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(54) **Method and plant for making ceramic ware products**

Verfahren und Vorrichtung zur Herstellung von keramischen Produkten

Procédé et dispositif de fabrication de produits en céramique

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Description

[0001] The present invention relates to a method and a plant for making ceramic ware products, in particular ceramic sanitary ware products.

[0002] As is well known in this trade, ceramic sanitary ware products (such as washbasins, toilet bowls, bidets and the like) are made by pressure casting a liquid mixture, known as slip, consisting of water, clay and very small quantities of other substances, in moulds made of porous resin. The mould gives the sanitary ware product the required shape and the article is then extracted from the mould in a solid, though plastic, form and further processed according to a well-known sequence of steps until it is completely finished.

[0003] More specifically, the steps of making the ceramic ware product essentially comprise:

- filling the mould with slip at an initial pressure;
- forming the product layer at pressure profiles higher than that used for filling;
- emptying excess slip from the mould;
- consolidating the product;
- opening the mould and removing the product, and
- positioning the product in stations for drying and finishing the product.

[0004] Some sanitary ware products, such as toilet bowls (purely by way of a non-limiting example) comprise at least two parts which can be joined to each other after being demoulded from a single mould or, in some cases, from separate moulds: a first bottom part comprising a pan and a drain siphon (that is, the inner parts of the bowl) and a second top part or "rim". The first part, consisting of the pan and siphon assembly, is the functional part of the bowl and must have dimensional characteristics such as to allow the collection pan and flushing system of the bowl to work correctly. The rim has a portion that is usually annular or ellipsoidal in shape, forming the upper edge of the pan and a rear extension, parallel to the siphon and having a hole through which the flushing water is delivered. Essentially, therefore, in a method for making this type of product it is necessary to perform a further set of steps, comprising:

- positioning the first part in the drying and finishing station;
- applying a bonding material (usually consisting of high-viscosity slip) uniformly to the surface to be joined to the rim;
- resting the rim on, and thereby joining it to, the surface of the first part. Obviously, this type of method can be applied to any other type of sanitary ware product whose initially separate parts need to be joined to each other by bonding using high-viscosity slip. EP-A2-1 273 406 discloses a method and a plant for making a ceramic sanitary ware product in accordance with the preamble of claims 1 and 8 respectively.

[0005] As may be inferred from the above description, the operation by which the (two or more) parts are joined is performed with the parts in the state known as the "green" state, that is, while the products still have a high water content of between 14% and 20%, also so as to allow the joined parts to be finished (even using robot units) by smoothing their surfaces to give the finished product a good appearance.

[0006] Then, allowing the sanitary ware product to remain in contact with the air (or in a controlled environment) brings about two main changes in the structure/consistency of the article, the first bringing it to an intermediate "leatherhard" state (in which the water content is approximately halved in weight compared to the previous state) and the second, to an almost finished "whitehard" state (in which the water content is further reduced): in these two states, the sanitary ware product is much less subject to plastic deformation than it is when in the green state.

[0007] The most critical situation is that created during the passage of the product from the green state to the leatherhard state, that is to say, the first drying step, which causes contractions in the product due to water loss and, therefore, product shrinkage.

[0008] These contractions during drying can lead to high stresses, particularly in the zone where, basically, the following three separate parts are located: rim - layer of bonding material - first part or pan surface, which is, in practice, a relatively large surface.

[0009] This phenomenon is due essentially to the fact that the three parts which are placed in contact with each other have three different initial states: the two demoulded parts have a percentage water content of between 14% and 20%, whilst the layer of viscous slip used for bonding has a markedly higher water content (up to as much as 33%).

[0010] During the drying process, this difference in the percentage water content and relative moisture causes a different shrinkage behaviour in each of the parts, creating high tensile or traction stresses (especially along the bonding line, for precisely the reasons mentioned above) which, in limit situations, may lead to cracking.

[0011] This invention therefore has for an aim to overcome these drawbacks by providing a method for the manufacture of a ceramic ware product by which the risks of cracking in product parts joined together or bonded using high-density slip can be eliminated rapidly and safely and without excessively affecting traditional operating times.

