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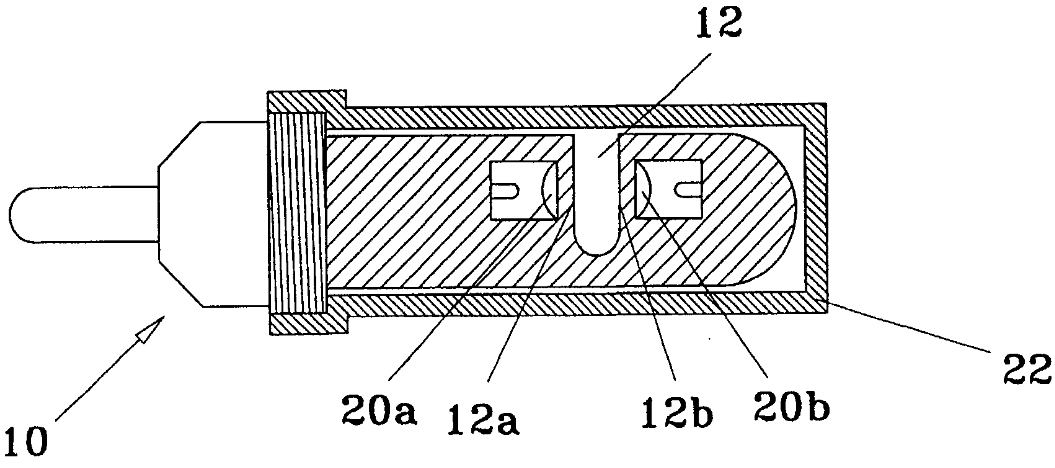

(57) Abstract

A method for detecting a coloured fluid, e.g. coloured diesel fuel, in a non–coloured fluid by emitting light of two different wavelengths into a sample of the fluid and measure the absorption. The coloured fluid absorbs light at one of the selected wavelengths, and by relating the two absorption values the coloured fluid can be detected. A probe comprising LEDs and focusing lenses suitable for the measurement is also described. The probe can also be used in a method for measuring of particles in a fluid.

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PROCESS AND DEVICE FOR THE MEASURING OF COLOUR AND/OR PARTICLES IN A FLUID

The present invention relates to a process for detecting a dye in a fluid. More specifically the present invention relates to a process for detecting fragments of dyed duty-free diesel in duty-levied undyed diesel. The present invention further relates to a process for determining the degree of particle contamination in a sample, plus a means for measuring dye and particles in solution.

In several countries, including Norway and Sweden, there is adopted a differentiated duty system for diesel oils, i.e. there is a distinction between duty-levied and duty-free diesel oils. In order to distinguish these from each other dyes plus a tracer have been added to the duty-free diesel, in Norway a red dye, and in Sweden a green dye. By virtue of the price difference between the two diesel variants extensive illegal use of the duty-free diesel has occurred.

There is therefore an expressed wish from the Duty Directorate for a handy measuring instrument which can be guided down into fuel tanks of motor vehicles in order to prove illegal use of such dyed duty-free diesel.

To-day there is employed a complicated chemical method of detection for identifying whether there exist fractions of dyed diesel in non-dyed diesel. This method of detection (based on DIN 51426) is based on a demonstration and a quantitative detection of Solvent Yellow 124 (tracer), which is employed inter alia in Norway as the stable tracer label in dyed diesel. The method is complicated and time-consuming, and employes a series of chemicals, inter alia hydrochloric acid and organic solvents. A standard calibration curve has to be prepared and the method also comprises a chromatography purificating step. This implies that by a control of diesel tanks of vehicles, one will then not get the result until after the analysis is conducted in a laboratory. This is a considerable weakness with said method.

The present invention aims therefore to provide a method of detection which is simple to employ, and where the result is available immediately. The method according to the invention is based on detecting a dye by measurement of the light absorption in the diesel sample of interest.

It is known from US Patents 5,696,592, 5,002,397 and 5,179,422, plus Norwegian Patent 177618 to utilise the pattern of absorption to light of particular wavelengths in order to determine the particle contamination in a fluid.

