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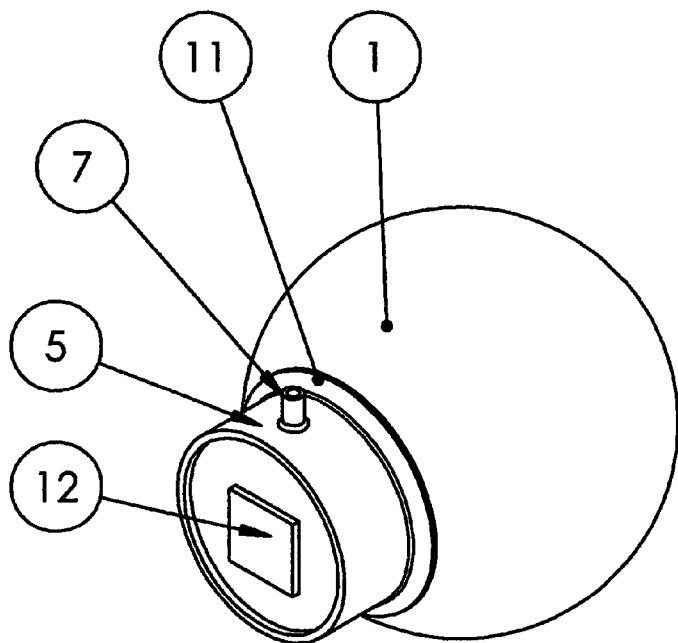
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- as to the identity of the inventor (Rule 4.17(i))
- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))

[Continued on next page]

(54) Title: DEVICE FOR MEASURING INTRA-OCULAR PRESSURE



**Fig.1**

**(57) Abstract:** A device for non-invasive determination of intra-ocular pressure comprising a pressure chamber with a flexible membrane for engaging with the cornea of a subject's eye and a strain gauge, wherein the pressure chamber may be internally pressurised and thereby exerts a pressure via the membrane upon both the cornea and the strain gauge that result in a deflection of the cornea and strains being generated at the strain gauge, which, in turn, enable to establish a correlation between inter ocular pressure and strains.

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## **Device for Measuring Intra-Ocular Pressure**

The invention relates to a device for measuring Intra ocular pressure.

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Measurement and detection of elevated Intra ocular pressures is a prime method for early detection of the onset of glaucoma.

10 Current methods for non-invasive detection of intra ocular pressures include the Goldman Aplanation method that involves the measurement of reactive forces due to a plunger, of known cross sectional area, engaging and flattening a small area of the cornea. Other methods involve the use of a jet of air for measuring the resulting corneal deformation. The main deficiencies of these methods arise from inaccuracies due to poor alignment with the radial axis of the cornea; the variation in local stiffness between cornea and the sclera and errors due to local deformation of a small area of the cornea when subjected to an external force.

15 Such constraints are known to have generated unreliable data about the actual pressure within the ocular region of the eye.

20 It is an aim of the present invention to provide an improved device for measuring inter ocular pressure. Another aim is to provide a solution of a type that is not made in a conventional manner and that will overcome the limitations mentioned above.

25 The invention provides a device for measuring inter ocular pressure as defined by claim 1 of the set of claims following this description. Preferred and / or optional features of the invention are the subject of other claims of the set of claims.

30 An alternative solution for measuring intra ocular pressure that overcomes the above mentioned constraints is the main aim of this invention and will hereby be described by means of a non-limited example.

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Accordingly, this invention provides for a pressure measuring device, characterized in that it has a pressure chamber that is equipped with a flexible membrane for contacting the cornea via an engagement contact lens and a strain measuring piece, on the opposite side of the pressure chamber, for measuring strains. Deflections of the cornea are dependent upon the difference between the applied external chamber pressure and the intraocular pressure. By using metered volumes of fluid to pressurise the chamber, a correlation between applied pressure and strains can be established. Hence, a comparison between strains and a range of applied pressures may be used to enable the determination of a specific range of inter ocular pressures. Results so obtained may be used to provide several data points that reduce errors associated with using a single data point as is the current practice. By such means it is possible to overcome errors due to directionality and local deformations, as mentioned above.