[0012] This invention also has for an aim to provide a plant which implements the method described above and which is very practical, with structures adapted to reduce the risks of cracking, during the drying process, in the zones along which the product parts are joined, all without adding a large number of components in the stations making up the plant.

[0013] In accordance with the invention, these aims are achieved by a method and a plant for making a ceramic sanitary ware product in accordance with claims 1 and 8 respectively. According to a preferred embodiment of the invention, after the step of joining the second part to the first part, there is a step of applying, through the agency of respective means, a flow of electric charge uniformly distributed at least along the joining zone at a predefined power and for a predetermined length of time so as to increase mechanical strength at least at the joining zone. Preferably, the step of applying the flow of electric charge reduces the moisture content around the joining zone.

[0014] Preferably, the step of applying the flow of electric charge creates uniformity of moisture content around the joining zone.

[0015] These and other features of the invention will become more apparent from the following detailed description of a preferred, non-limiting example embodiment of it, with reference to the accompanying drawings, in which:

- Figure 1 is a schematic side view, with some parts cut away in order to better illustrate others, of a station of a casting plant for making ceramic sanitary ware products implementing the method of the invention;
- Figure 2 illustrates the station of Figure 1 in a schematic top plan view and shows means for generating a flow of electric charge forming part of the method and plant of the invention;
- Figure 3 is schematic front cross section of a detail B from Figure 2. With reference to the accompanying drawings, in particular Figures 1 and 2, the method and plant of the invention are used to manufacture ceramic sanitary ware products.

[0016] More specifically, in the solution contemplated here, the sanitary ware product, denoted in its entirety by the letter M, has at least two parts which can be associated with each other after being demoulded from a single mould or from respective separate moulds (not illustrated here), but without thereby limiting the scope of the solution.

[0017] Essentially, therefore, the method for making a ceramic ware product may basically comprise the following traditional steps:

- filling the mould with slip at an initial pressure;
- forming the layer which defines the product surfaces at pressure profiles higher than that used for filling;
- emptying excess slip from the mould;
- consolidating the product;
- partly opening the mould to release the product surfaces.

[0018] These basic steps are followed by the further steps of:

- opening the mould completely and removing the product therefrom, and
- positioning the product in stations for drying and finishing the product.

[0019] It should be noted that after the step of partly opening the mould or, in a non-limiting alternative of the invention, when the product is positioned in stations for finishing it (these steps not being illustrated in detail since they are of known type and do not strictly form part of the invention), further steps may follow for certain products which are precisely the products which, after moulding, require at least two parts to be joined.

[0020] In the case of the embodiment described here by way of example only, the product shown in the drawings is a customary toilet bowl which comprises at least two parts M2 and M3 which can be associated with each other at least after the step of partly opening the mould or moulds.

[0021] The product comprises a first bottom part M2 comprising a pan and a drain siphon (that is, the inner parts of the bowl) and a second top part M3 or "rim".

[0022] The first part M2, consisting of the pan and siphon assembly, is the functional part of the bowl and must have dimensional characteristics such as to allow the collection pan and flushing system of the bowl to work correctly.

[0023] The rim M3 has a portion that is usually annular or ellipsoidal in shape, forming the upper edge of the pan and a rear extension, parallel to the siphon and having a hole through which the flushing water is delivered. The two parts M2 and M3 may be cast in the same mould (even if separate from each other).

[0024] Alternatively, the two parts M2 and M3 may be cast in separate moulds. The method for making this type of ceramic sanitary ware product further comprises the following steps, in addition to those mentioned above:

- applying (arrows F1, Figure 1) a uniform layer S of bonding material comprising a high-viscosity fluid mixture or slip to at least one surface 2 intended to be joined to at least the second part M3 or rim of the sanitary ware product M (this step being performed either manually or with a robot unit UR);
- joining the second part M3 or rim to the first part M2 along a joining zone defined by two respective contact surfaces 2 and 3 of the selfsame parts M2, M3 with the layer S of bonding material interposed between them (see arrow F2, Figure 1);
- drying the sanitary ware product M thus obtained.

