



Europäisches Patentamt
European Patent Office
Office européen des brevets



(11) **EP 1 214 864 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention
of the grant of the patent:

04.06.2003 Bulletin 2003/23

(21) Application number: **00958265.1**

(22) Date of filing: **06.09.2000**

(51) Int Cl.7: **H04R 19/00**

(86) International application number:
PCT/DK00/00491

(87) International publication number:
WO 01/019134 (15.03.2001 Gazette 2001/11)

(54) **SILICON-BASED SENSOR SYSTEM**

SILIKON BASIERTE SENSOR-SYSTEME

SYSTEME DE CAPTEUR A BASE DE SILICIUM

(84) Designated Contracting States:
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU
MC NL PT SE**

(30) Priority: **06.09.1999 DK 125499**
07.09.1999 US 391628
12.05.2000 US 570434

(43) Date of publication of application:
19.06.2002 Bulletin 2002/25

(73) Proprietor: **SonionMEMS A/S**
2800 Kongens Lyngby (DK)

(72) Inventors:
• **MÜLLENBORN, Matthias**
DK-2800 Lyngby (DK)
• **KUHMAN, Jochen, F.**
DK-2400 Copenhagen NV (DK)

• **SCHEEL, Peter, U.**
DK-2820 Gentofte (DK)

(74) Representative: **Frederiksen, Jakob Pade et al**
Plougmann & Vingtoft A/S
Sundkrogsgade 9
P.O. Box 831
2100 Copenhagen O (DK)

(56) References cited:
US-A- 4 533 795 **US-A- 5 490 220**
US-A- 5 856 914 **US-A- 5 870 482**
US-A- 5 889 872

• **KRISTIANSEN L: "Forste Silicium-baserede
Mikro-mikrofon" NYHEDSMAGASINET
ELEKTRONIK & DATA, no. 3, 1998, pages 4-8,
XP002901441**

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

EP 1 214 864 B1

Description

FIELD OF INVENTION

[0001] The present invention relates to a sensor system comprising a carrier member, a transducer element and an electronic device. The present invention relates in particular to condenser microphone systems assembled using flip-chip technology. The present invention further relates to condenser microphone systems adapted for surface mounting on e.g. printed circuit boards (PCB's).

BACKGROUND OF THE INVENTION

[0002] In the hearing instrument and mobile communication system industry, one of the primary goals is to make components of small sizes while still maintaining good electroacoustic performance and operability giving good user friendliness and satisfaction. Technical performance data include sensitivity, noise, stability, compactness, robustness and insensitivity to electromagnetic interference (EMI) and other external and environmental conditions. In the past, several attempts have been made to make microphone systems smaller while maintaining or improving their technical performance data.

[0003] Another issue within these component industries concerns the ease of integration into the complete system.

[0004] EP 561 566 discloses a solid state condenser microphone having a field effect transistor (FET) circuitry and a cavity or sound inlet on the same chip. The techniques and processes for manufacturing a FET circuitry are quite different from the techniques and processes used in manufacturing transducer elements. Consequently, the transducer element and FET system disclosed in EP 561 566 requires two (or possibly more) separate stages of production which by nature makes the manufacturing more complicated and thereby also more costly.

[0005] The development of hybrid microelectromechanical systems (MEMS) has progressed significantly over the last years. This has primarily to do with the development of appropriate techniques for manufacturing such systems. One of the advantages of such hybrid systems relates to the size with which relative complicated systems involving mechanical microtransducers and specially designed electronics may be manufactured.

[0006] US 5,889,872 discloses a hybrid system consisting of a silicon microphone and an integrated circuit chip mounted onto it using wire bonding for the electrical connection. This solution has the disadvantage of requiring additional protection and space for the bonding wires.

[0007] US 5,856,914 discloses a flip-chip mounted micromechanical device, such as a condenser micro-

phone, where part of the carrier upon which the micro-device is mounted, forms part of the final system. A disadvantage of this system is the fact that the micromechanical device may not be tested prior to the mounting on the carrier. Another disadvantage of the disclosed system relates to the chosen materials. The micromechanical device is comprised of Si whereas the carrier is made of a PCB or a ceramic material. Differences in thermal expansion coefficients may easily complicate the integration of such different materials.

[0008] The article "The first silicon-based micro-microphone" published in the Danish journal Elektronik og Data, No. 3, p. 4-8, 1998 discloses how silicon-based microphone systems can be designed and manufactured. The article discloses a three-layer microphone system where a transducer element is flip-chip mounted on an intermediate layer connecting the transducer element to an electronic device, such as an application specific integrated circuit (ASIC). The transducer element comprises a movable diaphragm and a substantially stiff back plate. On the opposite side of the transducer element a silicon-based structure forming a back chamber is mounted. It is worth noting that in order for the microphone system to be electrically connected to the surroundings wire bonding or direct soldering is required.

[0009] It is an object of the present invention to provide a sensor system where the different elements forming the sensor system are flip-chip mounted, applying standard batch-oriented techniques.

[0010] It is a further object of the present invention to provide a fully functional and encapsulated sensor system that can be operated independently of its final position on e.g. a PCB.

[0011] It is a still further object of the present invention to provide a fully functional and encapsulated sensor system that can be tested prior to the final mounting.

[0012] It is a still further object of the present invention to provide a sensor system suitable for mounting on e.g. PCB's using flip-chip or surface mount technologies and thereby avoid wire bonding or complicated single-chip handling.

[0013] It is a still further object of the present invention to provide a sensor system where the distance between the transducer element and the electronic circuit is reduced so as to reduce parasitics and space consumption.

SUMMARY OF THE INVENTION

[0014] The above-mentioned objects are complied with by providing, in a first aspect, a sensor system comprising

- a carrier member having a first surface, said first surface holding a first and a second group of contact elements,

- a transducer element comprising an active member, said active member being electrically connected to at least one contact element of the transducer element, and
- an electronic device comprising an integrated circuit having at least one contact element,

characterised in that

- at least one contact element of the transducer element is aligned with one of the contact elements of the first group of the carrier member so as to obtain electrical contact between the active member of the transducer element and the carrier member, and that
- at least one contact element of the electronic device is aligned with one of the contact elements of the second group of the carrier member so that the transducer element and the electronic device are positioned adjacently on the first surface of the carrier member, and so as to obtain electrical contact between the integrated circuit and the carrier member, and that
- at least one of the contact elements of the first group is electrically connected to at least one of the contact elements of the second group so as to obtain electrical contact between the active member of the transducer element and the integrated circuit of the electronic device.

[0015] The transducer element may in principle be any kind of transducer, such as a pressure transducer, an accelerometer or a thermometer.

[0016] In order for the sensor system to communicate with the surroundings the carrier member may further comprise a second surface, said second surface holding a plurality of contact elements. At least one of the contact elements of the first or second group is electrically connected to one of the contact elements being held by the second surface. The first and second surfaces may be substantially parallel and opposite each other.

[0017] The carrier member and the transducer element may be based on a semiconductor material, such as Si. In order to decouple thermal stresses, the carrier member, the transducer element and the electronic device may be based on the same semiconductor material. Again, the material may be Si.