The process according to the present invention for detecting dyes will however be independent of the degree of particle contamination in the sample, in that the absorption of light of the particles will be identical at the chosen light frequencies.

The present invention thus relates to a process for measuring/tracing fractions of a dyed fluid in a non-dyed fluid, for example dyed (duty-free) diesel in non-dyed (duty-levied) diesel, there being transmitted through the fluid via a number of light-emitting diodes a first and a second light beam of two different wavelengths, L1 and L2, and where the intensity of the light for the two light beams which have propagated themselves through the fluid are detected with two light registering means, or one light-registering means if the two light beams are transmitted sequentially, characterised in that the first light beam is transmitted with a wavelength L1 of about 600 nm or more, and that the quantity of light of the first light beam which passes the sample is detected and employed as a reference, and that the wavelength of the second beam of light has a wavelength L2 chosen so that the dye in the fluid has a large absorption coefficient at this wavelength, and that the quantity of light of the second light beam which passes the sample is detected, and that the two detected quantities of light are related to each other in order to establish a precise function of the presence of dye in the fluid.

Further the invention comprises a process for detection of particles in a fluid, characterised in that the probe which is employed comprises a number of focussing lenses, arranged in the probe so that the light which is emitted from the emitting diode(s) is guided via a first lens and at right angles to the fluid.

The present invention also relates to a means, preferably designed as a measuring probe, for measuring fractions of dyed diesel in a sample of non-dyed dye, and/or for measuring the degree of particle contamination in a sample, said means comprising a cavity for reception of the fluid which is to be investigated, and where the arrangement on each side of the cavity is equipped with a number of light-emitting diodes and a number of light-detecting diode/s, where between the light-emitting diodes and the space there is arranged a first focussing lens, and that between the cavity and the light-detecting diode/s there is arranged a second focussing lens, characterised in that the first focussing lens is a planoconvex lens where the lens is arranged in the probe so that the convex surface of the lens is directed towards the light-emitting diode/s and where the plane surface of the lens is arranged adjacent to, or at a distance from, and parallel to a plane wall portion of the space, and where the second focussing lens is a planoconvex lens where the lens is arranged so that the convex surface of the lens faces towards the light-detecting diode/s and where the plane surface of the lens is arranged adjacent to, or at a distance from, and parallel to the plane wall portion of the space.

The present invention will now be described in more detail, with reference to the accompanying Figures, in which:

Fig. 1 shows a measuring probe according to the invention in a section in the longitudinal direction.

Fig. 2 shows the same measuring probe seen in a section at 90 degrees to the section of Figure 1.

Fig. 1 shows an embodiment of an arrangement 10 according to the invention. In the arrangement 10 there is arranged a cavity, i.e. a space 12, in which the actual fluid is received by lowering down the arrangement 10 in the fluid. The means 10 comprises two light-emitting diodes 14,16, which emit light of predetermined wave length, i.e. a light spectrum having a top of a given wavelength. Thus there is emitted light of two different wavelengths, L1 and L2. On the opposite side of the space 12, in relation to the emitting diodes 14,16, a number of light-detecting diodes 18 are arranged. If light is emitted simultaneously from the two emitting diodes 14,16 two detecting diodes 18 are required, while there is only a need for one detecting diode if the light is emitted sequentially from the two emitting diodes 14,16.

The means 10 comprises further in an embodiment two focusssing lenses (20a, 20b), and where these are preferably arranged cast into the probe itself so that all the light which is conducted by the lens (20a) strikes at right angles to the fluid in the space 12. This makes the measurements which are carried out independent of the refractive index of the fluid, and the measurements are therefore independent of which type of diesel oil the measurement is conducted on.

A cable connects the diodes 14,16,18 with a source of current and equipment for recording and detecting the light which has passed through the fluid. The detected light of the two wavelengths L1 and L2 are related to each other, and the value shows whether the diesel sample includes fractions of a diesel which is dyed.

The means 10 according to the invention is designed as a probe in a preferred embodiment. Thus it can be thrust down into a diesel sample, and the test result can be immediately read off on a display (not shown). The control authorities who conduct the test thus receive immediately a very reliable indication of whether the vehicle illegally employs the duty-free dyed diesel.

