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This invention relates to a system for determining the contact surface and distribution of occlusal forces applied between the upper teeth and the lower teeth of a patient's jaw, comprising a member for detecting contacts between teeth arranged to be inserted between the patient's teeth, elements for connecting the detecting member with
5 means of calculating the distribution of occlusal forces to make the mapping, and said calculation means.

It also relates to a method implementing such a system and a removable flexible plate used with such a system.

The invention has a particularly important although non-exclusive application in
10 the field of making a dental impression and/or correction (polishing) of tooth surfaces in contact with each other, particularly to achieve good dental occlusion.

As used herein, good occlusion means good distribution of pressure forces between maxillary teeth and mandibular teeth during chewing and/or when the patient clenches his or her jaws.

15 When performing dental care, for example when fitting an implant, the practitioner must check that the patient's occlusion is good. More precisely, the dentist must verify that the newly installed implant does not hinder movement of the jaw and/or does not create any remanent internal pressure at rest.

It is known that occlusion defects, even of the order of a few micrometres and
20 that occur statically and/or dynamically, can be the cause of problems and/or diseases for the patient, such as necroses or loosening of the teeth, or can generate postural problems or headaches for the patient, and even cause depression.

To prevent such disadvantages, the dentist implanting a prosthesis, attempts to adjust it by detecting hard points and then to file the parts of the implant or the teeth that
25 hinder good occlusion.

Devices for detection of good occlusal contact are known. They make use of substrates impregnated with coloured agents released by chewing, commonly referred to by the term articulating paper, like that marketed by the German Bausch company.

However such devices do have disadvantages.

30 They cannot be used to make precise, reliable and easily repetitive measurements. They require a visual and therefore necessarily subjective reading by the dentist of the colour density, and cannot give an objective result.

In any case, none of these devices can determine occlusion dynamically and cannot be used to make a dental impression that can be kept in digital form and then
35 modified at a later time.

Determining the occlusion dynamically means measuring the order in which occlusion points appear during a movement of the jaw, while making an actual impression.

The possibility of modifying the file will make it possible to refresh and/up update
5 data about the patient's dentition model.

Devices for sensing contact between two facing objects are also known (EP 0 216 899, WO89/02727) comprising a set of electrodes mounted on a support sheet.

However, these devices do not have sufficient mechanical flexibility. Consequently they modify the behaviour of the jaw to be measured, so that they are not
10 very reliable. Furthermore, they do not have good spatial resolution.

This invention, as defined in claims 1 and 9, aims to overcome these disadvantages and discloses a device and a method that satisfies practical requirements better than those known previously, particularly in that reliable and repetitive measurements can be made in the form of easily manipulated digital files, that enable
15 comparisons and diagnostics that were hitherto impossible to achieve.

The dental practitioner will be able to make precise corrections to the dentition of his or her patients, that will considerably improve their comfort and health.

Therefore, with the invention, it will be possible to measure the pressure field applied to a non-plane surface with a spatial resolution of about one hundred
20 micrometres by means of a constraints array.

To achieve this, the invention discloses particularly a system for determining the contact area and the distribution of forces applied between the upper teeth and the lower teeth of a patient's jaw, comprising a member for detecting contacts between teeth arranged to be inserted between the patient's teeth, elements for connecting the
25 detecting member with means of calculating the distribution of occlusal forces to make the mapping, and said calculation means.

characterised in that said detecting member comprises a part for supporting a detachable flexible plate, said flexible plate being formed of a sheet of flexible plastic material locked integrally with a grid of pressure sensors comprising a first layer having
30 a first array of electrodes referred to as row electrodes, which are generally parallel, of a second intermediate layer of variable resistivity which varies as a function of the pressure which is applied to it, and of a third layer comprising a second array of electrodes, referred to as column electrodes, which are generally parallel, defining so-called zones of intersection with the row electrodes, in that the grid of sensors comprises
35 at least 5000 zones of intersection which are adjacent to one another, with a square section of less than or equal to 600 micrometres.

and in that the intermediate layer comprises a microcrystalline semiconducting silicon wafer less than or equal to 50 nanometres thick.

By using a very large number of measurement points, i.e. more than 5000, each composed of a sensor in which the set of sensors forms a grid, a precise and spatially
5 fine measurement can be made (one measurement point of the order of 500µm in the two directions in space).

It will be noted that the layers and/or wafers that usually have different thicknesses have constant or approximately constant thicknesses.

Similarly, by using one material for the thin intermediate layer that, under
10 pressures that can exceed 600 N, deforms sufficiently to not distort the measurement, and thus provides sufficient flexibility of the sensor.

In some advantageous embodiments, either or both of the following measures are separately and/or also adopted:

- 15 - the intermediate layer is formed by plasma deposition of doped silicon on an insulating layer;
- the electrodes are made of aluminium;
- the first layer comprises more than a hundred row electrodes and the third layer comprises more than fifty column electrodes;
- the first layer is between 200 nm and 400 nm thick, the plane microcrystalline
20 silicon wafer is less than 30 nm thick and the third layer is between 400 nm and 600 nm thick;
- the connection elements comprise an acquisition board and a connection pin with the support part;
- the calculation means comprise means arranged to dynamically display the
25 map of occlusal forces on a computer screen, including data specific to the jaw of a determined patient.

