



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification⁴ : G01N 21/87, 21/65, B07C 5/342	A1	(11) International Publication Number: WO 88/ 05534 (43) International Publication Date: 28 July 1988 (28.07.88)
(21) International Application Number: PCT/GB88/00022 (22) International Filing Date: 14 January 1988 (14.01.88) (31) Priority Application Number: 8700917 (32) Priority Date: 16 January 1987 (16.01.87) (33) Priority Country: GB (71) Applicant (for all designated States except US): THE BRITISH PETROLEUM COMPANY P.L.C. [GB/ GB]; Britannic House, Moor Lane, London EC2Y 9BU (GB). (72) Inventors; and (75) Inventors/Applicants (for US only) : BOWLEY, Heather, Jane [GB/GB]; 2 Benjamin Court, 424-428 Staines Road West, Ashford, Middlesex TW15 1RA (GB). GERRARD, Donald, Leslie [GB/GB]; 57 Larkspur Way, West Ewell, Epsom KT19 9LS (GB).		(74) Agent: CRACK, Richard, David; BP International Li- mited, Patents & Agreements Division, Chertsey Road, Sunbury-on-Thames, Middlesex TW16 7LN (GB). (81) Designated States: AT (European patent), AU, BE (Eu- ropean patent), BR, CH (European patent), DE, DE (European patent), FR (European patent), GB (Euro- pean patent), IT (European patent), JP, KR, LU (Eu- ropean patent), NL, NL (European patent), SE (Eu- ropean patent), SU, US. Published <i>With international search report.</i>
(54) Title: SEPARATION PROCESS FOR DIAMONDS (57) Abstract A method of assessing the colour type of diamonds by irradiating the diamonds with laser radiation of different wavelengths and generating a numerical value characteristic of the colour type of the diamond based on the measured intensities of the resultant scattered Raman radiation for two or more different incident radiation wavelengths. The colour type of the diamond may be determined by comparing derived relative intensities of each diamond with those of reference diamonds having been determined by standard subjective assessment. The method may also be used to sort diamonds according to their colour type.		

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	FR	France	ML	Mali
AU	Australia	GA	Gabon	MR	Mauritania
BB	Barbados	GB	United Kingdom	MW	Malawi
BE	Belgium	HU	Hungary	NL	Netherlands
BG	Bulgaria	IT	Italy	NO	Norway
BJ	Benin	JP	Japan	RO	Romania
BR	Brazil	KP	Democratic People's Republic of Korea	SD	Sudan
CF	Central African Republic	KR	Republic of Korea	SE	Sweden
CG	Congo	LI	Liechtenstein	SN	Senegal
CH	Switzerland	LK	Sri Lanka	SU	Soviet Union
CM	Cameroon	LU	Luxembourg	TD	Chad
DE	Germany, Federal Republic of	MC	Monaco	TG	Togo
DK	Denmark	MG	Madagascar	US	United States of America
FI	Finland				

Separation process for diamonds.

The present invention relates to the assessment of diamond colour and more particularly relates to the assessment of diamond colour by means of laser Raman spectroscopic techniques.

The colour of valuable gems such as diamonds is generally
5 determined in a subjective manner. Thus a person allegedly expert in the art will examine the diamond by eye and then express an opinion as to its colour. However, the procedure is slow, requires considerable skill and in view of its subjectivity could be open to error.

10 The Raman signal of diamond is much stronger than that of other materials because diamond only contains carbon to carbon bonding and its Raman signal occurs at a position well separated from those of other minerals. Thus the Raman signal is highly specific for diamond. Also, because diamond only contains one type of carbon to
15 carbon bond, there is only a single Raman signal which can be readily distinguished from associated broad band fluorescence.

Laser Raman spectroscopy may be used for the separation of diamonds from a diamondiferous material and a method using this technique is disclosed in our UK patent no. GB 2140555B. Laser
20 Raman spectroscopy may also be used for assessing the quality of a diamond in an objective manner and a method using this technique is disclosed in our PCT patent application no. WO 87/03963. The method comprises the steps of calibrating a laser Raman spectrometer with diamonds of known quality characteristics, placing a diamond of
25 unknown quality characteristic in a fixed orientation, passing

incident laser radiation of known frequency and intensity onto the diamond, and monitoring the intensity of the scattered Raman signal for one or more orientations of the diamond of unknown quality.

