(12) UK Patent Application (19) GB (11) 2 043 239 A

(21) Application No **7900089**
(22) Date of filing **3 Jan 1979**
(43) Application published **1 Oct 1980**
(51) **INT CL$^3$ G01L 7/08**
(52) Domestic classification **G1A** A3 A5 D4 EF G10 G1 G7 P1 R7 S5 T14 T26 T3 T8 T9
(56) Documents cited
**GB 1469240**
**GB 1284010**
**GB 1182137**
**GB 1070954**
**GB 1062967**
**GB 1014763**
**GB 910569**
(58) Field of search **G1A**
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# (54) A transducer

(57) A transducer for detecting, and permitting measurement of, ambient pressure and/or temperature, and comprising a light emitting device (10) and a light-receiving device (11), disposed side-by-side within a module (15) with an opaque screen (14) between the devices (10,11) and a light-reflecting surface (19) facing same whereby only the reflected light can reach the light-receiving device, the light-reflecting surface being mounted on a flexible diaphragm (18) such that deformation of the diaphragm as a result of a change in ambient conditions causes a change in the intensity of light reflected, so that this change can be detected and displayed.

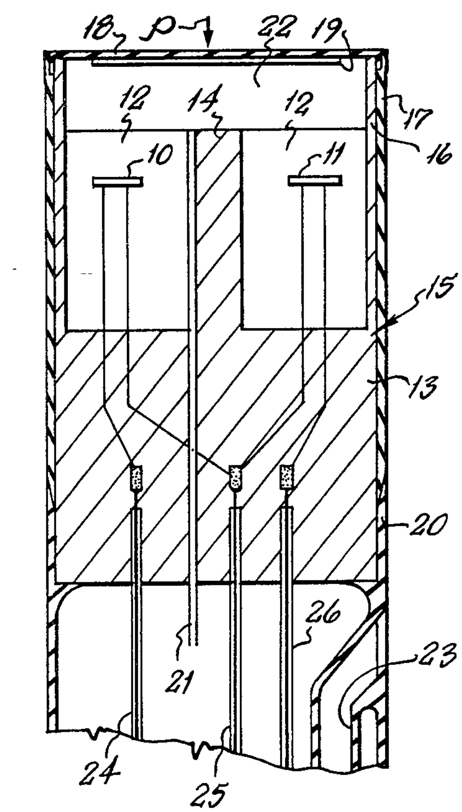

FIG. 1

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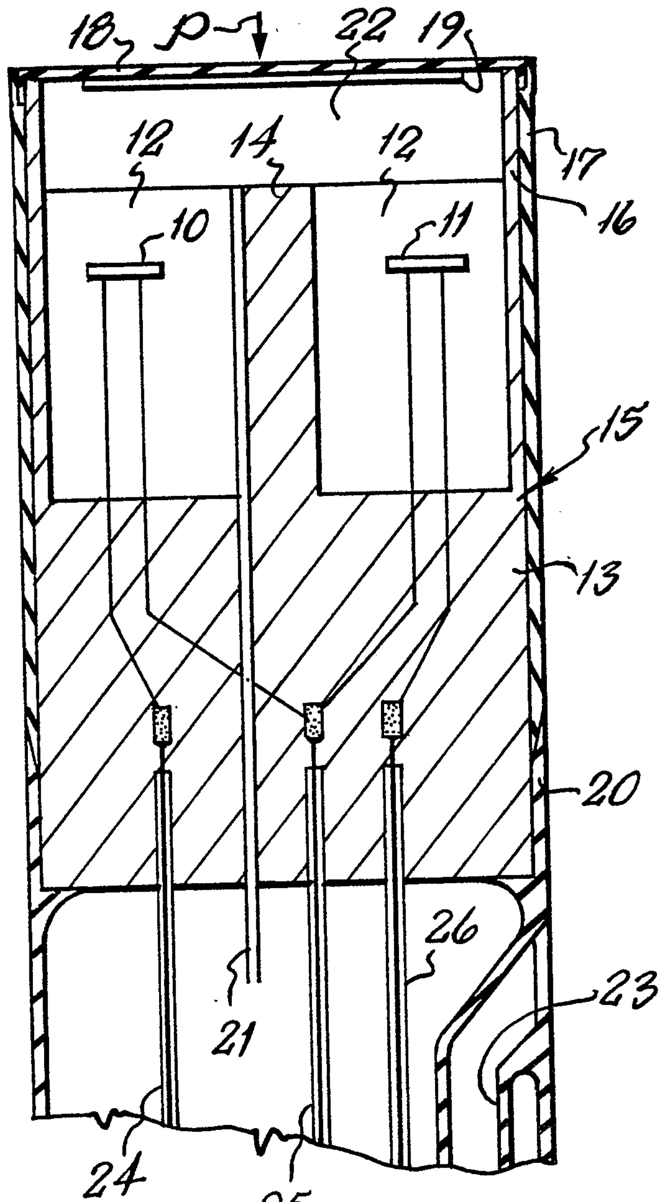