[0025] After the step of joining the rim M3 to the first part M2, there is a step of applying, through the agency of respective means 4, a flow F of electric charge uniformly distributed at least along the joining zone of the two parts M2 and M3 at a predefined power or intensity A and for a predetermined length of time T so as to increase mechanical strength at least at the selfsame join-

ing zone.

[0026] It should be noted that if the parts M2 and M3 of the sanitary ware product M are removed from the moulds completely, the step of applying a layer S of bonding material is preceded by a step of positioning the first part M2 of the sanitary ware product M in a drying station 1.

[0027] The above mentioned step of passing the flow of electric charge is facilitated also by the fact that both the parts of the sanitary ware product and the bonding material or slip contain electrolytes defined by salts present in the mixture they are made from.

[0028] It has been found that applying an electric charge to this zone considerably increases the mechanical strength of the layer S of bonding material: during the subsequent drying step, this property improves the shrinkage resistance of the joined parts.

[0029] To this must be added that applying a flow F of electric charge causes a relative reduction of the moisture content around the joining zone.

[0030] A further positive factor is that the step of applying the flow F of electric charge may create overall uniformity of moisture content around the joining zone.

[0031] All these factors markedly reduce the risk of cracking at the delicate zone where the parts making up the sanitary ware product M are joined.

[0032] Preferably, in the step of applying a flow F of electric charge, the charge is applied all around the joining zone, that is, on both sides of, and above and below a bonding line defined by the two respective joining surfaces 2 and 3 (see Figure 3).

[0033] Preferably, in the step of applying the flow F of electric charge, the electric current is applied at a power A of between 5 and 150 Watts.

[0034] Again preferably, the electric current is applied for a length of time T of between 2 and 300 seconds.

[0035] The intensity and time parameters are determined by the type of product M, the joined surface, the predicted obtainable increase in mechanical strength and the predicted obtainable reduction in the moisture content, without affecting the other portions of the product and the subsequent operating time scale.

[0036] The plant, denoted in its entirety by the numeral 5, which implements the method for making the sanitary ware product M made up of at least two parts M2 and M3 which can be joined to each other along the two opposable surfaces 2, 3 with the layer S of bonding material interposed between them, comprises at least:

- the station 1 for drying the sanitary ware product M;
- means 7 for spreading the layer S of bonding material (either a human operator or a robot unit), and
- means 8 for joining the two parts M2 and M3 (usually mechanical units for handling the products).

[0037] To these are added the aforementioned means 4 for applying a flow F of electric charge around the zone where the two parts M2, M3 are joined by the layer S of bonding material.

[0038] The means 4 are connected to a control unit 9 which controls the power or intensity A of the flow F and the length of time T for which it is applied.

[0039] In an exemplary embodiment, the application means 4 may comprise at least one pliable structure 10 shaped to adapt to the shape of the joining zone on at least two sides.

[0040] The structure 10 may be equipped with a plurality of conductive elements 11 or electrodes, for the passage of current and also positioned on two sides of the joining zone and for a stretch covering a zone above and a zone below the bonding line.

[0041] The pliable structure may consist of a metallic mesh 10 equipped with plates 11, also partly pliable, defining the electrodes.

[0042] In use, the mesh 10 may be positioned in such a way as to at least partly surround the joining zone.

[0043] The application means 4 as a whole are connected to a source 12 by which electrical current is generated and which is in turn connected to the control unit 9 which controls the power or intensity of the current and the length of time it is applied to the sanitary ware product M.

[0044] A method and plant as described above fully achieve the preset aims thanks to the inclusion of a step of applying electrical current to zone where the component parts of the sanitary ware product are joined to each other.

[0045] This step brings the following important advantages:

- higher mechanical strength of the joining zone thanks to improved interpenetration of the contact surfaces between the product parts and the bonding material;
- rapid reduction of moisture in the joining zone;
- improved uniformity of moisture in the zone where the parts are joined.

[0046] All of this makes it possible to reduce the risk of cracking at that zone thanks to the addition of one simple step which requires very little additional time, that is to say, without affecting the overall time scale of the production cycle.

[0047] This additional step is performed using simple, inexpensive means which can be quickly adapted to the shape of the product and which need very little application time.