Example 1

With a means 10 which is not equipped with focussing lenses there are conducted measurements on the same diesel distillate (base) of varying composition with respect to the mix ratio between dyed and non-dyed diesel. The results are given in Table I.

The accuracy of the measuring means is with respect to the second decimal in the ratio of detected light for L1 and L2, 600 nm and 430 nm, respectively. The results are accurate, and indicate with great reliability whether a diesel oil contains fractions of a dyed diesel. A mixture consisting of 97% non-dyed diesel and 3% dyed diesel yields measured results which are significantly different from a diesel sample which is not mixed with dyed diesel.

Table I

Sample	**Transmission at 600 nm (relative units)**	**Transmission at 430 nm (relative units)**	**Transm. 600/ Transm. 430**
Calibration	100	100	
Duty-levied non-dyed diesel	119,3 119,2 119,5	89,2 88,7 88,9	0,75 0,75 0,75
3% dyed diesel/ 97 % undyed diesel	118,6 118,7 118,4	87,6 87,9 87,8	0,74 0,74 0,74
10% dyed diesel/ 90% undyed diesel	118,9 118,2 118,9	84,8 84,5 84,8	0,71 0,71 0,71

It is evident from the results that even some few percentage parts of duty-free dyed diesel can be detected with reliability in a sample of undyed diesel.

The results are further independent of the degree of particle contamination in the sample, the absorption measurements for both the chosen wavelengths being influenced in the same proportion by particles in the solution.

Example 2

The preceding Example clearly demonstrates the accuracy and the potential of the measuring method. However various diesel distillates exist on the market. Inter alia these different distillates include dissimilar amounts of aromatics, and these aromatics will give the different diesel samples different refractive indices, and the measured values will therefore deviate somewhat when focussing lenses are not employed. This is evident from Table II where the undyed diesel has a ratio between transmissions at 430 nm and 600 nm which varies from 0.77 - 0.90. However, as is evident from Table II, one can clearly determine qualitatively whether a diesel sample includes dye additives. Other analyses (for example DIN 51426) will thereafter confirm and quantify the dye additive.

The experimental tests which are conducted in the Examples 1 - 4 are made with a probe without focussing lenses.

Table II

Sample	**Transmission at 600 nm (relative units)**	**Transmission at 430 nm (relative units)**	**Transm. 430/ Transm. 600**
Calibration	100	100	
Undyed Diesel			
Statoil	120,2	94,4	0,79
Shell	123	94,4	0,77
Esso	131,4	96,1	0,77
Hydro/Texaco	119,7	97,7	0,82
Fina	121,5	109,1	0,90

Table II (cont.)

Dyed Diesel			
Statoil	122,3	71,4	0,58
Shell	119,9	75,4	0,63
Esso	121,5	74	0,61
Hydro/Texaco	120,8	71,5	0,59
Fina	120,2	72,8	0,61

It is evident from the Table that the ratio is reduced for the duty-free dyed diesel as a consequence of the light passage of light having a wavelength of 430 nm being reduced.

Example 3

Table III shows that the measuring method can either detect red dye which is added to the diesel or the tracer or a combination of these. The tracer is the chemical compound added so as to be able to conduct a chemical quantification. The dye is added first and foremost so as to be able to distinguish purely visually duty-free diesel from duty-levied diesel.

Table III

Sample	**Transmission at 600 nm (relative units)**	**Transmission at 430 nm (relative units)**	**Transm. 430/ Transm. 600**
Calibration	100	100	
Sample with tracer	121,5	64,4	0,53
Sample with red dye	117,8	56,9	0,48
Sample red diesel	115,9	50,2	0,43
Undyed diesel	122,2	94,6	0,77

Table IV shows an outline of which tracers and dyestuffs which are employed for the marking of mineral oils in Europe.

Table IV

OUTLINE OF EUROPEAN TRACERS FOR MARKING OF MINERAL OIL.