FIG.1

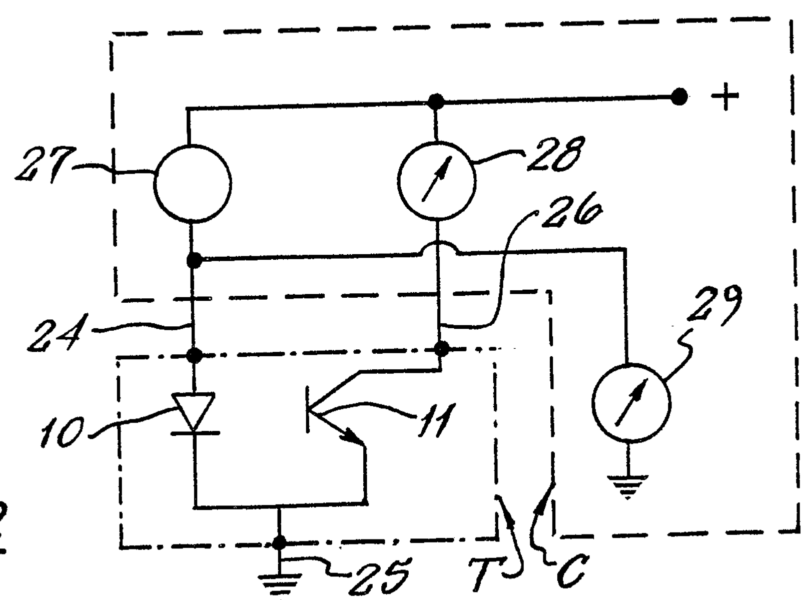


FIG. 2

SPECIFICATION

**A transducer**

This invention concerns a transducer for use in the measurement of pressure or temperature.

An object of the present invention is to provide a transducer which is simple and inexpensive to produce when compared with known systems employing, or example, strain gauges and differential transformers, whilst being of a sufficiently robust nature as to be capable of use in miniature form, yet providing an adequate level of accuracy in operation.

Thus, a transducer, according to the present invention, a comprises a light-emitting device and a light-sensitive device, a substantially opaque screen effectively preventing direct passage of light between the said devices, and a light-reflecting surface disposed in spaced relationship with said devices so as to provide a reflected light path therebetween, the light reflecting surface being attached to a flexible diaphragm, such that the distance between the reflecting surface and said devices, and thus the intensity of reflected light received by said light-sensitive device, is variable dependent upon the instantaneous pressure acting on the diaghragm, whereby measurement of the intensity of the reflected light received enables the value of said pressure to be determined.

Whilst there are many possible uses for the transducer, one embodiment of the invention, for use in cystometry, will now be described by way of example only, with reference to the accompanying drawings, in which:-

*Fgure 1* is a cross section of the transducer; and

*Figure 2* is a schematic electrical circuit diagram of a system employing the transducer to measure ambient pressure and temperature.