Claims

1. A method for making a ceramic sanitary ware product (M) comprising at least the following steps:

   - applying a uniform layer (S) of bonding material comprising a high-viscosity fluid mixture or slip

to at least one surface (2) of a first part (M2) intended to be joined to at least a second part (M3) of the sanitary ware product (M);
- joining the second part (M3) of the sanitary ware product (M) to the first part (M2) along a joining zone defined by two respective contact surfaces (2, 3) of the selfsame parts (M2, M3) with the layer (S) of bonding material interposed between them;
- drying the sanitary ware product (M) thus obtained;
characterized in that it comprises, after the step of joining the second part (M3) to the first part (M2), there is a step of applying, through the agency of respective means (4), a flow (F) of electric charge at least along the joining zone so as to increase mechanical strength at least at the joining zone.

2. The method according to claim 1, **characterized in that** the step of applying a flow (F) of electrical charge is uniformly distributed at least along the joining zone.

3. The method according to claim 1 or 2, **characterized in that** the step of applying a flow (F) of electrical charge is applied with a predefined power (A).

4. The method according to any of the preceding claims, **characterized in that** the step of applying a flow (F) of electric charge is applied for a predetermined length of time (T).

5. The method according to any of the preceding claims, **characterized in that** in the step of applying a flow (F) of electric charge, the charge is applied and distributed all around the joining zone, that is, on both sides of, and above and below a bonding line defined by the two respective joining surfaces (2, 3).

6. The method according to any of the preceding claims, **characterized in that** the step of applying a flow (F) of electric charge, comprises applying alternating electric current at a power (A) of between 5 and 150 Watts.

7. The method according to any of the preceding claims, **characterized in that** the step of applying a flow (F) of electric charge comprises applying the electric current for a length of time (T) of between 2 and 300 seconds.

8. A plant for making a sanitary ware product (M) made up of at least two parts (M2, M3) which can be joined to each other along two opposable surfaces (2, 3) with a layer (S) of bonding material consisting of a high-viscosity fluid mixture interposed between them, the plant (5) comprising at least:

- means (7) for spreading the layer (S) of bonding material, and
- means (8) for joining the two parts (M2, M3),
characterized in that it further comprises:
- means (4) for applying a flow (F) of electric charge around the zone where the two parts (M2, M3) are joined by the layer (S) of bonding material.

9. The plant according to claim 8, **characterized in that** it comprises a control unit (9) connected to the flow (F) application means (4) and configured to control the power (A) of the current and the length of time (T) the flow is applied.

10. The plant according to claim 8 or 9, **characterized in that** the application means (4) comprise at least one pliable structure (10) shaped to adapt to the shape of the joining zone on at least two sides; the structure (10) being equipped with a plurality of conductive elements (11) or electrodes, for the passage of current and also positioned on two sides of the joining zone and for a stretch covering a zone above and a zone below the bonding line.

11. The plant according to any of the preceding claims from 8 to 10, **characterized in that** the application means (4) are connected to a source (12) by which electrical current is generated and which is connected to the control unit (9).

12. The plant according to claim 10, **characterized in that** the pliable structure comprises a metallic mesh (10) equipped with plates (11) defining the electrodes; the mesh (10) being, in use, positioned in such a way as to at least partly surround the joining zone.

Patentansprüche

1. Verfahren zur Herstellung eines keramischen Sanitärprodukts (M), umfassend mindestens die folgenden Schritte:

- Auftragen einer gleichmäßigen Schicht (S) Klebematerial, umfassend eine Fluidmischung oder Schlicker mit hoher Viskosität, auf mindestens eine Oberfläche (2) eines ersten Teils (M2), das dazu bestimmt ist, mit mindestens einem zweiten Teil (M3) des Sanitärprodukts (M) verbunden zu werden;
- Verbinden des zweiten Teils (M3) des Sanitärprodukts (M) mit dem ersten Teil (M2) entlang eines Verbindungsbereichs, der durch zwei jeweilige Kontaktoberflächen (2, 3) dieser Teile

(M2, M3) mit der Schicht (S) Klebematerial dazwischen definiert ist;
- Trocknen des so erhaltenen Sanitärprodukts (M); **dadurch gekennzeichnet, dass** es nach dem Schritt des Verbindens des zweiten Teils (M3) mit dem ersten Teil (M2) einen Schritt des Anlegens eines Flusses (F) elektrischer Ladung mithilfe von entsprechenden Mitteln (4) zumindest entlang des Verbindungsbereichs umfasst, sodass zumindest am Verbindungsbereich die mechanische Festigkeit verstärkt wird.