[0018] In order to form a back chamber for microphone applications the carrier member may further comprise an indentation aligned with the active member of the transducer element. Also for microphone applications the active member of the transducer element may comprise a capacitor being formed by a flexible diaphragm and a substantially stiff back plate in combination. Furthermore, the transducer element further com-

prises a cavity or sound inlet. The bottom of the cavity may be defined or formed by the active member of the transducer element. The flexible diaphragm and the substantially stiff back plate may be electrically connected to a first and a second contact element of the transducer element, respectively, in order to transfer the signal received by the transducer element to the carrier member.

[0019] The integrated circuit may be adapted for signal processing. This integrated circuit may be an ASIC.

[0020] In order to obtain directional sensitivity the sensor may further comprise an opening or sound inlet between the second surface of the carrier member and the indentation. In order to protect the transducer element against e.g. particles or humidity an outer surface of the sensor is at least partly protected by a lid. The lid and the active member of the transducer element may define an upper and lower boundary of the cavity, respectively. Furthermore, at least one outer surface of the sensor system may hold a conductive layer. The conductive layer may comprise a metal layer or a conductive polymer layer.

[0021] The contact elements may comprise solder materials, such as a Sn, SnAg, SnAu or SnPb. Furthermore, the sensor system may comprise sealing means for hermetically sealing the transducer element.

[0022] In a second aspect, the present invention relates to a sensor system comprising

- a carrier member having a first surface, said first surface holding a first, a second and a third group of contact elements,
- a first transducer element comprising an active member, said active member being electrically connected to at least one contact element of the first transducer element,
- a second transducer element comprising an active member, said active member being electrically connected to at least one contact element of the second transducer element,
- an electronic device comprising an integrated circuit having at least one contact element,

characterised in that

- at least one contact element of the first transducer element is aligned with one of the contact elements of the first group of the carrier member so as to obtain electrical contact between the active member of the first transducer element and the carrier member, and that
- at least one contact element of the second transducer element is aligned with one of the contact elements of the second group of the carrier member

so that the first and second transducer elements are positioned adjacently on the first surface of the carrier member, and so as to obtain electrical contact between the active member of the second transducer element and the carrier member, and that

- at least one contact element of the electronic device is aligned with one of the contact elements of the third group of the carrier member so that the electronic device is positioned adjacent to the first respective second transducer element on the first surface of the carrier member, and so as to obtain electrical contact between the integrated circuit and the carrier member, and that
- at least one of the contact elements of the first group is electrically connected to at least one of the contact elements of the third group, and that at least one of the contact elements of the second group is electrically connected to at least one of the contact elements of the third group so as to obtain electrical contact between the active member of the first transducer element and the integrated circuit, and between the active member of second transducer element and the integrated circuit.

[0023] The sensor according to the second aspect may be suitable for directional sensing, such as for directional sensitive pressure transducers.

[0024] The carrier member, such as a Si-based carrier member, may further comprise a second surface holding a plurality of contact elements. In order to obtain electrical connection to the second surface at least one of the contact elements of the first, second or third group may be electrically connected to one of the contact elements being held by the second surface. The first and second surfaces may be substantially parallel and opposite each other. Preferably, the transducer elements and the electronic device are Si-based.

[0025] The carrier member may further comprise a first and a second indentation, the first indentation being aligned with the active member of the first transducer element, the second indentation being aligned with the active member of the second transducer element. The first and second indentations act as back chambers.

[0026] Each of the first and second transducer elements may further comprise a cavity, the bottom of said cavities being defined by the active members of the first and second transducer elements.

[0027] In order to measure e.g. pressure variations each of the active members of the first and second transducer elements may comprise a capacitor, said capacitor being formed by a flexible diaphragm and a substantially stiff back plate in combination. The flexible diaphragm and the substantially stiff back plate may be electrically connected to the contact elements of the respective transducer elements.

[0028] Each of the first and second transducer ele-

ments further may comprise a lid for protecting the transducer elements. The lids and the active members of the first and second transducer elements may be positioned in such a way that they define an upper and a lower boundary of the respective cavities.

[0029] At least part of an outer surface of the sensor system may hold a conductive layer. This conductive layer may be a metal layer or a conductive polymer layer. The contact elements may comprise a solder material, such as Sn, SnAg, SnAu or SnPb.

[0030] Solid state silicon-based condenser microphone systems according to the invention are suitable for batch production. The combination of the different elements forming the microphone system is more flexible compared to any other system disclosed in the prior art. The present invention makes it possible to provide a very well defined interface to the environment, e.g. by an opening on one side of the system. This opening can be covered by a film or filter preventing dust, moisture and other impurities from contaminating or obstructing the characteristics of the microphone. Electrical connections between the different elements of the microphone system are established economically and reliably via a silicon carrier using flip-chip technology.

[0031] The present invention uses an integrated electronic circuit chip, preferably an ASIC which may be designed and manufactured separately and independent of the design and manufacture of the transducer element of the microphone. This is advantageous since the techniques and processes for manufacturing integrated electronic circuit chips are different from those used in manufacturing transducer elements, and each production stage can thus be optimised independently. Furthermore, testing of transducer elements and ASICs may be performed on wafer level.

[0032] The complete sensor system can be electrically connected to an external substrate by surface mount technology with the contacts facing one side of the system that is not in conflict with the above-mentioned interface to the environment. This allows the user to apply simple and efficient surface mount techniques for the assembly of the overall system.

BRIEF DESCRIPTION OF THE DRAWINGS

[0033] The present invention will now be explained in further detail with reference to the accompanying drawings, where

Figure 1 is an illustration of a general application of a silicon-based sensor system,

Figure 2 is an illustration of a general application of a silicon-based sensor system with a lid,

Figure 3 is an illustration of a microphone application of the silicon-based sensor system,

Figure 4 is an illustration of an encapsulated microphone application,

Figure 5 is a close up of a lateral feed-through and sealing ring,

Figure 6 is an illustration of a directional microphone application of the silicon-based sensor system, and

Figure 7 is an illustration of a second directional microphone application of the silicon-based sensor system.

DETAILED DESCRIPTION OF THE INVENTION

[0034] The process used for manufacturing the different elements of the sensor system involves mainly known technologies within the field of microtechnology.

[0035] In Figure 1 a silicon carrier substrate 2 containing one or more vertical etched feed-through holes 20 is shown. The silicon carrier substrate 2, which is bulk crystalline silicon, has solder bumps 8, 22 on a first surface and a second surface, respectively. The electrical signal is carried from the first surface to the second surface via feed-through lines 23. On the first surface, one or more transducer elements 1 are flip-chip mounted onto the silicon carrier substrate 2, connected and fixed by a first group of solder bumps 8. Also on the first surface, one or more electronic devices, such as integrated circuit chips 3, are flip-chip mounted onto the silicon carrier substrate 2, connected and fixed by a second group of solder bumps 8. The solder bump 8 material is typically Sn, SnAg, SnAu, or SnPb, but other metals could also be used.

[0036] A solder sealing ring 9 provides sealing for the transducer element 1. In this case, feed-through lines 23 are used for carrying the electrical signals from the transducer element 1 under the sealing ring 9 to the electronic device 3. This is shown in greater detail in Figure 5. The signal can also be carried to the electronic circuit by other conductive paths.