5 It is an object of the present invention to provide means for assessing the colour type of a diamond in a less subjective manner than the known method of judgement by a human observer and it has been found that laser Raman spectroscopy may be used as a basis for an improved method of assessing the colour type of diamonds.

10 Thus according to the present invention there is provided a method of assessing the colour type of diamonds comprising the steps of (a) passing incident laser radiation of pre-determined intensity at two or more different, pre-determined wavelengths onto a diamond, the laser radiation being capable of causing Raman radiation to be scattered from the diamond, (b) measuring the intensity of the
15 scattered Raman radiation from the diamond for each of the incident laser radiation wavelengths, (c) generating a numerical value characteristic of the colour type of the diamond based on the measured intensities of scattered Raman radiation for the two or more different incident laser radiation wavelengths.

20 According to a further aspect of the invention there is provided an apparatus for assessing the colour type of diamonds comprising, (a) means for irradiating a diamond with laser radiation of pre-determined intensity at two or more different, pre-determined wavelengths, the laser radiation being capable of causing Raman
25 radiation to be scattered from the diamond, (b) means for measuring the intensity of the scattered Raman radiation from the diamond for each of the incident laser radiation wavelengths, (c) means for generating a numerical value characteristic of the colour type of the diamond based on the intensities of scattered Raman radiation
30 for the two or more different incident laser radiation wavelengths.

It is preferred that the diamonds are of similar size range and thus it may be necessary to sort diamonds into size ranges prior to using the method and apparatus according to the present invention. The present invention may be used for the assessment of
35 both cut and uncut diamonds.

The diamond may be irradiated with laser radiation of two or more wavelengths, either simultaneously or sequentially.

The source of laser radiation may be a single laser adapted to operate at two or more discrete, pre-determined wavelengths, simultaneously or sequentially. Alternatively two or more lasers may be used, each adapted to operate at one or more discrete, pre-determined wavelengths, simultaneously or sequentially. The diamond may be held or supported in the laser radiation by a holder. The diamond may be irradiated with laser radiation as it falls from the end of a conveyor belt or the like. Preferably the orientation of the diamonds with respect to the incident laser radiation is the same for each laser when more than one laser is used.

The scattered Raman radiation from the diamond being assessed is filtered from other types of radiation by a suitable optical arrangement such as a collection optic and monochromator. A detector such as a photomultiplier or multichannel detector (e.g. diode array detector) may be used to measure the intensity of the scattered Raman radiation. More than one detector, or a multichannel detector may be used to measure the intensities of scattered radiation at two or more different incident radiation wavelengths simultaneously.

The numerical value characteristic of the colour type of the diamond may be generated electronically by a computer or a microcomputer. Preferably, the numerical value is a relative intensity generated from the ratio of intensities of the scattered Raman radiation for two different incident laser radiation wavelengths.

It is envisaged that the method according to the present invention may be used to determine the colour type of diamonds by passing incident laser radiation of pre-determined intensity at two or more different, pre-determined wavelengths onto a diamond, the laser radiation being capable of causing Raman radiation to be scattered from the diamond, measuring the intensity of the scattered Raman radiation from the diamond for each of the incident

laser radiation wavelengths, generating a numerical value characteristic of the colour type of the diamond based on the measured intensities of scattered Raman radiation for the two or more different incident laser radiation wavelengths, and comparing
5 the generated numerical value with numerical values of diamonds of known colour type thereby to determine the colour type of the diamond. Preferably, the numerical value is a relative intensity generated from the ratio of intensities of scattered Raman radiation for two different incident laser radiation wavelengths. The
10 numerical values may be compared by a computer or a microprocessor.