The invention also discloses a method of determining the contact area and the distribution of occlusal forces of a patient's jaw, to obtain a map of said occlusal forces making use of a system like that described above.

30 It also discloses a method for determining the contact surface and the distribution of occlusal forces exerted between the upper teeth and the lower teeth of a jaw of a patient, adapted for taking a dental impression, in which the contacts between the teeth are detected by inserting a member between the teeth of the patient, the pressures are measured by means of said member provided with a sheet of flexible plastic material
35 bonded to a grid of pressure sensors comprising at least 5000 sensors which are adjacent to one another, with a square section of less than or equal to 600 micrometres,

said grid comprising an intermediate layer with variable resistivity which varies as a function of the pressure, said intermediate layer comprising a wafer of microcrystalline semiconducting material with a thickness equal to or less than 50 nanometres, and the mapping of occlusal forces is calculated from the distribution of the measured pressures.

5 Advantageously, the map is displayed dynamically on a computer screen by integrating addition data.

The invention also relates to a removable flexible plate used with such a system and like that described above.

Advantageously, the plate is discardable.

10 The invention will be better understood after reading the following description of an embodiment given as non-limitative examples.

The description refers to the accompanying figures among which:

Figure 1 is a diagrammatic view showing the system according to the invention in operation with a patient.

15 Figure 2 is an enlarged exploded and partial view of the flexible plate of the detection member of the system in figure 1 (the proportions between the layers are not to scale).

Figures 3A to 3D illustrate the steps in fabricating a pressure sensor of the detection member in figure 2, in a top view and a cross-sectional view A-B.

20 Figure 4 is a diagrammatic perspective view more precisely showing a method of fabricating the detection member in figure 1.

Figure 4A shows an experimental curve of the measurement of the electrical intensity as a function of the sensor strain for four sensor dimensions.

25 Figure 5 is a diagrammatic view of the acquisition board belonging to the connection elements of the system in figure 1.

Figure 6 is a flow chart showing the main steps of one embodiment of the method according to the invention.

Figure 7 is an example of a view of a computer screen illustrating a presentation of the measurements and the occlusal map of a patient obtained using the invention.

30 Figure 1 shows a system 1 for determining the contact surface and the distribution of occlusal forces between the upper teeth 2 and the lower teeth 3 of a jaw 4 of a patient 5.

The system 1 comprises a detecting member 6 detecting contacts between teeth.

35 This member 6 is removable inserted by the dentist (hand 7) between the patient's teeth, to detect the pressure field (arrow 7) when the jaw is clenched.

The detection member 6 is connected by connection means 8 including an electronic board 9 that will be described with reference to figure 5, with calculation means 10 arranged to create the map, dynamically shown by an image 11 on the screen of the computer 12.

- 5 The detection member 6 comprises a support part 13 for a removable flexible 14 plate, the composition of which will now be described with reference to figure 2.

The plate or part 14 is plane, for example it is parallelepiped in shape, with dimensions 7 cm x 7 cm so that it can easily be inserted into the mouth of the patient, and for example has a total thickness of the order of 800 μm .

- 10 It comprises a plastic support sheet 15, for example made of flexible polyethylene naphthalate (PEN), bonded to a grid 16 of pressure sensors 17.

Flexible means a plate that can be bent to radii of curvature smaller than 1.5 mm.

The support sheet 15 is approximately parallelepiped in shape, with dimensions of the same order as or less than the dimensions of the plate.

- 15 The part 14 comprises a thin ceramic layer 18, for example 100 micrometres thick bonded onto the PEN sheet 15, for example made of silicon nitride and with dimensions equal to the dimensions of the sheet 15.

The assembly thus formed comprises a first layer 19 comprising a first array of electrodes 20, 20', called row electrodes on the top.

- 20 Each electrode is an elongated electrically conducting metallic wire for example with a flattened rectangular section, for example made of aluminium.

The width of the electrodes is less than 2 mm, for example it is 0.5 mm and the thickness may for example be between 150 nm and 500 nm, for example between 200 and 400, for example 300 nm.

- 25 The electrodes array is thus formed from a beam of row electrodes approximately parallel to each other, and at a spacing of less than 2 mm, for example 0.25 mm.

In the embodiment described specifically herein, the number of row electrodes is more than 100, for example 120 and they work in pairs 20, 20'.

- 30 Conducting elements 21 and 22 are also provided and are described in detail below.

An intermediate layer 23 is place on the first layer 19 of row electrodes.

This intermediate layer 23 comprises a semiconducting layer or wafer 24 of a piezoelectric material. The piezoelectric material is semiconducting microcrystalline silicon (for example doped with arsenic).

The wafer 24 covers the parts 25 associated with the array of row electrodes and the space 26 between with an approximately uniform thickness of between 30 nm and 100 nm, forming an electric bridge between said parts that will be described in detail below.

