



AU8938379

(12) PATENT ABRIDGMENT (11) Document No. AU-B-38379/89
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 635175

(Modified Examination)

- (54) Title
INCLINATION GAUGE
- International Patent Classification(s)
(51)⁴ **G01C 009/06 . G01C 009/34**
(51)⁵ **G01C 009/32**
- (21) Application No. : **38379/89** (22) Application Date : **26.06.89**
- (87) PCT Publication Number : **WO90/00247**
- (30) Priority Data
- (31) Number (32) Date (33) Country
8801678 01.07.88 NL THE NETHERLANDS
- (43) Publication Date : **23.01.90**
- (44) Publication Date of Accepted Application : **11.03.93**
- (71) Applicant(s)
SOPHA BODEWES-TUNHAU
- (72) Inventor(s)
JOHANNES WIJNANDES MARIA BODEWES
- (74) Attorney or Agent
GRIFFITH HACK & CO , GPO Box 1285K, MELBOURNE VIC 3001
- (56) Prior Art Documents
AU 610751 40404/89 G01C 9/06 9/32 9/36
AU 35362/89 G01C 9/06 9/24 9/36
AU 20064/88 G01C 9/06 9/12
- (57) Claim

1. Inclination gauge comprising a reservoir, containing a clear liquid and a gas bubble, light emitting and light detecting means arranged at opposed positions with regard to said reservoir, the refractory index of the liquid, of the gas and of the tube material being chosen such that light going through the reservoir completely filled with liquid follows a trajectory substantially differing from the trajectory followed by light traversing the reservoir at least partially filled with gas, wherein on the center line in the path from the light emitting means and detecting means near the point of egress of light from the reservoir a shield is provided, arranged such that rectilinear transmittal of light from the light emitting means to the light detecting means through the gas bubble is substantially completely blocked.

OPI DATE 23/01/90

APPLN. ID 38379 / 89

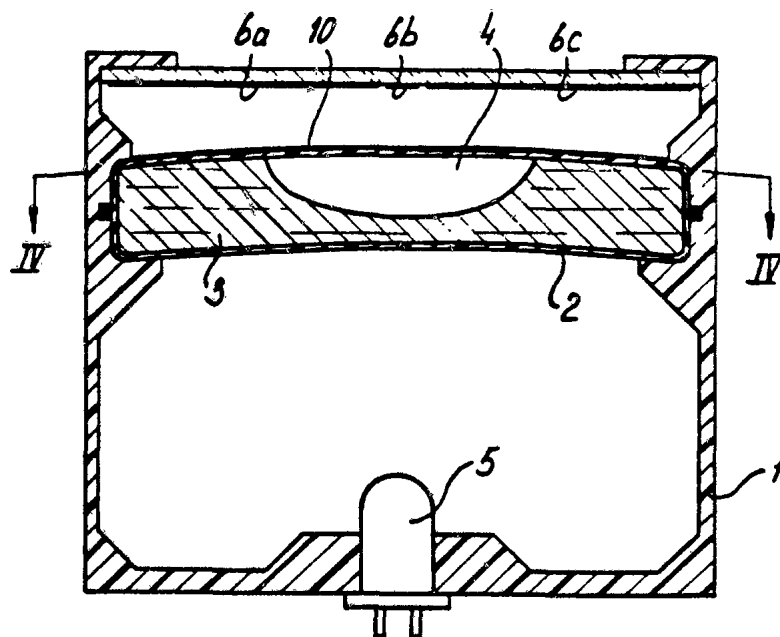
AOJP DATE 22/02/90

PCT NUMBER PCT/NL89/00052

PCT

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁴ : G01C 9/34, 9/06	A1	(11) International Publication Number: WO 90/00247 (43) International Publication Date: 11 January 1990 (11.01.90)
(21) International Application Number: PCT/NL89/00052 (22) International Filing Date: 26 June 1989 (26.06.89) (30) Priority data: 8801678 1 July 1988 (01.07.88) NL (71) Applicant: BODEWES-TUNHAU, Sopha [NL/NL]; Plesmanweg 371, NL-1945 WP Beverwijk (NL). (72) Inventor: BODEWES, Johannes, Wijnandes, Maria ; Plesmanweg 371, NL-1945 WP Beverwijk (NL). (74) Agents: DE BRUIJN, Leendert, C. et al.; Nederlandsch Octrooibureau, Scheveningseweg 82, P.O. Box 29720, NL-2502 LS The Hague (NL).		(81) Designated States: AU, BR, DK, FI, JP, KR, NO, SU. Published <i>With international search report.</i> 635175