It is further envisaged that the method according to the present invention may be used to sort diamonds according to their colour type by passing incident laser radiation of pre-determined intensity at two or more different, pre-determined wavelengths onto
15 a diamond, the laser radiation being capable of causing Raman radiation to be scattered from the diamond, measuring the intensity of the scattered Raman radiation from the diamond for each of the incident laser radiation wavelengths, generating a numerical value characteristic of the colour type of the diamond based on the
20 measured intensities of scattered Raman radiation for the two or more different incident laser radiation wavelengths, and sorting the diamond according to the generated numerical value. Preferably, the numerical value is a relative intensity generated from the ratio of intensities of scattered Raman radiation for two different incident
25 laser radiation wavelengths. Sorting of the diamond may be performed by conventional techniques such as compressed gas ejectors and the like. Preferably the sorting means is under the control of a computer or microprocessor which sorts the diamonds according to the generated numerical value.

30 The present invention may be adapted to a batch or continuous method of sorting diamonds into groups of known colour and quality from diamondiferous material. Thus, for example, the method of our UK patent no. GB 2140555B may be used to separate diamonds from diamondiferous material, the resultant diamonds then being sorted
35 into portions of diamonds of known colour type by the method as

hereinbefore described, the quality of the diamonds of each portion then being determined by the method of our PCT patent application No. WO 87/03963. The diamonds may be sorted according to colour type and quality simultaneously.

5 It is envisaged that the method of the present invention may be used for both natural and synthetic diamonds. Since it is believed that for synthetic diamonds the colour type is characteristic of the hardness of the diamond, the method and apparatus of the present invention may also be used for assessing the hardness of synthetic
10 diamonds.

The invention will now be described by way of example only and with reference to the accompanying drawings.

Figure 1 is a schematic diagram of an apparatus for assessing diamond colour type according to the method of the present
15 invention. Figure 2 is a schematic diagram of an apparatus for sorting diamonds according to their colour type according to the method of the present invention.

In Figure 1, the apparatus has two sources (1), (2) of laser radiation (9) and (10) capable of causing Raman radiation (8) to be
20 scattered from a diamond (7). Each source operates in a single wavelength mode i.e. only emitting a radiation of a single wavelength at one time. In this example the wavelength of laser radiation (9) from source (1) could be changed so that Raman intensities could be measured at two different wavelengths of
25 incident radiation. The laser used for source (1) was a Spectra-Physics model 2020 argon ion laser capable of output at 488.0 nanometers (nm) and 514.5 nanometres (nm). The laser used for source (2) was operated in a single wavelength mode i.e. only emitting laser radiation (10) of a single wavelength. In this
30 example, the laser used for source (2) was a Spectra-Physics model 164 Krypton ion laser capable of output at 647.1 nanometres (nm). Both lasers were operated in their "light" mode at 50mw, thus maintaining constant photon flux.

A diamond holder (6) was capable of holding a diamond (7) in
35 the laser radiation (9), (10) and was capable of varying the

orientation of the diamond with respect to the direction of the laser radiation (9), (10).

In use, measurement of the scattered Raman radiation (8) was carried out using an Anaspec 36 laser-Raman spectrometer (12) comprising a collection optic (3), a monochromator, (4) and a Reticon type S intensified diode array detector (5). Alternative detectors may be used, for example, a photomultiplier. The detector gave a digital output (11) which was a measure of the intensity of the scattered Raman radiation (8).

In use, a diamond (7) was held in the holder (6) and laser radiation (9), (10) of different wavelengths from the lasers (1) and (2) was passed sequentially onto the diamond (7). The position of the diamond (7) in the holder (6) was optimised to obtain the maximum intensity of scattered Raman radiation (8) at the detector (5). The maximum intensity of the scattered Raman radiation was measured for several orientations of the diamond at each incident laser radiation wavelength. The total accumulation time (the time taken to count the number of photons in the scattered Raman radiation) was of the order of one second. The accumulation time required is dependent on the frequency of the incident laser radiation and the diamond colour type. The maximum intensities of the scattered Raman radiation are expressed in number of photons counted per second. As the spread of these intensities for different orientations of the diamond was small, a mean value of the intensities of the Raman signal for the diamond was calculated herein referred to as the mean Raman intensity. The mean Raman intensity was determined at each of three incident laser radiation wavelengths (514.5 nm, 488.0 nm and 647.1 nm) sequentially.