[0037] Electrical conductive paths 23 are also formed through the carrier e.g. by etching holes 20 and subsequent metallization. The etching can be done by wet chemical etching or dry plasma etching techniques. This path 23 is called a vertical feed-through and can be used for carrying the electrical signal from either the transducer 1 or the electronic circuit 3 to the second surface of the carrier.

[0038] The second surface is supplied with solder bumps 22 for surface mounting onto e.g. a PCB or another carrier.

[0039] Figure 2 shows a package like the one shown in Figure 1, but in this embodiment the electronic device 3 has been connected and fixed by one group of solder bumps 8 as well as other means such as underfill or glue 21. Furthermore, the package is protected by a lid 5, which is fixed to the flip-chip mounted transducer ele-

ment 1 or electronic device 3 or both. The lid 5 has an opening 4 providing a well-determined access to the environment, e.g. a sound-transmitting grid or filter as protection against particles or humidity for a microphone.

The lid can be made separately, e.g. from metal or polymer by punching or injection moulding, respectively.

[0040] In Figure 3 and 4 a system for microphone applications is shown. In these embodiments the transducer element 1 is a microphone and a back chamber 11 has been etched into the silicon substrate 2. The back chamber is etched into the silicon carrier by wet etching processes using reactants as KOH, TMAH or EDP or by dry etching processes such as reactive ion etching. The cavity 11 can be etched in the same step as the feed-through hole 20.

[0041] The difference between Figure 3 and 4 is that the system, in Figure 4, has been encapsulated with a filter 5 for providing EMI-shielding. The EMI-shield 16 is a conductive polymer layer, such as silver epoxy or a metal layer, such as electroplated or evaporated Cu or Au. Furthermore, the integrated circuit chip 3 and the filter 5 in Figure 4 have been connected and fixed with additional means such as underfill or glue 21.

[0042] The function of the microphone is as follows. The opening 4 functions as a sound inlet, and ambient sound pressure enters through the filter 5 covering the opening 4 to the cavity 10 functioning as a front chamber for the microphone. The sound pressure deflects the diaphragm 12, which causes the air between the diaphragm 12 and the back plate 13 to escape through the perforations 19.

[0043] The diaphragm may be designed and manufactured in different ways. As an example the diaphragm may be designed as a three-layer structure having two outer layers comprising silicon nitride whereas the intermediate layer comprises polycrystalline silicon. The polycrystalline silicon comprised in the intermediate layer is doped with either boron (B) or phosphorous (P). The back plate also comprises B- or P-doped polycrystalline silicon and silicon nitride. The cavity 11 functions as a back chamber for the microphone.

[0044] When the diaphragm 12 is deflected in response to the incident sound pressure, the electrical capacity of the electrical capacitor formed by the diaphragm 12 and the back plate 13 will vary in response to the incident sound pressure. The circuit on the integrated circuit chip 3 is electrically connected to the diaphragm 12 and the back plate 13 through solder bumps 8. The circuit is designed to detect variations in the electrical capacity of the capacitor formed by the diaphragm 12 and the back plate 13. The circuit has electrical connections via the solder bumps 8 and the vertical feed-through lines 23 to the solder bumps 22 for electrically connecting it to a power supply and other electronic circuitry in e.g. a hearing instrument.

[0045] When operating the capacitor formed by the diaphragm 12 and the back plate 13, the back plate 13 is connected to a DC power supply in order to charge the

back plate 13. When the capacitance varies due to distance variation between the diaphragm 12 and the back plate 13 in response to a varying sound pressure, an AC voltage is superimposed on top of the applied DC level. The amplitude of the AC voltage is a measured for the change in capacitance and thus also a measure for the sound pressure experienced by the diaphragm.

In Figure 5 a close-up of a lateral feed-through line 24 and sealing ring 9 is shown. The feed-through 24 is electrically insulated from the sealing ring 9 and the substrate 2 by insulating layers 25. Insulating layers 25 similarly insulate the solder bumps 8 of the transducer 1 from the substrate 2. The solder bumps 8 of the transducer 1 and the solder bumps 8 of the circuit chip 3 are electrically connected via the feed-through line 24.

[0046] In Figure 6, a microphone similar to the one in Figure 3 is shown. However, an opening 24 has been introduced in the backchamber 11. The opening 24 causes a membrane deflection that reflects the pressure gradient over the membrane resulting in a directional sensitivity of the microphone.

[0047] In Figure 7, a microphone similar to the one in Figure 3 is shown. However, an additional transducer element has been added so that the microphone now uses two transducer elements 1, both containing a membrane 12 and a backplate 13. Both transducer elements are connected to the carrier member 3 by solder bumps 8 and seal ring 9 with an indentation 11 for each transducer element. The two transducer elements allow to measure the phase difference of an impinging acoustic wave resulting in a directional sensitivity of the microphone.

[0048] It will be evident for the skilled person to increase the number of sensing elements from two (as shown in Fig. 7) to an arbitrary number of sensing elements - e.g. arranged in an array of columns and rows.

Claims

1. A sensor system comprising

- a carrier member (2) having a first surface, said first surface holding a first and a second group of contact elements (8),
- a transducer element (1) comprising an active member, said active member being electrically connected to at least one contact element of the transducer element (1), and
- an electronic device (3) comprising an integrated circuit having at least one contact element,

characterised in that

- at least one contact element of the transducer element (1) is aligned with one of the contact

elements (8) of the first group of the carrier member (2) so as to obtain electrical contact between the active member of the transducer element (1) and the carrier member (2), and that

- at least one contact element of the electronic device (3) is aligned with one of the contact elements (8) of the second group of the carrier member (2) so that the transducer element (1) and the electronic device (3) are positioned adjacently on the first surface of the carrier member (2), and so as to obtain electrical contact between the integrated circuit and the carrier member (2), and that
- at least one of the contact elements (8) of the first group is electrically connected to at least one of the contact elements (8) of the second group so as to obtain electrical contact between the active member of the transducer element (1) and the integrated circuit of the electronic device (3).

2. A sensor system according to claim 1, wherein the carrier member (2) further comprises a second surface, said second surface holding a plurality of contact elements, wherein at least one of the contact elements of the first or second group is electrically connected to one of the contact elements being held by the second surface.

3. A sensor system according to claim 2, wherein the first and second surfaces are substantially parallel and opposite each other.

4. A sensor system according to any of claims 1-3, wherein the carrier member (2) is a Si-based carrier member.

5. A sensor system according to any of claims 1-4, wherein the carrier member (2) further comprises an indentation (11), said indentation (11) being aligned with the active member of the transducer element.

6. A sensor system according to any of claims 1-5, wherein the transducer element further comprises a cavity (10), the active member defining the bottom of said cavity (10).

7. A sensor system according to claim 5, further comprising an opening (24) between the second surface of the carrier member (2) and the indentation (11).

8. A sensor system according to any of the preceding claims, wherein the transducer element (1) is Si-based.

9. A sensor system according to any of the preceding claims, wherein the carrier member (2), the transducer element (1), and the electronic device (3) are Si-based.

5

10. A sensor system according to claim 1, wherein the active member of the transducer element comprises a capacitor, said capacitor being formed by a flexible diaphragm (12) and a substantially stiff back plate (13) in combination.

