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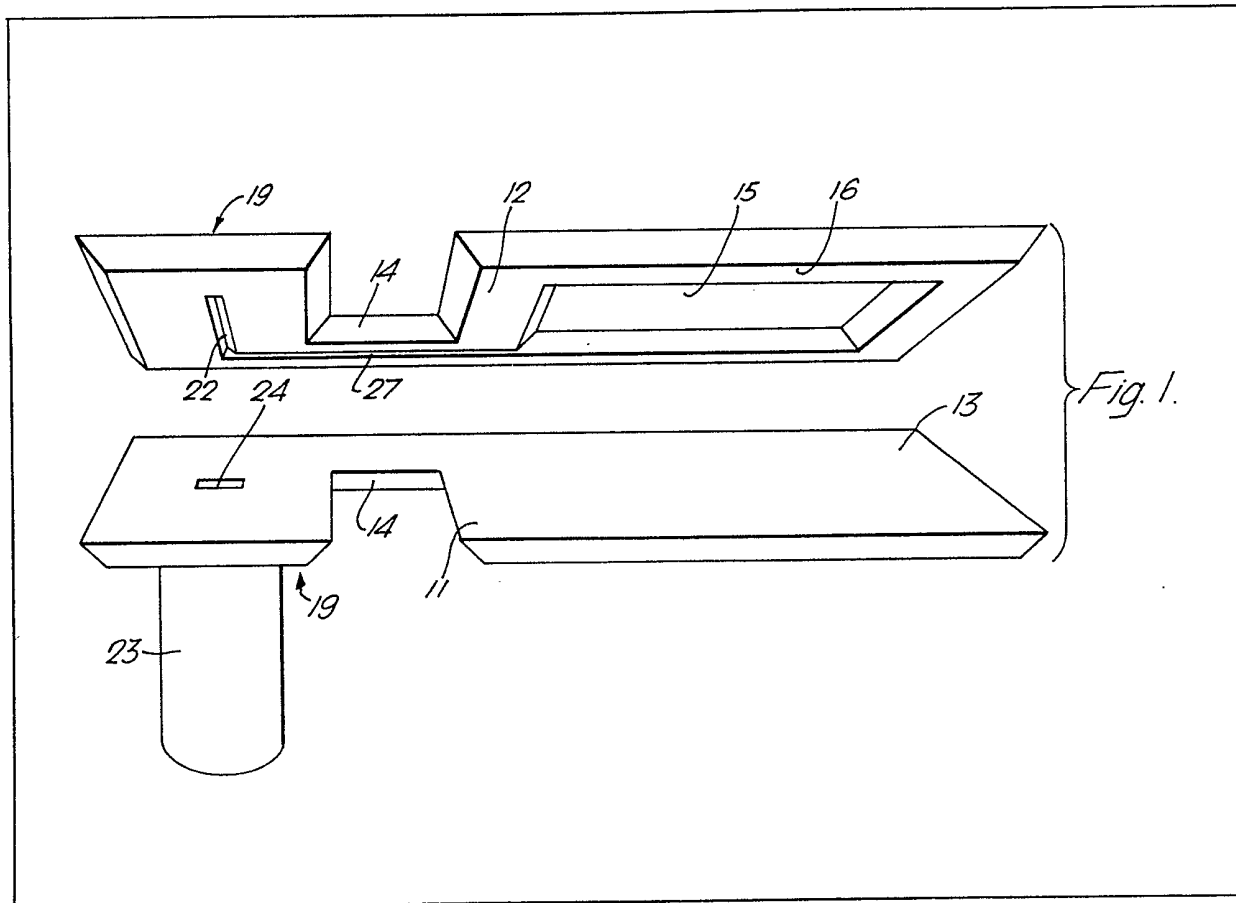
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(54) Strain gauge pressure transducers

(57) A strain gauge pressure transducer comprises a substrate 11 and a silicon layer 12 bonded thereto. The silicon is hollowed out to form a pressure chamber 18 and diaphragm 15, with piezo-resistors formed in it and connected externally 26 via deposited metal strips or runs of

doped semiconductor 25. Pressure connection to the pressure chamber is via a groove 22 in an arm 14 made up of silicon and substrate and leading to a connection body 19. Alternatively the groove may be in the substrate, also the pipe 23 may be in the silicon. This form of connection causes a minimum of distortion to the diaphragm due to load or thermal expansion and permits a high degree of accuracy.