The results of an assessment of diamonds of colour types yellow and green are given in Tables 1 and 2. Table 1 gives results for type yellow diamonds of classes 1 to 7 and Table 2 gives results for type green diamonds of classes 1 to 6, class 1 being of the highest quality and class 7 being of the lowest quality. The colours and the qualities were originally determined by standard subjective assessment.

The mean Raman intensities at each of the three wavelengths of incident radiation are given for five samples of diamonds (where possible) for each quality class and colour type. The mean Raman intensities in each case are those calculated from five different orientations of the diamond in the holder. It was found that in each case the orientation of the diamond made little difference to the intensity of the Raman signal due to its tetrahedral carbon to carbon stretching mode.

Relative intensities are also given in the tables, where the relative intensities are defined as the ratio of the mean Raman intensities, that is $I_{514.5}/I_{488}$ and $I_{514.5}/I_{647.1}$, and where $I_{514.5}$ is the mean Raman intensity for an incident laser radiation of wavelength 514.5 nanometres, etc.

The tables show that the relative intensities are more or less constant and characteristic of the colour type i.e yellow diamonds have relative intensities of about 7 and 8 and green diamonds have relative intensities of about 4.

It is envisaged that in this example, the colour type of diamonds of unknown colour type may be determined by comparing derived relative intensities of the unknown diamonds with the derived relative intensities of these diamonds of known colour type.

Figure 2, is a schematic diagram of an apparatus for sorting diamonds according to their colour type according to the method of the present invention. Diamonds (20) are transported on a moving conveyor (33) through a beam of laser radiation (22) from a laser (21). The laser (21) is capable of operating at two or more discrete, pre-determined wavelengths simultaneously (all lines mode). Raman radiation (23) scattered from each diamond (20) is measured using a spectrometer (26) comprising a collection optic (24), a monochromator (25) and a multichannel detector (27). The detector (27) gives digital outputs (28) which are measures of the intensities of the scattered Raman radiation (23) for the two or more incident laser radiation wavelengths. A microprocessor (29) generates a numerical value characteristic of the diamond colour

type from the measured intensities and transmits a suitable signal
along line (30) to operate a segregator (31) according to the
generated numerical value. Preferably, the numerical value is a
relative intensity generated from the ratio of intensities of
5 scattered Raman radiation for two different incident laser radiation
wavelengths. The segregator (31) sorts the diamonds into
collectors (32) according to the generated numerical value and hence
colour type. The segregator (31) may be a group of conventional gas
ejectors or the like.

10

15

20

25

30

35

TABLE 1
Diamond Type - Yellow

Quality Class	Sample Number	Mean Raman Intensity (counts/sec) at Different Incident Radiation Wavelengths			Relative Intensities	
		$\lambda_{e488.0}$	$\lambda_{e514.5}$	$\lambda_{e647.5}$	$I_{514.5}/I_{488}$	$I_{514.5}/I_{647.1}$
5						
10						
	1	24736	200 613	28295	8.11	7.09
	2	25136	200 588	28055	7.98	7.15
	3	25093	200 492	28198	7.99	7.11
	4	-	-	-	-	-
15	5	-	-	-	-	-
	1	20187	160 490	22732	7.95	7.06
	2	19988	160 101	22549	8.01	7.10
	3	19947	159 376	22384	7.99	7.12
20	4	19551	158 954	22675	8.13	7.01
	5	19729	158 627	22726	8.04	6.98
	1	16704	133 461	18981	7.99	7.03
	2	16374	133 450	18789	8.15	7.10
25	3	16497	132 968	19019	8.06	6.99
	4	16419	132 919	18898	8.10	7.03
	5	16621	132 888	18716	7.99	7.10
	1	14536	116 204	16374	7.99	7.01
30	2	14708	116 201	16502	7.90	7.04
	3	14314	115 972	16257	8.10	7.13
	4	14376	115 927	16575	8.06	6.99
	5	14608	115 883	16325	7.93	7.10
	1	12927	103 467	14549	8.00	7.11
35	2	12722	102 978	14649	8.09	7.03
	3	-	-	-	-	-
	4	-	-	-	-	-
	5	-	-	-	-	-
40						
	1	10186	81005	11523	7.05	7.03
	2	10246	80834	11386	7.89	7.01
	3	10062	80609	11525	8.01	6.99
	4	10067	80133	11360	7.96	7.05
45	5	-	-	-	-	-
	1	9512	74958	10733	7.88	6.98
	2	-	-	-	-	-
	3	-	-	-	-	-
50	4	-	-	-	-	-
	5	-	-	-	-	-