In one preferred embodiment of a pressure measuring device, a contact lens engagement piece may be used for providing hygienic separation between the cornea and the flexible membrane of the pressure chamber. The strain measuring piece may be placed or form part of the flexible membrane and thus be directly affected by pressurisation from within the pressure chamber. In turn, deflections of the cornea will result in corresponding strains at the strain measuring piece. Thus, a correlation between strains and inter ocular pressure may be established.

One embodiment of the invention will be described solely by way of non-limited example and with reference to the accompanying drawings in which:

**Fig. 1** shows a general external view of a pressure measuring device in contact with an eye;

**Fig. 2** shows a sectional view of a pressure measuring device attached to the eye;

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**Fig. 3** shows a sectional exploded view of a pressure measuring device near the eye;

**Fig. 4** shows a vertical section across the pressure chamber;

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**Fig. 1** shows an assembly of a pressure measuring device. The assembly consists of pressure chamber (5), with external suction port (7) and strain measurement piece (12), attached to sclera (1) via engagement ring (11).

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**Fig. 2** shows a vertical sectional view of an assembly of a pressure measuring device consisting of sclera (1), cornea (2) and regions of an eye. The pressure measuring device (5) has pressure chamber (10) that is equipped with strain measuring piece (12) and transparent piece (6). The pressure within the chamber (10) may be varied by means of pressure port (8). The flexible membrane (4) is held onto the sclera (1) by means of engagement ring (11) that has a peripheral suction channel (9), which is connected to an external suction port (7). The cornea (2) is in contact with contact lens engagement piece (13) that has ring (14) for axial alignment and engagement with peripheral suction channel (9). The contact lens engagement piece (13) is in contact with flexible membrane (4) and the cornea (2) which, in turn, is subjected to pressurisation from chamber (10). Transparent piece (6) enables investigation of the contours of the iris (3) by means of ultrasound and interferometry.

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**Fig.3** shows a sectional exploded view of a pressure measuring device.

**Fig.4** shows a vertical section across the pressure chamber showing pressure port (8), suction port (7), strain gauge (4a) and engagement ring (11).