The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

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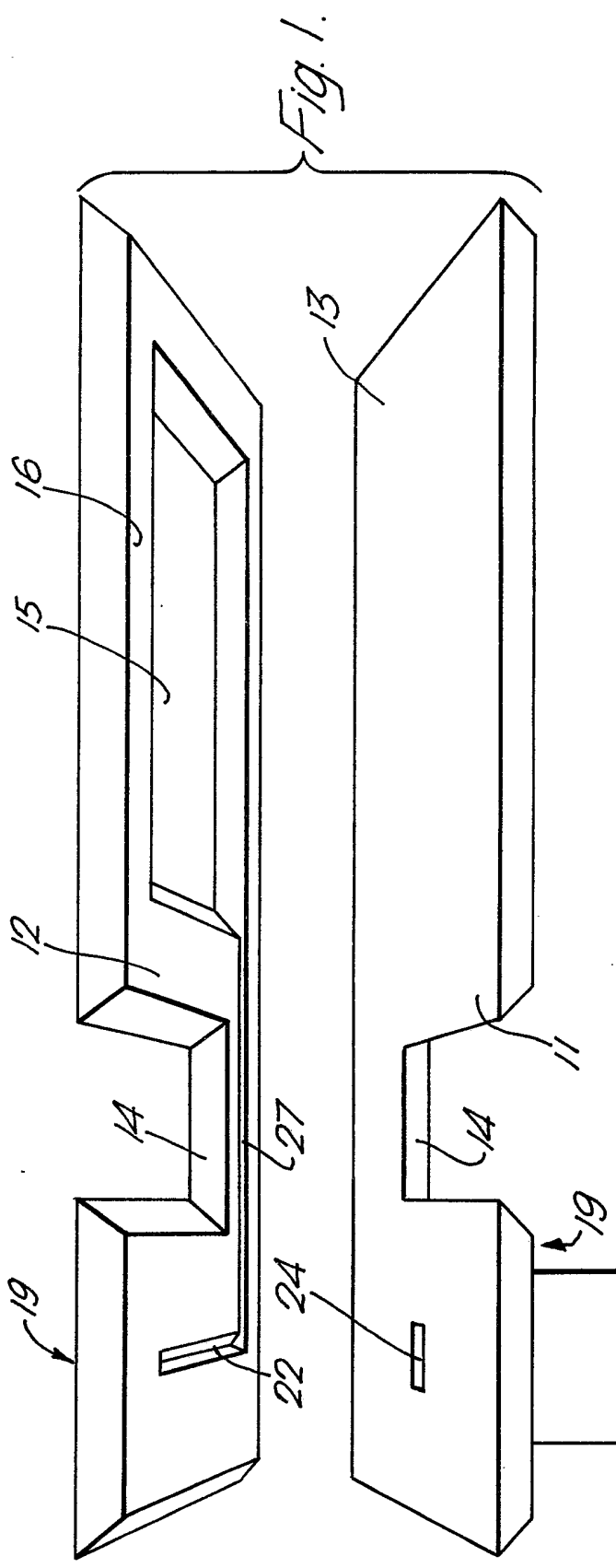
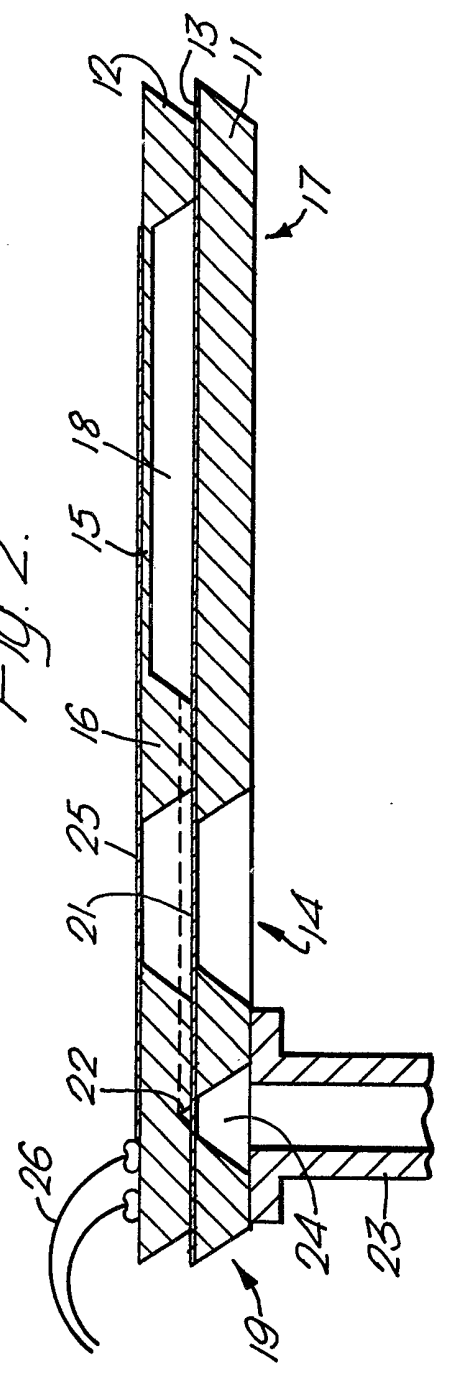