10

11. A sensor system according to claim 6, wherein the transducer element (1) further comprises a lid (5), the lid (5) and the active member of the transducer element (1) defining an upper and a lower boundary of the cavity (10).

15

12. A sensor system according to any of the preceding claims, wherein at least part of an outer surface of the sensor system holds a conductive layer (16).

20

13. A sensor system according to claim 12, wherein the conductive layer comprises a metal layer.

14. A sensor system according to claim 12, wherein the conductive layer comprises a conductive polymer layer.

25

15. A sensor system according to any of the preceding claims, wherein the contact elements comprise a solder material, such as Sn, SnAg, SnAu or SnPb.

30

16. A sensor system according to claim 6, further comprising sealing means for hermetically sealing the transducer element.

35

17. A sensor system comprising

- a carrier member having a first surface, said first surface holding a first, a second and a third group of contact elements,
- a first transducer element comprising an active member, said active member being electrically connected to at least one contact element of the first transducer element,
- a second transducer element comprising an active member, said active member being electrically connected to at least one contact element of the second transducer element,
- an electronic device comprising an integrated circuit having at least one contact element,

40

45

50

characterised in that

- at least one contact element of the first trans-

55

ducer element is aligned with one of the contact elements of the first group of the carrier member so as to obtain electrical contact between the active member of the first transducer element and the carrier member, and that

- at least one contact element of the second transducer element is aligned with one of the contact elements of the second group of the carrier member so that the first and second transducer elements are positioned adjacently on the first surface of the carrier member, and so as to obtain electrical contact between the active member of the second transducer element and the carrier member, and that

- at least one contact element of the electronic device is aligned with one of the contact elements of the third group of the carrier member so that the electronic device is positioned adjacent to the first respective second transducer element on the first surface of the carrier member, and so as to obtain electrical contact between the integrated circuit and the carrier member, and that

- at least one of the contact elements of the first group is electrically connected to at least one of the contact elements of the third group, and that at least one of the contact elements of the second group is electrically connected to at least one of the contact elements of the third group so as to obtain electrical contact between the active member of the first transducer element and the integrated circuit, and between the active member of second transducer element and the integrated circuit.

18. A sensor system according to claim 17, wherein the carrier member further comprises a second surface, said second surface holding a plurality of contact elements, wherein at least one of the contact elements of the first, second or third group is electrically connected to one of the contact elements being held by the second surface.

19. A sensor system according to claim 18, wherein the first and second surfaces are substantially parallel and opposite each other.

20. A sensor system according to any of claims 17-19, wherein the carrier member is a Si-based carrier member.

21. A sensor system according to any of claims 17-20, wherein the carrier member further comprises a first and a second indentation, the first indentation being aligned with the active member of the first transducer element.

er element, the second indentation being aligned with the active member of the second transducer element.

22. A sensor system according to any of claims 17-21, wherein each of the first and second transducer elements further comprises a cavity, the bottom of said cavities being defined by the active members of the first and second transducer elements. 5
23. A sensor system according to any of claims 17-22, wherein the first and second transducer elements are Si-based. 10
24. A sensor system according to any of claims 17-23, wherein the carrier member, the first and second transducer elements, and the electronic device are Si-based. 15
25. A sensor system according to any of claims 17-24, wherein each of the active members of the first and second transducer elements comprises a capacitor, said capacitor being formed by a flexible diaphragm and a substantially stiff back plate in combination. 20
26. A sensor system according to any of claims 17-25, wherein each of the first and second transducer elements further comprises a lid, wherein the lids and the active members of the first and second transducer elements define an upper and a lower boundary of the respective cavities. 25
27. A sensor system according to any of claims 17-26, wherein at least part of an outer surface of the sensor system holds a conductive layer. 30
28. A sensor system according to claim 27, wherein the conductive layer comprises a metal layer. 35
29. A sensor system according to claim 27, wherein the conductive layer comprises a conductive polymer layer. 40
30. A sensor system according to any of claims 17-29, wherein the contact elements comprise a solder material, such as Sn, SnAg, SnAu or SnPb. 45

Patentansprüche

1. Sensorsystem mit:

- einem Trägerglied (2) mit einer ersten Oberfläche, wobei diese erste Oberfläche eine erste und eine zweite Gruppe von Kontaktelementen (8) hält; 55
- einem Wandlerelement (1), das ein aktives Glied aufweist, wobei dieses aktive Glied mit

mindestens einem Kontaktelement des Wandlerelements (1) elektrisch verbunden ist; und

- einer elektronischen Vorrichtung (3), die eine integrierte Schaltung mit mindestens einem Kontaktelement aufweist,

dadurch gekennzeichnet, daß

- mindestens ein Kontaktelement des Wandlerelements (1) mit einem der Kontaktelemente (8) der ersten Gruppe des Trägerglieds (2) ausgerichtet ist, um einen elektrischen Kontakt zwischen dem aktiven Glied des Wandlerelements (1) und dem Trägerglied (2) zu erhalten; und daß
 - mindestens ein Kontaktelement der elektronischen Vorrichtung (3) mit einem der Kontaktelemente (8) der zweiten Gruppe des Trägerglieds (2) ausgerichtet ist, so daß das Wandlerelement (1) und die elektronische Vorrichtung (3) benachbart auf der ersten Oberfläche des Trägerglieds (2) positioniert sind, und um einen elektrischen Kontakt zwischen der integrierten Schaltung und dem Trägerglied (2) zu erhalten; und daß
 - mindestens eines der Kontaktelemente (8) der ersten Gruppe mit mindestens einem der Kontaktelemente (8) der zweiten Gruppe elektrisch verbunden ist, um einen elektrischen Kontakt zwischen dem aktiven Glied des Wandlerelements (1) und der integrierten Schaltung der elektronischen Vorrichtung (3) zu erhalten.
2. Sensorsystem nach Anspruch 1, wobei das Trägerglied (2) ferner eine zweite Oberfläche aufweist, wobei diese zweite Oberfläche mehrere Kontaktelemente hält, wobei mindestens eines der Kontaktelemente der ersten oder zweiten Gruppe mit einem der von der zweiten Oberfläche gehaltenen Kontaktelemente elektrisch verbunden ist.
3. Sensorsystem nach Anspruch 2, wobei die ersten und zweiten Oberflächen im wesentlichen parallel und zueinander entgegengesetzt sind.
4. Sensorsystem nach einem der Ansprüche 1 bis 3, wobei das Trägerglied (2) ein Si-basiertes Trägerglied ist.
5. Sensorsystem nach einem der Ansprüche 1 bis 4, wobei das Trägerglied (2) ferner eine Einkerbung (11) aufweist, wobei diese Einkerbung (11) mit dem aktiven Glied des Wandlerelements ausgerichtet ist.
6. Sensorsystem nach einem der Ansprüche 1 bis 5, wobei das Wandlerelement ferner einen Hohlraum (10) aufweist und das aktive Glied den Boden die-

ses Hohlraums (10) begrenzt.