Country	Dye	Tracer
Belgium	red dye	furfural
Denmark	none	none
Finland	red, same as in Norway	furfural
France	Solvent Red 24	furfural+ diphenylamine
Greece (fuel oil)	Sudan Red ..	furfural
Irland (diesel) (paraffin)	Solvent Blue 79 Solvent Red 19	Solvent Yellow 124 "
Italy (diesel, fishing boats) Light fuel oil	Alizarin Green G base Alizarin Green 3 B phase	furfural RS(2-ethyl-anthraquinone) Secret mix
Luxembourg	red dye	furfural
Netherlands diesel and light fuil oil	alkyl derivatives of azobenzene-4-azo-2-naphtol, (red dye)	furfural
Norway	Solvent Red 462	Solvent Yellow 124
Spain	red, same as in Norway, or a hydroxy-derivative of this	Solvent Yellow 124/ furfural
Great Britain (diesel) (paraffin)	Solvent Red 24 "	1,4-dihydroxy anthraquinone coumarin
Sweden	Solvent Blue 79	Solvent Yellow 124
Germany	red dye *	furfural

* the following red dyes are used in Germany, either separately or in mixture:
4-amino-azobenzene-2-ethylaminonaphthalene, 4-amino-azotoluene-2-tridecylaminonaphthalene or 4-amino-azotoluene-2-(2-ethyl)-hexylaminonaphthalene

Example 4

Table V shows the results of detection of 10% dyed diesel in undyed diesel

Table V

Sample	**Transmission at 600 nm (relative units)**	**Transmission at 430 nm (relative units)**	**Transm. 430/ Transm. 600**
Calibration	100	100	
Undyed diesel			
Shell	122,6	103	0,84
Hydro/Texaco	121,1	101,8	0,84
Fina *	121	108,5	0,90
Esso	116,3	98,8	0,85
Dyed diesel			
Shell	120,6	95,9	0,79
Hydro/Texaco	120,1	95,2	0,79
Fina *	119,7	104,8	0,87
Esso	114,8	92	0,80

As previously shown the measuring method according to the invention is sufficiently sensitive to be able to measure additives of only some few percent dyed diesel in undyed diesel. This is also evident from Table V where the relation proportions of each of the samples decreases with the addition of dye.

As mentioned, it is a problem that the base values for the different diesel samples have dissimilar transmission values, and also dissimilar proportions. Since we measure at two different wavelengths, as is indicated in claim 1, the degree of particles in the samples will not affect the result. However the arrangement which is employed for the Examples 1 - 4, i.e. without focussing lenses, will yield results which are dependent on the refractive index of the fluid. Different amounts of aromatics in the fluid will affect the refractive index, and hence the base values of the different diesel distillates. This explains that the sample from Fina yields high ratios.

By equipping the arrangement 10 with a set of focussing lenses 20a, 20b, which arrange for the light which is guided into the sample to strike the fluid at right angles, i.e. at right angles relative to the wall portions 12a and 12b of the cavity 12, i.e. as indicated in Fig. 1, the measuring results will be made independent of the refractive index of the fluid. The wall portions 12a, 12b of the cavity 12 are planar. With such a probe, as indicated in claim 7, one will expect that the base values, for dissimilar diesel distillates, i.e. in undyed samples, become more alike. When the base values are identical one will be able to determine fractions of dyed diesel of only a few per cent in an unknown diesel sample. Results as in Example 1 are expected.

Further, by the application of focussing lenses a significant increase in the sensitivity of the method is anticipated.

On measuring dye fractions it is not necessary to have a calibration of the measuring apparatus before use, since the results measured for the two different wavelengths are related to each other.

However the arrangement can also be employed for measuring fractions of particles in a solution if the apparatus is calibrated in advance in the dark, and where one thereafter measures the decline in the passage of light. There is a correlation between the quantity of particles in the solution and the reduction in transmission, and by establishing a standard curve for the transmission/ particle contamination ratio it will be possible to deduce from this how much a solution is with contaminated particles. By measurements at 600 nm this method will be independent of the amount of dye in the solution. This means that the means can simultaneously detect dye and particles respectively. By employing a set of focussing lenses the measurements will also be independent of refractive indies, and thus represents an improvement in relation to NO-177618.