With particular reference to the drawings, the transducer comprises an emitter 10 in the form of an infrared light-emitting diode, and a receiver 11 in the form of a phototransistor. These two components may be obtained in a plastics encapsulation as illustrated here at 12. The two encapsulated components, machined if necessary to a desired shape, are placed side-by-side in a mould which is then filled with a material 13 such as an epoxy resin which is coloured to be opaque, and which forms an electrical insulator. In this way, the components 10 and 11 are supported and surrounded by a protective casing and are held in spaced relationship by the material 13 so that an opaque screen 14 exists therebetween. The module so formed and generally inidicated at 15 is preferably circular in section and has an annular wall 16 extending beyond the screen 14. A sleeve 17 of a clinically inert material such as silicone rubber is placed over the module 15, and a web 18 of a similar material in a prestretched condition forming a resilient diaphragm is then bonded to the open end of the wall 16 to close and seal same.

A mirror 19, for example, a circular sheet of reflecting material such as aluminium, is bonded to the inner surface of the diaphragm 18 prior to its attachment to the wall 16.

Near the opposite end of the module 15, the silicone sleeve 17 abuts, and may be bonded to, the end of a translucent rubber or plastics tube 20 which supports the transducer and encases an array of electrical conductors and other ducts (to be described) which serve the transducer.

A passage 21 is bored through the filling 13 (or alternatively may be provied by a tube placed in the mould prior to the filling 13) and serves to provide a free air duct through the module between the interior of tube 20, and a substantially closed chamber 22 defined by the wall 16 and the diaphragm 18. A further duct 23 conveniently passing through the tube 20 but isolated from the interior thereof can serve to transmit fluids from the external environment to that in which the transducer is operating.

Three electrical conductors 24, 25 and 26 are provided for connection of the transducer to a control and monitoring circuit to be described. Conductor 24 is connected to the anode of the diode 10; conductor 25 is connected jointly to the cathode of the diode 10 and the emitter of the phototransistor 11; and conductor 26 is connected to the collector of the phototransistor.

It will be seen that the components 10 and 11 as well as the connections thereof to the conductors 24, 25 and 26 are optically and electrically sealed, the only optical path between the components 10 and 11 being via the reflective surface of the mirror 19.

In a practical application of the transducer, for cystometry, the system of Figure 2 illustrates that the transducer generally indicated by the chain dotted line *T* is connected to the control and monitoring facility generally indicated by the dotted line *C*, by conductors 24, 25 and 26. A constant current source is shown at 27 and typically operates at 20 milliamps. An ammeter 28 carries the output from the phototransistor 11 and may be calibrated in terms of pressure. A volt meter 29 is connected to conductor 24 and is capable of detecting the voltage across the diode 10, and this can be represented in terms of temperature, as the operation of the diode is sensitive to temperature and the transducer output cannot be independent of temperature.

In operation, light emitted by the diode 10 passes through an optical slit formed between the screen 14 itself and the reflected image thereof. This slit varies in width when the distance between the mirror 19 and the top of the screen 14 changes.

Thus, when there is a change in the pressure (indicated diagrammatically at *P*) acting upon the diaphragm 18, the width of the optical slit changes, and as the light received by the phototransistor 11 as reflected by the mirror 19 is dependent upon this width the change is displayed on the ammeter 28. It will be appreciated that if the chamber 22 were completely sealed, then its volume change as a result of the application of pressure *P* would be dependent upon temperature and not solely the pressure exerted from outside. The passage 21 therefore enables free movement of the diaphragm by permitting surplus air in the chamber 22 to escape into the tube 20 which is open to atmosphere. Thus also, the measured pressures can be related to atmospheric pressure. The passage 23 allows liquids or gases to be introduced into or removed from the space around the transducer where conditions are being measured.

The sensitivity of the device can be set by selection of appropriate values for the current passed by the constant current source 27, or various geometric configurations of the device such as the distance from the components 10 and 11 to the adjacent surface of the screen 14, the thickness of the screen 14 itself, or the distance from the components 10 and 11 to the adjacent surface of the module 15 in the chamber 22.

The temperature indication provided by the volt meter 29 can be used in the control circuit to compensate for temperature variations, or simply to serve to give the operator a reading of the temperature present.