(54) Title: INCLINATION GAUGE**(57) Abstract**

Inclination gauge having a reservoir filled with liquid and containing a gas bubble. The position of the gas bubble is detected by light detecting means in that light going through the completely filled tube gives another convergent nature than light going through tube partially filled with liquid and partially filled with gas. On the centerline light emitting - light detecting means between the reservoir and the light detecting means a shield is provided.

BUBBLE INCLINATION GAUGE INCLUDING A CENTRAL SHIELD
FOR LIGHT-EMITTING AND LIGHT-DETECTING MEANS

BACKGROUND OF THE INVENTION:

The invention relates to an inclination gauge
5 comprising a reservoir containing a clear liquid and a gas
bubble and light emitting and light detecting means arranged
at opposed positions with regard to said reservoir. It is
intended to convert the movement of the gas bubble in the
reservoir to an electric signal. By this it is no longer
10 necessary to monitor directly the gas bubble in the reservoir.
Also it is possible to provide self-adjusting devices.

From U.S. Patent No. 4,625,423 it is known to direct
a beam of light through a tubular reservoir containing either
liquid or a gas volume. When light is transmitted through the
15 liquid a converging effect is obtained. When light traverses
to the gas volume a non converging beam leaving the reservoir
is realized. By monitoring the change in light intensity at
the spot of the light dependent resistance, information can be
obtained with regard to the position of the gas volume in the
20 reservoir. However, the transition from converging to parallel
and diverging is a continuous process. This means that only
by considerable amplification of the light dependent resistance
can an exact prediction can be obtained about the position of
the inclination gauge. However, if there are slight changes
25 in the light emitting source and/or the transparency of the
reservoir and/or its contents, the results of the measurements
will be affected. This means that this device is not reliable
in long term.

SUMMARY OF THE INVENTION:

30 It is the main purpose of the invention to obviate
this problem. This is realized with an inclination gauge
comprising a reservoir containing a clear liquid and a gas
bubble, light emitting and light detecting means arranged at
opposite positions with regard to said reservoir, the
35 refractory index of the liquid, of the gas and of the tube
material being chosen such that the light going through the



reservoir completely filled with liquid follows a trajectory substantially differing from the trajectory followed by light traversing the reservoir at least partially filled with gas, characterized in that on the center line from the light
5 emitting and detecting means near the point of egress of the light from the reservoir a shield is provided.

If e.g. the light is converging as with the U.S. Patent No. 4,625,423 device when completely filled with liquid, despite of the shield provided the light detecting means will
10 receive a strong focussed light beam. However, as soon as the beams emitting from the reservoir are parallel or diverging no light at all will be incident at the light detecting means. This means that because of the shield provided by the invention a kind of on/off effect is obtained for the light impinging the
15 light detecting means. Even if the light source and/or the light properties of the reservoir and/or the contents slightly change during production or use, this has no effect on this on/off effect. This means that it is always guaranteed that optimum detection is obtained. Also it is always guaranteed
20 that optimum detection is obtained. Also it is not longer necessary to considerably amplify the signal obtained from the light detecting means/ Preferably the surface area of the shield is at least as large as the effective surface area of said light detecting means.