In order to obtain a favorable calibration, the measuring probe is equipped with a case 22, constructed of light-proof material, so that calibration of the probe can be effected in the dark, if desired in the air or in a particle-free fluid. The case 22 can for example be fastened to the measuring probe by a set of threads 24.

Patent Claims

1. Process for measuring/tracing of fractions of a dyed fluid in a non-dyed fluid, for example dyed (duty-free) diesel in non-dyed (duty-levied) diesel, there being transmitted through the fluid, via a number of light-emitting diodes (14,16), a first and a second beam of light of two different wavelengths, L1 and L2, and where the intensity of light of the two light beams which have propagated themselves through the fluid is detected by two light-registering means (18), or one light-registering means (18) if the two light beams are emitted sequentially, characterised in that the first light beam is emitted with a wavelength L1 of about 600 nm or more, and that the quantity of light of the first light beam which passes the sample is detected and employed as a reference, and that the wavelength of the second light beam has a wavelength L2 chosen so that the dye in the fluid has a large absorption coefficient at this wavelength, and that the quantity of light of the second light beam which passes the sample is detected, and that the two detected light quantities are related to each other so as to establish a precise function of the presence of dyestuff in the fluid.

2. Process in accordance with claim 1, for detecting tracer, red dye and/or green dye from duty-free dyed diesel in a sample of undyed diesel, characterised in that the wavelength for L1 is about 600 nm, and the wavelength for L2 is in the region of 380 - 450 nm, preferably about 410 nm.

3. Process in accordance with claim 1 or 2, characterised in that the light beams from the emitting diodes (14,18) are guided via a first focussing lens (20a) perpendicularly to a plane wall portion (12a) of the fluid-receiving space (12), and where the light which has

propagated itself through the fluid is guided out through a plane wall portion (12b) of the space (12), and thereafter through a second focussing lens (20b) to the detecting diode/s (18).

4. Process in accordance with one of the claims 1 - 3, characterised in that a decline in the number of the $transmission_{410\ nm}/transmission_{600\ nm}$ ratio relative to the ratio number for a undyed sample, indicates that the sample includes fractions of dyed diesel.

5. Process for measuring particles in a fluid, light being transmitted through the fluid by means of light-emitting diode/s (14,16), and the intensity of the light for the light which is propagated through the fluid is detected by light-registering diode/s (18), where the detected light intensity is compared with previous values for known degrees of contamination so as to provide a statement of the degree of particle contamination, characterised in that the light from the emitting diode/s (14,16) is guided via a first focussing lens (20a) perpendicularly to a plane wall portion (12a) of the fluid-receiving space (12), and where the light which has propagated itself through the fluid is guided out through a plane wall portion (12b) of the space (12), and thereafter through a second focussing lens (20b) to the detecting diode/s (18).

6. Process in accordance with claim 5, characterised in that a calibration of the measuring instrument is effected in a light-free environment, for example in air or particle-free fluid, before measurement of the particle contamination is conducted.

7. Means (100), preferably designed as a measurement probe, for measuring fractions of dyed diesel in a sample of non-dyed diesel, and/or for measuring particle contamination in a sample, comprising a cavity (12) for the reception of the fluid which is to be investigated, and where the means (10) on each side of the cavity (12) is equipped with a

number of light-emitting diodes (14,16) and a number of light-detecting diode/s (18), where a first focussing lens (20a) is arranged between the space (12) and the light-emitting diode/s (14,16), and a second focussing lens (20b) is arranged between the cavity (12) and the light-detecting diode/s (18), characterised in that the first focussing lens (20a) is a planoconvex lens (20a) where the lens is arranged in the probe so that the convex surface of the lens is directed towards the light-emitting diode/s (14,16) and where the plane surface of the lens is arranged adjacent to, or at a distance from, and parallel to a plane wall portion (12a) of the space (12), and where the second focussing lens (20b) is a planoconvex lens (20b) where the lens is arranged so that the convex surface of the lens faces towards the light-detecting diode/s (18) and where the plane surface of the lens is arranged adjacent to, or at a distance from, and parallel to the plane wall portion (12b) of the space (12).