5 The space between two pairs of row electrodes 20, 20' does not include a layer of semiconducting material.

The intermediate layer 21 also comprises a layer 27 of electrically conducting material above the semiconducting layer 24.

10 Its lateral and longitudinal dimensions are equal to the dimensions of the plastic sheet and its maximum thickness is between 50 nm and 250 nm.

It entirely covers the first layer 19 of electrodes 20, 20' and the semiconducting layer 24 except at determined locations 28 that will be described in detail with reference to figures 3A to 3D.

15 The intermediate layer 27 thus formed has a variable resistivity as a function of the pressure and/or strain applied to it.

The detecting member 6 and more precisely the part 14 also includes a third layer 29 above the intermediate layer 23, including a second array of metal electrodes called column electrodes 30.

20 For example, the column electrodes 30 may be similar to the row electrodes but arranged such that superposition of said row and column arrays forms a grid.

For example, the two arrays are practically orthogonal to each other defining so-called intersection zones with row electrodes to form pressure sensors 17 bonded to the plate.

25 Advantageously, a neutral (insulating) protection layer 31 (chain dotted line on figure 2), fills in the voids and protects the top of the part 14 so that it has a plane face 32 arranged to cooperate with the measured object.

The thickness of the column electrodes is between 400 nm and 600 nm and there are more than 40 of them, for example 54.

30 Since the number of sensors 17 is equal to the number of grid intersections, in the embodiment described specifically herein, there are more than 4000, for example 6480. Therefore the grid comprises at least 5000 sensors adjacent to each other, the intersection being orthogonal, the section of each sensor is square and smaller than or equal to 600 micrometres.

35 A method of fabricating the sensor member according to one embodiment of the invention will now be described with reference to figures 3A to 3D.

This method comprises a first step (figure 3A) in which a first polyimide substrate is supplied in the form of plastic sheet like those marketed by the DuPont Teijin Films company to form the support sheet 15.

5 This forms an approximately parallelepiped shaped plate with a rectangular section, for example smaller than or equal to 15 cm by 15 cm and less than 125 μm thick, for example less than 50 μm (for example 10cm X 10 cm X 10 μm).

Advantageously, impurities on the plate are removed by cleaning in an ultrasonic bath with acetone and rinsed with ethanol or isopropanol in a manner known in itself.

10 A second step is then performed to deposit the ceramic layer 18 such as silicon nitride. For example, it may be a plasma-enhanced chemical vapour deposition (PECVD). The gas phase of the PECVD is composed of a gas mix of silicon tetrahydride (SiH_4) called silane, nitrogen (N_2) and hydrogen (H_2) and is done at a temperature of less than 200°, for example 165°C.

The required silicon nitride layer is thinner than 100 nm, for example 50 nm.

15 The next step is a third step to deposit the array or layer of row electrodes 20, 20' on the ceramic layer 18.

The deposit is made by electron beam lithography or by evaporation due to the Joule effect, to create metallic row contacts on a thickness of the order of 300 nm.

20 The contacts are then etched by wet etching. For example, the sample is immersed in a hot aluminium bath (about 50°C) with an etching agent such as phosphoric acid (H_3PO_4) for a determined time. This determined time may be of the order of 2 to 3 minutes.

The sample is then rinsed in distilled water and dried under a flow of N_2 gas.

25 In one embodiment described more particularly herein, the metal contacts comprise a first row electrode 20, a second row electrode 20' parallel to the first and first 21 and second 22 contact pads.

The first contact pad 21 is approximately parallelepiped shaped and is orthogonal to the electrodes, being connected to the first electrode 20 and extends in the space between the pair 20, 20' of electrodes.

30 The second square-shaped pad 22 is located at the end portion of the first pad 21.

The intermediate layer 23 is formed in a fourth step (figures 3B and 3C).

The fabrication method consists of a sub-step in which a piezoelectric layer 24 of semiconductors is deposited.

35 The piezoelectric layer 24 entirely covers the pads 21, 22 of row electrodes and fills in the space between the two electrode pads 21 and 22 in a particular pair.

The deposition is made by PECVD, for example by depositing a thickness of about 130 nm of microcrystalline silicon nitride doped in arsenic (AsH_4).

The method is followed by another photolithography. Etching is made using a method known to an expert in the subject under the name Reactive Ion Etching (RIE) using sulphur hexafluoride (SF_6) plasma.

The intermediate layer is thus formed by plasma deposition of doped silicon under an insulating layer.

The second sub-step in formation of this layer consists of depositing the layer of electrically insulating material. The maximum thickness of this layer is 300 nm.

This layer will comprise holes 28 passing in line with second pads 22 of the first row electrodes array layer.

For example, the insulating material is silicon oxide (SiO_2). For example, it is deposited by spraying and a photolithography is then done. Etching is done by reactive ion etching RIE using SF_6 .

In a fifth step (figure 3D) the layer called the third layer of column electrodes 30, 30' is deposited for example with a thickness of 500 nm of aluminium by evaporation due to the Joule effect, followed by photolithography to create the second metallic columns contacts 22 in an array orthogonal to the rows array.