7. Sensorsystem nach einem Anspruch 5, das ferner eine Öffnung (24) zwischen der zweiten Oberfläche des Trägerglieds (2) und der Einkerbung (11) aufweist. 5
8. Sensorsystem nach einem der vorhergehenden Ansprüche, wobei das Wandlerelement (1) Si-basiert ist. 10
9. Sensorsystem nach einem der vorhergehenden Ansprüche, wobei das Trägerglied (2), das Wandlerelement (1) und die elektronische Vorrichtung (3) Si-basiert sind. 15
10. Sensorsystem nach Anspruch 1, wobei das aktive Glied des Wandlerelements einen Kondensator aufweist, wobei dieser Kondensator aus einer flexiblen Membran (12) in Verbindung mit einer im wesentlichen starren Verstärkungsplatte (13) gebildet ist. 20
11. Sensorsystem nach Anspruch 6, wobei das Wandlerelement (1) ferner einen Deckel (5) aufweist, wobei der Deckel (5) und das aktive Glied des Wandlerelements (1) eine obere und eine untere Grenze des Hohlraums (10) definieren. 25
12. Sensorsystem nach einem der vorhergehenden Ansprüche, wobei zumindest ein Teil einer äußeren Oberfläche des Sensorsystems eine leitende Schicht (16) hält. 30
13. Sensorsystem nach Anspruch 12, wobei die leitende Schicht eine Metallschicht aufweist. 35
14. Sensorsystem nach Anspruch 12, wobei die leitende Schicht eine leitende Polymerschicht aufweist. 40
15. Sensorsystem nach einem der vorhergehenden Ansprüche, wobei die Kontaktelemente ein Lötmaterial, wie Sn, SnAg, SnAu oder SnPb, aufweisen. 45
16. Sensorsystem nach Anspruch 6, das ferner eine Dichtungseinrichtung zum hermetischen Verschließen des Wandlerelements aufweist. 50
17. Sensorsystem mit:
 - einem Trägerglied mit einer ersten Oberfläche, wobei diese erste Oberfläche eine erste, eine zweite und eine dritte Gruppe von Kontaktelementen hält;
 - einem ersten Wandlerelement, das ein aktives Glied aufweist, wobei dieses aktive Glied mit mindestens einem Kontaktelement des ersten Wandlerelements elektrisch verbunden ist; 55

- einem zweiten Wandlerelement, das ein aktives Glied aufweist, wobei dieses aktive Glied mit mindestens einem Kontaktelement des zweiten Wandlerelements elektrisch verbunden ist; und
- einer elektronischen Vorrichtung, die eine integrierte Schaltung mit mindestens einem Kontaktelement aufweist,

dadurch gekennzeichnet, daß

- mindestens ein Kontaktelement des ersten Wandlerelements mit einem der Kontaktelemente der ersten Gruppe des Trägerglieds ausgerichtet ist, um einen elektrischen Kontakt zwischen dem aktiven Glied des ersten Wandlerelements und dem Trägerglied zu erhalten; und daß
 - mindestens ein Kontaktelement des zweiten Wandlerelements mit einem der Kontaktelemente der zweiten Gruppe des Trägerglieds ausgerichtet ist, so das erste und zweite Wandlerelement benachbart auf der ersten Oberfläche des Trägerglieds positioniert sind, um einen elektrischen Kontakt zwischen dem aktiven Glied des zweiten Wandlerelements und dem Trägerglied zu erhalten; und daß
 - mindestens ein Kontaktelement der elektronischen Vorrichtung mit einem der Kontaktelemente der dritten Gruppe des Trägerglieds ausgerichtet ist, so daß die elektronische Vorrichtung benachbart zum ersten bzw. zweiten Wandlerelement auf der ersten Oberfläche des Trägerglieds positioniert ist, und um einen elektrischen Kontakt zwischen der integrierten Schaltung und dem Trägerglied zu erhalten; und daß
 - mindestens eines der Kontaktelemente der ersten Gruppe mit mindestens einem der Kontaktelemente der dritten Gruppe elektrisch verbunden ist, und daß mindestens eines der Kontaktelemente der zweiten Gruppe mit mindestens einem der Kontaktelemente der dritten Gruppe elektrisch verbunden ist, um einen elektrischen Kontakt zwischen dem aktiven Glied des ersten Wandlerelements und der integrierten Schaltung und zwischen dem aktiven Glied des zweiten Wandlerelements und der integrierten Schaltung zu erhalten.
18. Sensorsystem nach Anspruch 17, wobei das Trägerglied ferner eine zweite Oberfläche aufweist, wobei diese zweite Oberfläche mehrere Kontaktelemente hält, wobei mindestens eines der Kontaktelemente der ersten, zweiten oder dritten Gruppe mit einem der von der zweiten Oberfläche gehaltenen Kontaktelemente elektrisch verbunden ist.

19. Sensorsystem nach Anspruch 18, wobei die ersten und zweiten Oberflächen im wesentlichen parallel und zueinander entgegengesetzt sind.

20. Sensorsystem nach einem der Ansprüche 17 bis 19, wobei das Trägerglied ein Si-basiertes Trägerglied ist.

21. Sensorsystem nach einem der Ansprüche 17 bis 20, wobei das Trägerglied ferner eine erste und eine zweite Einkerbung aufweist, wobei die erste Einkerbung mit dem aktiven Glied des ersten Wandlerelements ausgerichtet ist und die zweite Einkerbung mit dem aktiven Glied des zweiten Wandlerelements ausgerichtet ist.

22. Sensorsystem nach einem der Ansprüche 17 bis 21, wobei jedes der ersten und zweiten Wandlerelemente ferner einen Hohlraum aufweist, wobei der Boden dieser Hohlräume durch die aktiven Glieder der ersten und zweiten Wandlerelemente begrenzt ist.

23. Sensorsystem nach einem der Ansprüche 17 bis 22, wobei die ersten und zweiten Wandlerelemente Si-basiert sind.

24. Sensorsystem nach einem der Ansprüche 17 bis 23, wobei das Trägerglied, die ersten und zweiten Wandlerelemente und die elektronische Vorrichtung Si-basiert sind.

25. Sensorsystem nach einem der Ansprüche 17 bis 24, wobei jedes der aktiven Glieder der ersten und zweiten Wandlerelemente einen Kondensator aufweist, wobei dieser Kondensator durch eine flexible Membran in Verbindung mit einer im wesentlichen starren Verstärkungswand gebildet ist.

26. Sensorsystem nach einem der Ansprüche 17 bis 25, wobei jedes der ersten und zweiten Wandlerelemente ferner einen Deckel aufweist, wobei die Deckel und die aktiven Glieder der ersten und zweiten Wandlerelemente eine obere und eine untere Grenze der jeweiligen Hohlräume definieren.

27. Sensorsystem nach einem der Ansprüche 17 bis 26, wobei zumindest ein Teil einer äußeren Oberfläche des Sensorsystems eine leitende Schicht hält.

28. Sensorsystem nach Anspruch 27, wobei die leitende Schicht eine Metallschicht aufweist.

29. Sensorsystem nach Anspruch 27, wobei die leitende Schicht eine leitende Polymerschicht aufweist.

30. Sensorsystem nach einem der Ansprüche 17 bis

29, wobei die Kontaktelemente ein Lötmaterial, wie Sn, SnAg, SnAu oder SnPb, aufweisen.