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### Claims

1. A device for non-invasive determination of intra-ocular pressure comprising of at least one pressure chamber (5) with a flexible membrane (4), wherein the pressure chamber (5) has an inlet port (8) for charging the chamber (10) with fluid and exerting pressure on the cornea (2) via flexible membrane (4) and on the strain measurement means (12) for determination of inter-ocular pressure due to the deflection of the cornea (2).  
5
2. A device assembly according to claim 1 characterised in that the flexible membrane (4) has a strain gauge (4a) attached to the outer surface of the flexible membrane (4) for determination of strains due to internal pressure variations within the pressure chamber (5).  
10
3. A device assembly according to claim 1 or claim 2 comprising a measurement piece (6) having patterns that enable interrogation by means of interferometry for determination of strains due to internal pressure variations within the pressure chamber (5).  
15
4. A device assembly according to any of claims 1 to 3 characterised in that the flexible membrane (4) is transparent for enabling electro-magnetic radiation, such as visible light, to pass through the membrane and the measurement piece (6) for interrogation by external means.  
20
5. A device assembly according to any claims 1 to 4 characterised in that contact between flexible membrane (4) and cornea (2) is enhanced by means of contact between the sclera (1) and engagement ring (11) which is equipped with peripheral suction port (7) and which, in turn, is guided by means of ring (14).  
25
6. A device assembly as in any of claims 1 to 5 comprising of a lens engagement piece (13) which, in use, is located between the membrane  
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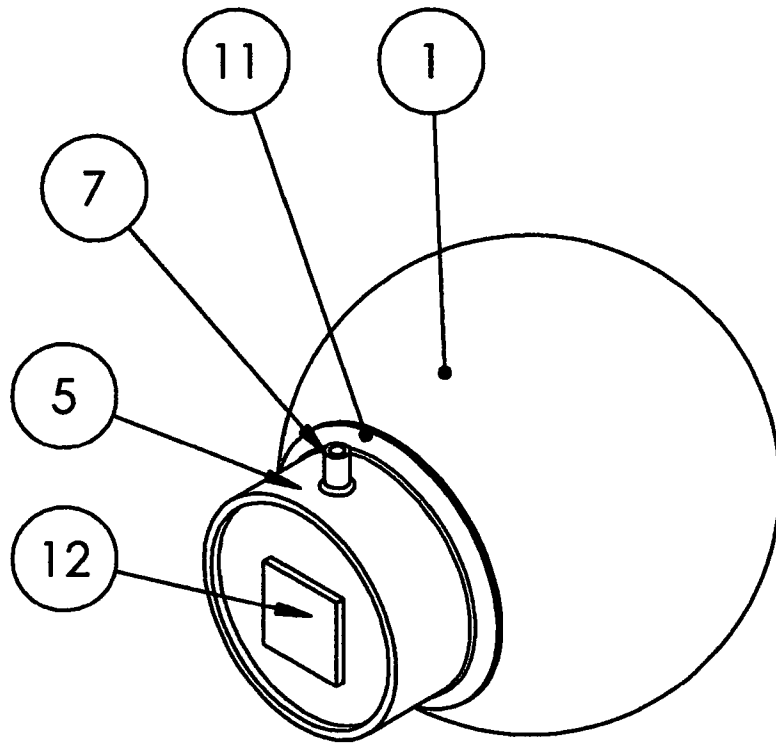