8. Means (10) in accordance with claim 7, characterised in that it is die casted of a transparent material, in which the light-emitting and light-detecting diodes (14,16,18), plus the focussing lenses (20a, 20b) are cast-in.

9. Means (10) in accordance with claims 7 - 8, characterised in that the means (10) comprises a detachable case (22) which surrounds the fluid-receiving space (12) in a light-proof manner, so that the arrangement (10) can be calibrated in a light-free environment.

10. Means (10) in accordance with one of the claims 7 - 9, characterised in that the means (10) comprises or communicates with a processor which calculates the number of the $transmission_{L2}/transmission_{L1}$ ratio, and that the processor at a predetermined ratio number, or at predetermined values for transmitted L1 and L2 emits a signal to a warning arrangement, adapted so that the user is

warned by for example a sound and/or a sound signal if the diesel sample contains fractions of dyed diesel, or an undesired amount of particles.

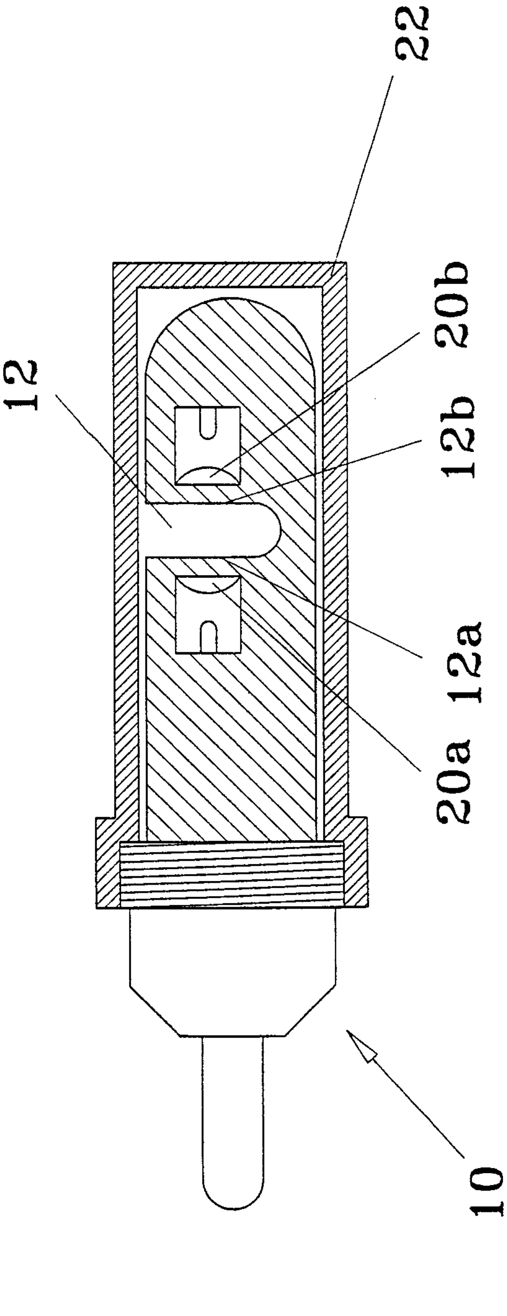

Fig. 1

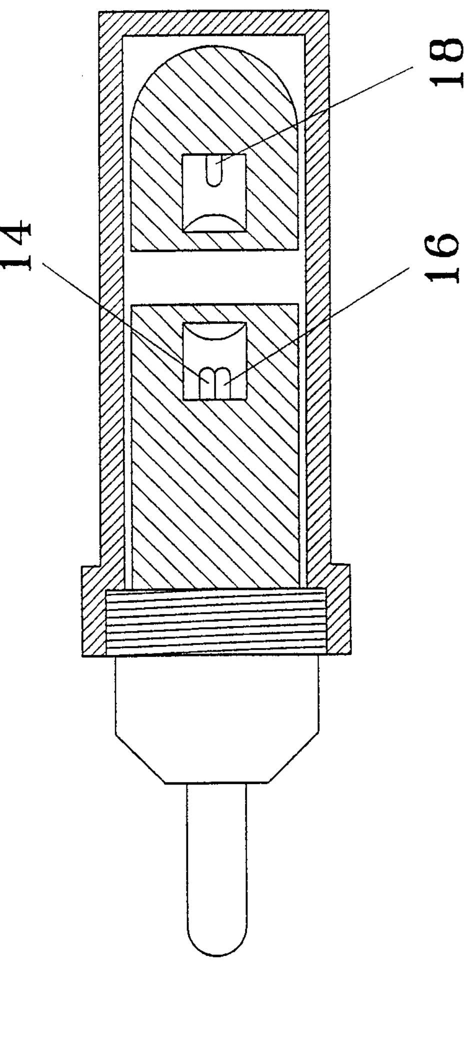

Fig. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 99/00227

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: G01N 21/25, G01N 21/03, G01N 33/22
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: G01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	WO 9900666 A1 (BOSTON ADVANCED TECHNOLOGIES, INC.), 7 January 1999 (07.01.99), page 1, line 4 - page 2, line 17; page 11, line 26 - page 12, line 11	1,4
P,A		2,3,5-10
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X	EP 0304230 A2 (THE BRITISH PETROLEUM COMPANY P.L.C.), 22 February 1989 (22.02.89), column 3, line 2 - line 22, claims 1,6, abstract	1,3
A		2,4
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
14 October 1999	30 -10- 1999
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Gunnel Wästerlid/MP Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	Derwent's abstract, No 86-263943/40, week 8640, ABSTRACT OF SU, 1213-392 (GORENKOV AF), 23 February 1986 (23.02.86)	1,2,4
A		3,5-10
	--	
X	US 4810090 A (TERRY D. BOUCHER ET AL), 7 March 1989 (07.03.89), column 2, line 59 - column 3, line 22, figure 2, abstract	5,6