The array is arranged such that the rows of a pair of column electrodes 30 pass in line with the first 21 and second 22 contact pads.

One of the column electrodes 30 of the pair lies above, in order, an insulating layer 27, a piezoelectric layer 24 and the first contact pad 21.

The other is directly in line with a piezoelectric layer 24 and the second contact pad 22.

Once again, a wet etching technique may for example be used, as before.

In one embodiment of the invention, the previously obtained assembly is subjected to a thermal annealing at low temperature (for example less than 200°C and for example 1860°C) for a determined time, for example for 2 hours in a furnace. This improves the microcrystalline silicon / aluminium interface, and increases the conductivity by a factor of more than 1.5 or even 2.

Figure 4 shows a perspective view of the sensor member 6 in figure 1. The sensor comprises a support part S in the form of a rigid filiform arc A, providing external support for the plate 14 onto which it is fixed for example removably by self-bonding points P distributed on the external face of the support sheet 15 made of a flexible plastic material, of the plate 14.

More precisely the support part S comprises a U-shaped part on one side that can be placed on the side of the teeth and is closed on the other side by a bar B stiffening the legs of the U that will fit above the patient's palate. The rigid arc shape, shaped slightly for example in a spoon-shape, is arranged so that it can easily be inserted into the patient's mouth such that the plate 14 can be in contact, sandwiched between the upper and lower teeth, releasing this contact surface.

In other words, the arc comprises a portion that is approximately in the shape of a horseshoe or "U" as seen in a top view and comprises a central bar between the branches of the "U" that forms a convex part, that for example can come into contact with the patient's palatal arch, to hold the assembly firmly.

The plate 14 and its sensors are supported by the arc A.

This plate comprises a specific measurement end, fitted with a central part C without a sensor, and two peripheral parts H symmetrical about the transverse axis XX' of the sensor member 6, inside the arc and facing the teeth, provided with said sensors.

The plate also comprises connection pins 33 on the outside of the support arc on the side opposite the central part C and towards the gripping handle for use by the dentist.

These electrical connection pins 33 come into contact with the pins (not shown) fixed to a support plate R (in chain dotted lines) through which measurements from the plate are recovered to be sent to the calculation means through the acquisition board 9.

In one embodiment of the invention, the sensor plate 14 can be reused a given number of times or it can be discardable.

Figure 4 also shows an enlargement of the sensor part itself that will now be described in more detail.

In the embodiment described most particularly herein, each row element 20 is doubled up by a parallel and offset electrode 20' that enables geometry flexibility in the formation of the detector member that in particular enables the "U" formation of the plate.

The two electrodes 20, 20' thus form a pair of electrodes.

Each row electrode (one per pair) and each column electrode is connected to a connection pin 33 known in itself and mounted on the support part and forming a connection element.

For a given row or a given column, there is a single electrical connection pin 33.

The electrical measurement principle will now be described.

An electrical voltage is applied for example between a row pin 20 and a column pin 30.

The current intensity is measured at one of the pins and according to Ohm's law, depends on the electrical resistance along the path of the electrons.

When a pressure is applied on a pressure sensor, the geometry of the piezoelectric layer is modified and therefore its electrical properties including its resistivity are modified.

The electrical measurement can be related to geometric data because the electrical contact between a row and column can only be made through the piezoelectric layer and through the holes in the insulating layer.

The value of the electrical resistance of such a material is modified during a physical strain according to the equation:

$$\varepsilon * FG = \Delta R / R_0$$

In which ΔR is the variation of the electrical resistance between the initial resistance and the final resistance, R_0 is the initial electrical resistance, FG is the gauge factor (constant characteristic of the piezoelectric material) and ε (epsilon) is the strain of the material that is used to make the link with an external pressure.

More precisely, considering the preponderant nature of the Young's modulus of PEN and of silicon nitride (270 GPa and 6.45 GPa respectively) in comparison with the other layers, the model described above can relate to a PEN layer sandwiched between two silicon nitride layers. For example, the layers may be 125 μ m, 550nm and 250nm thick respectively.

Thus, the result obtained is the following model relating the strain and the measured resistance:

$$\varepsilon = \left(\frac{1}{R} \pm \frac{1}{R_0} \right) \frac{d_0 + d_{f1} + d_{f2}}{2} \frac{\chi(\eta_1^2 + \eta_2^2) + 2(\chi\eta_1 + \chi\eta_2\eta_2 + \eta_2) + 1}{\chi(\eta_1 + \eta_2)^2 + (\eta_1 + \eta_2)(1 + \chi) + 1}$$

Where ε : the strain in the material

d_s ; d_{f1} and d_{f2} : thicknesses of PEN and the silicon nitride layers, respectively

$$\chi = \frac{Y_f}{Y_s} ; \quad \eta_1 = \frac{d_{f1}}{d_s} ; \quad \eta_2 = \frac{d_{f2}}{d_s}$$

In which Y_s and Y_f are values of the Young's modulus of the substrate (Y_s) i.e. 2.5GPa, and the silicon nitride layers (Y_f) i.e. 270 GPa respectively.