2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** der Schritt des Anlegens eines Flusses (F) elektrischer Ladung zumindest entlang des Verbindungsbereichs gleichmäßig verteilt wird.

3. Verfahren nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** der Schritt des Anlegens eines Flusses (F) elektrischer Ladung mit einer vordefinierten Leistung (A) durchgeführt wird.

4. Verfahren nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** der Schritt des Anlegens eines Flusses (F) elektrischer Ladung für eine vordefinierte Zeitdauer (T) durchgeführt wird.

5. Verfahren nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** im Schritt des Anlegens eines Flusses (F) elektrischer Ladung die Ladung angelegt und um den gesamten Verbindungsbereich herum, d. h. an beiden Seiten und über und unter einer von den beiden entsprechenden Verbindungsoberflächen (2, 3) definierten Verbindungslinie, verteilt wird.

6. Verfahren nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** der Schritt des Anlegens eines Flusses (F) elektrischer Ladung das Anlegen von Wechselstrom bei einer Leistung (A) zwischen 5 und 150 Watt umfasst.

7. Verfahren nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** der Schritt des Anlegens eines Flusses (F) elektrischer Ladung das Anlegen des elektrischen Stroms für eine Zeitdauer (T) von zwischen 2 und 300 Sekunden umfasst.

8. Anlage zur Herstellung eines Sanitärprodukts (M), das sich aus mindestens zwei Teilen (M2, M3) zusammensetzt, die miteinander entlang von zwei gegenüberstellbaren Oberflächen (2, 3) mit einer Schicht (S) Klebematerial, das aus einer dazwischenliegenden Fluidmischung mit hoher Viskosität besteht, verbunden werden können, wobei die Anlage (5) mindestens Folgendes umfasst:
- Mittel (7) zum Ausbreiten der Schicht (S) Klebematerial, und
- Mittel (8) zum Verbinden der zwei Teile (M2, M3), **dadurch gekennzeichnet, dass** sie ferner Folgendes umfassen:
- Mittel (4) zum Anlegen eines Flusses (F) elektrischer Ladung um den Bereich herum, in dem die beiden Teile (M2, M3) durch die Schicht (S) Klebematerial verbunden sind.

9. Anlage nach Anspruch 8, **dadurch gekennzeichnet, dass** sie eine Steuereinheit (9) umfasst, die mit den Mitteln (4) zum Anlegen des Flusses (F) verbunden und dazu konfiguriert ist, die Leistung (A) des Stroms und die Zeitdauer (T) zu steuern, für die der Fluss angelegt wird.

10. Anlage nach Anspruch 8 oder 9, **dadurch gekennzeichnet, dass** die Mittel zum Anlegen (4) mindestens eine biegsame Struktur (10) umfassen, die so gestaltet ist, dass sie sich an mindestens zwei Seiten an die Gestalt des Verbindungsbereiches anpasst; wobei die Struktur (10) mit einer Vielzahl von leitfähigen Elementen (11) oder Elektroden für das Durchfließen von Strom ausgestattet ist und ebenfalls an zwei Seiten des Verbindungsbereiches und für einen Abschnitt, der einen Bereich über und einen Bereich unter der Verbindungslinie bedeckt, positioniert ist.

11. Anlage nach einem der vorangehenden Ansprüche 8 bis 10, **dadurch gekennzeichnet, dass** die Mittel (4) zum Anlegen an eine Quelle (12) angeschlossen sind, durch die elektrischer Strom erzeugt wird und die an die Steuereinheit (9) angeschlossen ist.

12. Anlage nach Anspruch 10, **dadurch gekennzeichnet, dass** die biegsame Struktur ein Metallgeflecht (10) umfasst, das mit Platten (11) ausgestattet ist, welche die Elektroden definieren, wobei das Geflecht (10) bei der Verwendung so positioniert ist, dass es zumindest teilweise den Verbindungsbereich umgibt.