A		1-4,7-10
	--	
X	US 5172192 A (WILLIAM S. PRATHER), 15 December 1992 (15.12.92), column 1, line 56 - column 2, line 34; column 2, line 55 - column 3, line 20, figure 1	7,10
A		1-6,8,9
	--	
A	US 5696592 A (CHING FU KUAN), 9 December 1997 (09.12.97), column 2, line 30 - line 54	7-10
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A	JP 60044851 A (SHIMAZU SEISAKUSHO KK) 1985-07-12 (abstract) (online) (retrieved on 1999-10-14). Retrieved from: EPO PAJ Database.	7-10
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO99/00227

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Invention 1: Claims 1-4 directed to a method for detecting a coloured fluid in a non-coloured fluid.

Invention 2: Claims 5-10 directed to a method for measuring of particles in a fluid and an apparatus for measuring of particles or a coloured fluid in a fluid.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest ☐ The additional search fees were accompanied by the applicant's protest.
☐ No protest accompanied the payment of additional search fees.

A method for detecting a coloured fluid, e.g. coloured diesel fuel, in a non-coloured fluid by emitting light of two different wavelengths into a sample of the fluid and measure the absorption. The coloured fluid absorbs light at one of the selected wavelengths, and by relating the two absorption values the coloured fluid can be detected.
A probe comprising LEDs and focusing lenses suitable for the measurement is also described. The probe can also be used in a method for measuring of particles in a fluid.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/NO 99/00227

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9900666 A1	07/01/99	AU 8377998 A	19/01/99
EP 0304230 A2	22/02/89	US 5124553 A	23/06/92
US 4810090 A	07/03/89	AU 610029 B	09/05/91
		AU 2108488 A	02/03/89
		AU 4699189 A	26/04/90
		CA 1325162 A	14/12/93
		DE 3828618 A,C	16/03/89
		FR 2619923 A,B	03/03/89
		GB 2208927 A,B	19/04/89
		GB 2219083 A,B	29/11/89
		IT 1223785 B	29/09/90
		IT 8867772 D	00/00/00
		JP 1097437 A	14/04/89
		JP 1707467 C	27/10/92
		JP 3069532 B	01/11/91
US 5172192 A	15/12/92	NONE	
US 5696592 A	09/12/97	EP 0857965 A	12/08/98