Fig.1

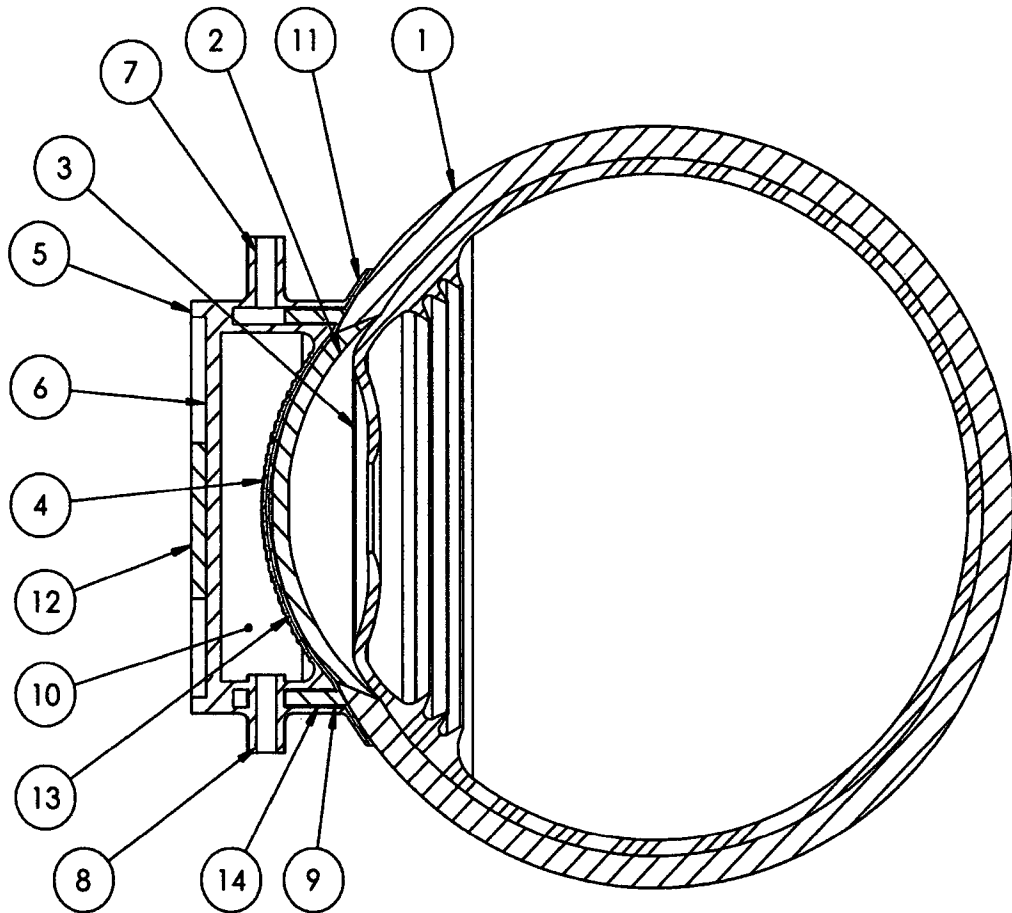


Fig.2

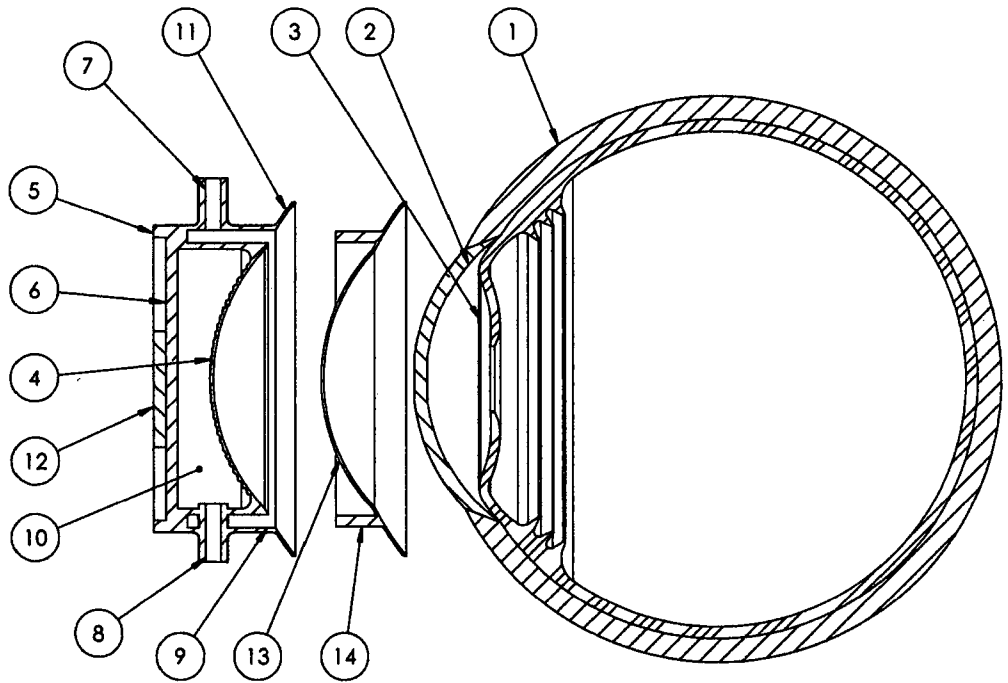


Fig.3

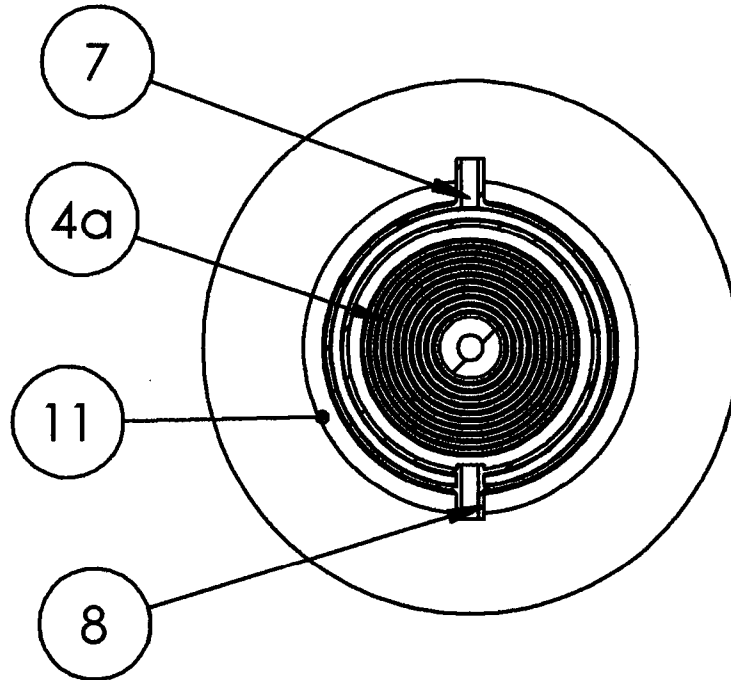


Fig.4

INTERNATIONAL SEARCH REPORT

International application No  
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A. CLASSIFICATION OF SUBJECT MATTER  
INV. A61B3/16  
ADD.  
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)  
A61B  
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2002/159031 A1 (KANNGIESSER HARTMUT [CH]) 31 October 2002 (2002-10-31) paragraph [0048] - paragraphs [0050], [0056], [0057] figures 1-3	1,2,4,6
X	WO 2006/087715 A2 (A T I ADVANCED MEDICAL TECHNOL [IL]; LIVNE ABRAHAM [IL]; RON ILAN [IL]) 24 August 2006 (2006-08-24) page 10, line 10 - page 14, line 7 figures 1,2A	1-3,6
X	US 5 032 020 A (ROBERT YVES [CH]) 16 July 1991 (1991-07-16) column 2, line 35 - column 4, line 54 figures 1-4	1-4,6
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Further documents are listed in the continuation of Box C.

See patent family annex.

\* Special categories of cited documents :

<p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier application or patent but published on or after the international filing date</p> <p>"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)</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>	<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 when the document is taken alone</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>"&amp;" document member of the same patent family</p>