Fig. 2.



SPECIFICATION

Strain gauge pressure transducers

This invention relates to strain gauge pressure transducers.

5 A typical strain gauge pressure transducer has a diaphragm of piezo-resistive semiconductor material such as doped silicon. Pressure to which the transducer should respond is applied to one face of the diaphragm and causes the diaphragm to bend. The resistance of the diaphragm varies with strain, i.e. bending, of the diaphragm and the strain varies with pressure, so the resistance of the diaphragm is an indication of the pressure to be measured.

10 Diaphragms of this kind are very sensitive to their mountings. Local areas of high flexibility or high stiffness around the edge of the diaphragm, such as can be caused by connections to the pressure chamber behind the diaphragm, or distortions occurring due to irregular thermal expansion can make strain gauge pressure transducers very inaccurate.

An object of the present invention is to provide a strain gauge pressure transducer in which the pressure connection causes little or not distortion to the diaphragm or its mounting.

25 According to the present invention there is provided a strain gauge pressure transducer comprising a substrate, a layer of semiconductor material supported on the substrate, the semiconductor layer being hollowed out on the side facing the substrate to leave a diaphragm with piezo-resistive semiconductor material and spaced from the substrate by a pressure chamber, wherein a fluid connection to the pressure chamber is provided by a groove in the silicon layer or the substrate at the interface thereof.

30 Preferably the groove is in the semiconductor layer and an external fluid connection to the pressure chamber is provided from the substrate.

The semiconductor material may be silicon, and the diaphragm thereof may be doped to provide piezo-resistive properties to the diaphragm.

35 Preferably the area of semiconductor and substrate defined by the diaphragm and a supporting rim make up a pressure body, the pressure body is connected by an integral arm of substrate and semiconductor to an integral connection body formed of substrate and semiconductor, the groove passes along the arm to the connection body and the external pressure connection to the transducer is made to the connection body, the arm joining the pressure body is such a way as to cause little or no influence on strain of the diaphragm due to temperature variations or pressure being measured.

40 The electrical connections to the diaphragm may also lead along the arm to external connections made to the connection body.