5 Revendications

1. Système de capteur comprenant
un élément support (2) ayant une première surface, ladite première surface contenant un premier groupe et un second groupe d'éléments de contact (8),

un élément transducteur (1) comprenant un élément actif, ledit élément actif étant relié électriquement à au moins un élément de contact de l'élément transducteur (1) et

un dispositif électronique (3) comprenant un circuit intégré ayant au moins un élément de contact,

caractérisé en ce que

au moins un élément de contact de l'élément transducteur (1) est aligné avec un des éléments de contact (8) du premier groupe de l'élément support (2) de sorte à obtenir un contact électrique entre l'élément actif de l'élément transducteur (1) et l'élément support (2) et **en ce que**

au moins un élément de contact du dispositif électronique (3) est aligné avec un des éléments de contact (8) du second groupe de l'élément support (2) de sorte que l'élément transducteur (1) et le dispositif électronique (3) soient positionnés côte à côte sur la première surface de l'élément support (2) et de sorte à obtenir un contact électrique entre le circuit intégré et l'élément support (2) et **en ce que**

au moins un des éléments de contact (8) du premier groupe est relié électriquement à au moins un des éléments de contact (8) du second groupe de sorte à obtenir un contact électrique entre l'élément actif de l'élément transducteur (1) et le circuit intégré du dispositif électronique (3).

2. Système de capteur selon la revendication 1, dans lequel l'élément support (2) comprend en outre une seconde surface, ladite seconde surface contenant une multiplicité d'éléments de contact, dans lesquels au moins un des éléments de contact du premier ou du second groupe est relié électriquement à un des éléments de contact contenus par la seconde surface.

3. Système de capteur selon la revendication 2, dans lequel la première et la seconde surface sont sensiblement parallèles et se font face.

4. Système de capteur selon l'une quelconque des revendications 1 à 3, dans lequel l'élément support (2) est un élément support à base de silicium.

5. Système de capteur selon l'une quelconque des re-

vendications 1 à 4, dans lequel l'élément support (2) comprend en outre une découpe (11), ladite découpe (11) étant alignée avec l'élément actif de l'élément transducteur.

6. Système de capteur selon l'une quelconque des revendications 1 à 5, dans lequel l'élément transducteur comprend en outre une cavité (10), l'élément actif constituant le fond de ladite cavité (10).

7. Système de capteur selon la revendication 5, comprenant en outre une ouverture (24) entre la seconde surface de l'élément support (2) et la découpe (11).

8. Système de capteur selon l'une quelconque des revendications précédentes, dans lequel l'élément transducteur (1) est à base de silicium.

9. Système de capteur selon l'une quelconque des revendications précédentes, dans lequel l'élément support (2), l'élément transducteur (1) et le dispositif électronique (3) sont à base de silicium.

10. Système de capteur selon la revendication 1, dans lequel l'élément actif de l'élément transducteur comprend un condensateur, ledit condensateur étant formé par la combinaison d'un diaphragme flexible (12) et d'une plaque arrière sensiblement rigide (13).

11. Système de capteur selon la revendication 6, dans lequel l'élément transducteur (1) comprend en outre un couvercle (5), le couvercle (5) et l'élément actif de l'élément transducteur (1) définissant les limites supérieure et inférieure de la cavité (10).

12. Système de capteur selon l'une quelconque des revendications précédentes, dans lequel au moins une partie d'une surface extérieure du système de capteur porte une couche conductrice (16).

13. Système de capteur selon la revendication 12, dans lequel la couche conductrice comprend une couche métallique.

14. Système de capteur selon la revendication 12, dans lequel la couche conductrice comprend une couche de polymère conducteur.

15. Système de capteur selon l'une quelconque des revendications précédentes, dans lequel les éléments de contact comprennent un matériau de soudure tel que Sn, SnAg, SnAu ou SnPb.

16. Système de capteur selon la revendication 6, comprenant en outre des moyens d'obturation pour fermer hermétiquement l'élément transducteur.

17. Système de capteur comprenant

un élément support ayant une première surface, ladite première surface contenant un premier, un deuxième et un troisième groupes d'éléments de contact,

un premier élément transducteur comprenant un élément actif, ledit élément actif étant relié électriquement à au moins un élément de contact du premier élément transducteur,

un second élément transducteur comprenant un élément actif, ledit élément actif étant relié électriquement à au moins un élément de contact du second élément transducteur,

un dispositif électronique comprenant un circuit intégré ayant au moins un élément de contact,

caractérisé en ce que

au moins un élément de contact du premier élément transducteur est aligné avec un des éléments de contact du premier groupe de l'élément support de sorte à obtenir un contact électrique entre l'élément actif du premier élément transducteur et l'élément support, et **en ce que**

au moins un élément de contact du second élément transducteur est aligné avec un des éléments de contact du deuxième groupe de l'élément support de sorte que les premier et second éléments transducteurs soient positionnés côte à côte sur la première surface de l'élément support et de sorte à obtenir un contact électrique entre l'élément actif du second élément transducteur et l'élément support, et **en ce que**

au moins un élément de contact du dispositif électronique est aligné avec un des éléments de contact du troisième groupe de l'élément support de sorte que le dispositif électronique soit attenant au premier ou au second élément transducteur sur la première surface de l'élément support et de sorte à obtenir un contact électrique entre le circuit intégré et l'élément support, et **en ce que**

au moins un des éléments de contact du premier groupe est relié électriquement à au moins un des éléments de contact du troisième groupe et au moins un des éléments de contact du deuxième groupe est relié électriquement à au moins un des éléments de contact du troisième groupe, de sorte à obtenir un contact électrique entre l'élément actif du premier élément transducteur et le circuit intégré et entre l'élément actif du second élément transducteur et le circuit intégré.

18. Système de capteur selon la revendication 17, dans lequel l'élément support comprend en outre une seconde surface, ladite seconde surface contenant une multiplicité d'éléments de contact, dans lesquels au moins un des éléments de contact du premier, du deuxième ou du troisième groupe est relié électriquement à un des éléments de contact contenus par la seconde surface.

19. Système de capteur selon la revendication 18, dans lequel les première et seconde surfaces sont sensiblement parallèles et se font face.
20. Système de capteur selon l'une quelconque des revendications 17 à 19, dans lequel l'élément support est un élément support à base de silicium.
21. Système de capteur selon l'une quelconque des revendications 17 à 20, dans lequel l'élément support comprend en outre une première et une seconde découpe, la première découpe étant alignée avec l'élément actif du premier élément transducteur, la seconde découpe étant alignée avec l'élément actif du second élément transducteur.
22. Système de capteur selon l'une quelconque des revendications 17 à 21, dans lequel les premier et second éléments transducteurs comprennent en outre chacun une cavité, le fond desdites cavités étant délimité par les éléments actifs des premier et second éléments transducteurs.
23. Système de capteur selon l'une quelconque des revendications 17 à 22, dans lequel les premier et second éléments transducteurs sont à base de silicium.
24. Système de capteur selon l'une quelconque des revendications 17 à 23, dans lequel l'élément support, les premier et seconds éléments transducteurs et le dispositif électronique sont à base de silicium.
25. Système de capteur selon l'une quelconque des revendications 17 à 24, dans lequel les éléments actifs des premier et second éléments transducteurs comprennent chacun un condensateur, ledit condensateur étant formé par la combinaison d'un diaphragme flexible et d'une plaque arrière sensiblement rigide.
26. Système de capteur selon l'une quelconque des revendications 17 à 25, dans lequel les premier et second éléments transducteurs comprennent en outre chacun un couvercle et où les couvercles et les éléments actifs des premier et second éléments transducteurs définissent les limites supérieure et inférieure des cavités respectives.
27. Système de capteur selon l'une quelconque des revendications 17 à 26, dans lequel au moins une partie d'une surface extérieure du système de capteur porte une couche conductrice.
28. Système de capteur selon la revendication 27, dans lequel la couche conductrice comprend une couche métallique.
29. Système de capteur selon la revendication 27, dans lequel la couche conductrice comprend une couche de polymère conducteur.
30. Système de capteur selon l'une quelconque des revendications 17 à 29, dans lequel les éléments de contact comprennent un matériau de soudure tel que Sn, SnAg, SnAu ou SnPb.