TABLE 2
Diamond Type - Green

5	Quality Class	Sample Number	Mean Raman Intensity (counts/sec) at Different Incident Radiation Wavelengths			Relative Intensities	
			λ e488.0	λ e514.5	λ e647.1	$I_{514.5}/I_{488}$	$I_{514.5}/I_{647.1}$
10	1	1	16790	67355	16988	4.01	3.96
		2	16363	67326	16737	4.11	4.02
		3	16424	66839	16352	4.07	4.09
		4	16443	65814	16506	4.00	3.98
15		5	15840	65787	15989	4.15	4.11
20	2	1	12247	49755	12093	4.06	4.11
		2	12114	49658	12279	4.01	4.04
		3	12006	49616	12059	4.13	4.11
		4	12139	49383	12241	4.07	4.03
		5	12103	49072	11987	4.05	4.09
25	3	1	11242	45301	11146	4.03	4.06
		2	11058	45273	11206	4.09	4.04
		3	10928	44796	11032	4.01	4.06
		4	10858	44135	10669	4.06	4.13
		5	10641	43517	10789	4.09	4.03
30	4	1	10293	41759	10351	4.06	4.03
		2	9955	40958	9877	4.11	4.15
		3	9876	40531	10063	4.10	4.03
		4	9653	39467	9821	4.09	4.02
		5	9824	39401	9712	4.01	4.06
35	5	1	8608	35289	8750	4.10	4.03
		2	8147	32705	8229	4.01	3.97
		3	7935	31642	7719	3.99	4.10
		4	7017	27677	7089	3.94	3.90
		5	6067	23552	6115	3.88	3.85
40	6	1	3546	14015	3599	3.95	3.89
		2	977	3584	993	3.67	3.61
		3	-	-	-	-	-
		4	-	-	-	-	-
45		5	-	-	-	-	-

Claims:

1. A method of assessing the colour type of diamonds comprising the steps of (a) passing incident laser radiation of pre-determined intensity at two or more different, pre-determined wavelengths onto a diamond, the laser radiation being capable of causing Raman radiation to be scattered from the diamond, (b) measuring the intensity of the scattered Raman radiation from the diamond for each of the incident laser radiation wavelengths, (c) generating a numerical value characteristic of the colour type of the diamond based on the measured intensities of scattered Raman radiation for the two or more different incident laser radiation wavelengths.
2. A method of assessing the colour type of diamonds according to claim 1 in which the numerical value characteristic of the diamond colour type of the diamond is a relative intensity generated from the ratio of intensities of scattered Raman radiation for two different incident laser radiation wavelengths.
3. A method according to claim 1 or claim 2 in which the incident laser radiation has a wavelength of 488.0 nanometres, 514.5 nanometres or 647.5 nanometres.
4. A method according to any of the preceding claims in which the diamonds are sorted into a known size range prior to assessment.
5. A method according to any of the preceding claims in which the diamonds to be assessed are natural diamonds.
6. A method according to any of claims 1 to 4 in which the diamonds to be assessed are synthetic diamonds.
7. A method according to any of the preceding claims in which the

incident laser radiation is passed onto the diamond at more than one wavelength simultaneously.

8. A method according to any of claims 1 to 6 in which the incident laser radiation is passed onto the diamond at more than one
5 wavelength sequentially.

9. A method of assessing the colour type of diamonds as hereinbefore described and with reference to the accompanying drawings.

10. An apparatus for assessing the colour type of diamonds comprising, (a) means for irradiating a diamond with laser radiation of pre-determined intensity at two or more different, pre-determined wavelengths, the laser radiation being capable of causing Raman radiation to be scattered from the diamond, (b) means for measuring the intensity of the scattered Raman radiation from the diamond for
15 each of the incident laser radiation wavelengths, (c) means for generating a numerical value characteristic of the colour type of the diamond based on the intensities of scattered Raman radiation for the two or more different laser radiation wavelengths.