In choosing this limitation, the calculations associating a pressure with a measured difference in resistance are simplified as demonstrated by the linear nature of experimental readings of the current variation as a function of the strain, that always has the same slope (figure 4A).

5 The strain epsilon in % is shown as the abscissa and the relative current variation is shown as the ordinate. The four values obtained are given by varying the width (W) for the same length (L) or vice versa. This limitation can give a measurement precision of the order of one micrometre.

10 In the embodiment described particularly herein, the device comprises acquisition means (figure 5). These acquisition means comprise an acquisition board 34 on which a multiplexing/demultiplexing module 35 of information derived from rows 36 and columns 37 is installed.

15 The board also comprises electrical signal adapter means 38 so that it can be input to an analogue/digital converter 39/40 to enable processing by the calculation means 10, and a module 41 for communication between the board and the computer 12.

Each pressure measurement comprises two resistivity measurements, the first "initial" measurement without any applied pressure to be measured and the second with the pressure to be measured applied on the object.

20 For example, the following procedure can be used for the measurement of each sensor 17:

- By random query (action by application of a voltage to the corresponding pins) on any sensor present, and so on until all have been queried.

25 - by querying all sensors for a fixed column or row, until all columns or rows have been queried.

- By querying a particular zone of interest.

A method according to one embodiment of the invention will now be described with reference to figures 1, 6 and 7.

The dentist (hand 7) starts the measurement, using the computer 12.

30 In a first step (42), a first measurement pass is made for all sensors and the result is entered in a computer memory, for example in the form "Row 5 - column 27 - Initial - Initial - 28 (M Ω) Megohms".

In a second step (43), the support part fitted with the plate 14 is placed inside the mouth of the patient 5 who closes his or her jaws 4.

35 Therefore the plate 14 is sandwiched between the upper and lower teeth.

The jaw then applies and maintains an approximately constant pressure, for which the average pressure can easily be determined by the averaged measurement and the calculation.

The calculation means 10 then trigger (step 44) a second measurement of all or
5 of some pressure sensors.

The measurement results are also input into the computer memory for example in the form "Row 5 - column 27 - measurement 1 - 245 /2Ωohms."

Since the calculation means 10 have the internal characteristics of the detection member (in particular thicknesses and Young's moduli of the materials) previously
10 entered into the computer and have differences in resistance between the initial position and the position under pressure for a given coordinate pair (row/column), they determine the pressure applied to the plate for each coordinate pair (step 45).

For each coordinate in the space within the plane, the calculation means then associate (step 46) a value of the difference in resistance and therefore pressure and
15 establish the pressure intensities field, thus creating the map (step 47) of the patient's occlusion forces.

Each pressure intensity corresponds to a strain intensity and penetration of a tooth into the thickness of the detection plate.

The measurements can thus be used to determine the surface (coordinates) and
20 occlusal forces (pressure intensity).

In one embodiment, the second pressure measurement can be repeated (test 53), for example at a refreshment rate of more than 100 Hz, so as to obtain a dynamic determination.

Also in one embodiment, the calculation means comprise time-dating means and
25 record the time elapsed after a reference event (for example the start of the measurement), for each measurement.

Thus, the dynamic measurement of the occlusion is made.

With reference to figure 7, the calculation means 10 also comprise means arranged to dynamically display the map 11 of occlusion forces and possibly the shape
30 51 of the patient's dentition on a computer screen 50, including additional data 52 (jaw data specific to a given patient, history, dates, etc.).

These data are acquired by imagery means known in themselves, for example optical and/or radiography means (not shown).

The data are then merged with data determined from the occlusal surface to form
35 a complete map 52 of the patient's dentition 53 and occlusal forces that he or she experiences when eating.

This will allow the dentist to modify the patient's teeth and/or prostheses in real time in a perfectly controlled and traceable manner so as to minimise and/or eliminate stresses and unbalance of the jaw.

5 A classical Windows (registered trademark) type menu 55 can be used for example to easily move in the different files by a single click, and synthetic views can be displayed, for example in the form of pie charts 56.

The acquired data can also be refreshed dynamically.

