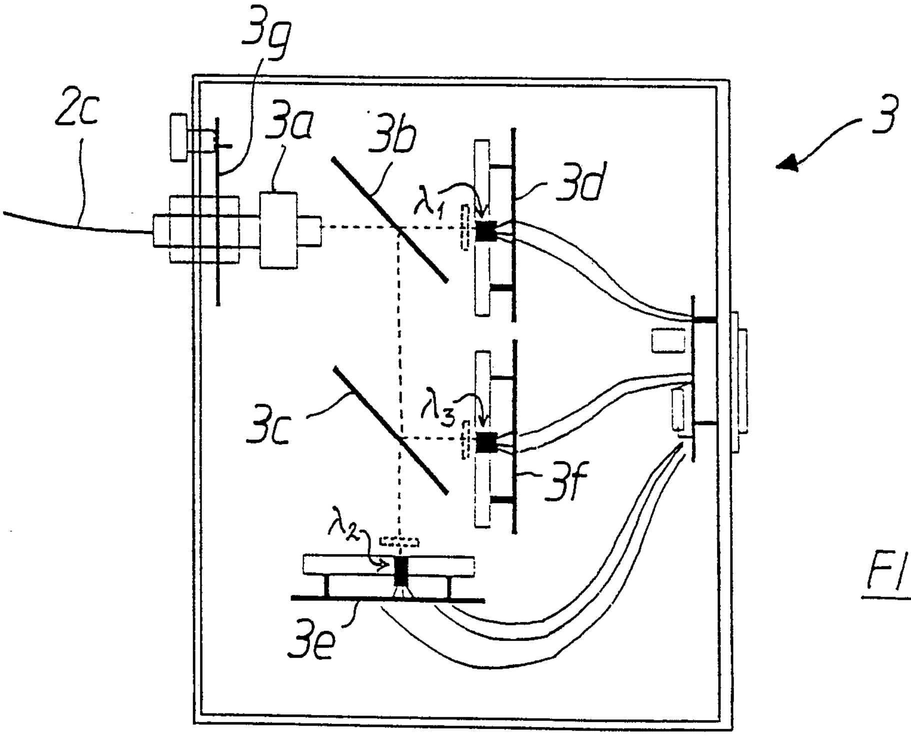

FIG.3

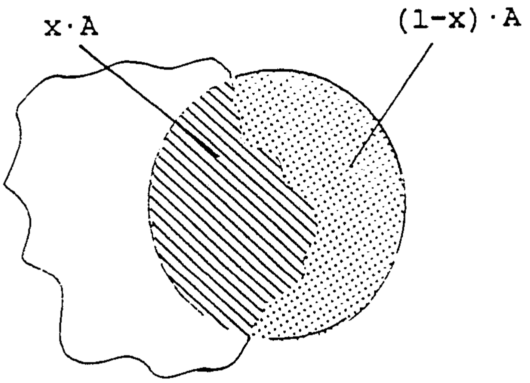

FIG. 4

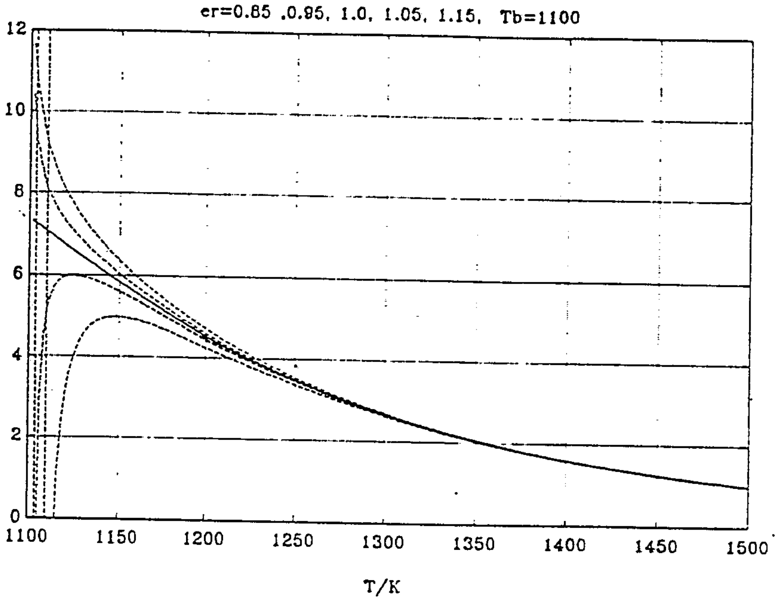

FIG. 5

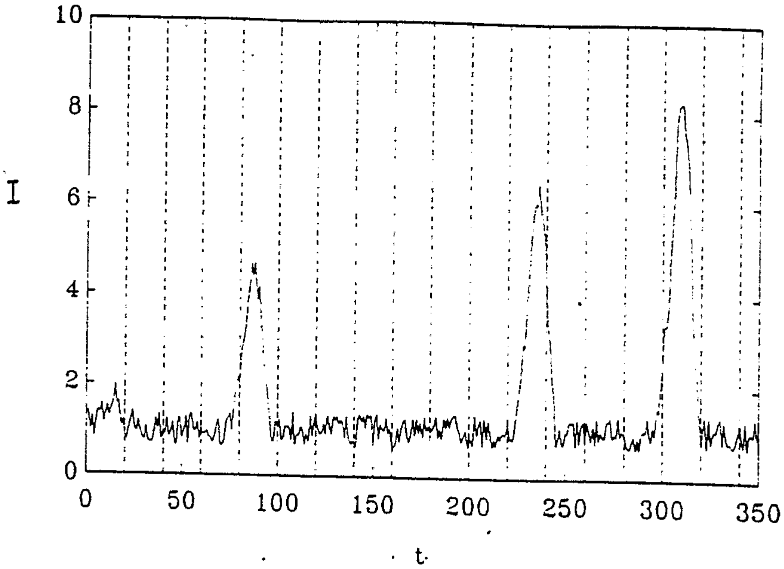

FIG. 6

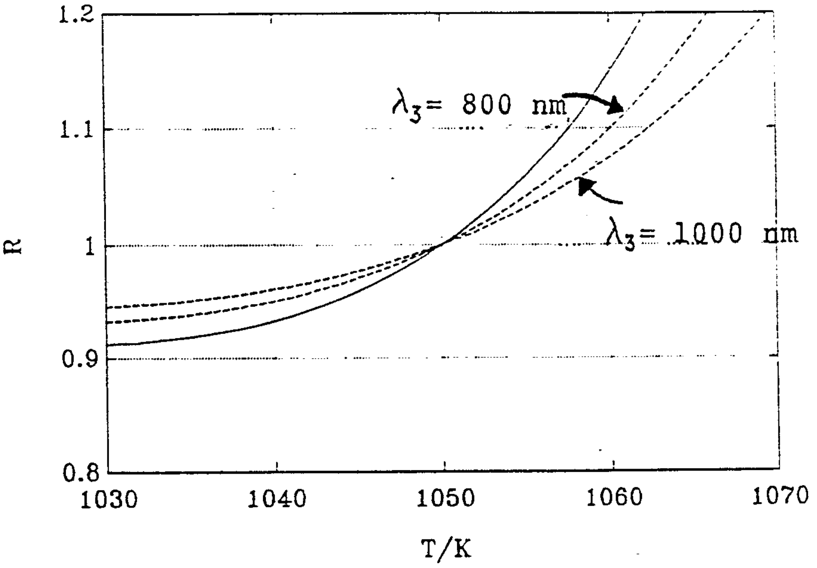
1.2
1.1
1
0.9
0.8
R
1030
1040
1050
1060
1070
T/K
λ_3= 800 nm
λ_3= 1000 nm

FIG. 7a

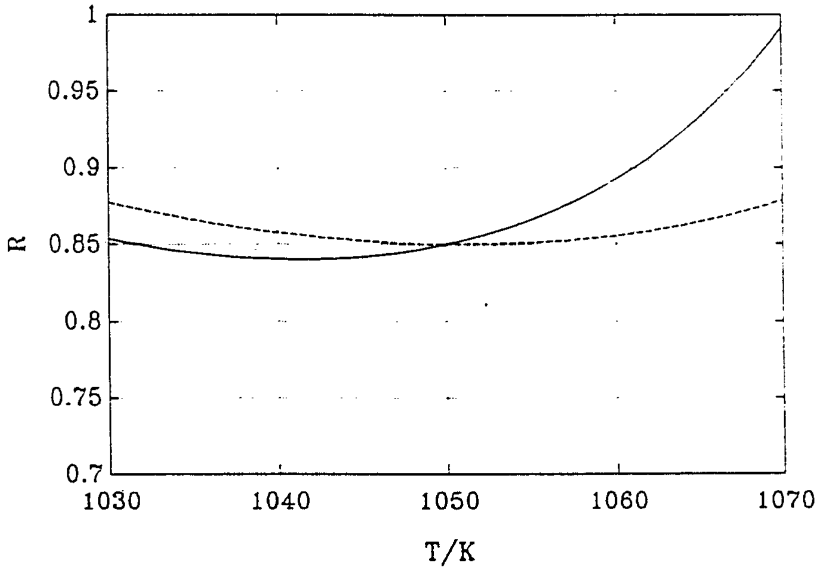
1
0.95
0.9
0.85
0.8
0.75
0.7
R
1030
1040
1050
1060
1070
T/K

FIG. 7b

INTERNATIONAL SEARCH REPORT

International Application No PCT/FI 90/00207

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: G 01 J 5/60

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	G 01 J

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched[8]

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
A	DE, A1, 3616505 (VEB MESSGERÄTEWERK) 15 January 1987, see page 3, line 40 - page 4, line 44 --	1,7
A	DE, A1, 3149138 (VEB MESSGERÄTEWERK) 12 August 1982, see page 6, line 6 - page 7, line 29; claims 1,4 --	1,7
A	EP, A2, 0294747 (MINOLTA CAMERA) 14 December 1988, see abstract; figure 2 --	1,7
A	EP, A2, 0173548 (ROLLS-ROYCE) 5 March 1986, see abstract; figure 3 -- --------	1,7

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

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"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search 3rd December 1990	Date of Mailing of this International Search Report 1990 -12- 07
International Searching Authority SWEDISH PATENT OFFICE	Signature of Authorized Officer Lars Jakobsson

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.PCT/FI 90/00207

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the Swedish Patent Office EDP file on 90-11-01
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE-A1- 3616505	87-01-15	NONE	
DE-A1- 3149138	82-08-12	FR-A-B- 2497343	82-07-02
		GB-A- 2090402	82-07-07
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		JP-A- 63305228	88-12-13
EP-A2- 0173548	86-03-05	JP-A- 61062827	86-03-31
		US-A- 4780832	88-10-25