25 If the inclination gauge comprises a reservoir in which the gas bubble in the balanced position does not completely fill the cross section of the reservoir, problems might arise if one or two LDR's (Light Dependent Resistors) are used. These LDR's only measure the surface area lightened.
30 If the reservoir according to the invention with a gas bubble not completely filling the cross section of the reservoir is tilted to one side the LDR on that side will first register complete darkness or light. However, after further tilting the reservoir gas will accumulate near one end and fill the cross
35 section of the reservoir completely by which the length of the gas bubble decreases and so an error signal can be obtained. To obviate this problem according to a further embodiment of the invention said light detecting members comprise at least



three light sensitive means arranged in line, wherein the outermost ones have a relatively large extent and the center one has a relatively smaller extent. The extent of the outermost light sensitive members preferably substantially equals the length of the gas bubble in the balance position. By having an intermediate light detecting means with a relative small dimension the problem described above is obviated. The signal obtained from the light detecting means can be processed in any known way to display a signal or to provide an acoustical signal or both. The acoustical means can be devised such that when moving from one extremity of the inclination gauge to the other, first a first signal is produced having a first frequency with first constant intervals between signal periods, after which a second signal is produced having the first frequency and second variable intervals between signal periods, said intervals decreasing towards the third signal, said third signal being continuous and having said first or a second frequency, after which a fourth signal is produced having a second frequency and third variable intervals between signal periods, said intervals increasing towards the fifth signal, said fifth signal having the second frequency and fourth constant intervals between signal periods.

The invention also relates to a device for measuring the movement of an object comprising the inclination gauge as described herein. This can e.g. be an acceleration gauge.

The invention will be described in further detail with reference to the drawing in which a preferred embodiment is shown and wherein:

FIG. 1 shows a trajectory of light followed according to the prior art with a completely liquid filled reservoir,

FIG. 2 shows the device according to FIG. 1, with a partly liquid filled reservoir;

FIG. 3 shows schematically the device according to the invention:

FIG. 4 shows a cross section according to line IV-IV in FIG. 3,

FIG. 5 shows schematically the trajectory of light with a completely liquid filled tube according to the invention



along line V-V of FIG. 4, and

FIG. 6 shows a trajectory of light with a partially liquid filled tube according to the invention along line VI-VI of FIG. 4.

5 In FIG. 1 schematically the path followed by the light according to the prior art is shown. 7 indicates incident light, 2 a tube like reservoir, 3 the liquid contained in this reservoir, 8 exiting light and 6 light detecting means. In FIG. 2 the same is shown except that the tube is not
10 completely filled with liquid 3 but also comprises a gas bubble 4. Because of the different refractive index of gas relative to the liquid used, as shown in the figure, the parallel incident light beam will diverge. This means that in the FIG. 1 case a strong signal is obtained on light detecting means 6 whilst in the FIG. 2 situation a less intense signal is
15 obtained. However, there is still light incident on light detecting means 6, which means that the light detecting means 6 must be able to discriminate between more and less light. This means that when during production or use variations occur
20 affecting the quantity of light detected by light detecting means 6 corresponding adaptations have to be made. The invention provides a solution for this problem and a preferred embodiment of it is schematically shown in FIG. 3. This embodiment comprises a frame 1 in which a tube-like element 2 is mounted.
25 Also light emitting diode 5 is arranged in the frame 1 as well as light detecting means 6a, 6b, and 6c. As shown in the cross section of FIG. 4 tube 2 is provided at its upper side with a dark line or shield 10. From FIGS. 5 and 6, being cross sections through the FIG. 4 tube 2, it is clear what effect
30 will be obtained from displacing gas bubble 4 through tube 2. Comparing FIG. 5 and FIG. 1 there will not be a large difference except that the light following the center line is blocked in the embodiment of FIG. 5.

However, comparing FIG. 2 and FIG. 6 indicates that
35 because of the shield 10, no light at all will reach light detecting means 6. Because of this an on/off configuration is obtained being less sensitive for variations occurring during use or production. The reason that three light detecting means



are used is based on the fact that the light detecting means which are used are so called light dependent resistors. These resistors only measure the quantity of light incident. If it is e.g. given that a balance situation is obtained if half of
5 LDR 6a is radiated, during tilting of tube 2 clockwise this balance position will be disrupted. However, as soon as gas bubble 4 hits the left extremity of tube 2 its length will decrease by increasing its cross sectional area. An air chamber will be formed at the left side and it is possible that
10 the length of the air bubble substantially corresponds with the balanced position of LDR 6a. To prevent this, much smaller LDR 6b is provided such that in this error situation there is a signal from LDR 6b, which is not the case if there is a balanced position. This LDR 6b can also be used for
15 automatically switching to another tube 2 being arranged perpendicular with regard to tube 2 shown. This permits horizontal - vertical use of the inclination gauge.