PATENTKRAV

1. System til bestemmelse af kontaktfladen og fordelingen af kræfter udøvet mellem de øvre tænder (2) og nedre tænder (3) i kæberne (4) på en patient (5), omfattende et
 - 5 detektionselement (6) til at detektere kontakter imellem tænderne, indrettet til at blive indsat imellem tænderne (2, 3) på patienten (5), elementer (8) til at forbinde detektionselementet (6) med organer (10) til at beregne fordelingen af okklusionskræfter med henblik på at tilvejebringe afbildningen (11) deraf, og de nævnte beregningsorganer (10),
 - 10 **kendetegnet ved, at** det nævnte detektionselement (6) omfatter en del (13) til at understøtte en aftagelig fleksibel plade (14), hvilken fleksibel plade (14) er udformet af et ark (15) af fleksibelt plastmateriale fastlåst integreret med et gitter (16) af trykfølere (17), omfattende et første lag (19) med et første arrangement af elektroder (20, 20') betegnede som rækkeelektroder, som er generelt parallelle, af et andet mellemliggende
 - 15 lag (23) med variabel resistivitet, som varierer som en funktion af det tryk, som påføres dette, og et tredje lag (29) omfattende et andet arrangement af elektroder (30, 30'), betegnede som søjleelektroder, som er generelt parallelle, som definerer såkaldte skæringszoner med rækkeelektroderne (20, 20'),
 - at gitteret (16) af følere omfatter i det mindste 5000 skæringszoner, som er indbyrdes
 - 20 tilstødende, med et kvadratisk tværsnit på mindre end eller lig med 600 mikrometer, og at det mellemliggende lag (23) omfatter et halvledende lag eller wafer (24) af et piezoelektrisk materiale.
 2. System ifølge krav 1, **kendetegnet ved, at** den halvledende wafer (24) er fremstillet
 - 25 af halvledende mikrokrySTALLINSK silicium med en tykkelse på mindre end eller lig med 50 nm.
 3. System ifølge krav 2, **kendetegnet ved, at** det mellemliggende lag (23) er dannet ved plasmaudfældning af doteret silicium på et isolerende lag.
 - 30
 4. System ifølge ethvert af de foregående krav, **kendetegnet ved, at** metallet er aluminium.
 5. System ifølge ethvert af de foregående krav, **kendetegnet ved, at** det første lag (19)
 - 35 omfatter mere end hundrede rækkeelektroder (20, 20') og det tredje lag (29) omfatter mere end halvtreds søjleelektroder (30, 30').

6. System ifølge ethvert af de foregående krav, **kendetegnet ved, at** det første lag (19) har en tykkelse på imellem 200 nm og 400 nm, det mellemliggende lag (23) har en tykkelse på imellem 100 nm og 200 nm, idet tykkelsen af waferen (24) er mindre end 30 nm, og at det tredje lag (29) har en tykkelse på imellem 400 nm og 600 nm.

5

7. System ifølge ethvert af de foregående krav, **kendetegnet ved, at** forbindelses-elementet (8) omfatter et kort (9) til detektion og et stik (33) til forbindelse med bærer-delen (13).

10 8. System ifølge ethvert af de foregående krav, **kendetegnet ved, at** beregnings-organerne (10) omfatter organer indrettede til at fremvise afbildningen (11) af okklusionskræfterne dynamisk på en computerskærm (12, 50), omfattende data for kæberne (4) relateret til en given patient (5).

15 9. Fremgangsmåde til bestemmelse af kontaktfladen og fordelingen af okklusionskræfterne udøvet imellem de øvre tænder (2) og nedre tænder (3) i kæberne (4) på en patient (5), indrettet til at tage et tandaftryk, hvor kontakterne imellem tænderne detekteres ved indsætning af et element (6) imellem tænderne (2, 3) på patienten (5), trykkene måles ved hjælp af elementet (6), som er forsynet med et ark (15) af fleksibelt plast-

20 materiale limet til et gitter (16) af trykfølere (17), omfattende i det mindste 5000 følere, som er indbyrdes tilstødende, med et kvadratisk tværsnit på mindre end eller lig med 600 mikrometer, hvilket gitter (16) omfatter et mellemliggende lag (23) med variabel resistivitet, som varierer som en funktion af trykket, hvilket mellemliggende lag (23) omfatter en wafer (24) af piezoelektrisk halvledende materiale, og afbildningen (11) af

25 okklusionskræfterne beregnes ud fra fordelingen af de målte tryk.

10. Fremgangsmåde ifølge krav 9, **kendetegnet ved, at** det piezoelektriske halvledende materiale er mikrokrySTALLinsk silicium med en tykkelse på mindre end eller lig med 50 nm.

30

11. Fremgangsmåde ifølge ethvert af kravene 9 og 10, **kendetegnet ved, at** afbildningen (11) fremvises dynamisk på en computerskærm (12, 50), under inkorporering af yderligere data.