An embodiment of the invention will now be described with reference to the accompanying drawings in which:

Figure 1 is an exploded view of a strain gauge

65 pressure transducer in accordance with the invention; and

Figure 2 is a corresponding sectional view.

70 A substrate 11 and silicon layer 12 supported thereon by a bonding layer 13 are of the same general configuration as each other, namely two rectangles joined at one corner of each by an arm 14. In the larger rectangle, the silicon has been hollowed out, on the side facing the substrate 11 to form a diaphragm 15, and the diaphragm thickness is determined by the etch time. The diaphragm extends over substantially the whole of one of the rectangles, apart from a rim 16 extending round its periphery. This rectangle forms a pressure body 17 within which there is a pressure chamber 18.

80 The silicon is doped in selected areas to form resistors in a manner similar to that which is known in the semiconductor electronics industry. These areas are positioned on the diaphragm to be strained in the required manner.

85 The arm 14 projects as an extension to one edge of the rectangle pressure body and joins the second rectangle, constituting a connection body 19 to the pressure body 17. As seen in Figure 1, a groove 21 extends within the surface of the silicon layer one corner of the pressure chamber 18 along the arm 14 and into the connection body 19. Groove 22 then extends at right angles to groove 21 within the connection body 19. A pipe 23 is connected to the part of the substrate forming the connection body 19 and leads to a pressurised region, the pressure of which is to be measured. Pipe 23 terminates in a slot 24, traverse to the groove 22, to ensure that the slot and groove interconnect even if the substrate and silicon layer are not aligned accurately. In this way a pressure connection is provided to the diaphragm along the arm 14.

90 The arm 14 is arranged to have as little effect as possible on the structure of the pressure chamber as regards loading by pressure in the pressure chamber and differential thermal expansion. The pipe connection is remote from and has little or no influence on the pressure chamber. In this way, a stable and accurate pressure transducer can be provided.

95 As an alternative to the grooves 21, 22 in the silicon, these could be in the substrate. Similarly the pipe connection could be to the silicon. However, the arrangement shown is preferred.

100 Electrical connections, as are required to the piezo-resistors on the diaphragm can exert sufficient extraneous load on the diaphragm to introduce inaccuracies. To avoid this, integral electric leads 25, either deposited strips of metal or runs of doped semiconductor lead across the arm 14 to the connection body from which they are connected in to an electrical measuring circuit by external connectors 26.

125 CLAIMS

1. A strain gauge pressure transducer comprising a substrate, a layer of semiconductor material supported on the substrate, the

- semiconductor layer being hollowed out on the side facing the substrate to leave a diaphragm with piezo-resistive semiconductor material and spaced from the substrate by a pressure chamber,
- 5 wherein a fluid connection to the pressure chamber is provided by a groove in the silicon layer or the substrate at the interface thereof.
2. A pressure transducer as claimed in claim 1 wherein the groove is in the semiconductor layer and an external fluid connection to the pressure chamber is provided from the substrate.
- 10 3. A pressure transducer as claimed in claim 1 or 2 wherein the semiconductor material is silicon and the diaphragm thereof is doped to provide piezo-resistive properties to the diaphragm.
- 15 4. A pressure transducer as claimed in any preceding claim wherein the area of semiconductor and substrate defined by the diaphragm and a supporting rim make up a
- 20 pressure body, the pressure body is connected by an integral arm of substrate and semiconductor to an integral connection body formed of substrate and semiconductor, the groove passes along the arm to the connection body and the external
- 25 pressure connection to the transducer is made to the connection body, the arm joining the pressure body is such a way as to cause little or no influence on strain of the diaphragm due to temperature variations or pressure being
- 30 measured.
5. A pressure transducer as claimed in claim 4 wherein electrical connection for the diaphragm lead along the arm and external electrical connections are made to the connection body.
- 35 6. A pressure transducer substantially as described with reference to and as illustrated by the accompanying drawings.