11. An apparatus for assessing the colour type of diamonds as
20 hereinbefore described and with reference to the accompanying drawings.

12. A method of determining the colour type of diamonds comprising the steps of (a) passing incident laser radiation of pre-determined intensity at two or more different, pre-determined wavelengths onto
25 a diamond, the laser radiation being capable of causing Raman radiation to be scattered from the diamond, (b) measuring the intensity of the scattered Raman radiation from the diamond for each of the incident laser radiation wavelengths, (c) generating a numerical value characteristic of the colour type of the diamond
30 based on the measured intensities of scattered Raman radiation for the two or more different incident laser radiation wavelengths, (d) comparing the numerical value with numerical values of diamonds of known colour type thereby to determine the colour type of the diamond.

35 13. A method of determining the colour type of diamonds according

to claim 12 in which the generated numerical value is a relative intensity generated from the ratio of intensities of scattered Raman radiation for two different incident laser radiation wavelengths.

14. A method of determining the colour type of diamonds as
5 hereinbefore described and with reference to the accompanying drawings.

15. A method of sorting diamonds according to their colour type comprising (a) passing incident laser radiation of pre-determined intensity at two or more different, pre-determined wavelengths onto
10 a diamond, the laser radiation being capable of causing Raman radiation to be scattered from the diamond, (b) measuring the intensity of the scattered Raman radiation from the diamond for each of the incident laser radiation wavelengths, (c) generating a numerical value characteristic of the colour type of the diamond
15 based on the measured intensities of scattered Raman radiation for the two or more different incident laser radiation wavelengths, (d) sorting the diamond according to the generated numerical value.

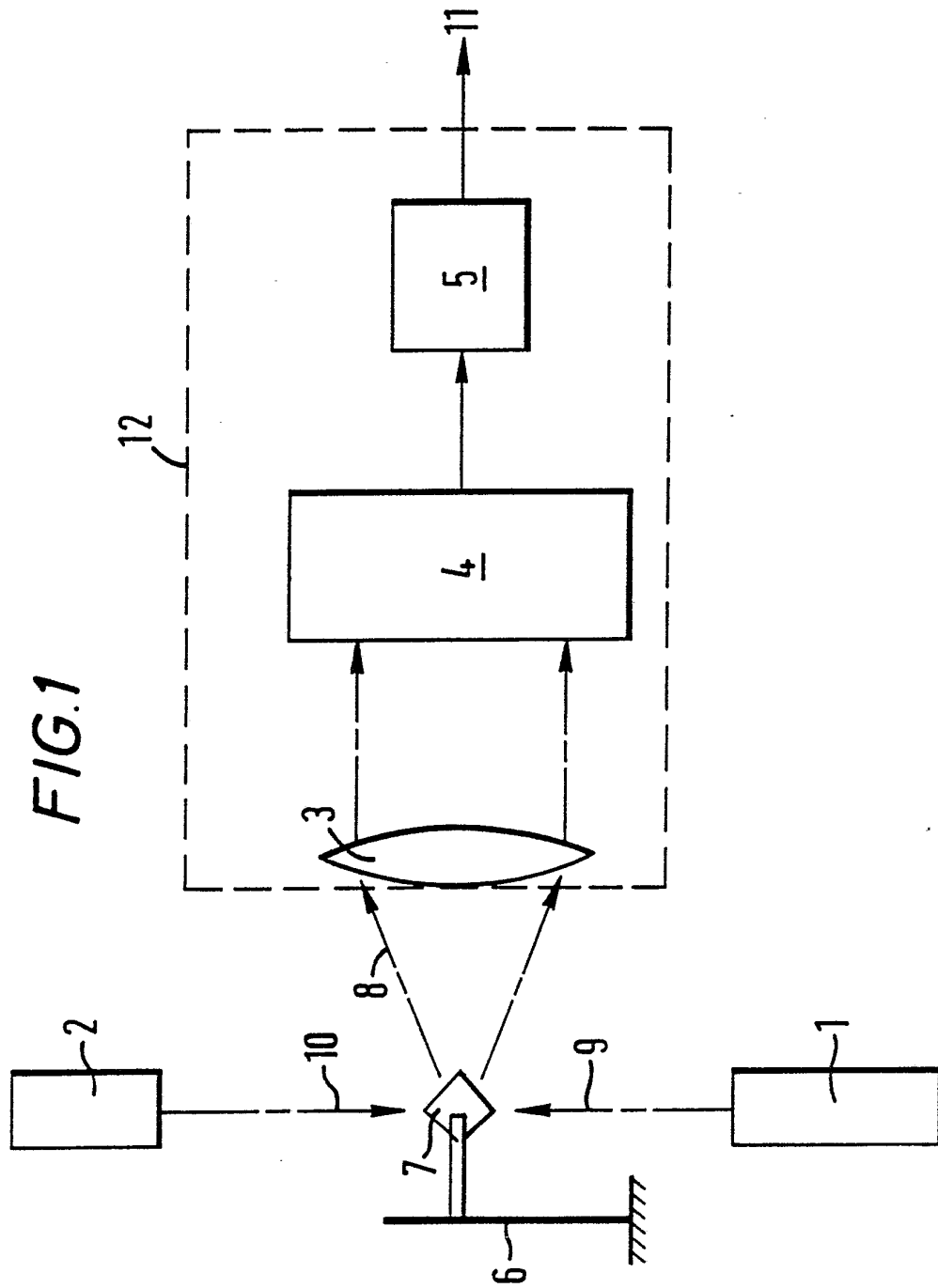
16. A method of sorting diamonds according to their colour type according to claim 15 in which the generated numerical value is a
20 relative intensity generated from the ratio of intensities of scattered Raman radiation for two different incident laser radiation wavelengths.