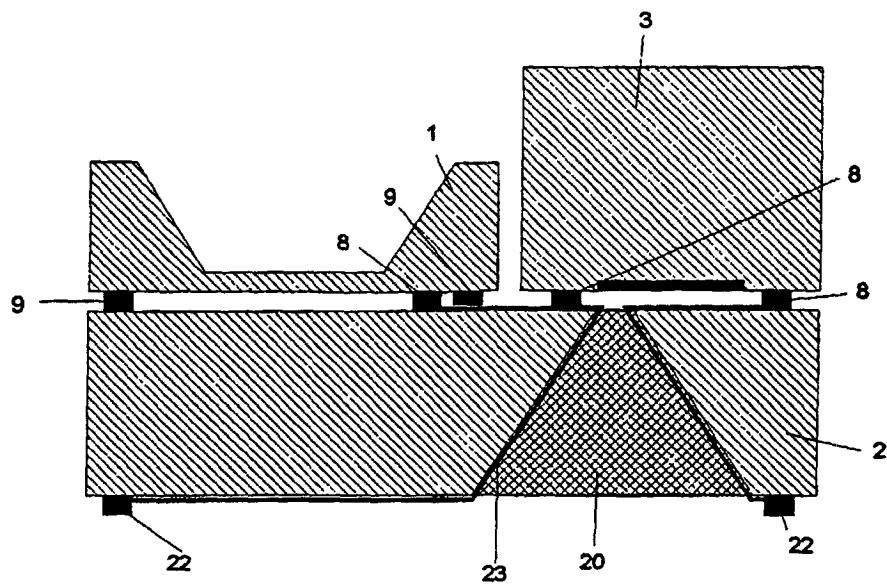


Figure 1

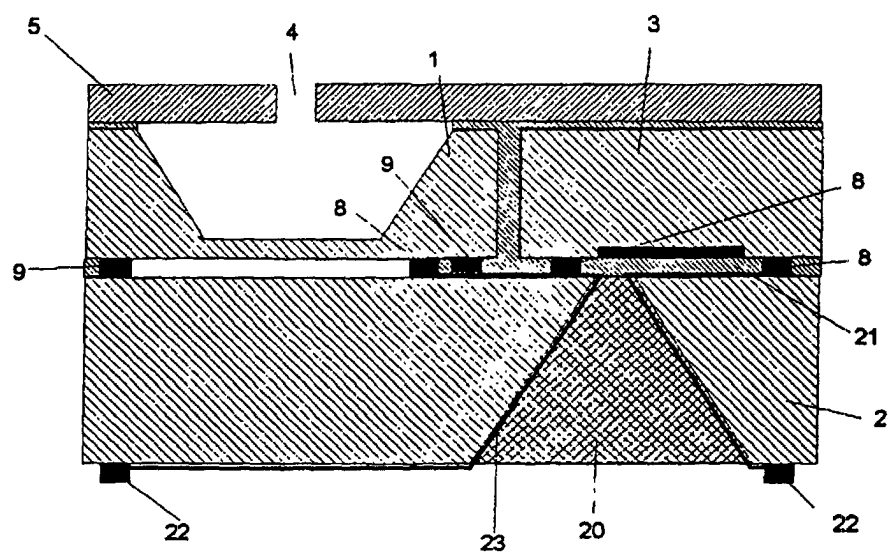


Figure 2

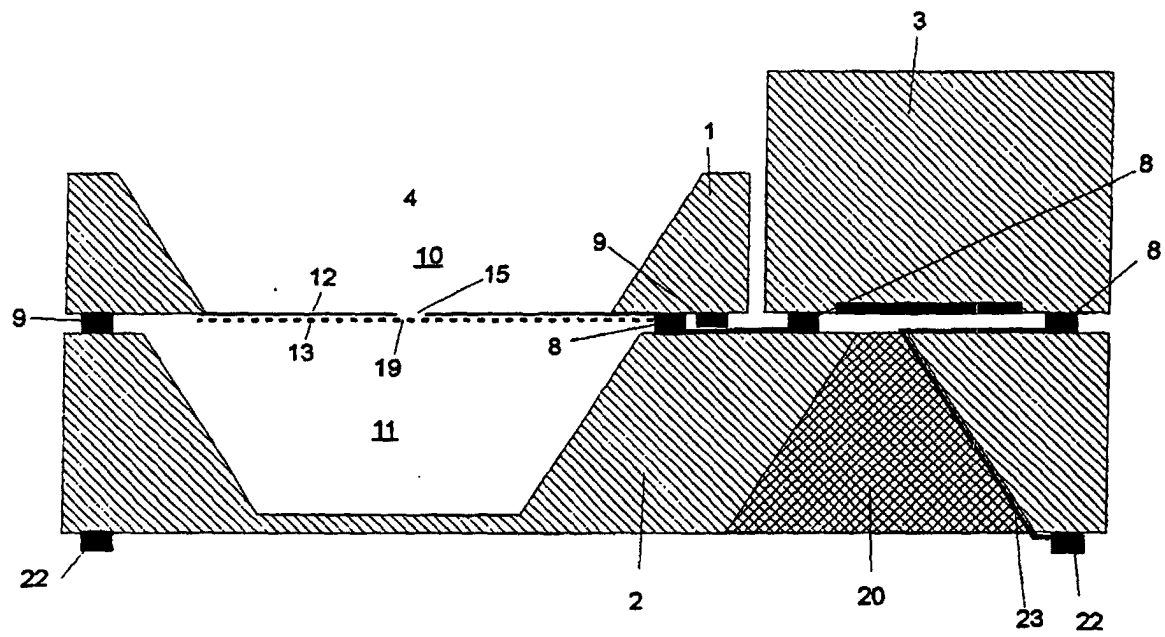


Figure 3

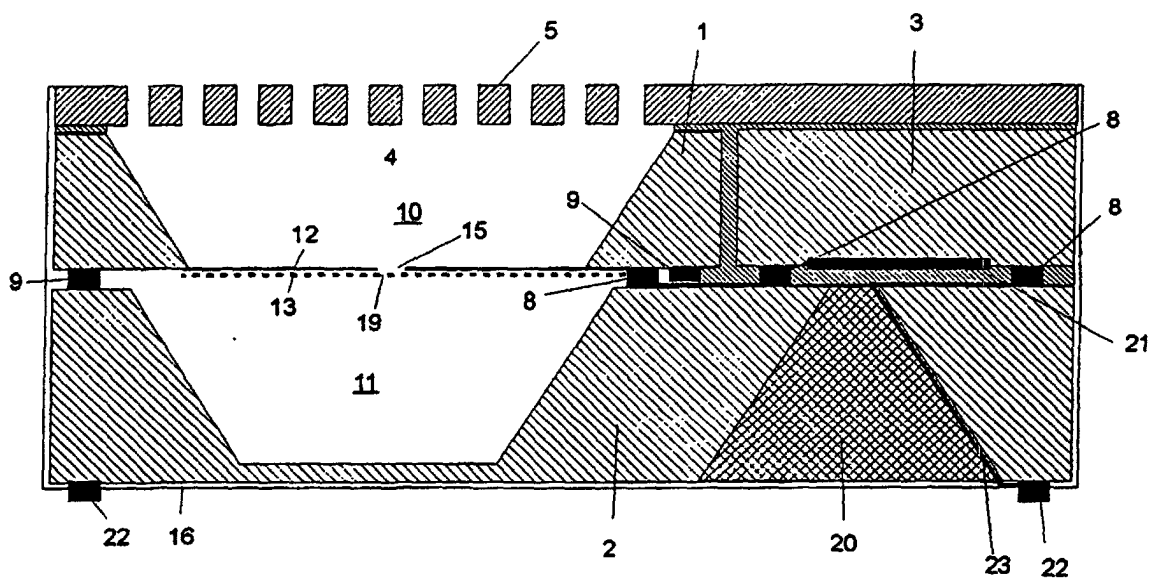