Owing to its mode of construction and the characteristics of the components used, the transducer can be produced in very small sizes when compared with known transducers of conventional design and is thus particularly useful in cystometry. The transducer may have many other applications in medicine and in industry. For example, it can be adapted for use in the measurement of gas pressure and temperature inside a container, or of hydrostatic pressure and thus liquid level in a tank without the necessity for any moving parts such as floats, rheostats, etc. Greater pressures than those experienced in the kinds of application mentioned can be measured by the use of this device if a less resilient material is used to support the mirror and the geometric configuration of the device as a whole is modified accordingly.

The transducer employs semi-conductor components which thus provides the possibility of using solid state integrated electronics. Thus very accurate measurements can be taken at the relatively low production costs inherent in the use of such technology.

As an alternative to the embodiment described, in place of the chamber 22 bounded by the wall 16 and the diaphram 18, a pad of translucent and resilient material may be bonded directly onto the surface of the module 15 and carry, on or close to its outer surface, a mirror, so that the reflected light path is through the substance of the pad whilst the pad is capable of being deformed by changes in pressure, to vary the intensity of reflected light.

CLAIMS

1. A transducer comprising a light-emitting device and a light sensitive device, a substantially opaque screen effectively preventing direct passage of light between the said devices, and a light-reflecting surface disposd in spaced relationship with said devices so as to provide a reflected light path therebetween, the light-reflecting surface being attached to a flexible diaphragm, such that the distance between the reflecting surface and said devices, and thus the intensity of reflected light received by said light-sensitive device, is variable dependent upon the instantaneous pressure acting on the diaphragm, whereby measurement of the intensity of the reflected light received enables the value of said pressure to be determined.

2. A transducer according to claim 1, wherein said diaphragm partially defines a substantially closed chamber between the light-reflecting surface and the said devices, such that the volume of the chamber is dependent upon the instantaneous pressure differential between inner and outer surfaces of the diaphragm.

3. A transducer according to claim 1 or claim 2, wherein said light-emitting device and said light-sensitive device are separated in spaced side-by-side relationship by a material which partially surrounds the devices and forms the substantially opaque screen therebetween, the material being substantially electrically non-conducting.

4. A transducer according to claim 3, wherein said devices and said material are integrally moulded to form a module, there being a passage for transfer of gases through said module between said chamber and an area remote therefrom.

5. A transducer according to claim 4, wherein said module is received within an end region of a tube which supports the module and carries an array of electrical conductors serving said devices.

6. A transducer according to claim 5, wherein a duct passes through said tube but is isolated from the interior thereof, said duct passing outwardly through the wall of the tube adjacent the module.

7. A transducer according to any preceding claim, wherein said light-emitting device comprises a light-emitting diode, and wherein said light-receiving device comprises a photo-transistor.

8. A transducer according to claim 3, wherein said material is an epoxy resin.

9. A transducer according to claim 5, wherein said tube is of a flexible material such as silicone rubber.

10. A transducer according to any preceding claim, including a first electrical conductor connected to the light-emitting device to supply electrical current thereto; a second electrical conductor connected to the light-receiving device for conducting a signal representative of the light received; and a third conductor connected to both devices to provide a common earth line.

11. A transducer according to any preceding claim, wherein said light-emitting device and said light-receiving device are each encapsulated in a translucent plastics material.

12. A system for measuring, for example, ambient pressure and temperature including a transducer according to any one of the preceding claim, and means for measuring the signal generated by the light-receiving device.

13. A system according to claim 11, comprising a control and monitoring circuit including a device adapted to supply a constant electrical current to the light-emitting device, an ammeter calibrated in terms of pressure and connected to the output of the light-receiving device, and a volt meter connected to the input of the light-emitting device and adapted to provide a reading of ambient temperature.

14. A transducer substantially as hereinbefore

described with reference to, and as illustrated in, the accompanying drawings.

15. A system for measuring ambient pressure and temperature, substantially as hereinbefore described with reference to, and as illustrated in, the accompanying drawings.

Printed for Her Majesty's Stationery Office by Croydon Printing Company Limited, Croydon Surrey, 1980.
Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.