Although the embodiment shown in the drawing is preferred at the time being, many amendments can be made
20 without leaving the scope of protection as defined by the appended claims.



THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. Inclination gauge comprising a reservoir, containing
a clear liquid and a gas bubble, light emitting and light
detecting means arranged at opposed positions with regard to
5 said reservoir, the refractory index of the liquid, of the gas
and of the tube material being chosen such that light going
through the reservoir completely filled with liquid follows a
trajectory substantially differing from the trajectory followed
by light traversing the reservoir at least partially filled
10 with gas, wherein on the center line in the path from the light
emitting means and detecting means near the point of egress of
light from the reservoir a shield is provided, arranged such
that rectilinear transmittal of light from the light emitting
means to the light detecting means through the gas bubble is
15 substantially completely blocked.

2. Inclination gauge according to claim 1, wherein the
surface area of said shield is at least as large as the
effective surface area of said light detecting means.

3. Inclination gauge according to claim 1, wherein said
20 light detecting means comprises at least three light sensitive
members arranged in line, two outermost ones having a larger
extent than a center one.

4. Inclination gauge according to claim 3, wherein the
extent of at least one of the outermost light sensitive members
25 substantially equals the length of the gas bubble in the
balanced position of the inclination gauge.

5. Inclination gauge according claim 1, wherein the
reservoir comprises a tube-like body, of which in the position
of use an upper part is internally curved.

30 6. Inclination gauge according to claim 1, wherein said
means for emitting light comprises a light emitting diode.



7. Inclination gauge according to claim 1, wherein said means for detecting of light are connected with a measuring device.

Dated this 22nd day of July 1992.

5 SOPHA BODEWES-TUNHAU
By Its Patent Attorneys:

GRIFFITH HACK & CO.
Fellows Institute of Patent
Attorneys of Australia.



fig-1
PRIOR ART

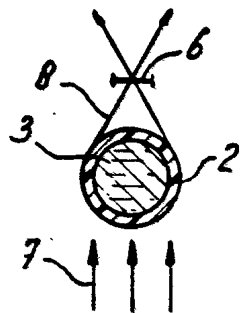


fig-2
PRIOR ART

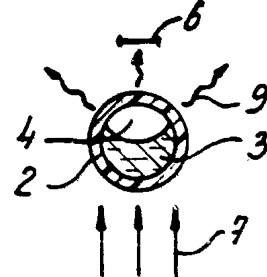


fig-4

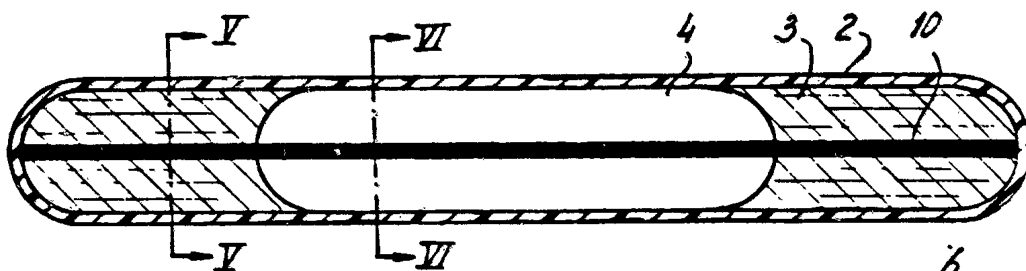


fig-5

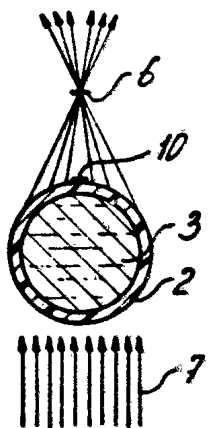
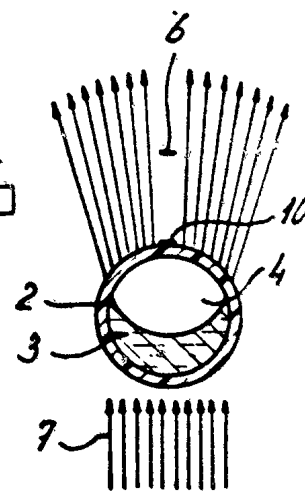