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Date of the actual completion of the international search <b>26 August 2016</b>	Date of mailing of the international search report <b>07/09/2016</b>
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer <b>Doyle, Aidan</b>

## INTERNATIONAL SEARCH REPORT

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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	US 4 628 938 A (LEE DAVID A [US]) 16 December 1986 (1986-12-16) column 1, line 42 - column 1, line 51 column 2, line 6 - column 2, line 8 column 4, line 44 - column 6, line 7 figures 1,2 -----	1,2,4-6

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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Patent document cited in search report	Publication date	Publication date	Patent family member(s)	Publication date
US 2002159031	A1	31-10-2002	NONE	
<hr style="border-top: 1px dashed black;"/>				
WO 2006087715	A2	24-08-2006	EP 1850729 A2	07-11-2007
			IL 166962 A	28-06-2012
			JP 5161587 B2	13-03-2013
			JP 2008529710 A	07-08-2008
			US 2008154114 A1	26-06-2008
			WO 2006087715 A2	24-08-2006
<hr style="border-top: 1px dashed black;"/>				
US 5032020	A	16-07-1991	CH 673760 A5	12-04-1990
			DE 3884181 D1	21-10-1993
			EP 0327693 A1	16-08-1989
			JP 3008197 B2	14-02-2000
			JP H0229233 A	31-01-1990
			US 5032020 A	16-07-1991
<hr style="border-top: 1px dashed black;"/>				
US 4628938	A	16-12-1986	NONE	
<hr style="border-top: 1px dashed black;"/>				