17. A method of sorting diamonds according to their colour type as hereinbefore described and with reference to the accompanying
25 drawings.

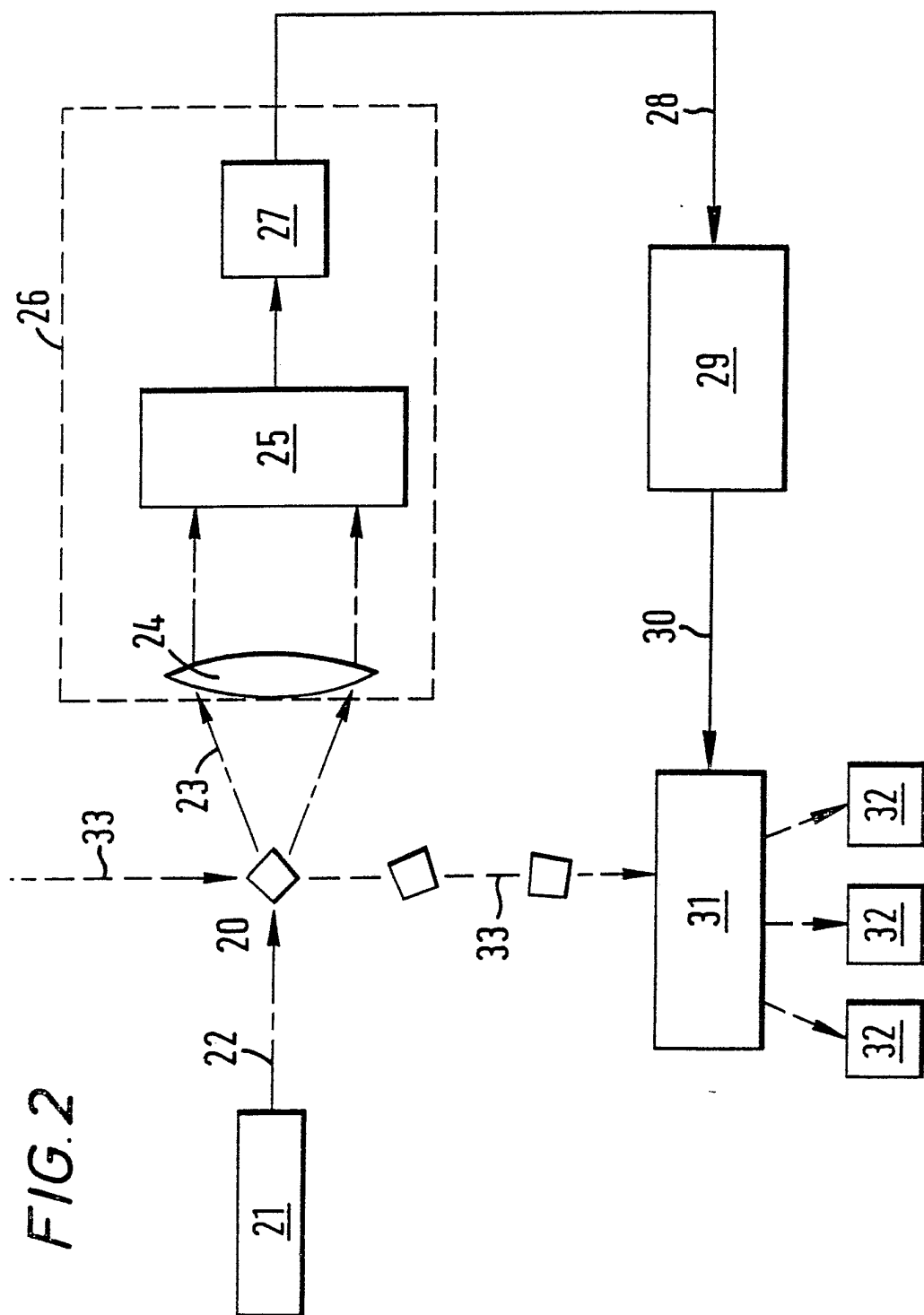
30

35

1/2



2/2



INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 88/00022

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		
IPC ⁴ : G 01 N 21/87; G 01 N 21/65; B 07 C 5/342		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System	Classification Symbols	
IPC ⁴	G 01 N; G 01 J; B 07 C	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸		
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
Y	EP, A, 0071462 (LCE, LTD) 9 February 1983 see page 4, lines 8-14; page 6, lines 8-18; page 17, lines 33-38; page 18, lines 1-10, claims 1,4-6,10-13 --	1,10
Y	WO, A, 86/07457 (THE BRITISH PETROLEUM CO.) 18 December 1986 see claims 1-20 --	1,10
A	GB, A, 2010474 (STEPHEN ALEXANDER et al.) 27 June 1979 see claims 1-8 --	1,10,12
A	FR, A, 2496888 (GEMOLOGICAL LABORATORY OF ANTWERP) 25 June 1982 see claims 1-4 --	1,10
Y	GB, A, 2140555 (THE BRITISH PETROLEUM CO.) 28 November 1984 see claims 1-8 cited in the application -- ./.	15,16
[*] Special categories of cited documents: ¹⁰ "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
18th March 1988	18 APR 1988	
International Searching Authority	Signature of Authorized Officer	
EUROPEAN PATENT OFFICE	 P.C.G. VAN DER PUTTEN	

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
Y	EP, A, 0064842 (SPHERE INVESTMENTS LTD) 17 November 1982 see claims 1,2 -----	15,16

**ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO.**

GB 8800022
SA 20243

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 European Patent Office EDP file on 11/04/88
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A- 0071462	09-02-83	WO-A- 8300389	03-02-83
		AU-A- 8823782	17-03-83
		US-A- 4394580	19-07-83
WO-A- 8607457	18-12-86	AU-A- 5993786	07-01-87
		NL-T- 8620244	01-04-87
		EP-A- 0226608	01-07-87
		GB-A- 2191282	09-12-87
		JP-T- 62503127	10-12-87
GB-A- 2010474	27-06-79	None	
FR-A- 2496888	25-06-82	None	
GB-A- 2140555	28-11-84	AU-A- 2840084	29-11-84
		US-A- 4693377	15-09-87
		AU-B- 565527	17-09-87
EP-A- 0064842	17-11-82	AU-A- 8319082	18-11-82