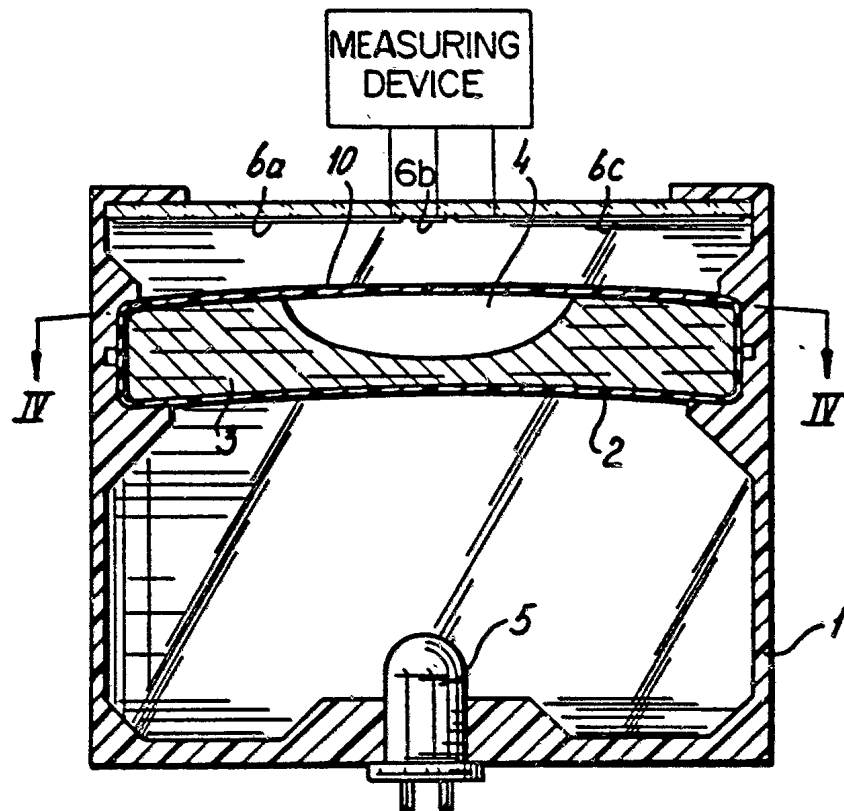
fig-6



2/2

38379/89

Fig-3



INTERNATIONAL SEARCH REPORT

International Application No. PCT/NL 89/00052

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 C 9/34, G 01 C 9/06																	
II. FIELDS SEARCHED <div style="text-align: right; font-size: small;">Minimum Documentation Searched ⁷</div> <table style="width: 100%; border: none;"> <tr> <td style="width: 20%; border-bottom: 1px solid black; font-size: small;">Classification System</td> <td style="border-bottom: 1px solid black; font-size: small;">Classification Symbols</td> </tr> <tr> <td style="border: 1px solid black; padding: 5px;">IPC⁴ :</td> <td style="border: 1px solid black; padding: 5px;">G 01 C</td> </tr> </table> <div style="text-align: center; font-size: x-small; margin-top: 5px;">Documentation Searched other than Minimum Documentation to the extent that such Documents are included in the Fields Searched ⁸</div>			Classification System	Classification Symbols	IPC ⁴ :	G 01 C											
Classification System	Classification Symbols																
IPC ⁴ :	G 01 C																
III. DOCUMENTS CONSIDERED TO BE RELEVANT ⁹ <table style="width: 100%; border-collapse: collapse; font-size: small;"> <tr> <th style="width: 10%; border-bottom: 1px solid black;">Category ¹⁰</th> <th style="width: 60%; border-bottom: 1px solid black;">Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²</th> <th style="width: 30%; border-bottom: 1px solid black;">Relevant to Claim No. ¹³</th> </tr> <tr> <td style="border: 1px solid black; text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="border: 1px solid black; padding: 5px;">US, A, 4625423 (R.R. SACKETT) 2 December 1986, see abstract; column 5, lines 39-68; figures 6,7,8A</td> <td style="border: 1px solid black; text-align: center; vertical-align: top; padding: 5px;">1,5,6,7, 8,10</td> </tr> <tr> <td style="border: 1px solid black; text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="border: 1px solid black; padding: 5px;">EP, A, 0168150 (TECHNICAL DESIGNS INC.) 15 January 1986, see page 7, lines 9-18; figure 3; page 8, lines 1-9; page 12, lines 26-29</td> <td style="border: 1px solid black; text-align: center; vertical-align: top; padding: 5px;">1,5,6,7,8,10</td> </tr> <tr> <td style="border: 1px solid black; text-align: center; vertical-align: top; padding: 5px;">A</td> <td style="border: 1px solid black; padding: 5px;">Patent Abstracts of Japan, vol. 10, no. 127 (P-455)(2184), 13 May 1986; & JP, A, 60252215 (SABUROU SUGAWARA) 12 December 1985, see the abstract</td> <td style="border: 1px solid black; text-align: center; vertical-align: top; padding: 5px;">1</td> </tr> <tr> <td colspan="3" style="border: 1px solid black; text-align: center; padding: 20px;">-----</td> </tr> </table>			Category ¹⁰	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³	A	US, A, 4625423 (R.R. SACKETT) 2 December 1986, see abstract; column 5, lines 39-68; figures 6,7,8A	1,5,6,7, 8,10	A	EP, A, 0168150 (TECHNICAL DESIGNS INC.) 15 January 1986, see page 7, lines 9-18; figure 3; page 8, lines 1-9; page 12, lines 26-29	1,5,6,7,8,10	A	Patent Abstracts of Japan, vol. 10, no. 127 (P-455)(2184), 13 May 1986; & JP, A, 60252215 (SABUROU SUGAWARA) 12 December 1985, see the abstract	1	-----		