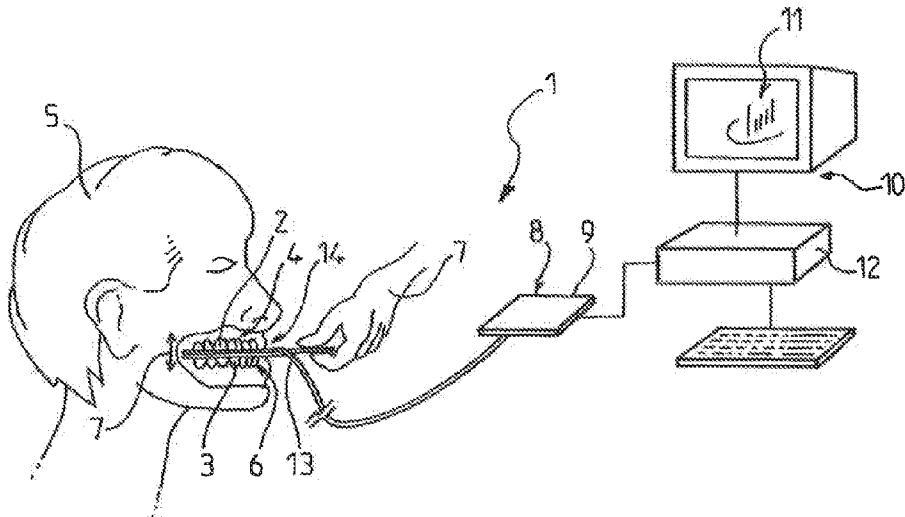


FIG.1

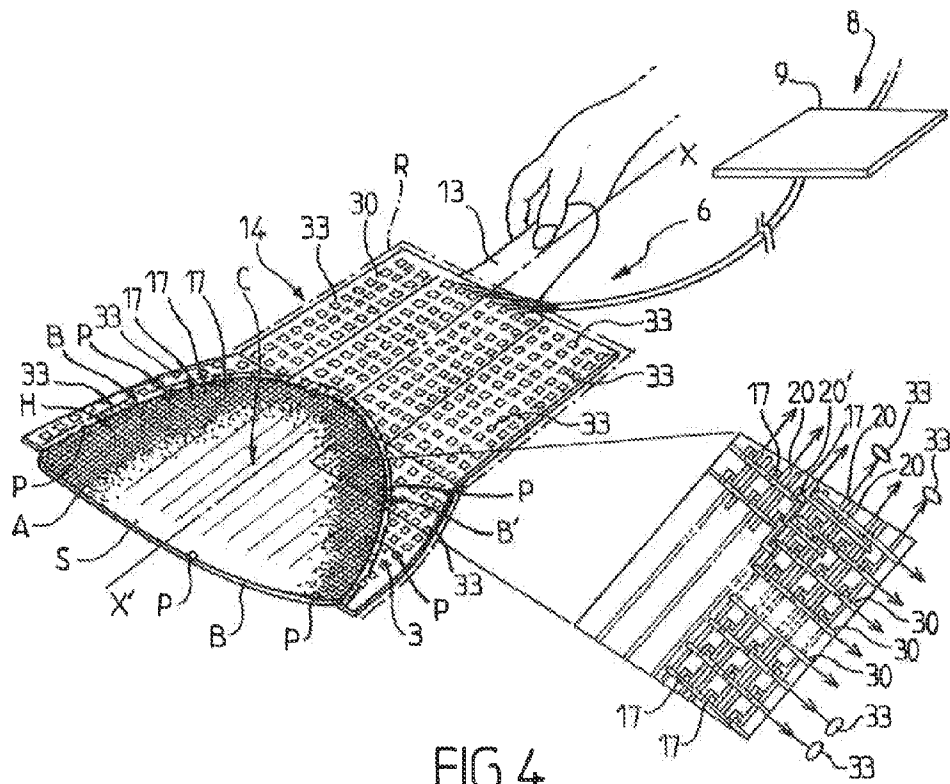


FIG.4

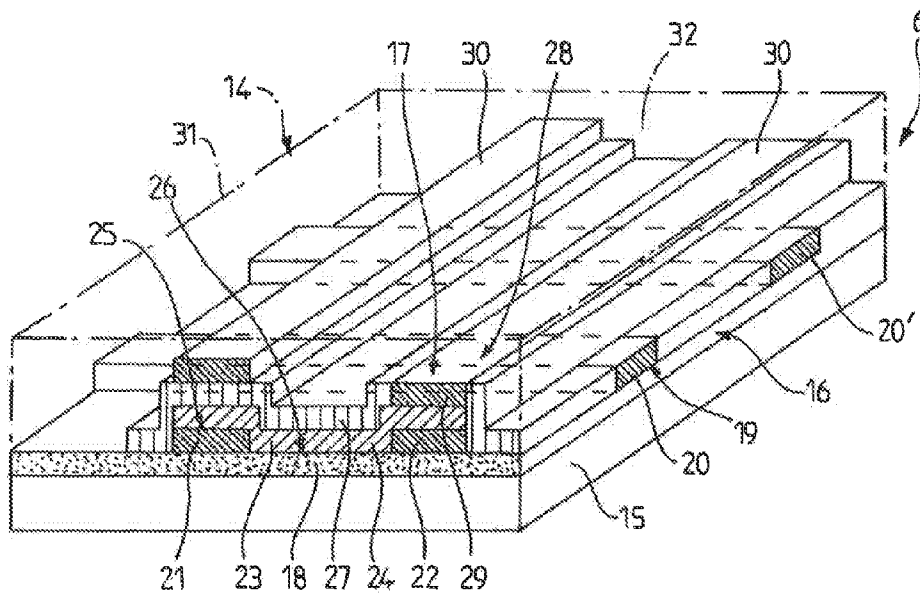


FIG. 2

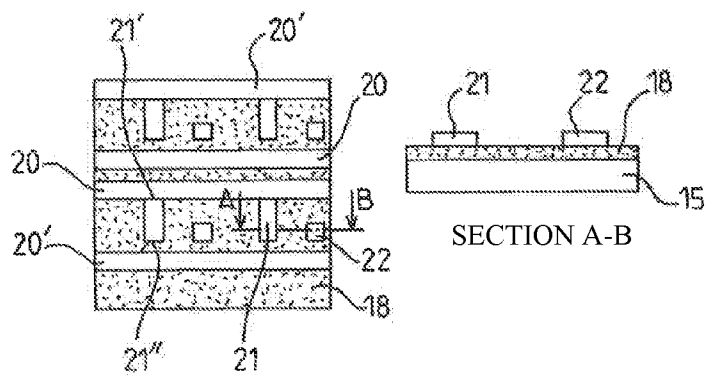


FIG. 3A

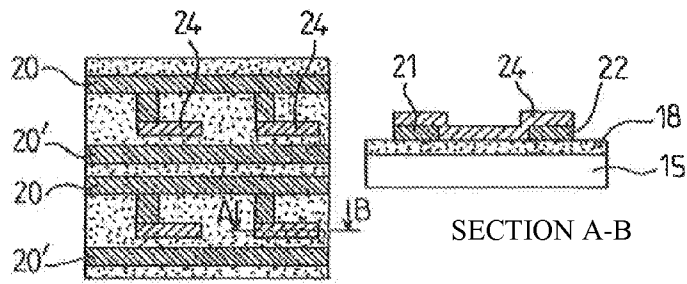


FIG. 3B