Figure 4

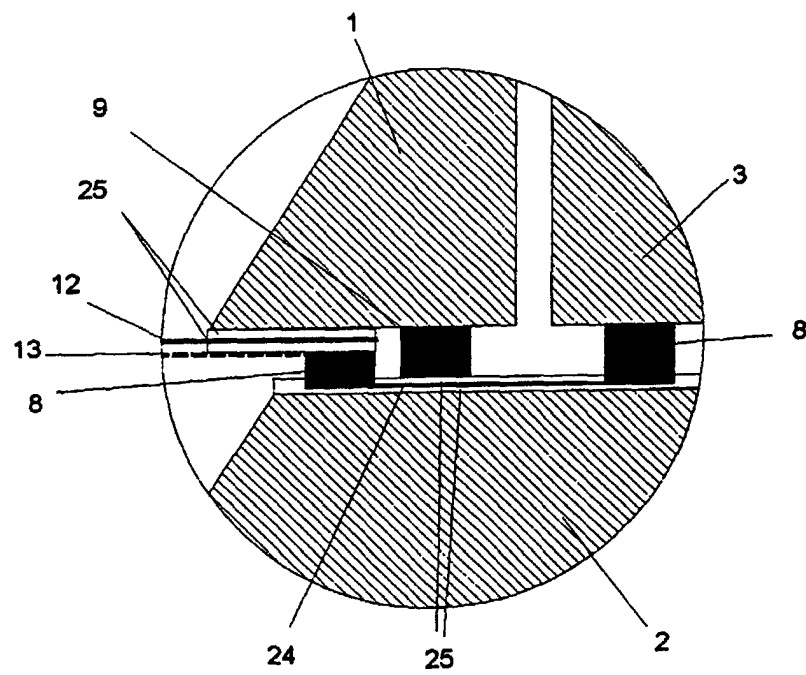


Figure 5

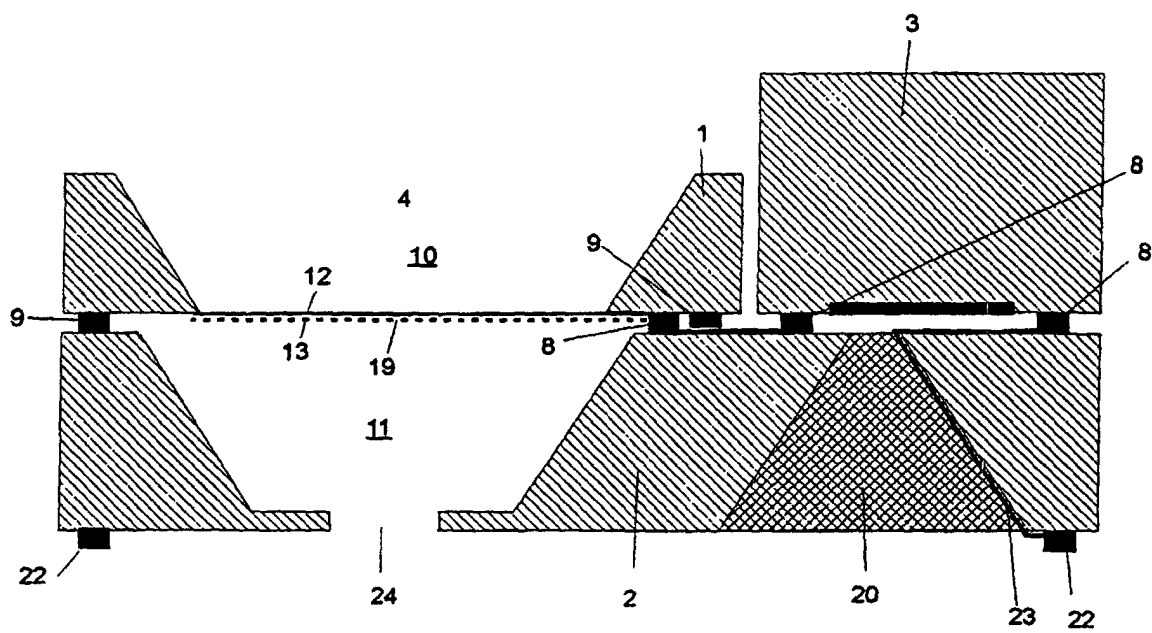


Figure 6

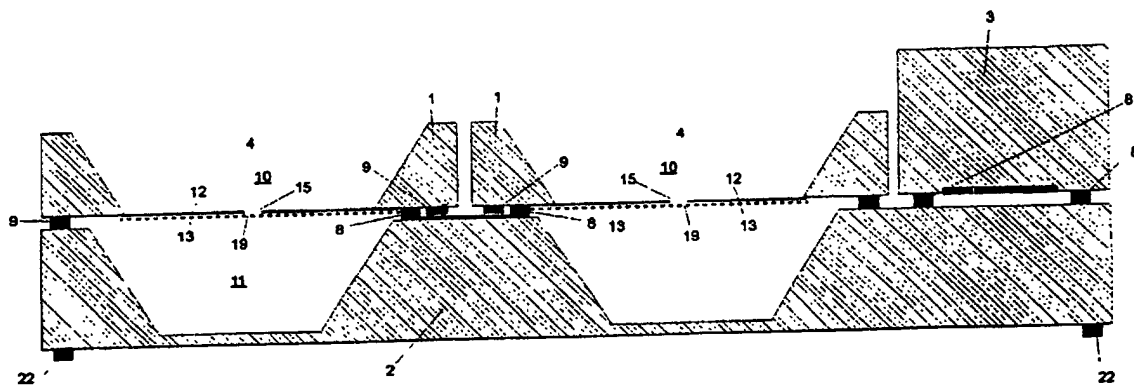


Figure 7