Category ¹⁰	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³															
A	US, A, 4625423 (R.R. SACKETT) 2 December 1986, see abstract; column 5, lines 39-68; figures 6,7,8A	1,5,6,7, 8,10															
A	EP, A, 0168150 (TECHNICAL DESIGNS INC.) 15 January 1986, see page 7, lines 9-18; figure 3; page 8, lines 1-9; page 12, lines 26-29	1,5,6,7,8,10															
A	Patent Abstracts of Japan, vol. 10, no. 127 (P-455)(2184), 13 May 1986; & JP, A, 60252215 (SABUROU SUGAWARA) 12 December 1985, see the abstract	1															

<div style="display: flex; justify-content: space-between; font-size: x-small;"> <div style="width: 45%;"> <p>* Special categories of cited documents: ¹⁴</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubt on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>"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</p> <p>"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"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.</p> <p>"&" document member of the same patent family</p> </div> </div>																	
IV. CERTIFICATION <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border-bottom: 1px solid black; padding: 5px;">Date of the Actual Completion of the International Search 22nd September 1989</td> <td style="width: 50%; border-bottom: 1px solid black; padding: 5px;">Date of Mailing of this International Search Report 27 OCT 1989</td> </tr> <tr> <td style="border-bottom: 1px solid black; padding: 5px;">International Searching Authority EUROPEAN PATENT OFFICE</td> <td style="border-bottom: 1px solid black; padding: 5px;">Signature of Authorized Officer: T.K. WILLIS</td> </tr> </table>			Date of the Actual Completion of the International Search 22nd September 1989	Date of Mailing of this International Search Report 27 OCT 1989	International Searching Authority EUROPEAN PATENT OFFICE	Signature of Authorized Officer: T.K. WILLIS											
Date of the Actual Completion of the International Search 22nd September 1989	Date of Mailing of this International Search Report 27 OCT 1989																
International Searching Authority EUROPEAN PATENT OFFICE	Signature of Authorized Officer: T.K. WILLIS																

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

NL 8900052
SA 29487

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 18/10/89. 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
US-A- 4625423	02-12-86	None	
EP-A- 0168150	15-01-86	US-A- 4590680	27-05-86
		CA-A- 1229976	08-12-87