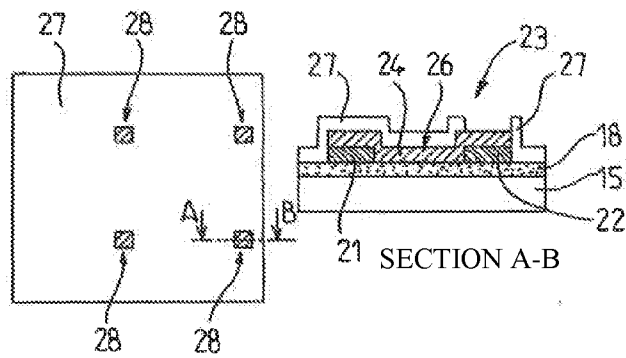


FIG. 3C

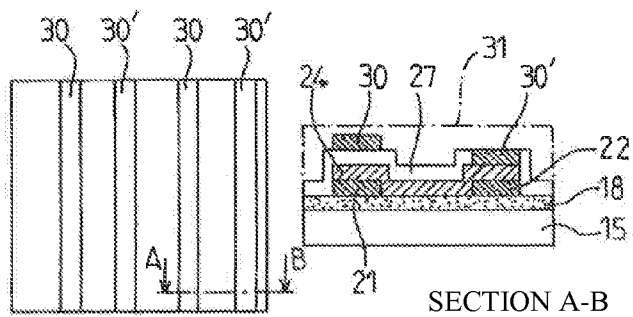


FIG. 3D

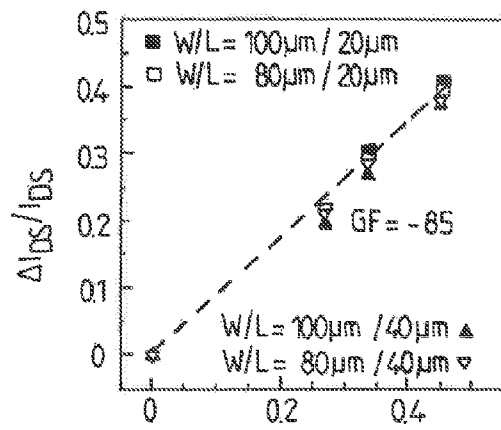


FIG. 4A

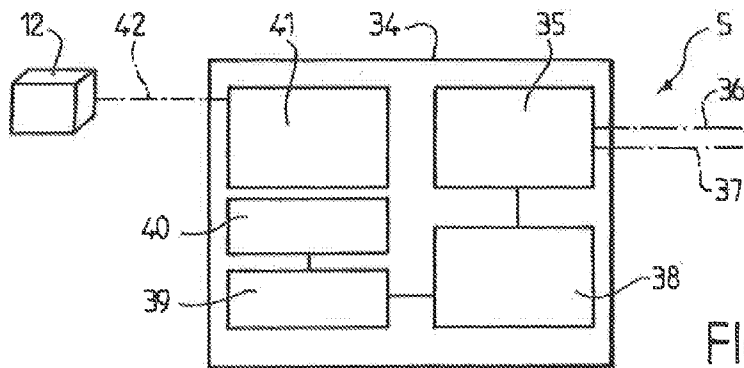


FIG. 5

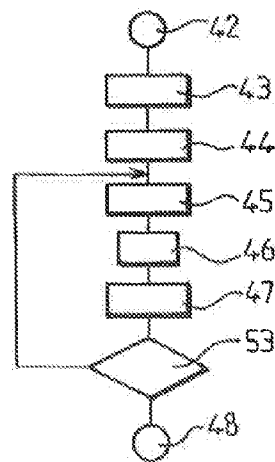


FIG. 6