Revendications

1. Procédé de fabrication d'un produit sanitaire en céramique (M) comprenant au moins les étapes suivantes :

- application d'une couche uniforme (S) d'un liant comprenant un mélange fluide ou barbotine à haute viscosité à au moins une surface (2) d'une première partie (M2) destinée à être assemblée à au moins une seconde partie (M3) du produit sanitaire (M) ;
- assemblage de la seconde partie (M3) du produit sanitaire (M) à la première partie (M2) le

long d'une zone d'assemblage définie par deux surfaces de contact respectives (2, 3) desdites parties (M2, M3) ayant la couche (S) de liant interposée entre elles ;
- séchage du produit sanitaire (M) alors obtenu ;
caractérisé en ce qu'il comprend, après l'étape d'assemblage de la seconde partie (M3) à la première partie (M2), une étape d'application, par le biais de moyens respectifs (4), d'un flux (F) de charge électrique au moins le long de la zone d'assemblage de manière à augmenter la résistance mécanique au moins au niveau de la zone d'assemblage.

2. Procédé selon la revendication 1, **caractérisé en ce que** l'étape d'application d'un flux (F) de charge électrique est répartie uniformément au moins le long de la zone d'assemblage.

3. Procédé selon les revendications 1 ou 2, **caractérisé en ce que** l'étape d'application d'un flux (F) de charge électrique est appliquée avec une puissance prédéfinie (A).

4. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** l'étape d'application d'un flux (F) de charge électrique est appliquée pendant un laps de temps prédéterminé (T).

5. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce qu'**au cours de l'étape d'application d'un flux (F) de charge électrique, la charge est appliquée et répartie tout autour de la zone d'assemblage, c'est-à-dire, sur les deux côtés et au-dessus et en-dessous d'un plan de jonction défini par les deux surfaces d'assemblage respectives (2, 3).

6. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** l'étape d'application d'un flux (F) de charge électrique comprend l'application d'un courant électrique alternatif à une puissance (A) comprise entre 5 et 150 watts.

7. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** l'étape d'application d'un flux (F) de charge électrique comprend l'application du courant électrique pendant un laps de temps (T) compris entre 2 et 300 secondes.

8. Installation de production d'un produit sanitaire (M) composé d'au moins deux parties (M2, M3) pouvant être assemblées l'une à l'autre le long de deux surfaces opposées (2, 3) avec une couche (S) de liant, consistant en un mélange de fluide à haute viscosité, interposée entre elles, l'installation (5) comprenant au moins :
- des moyens (7) permettant d'étaler la couche (S) de liant, et
- des moyens (8) permettant l'assemblage des deux parties (M2, M3), **caractérisée en ce qu'**elle comprend de plus :
- des moyens (4) permettant l'application d'un flux (F) de charge électrique autour de la zone où les deux parties (M2, M3) sont assemblées par la couche (S) de liant.

9. Installation selon la revendication 8, **caractérisée en ce qu'**elle comprend une unité de commande (9) reliée aux moyens d'application (4) du flux (F) et configurée pour commander la puissance (A) du courant et le laps de temps (T) d'application du flux.

10. Installation selon les revendications 8 ou 9, **caractérisée en ce que** les moyens d'application (4) comprennent au moins une structure souple (10) présentant une forme pouvant s'adapter à celle de la zone d'assemblage sur au moins deux côtés ; la structure (10) étant équipée d'une pluralité d'éléments conducteurs (11) ou électrodes laissant passer le courant et aussi placés sur les deux côtés de la zone d'assemblage et sur une étendue permettant de recouvrir une zone supérieure et inférieure de la ligne de jonction.

11. Installation selon l'une quelconque des revendications de 8 à 10, **caractérisée en ce que** les moyens d'application (4) sont reliés à une source (12) générant le courant électrique et étant reliée à l'unité de commande (9).

12. Installation selon la revendication 10, **caractérisée en ce que** la structure souple comprend des mailles métalliques (10) équipées de plaques (11) définissant les électrodes ; les mailles (10) étant, en fonctionnement, placées de manière à au moins entourer en partie la zone d'assemblage.

FIG.1

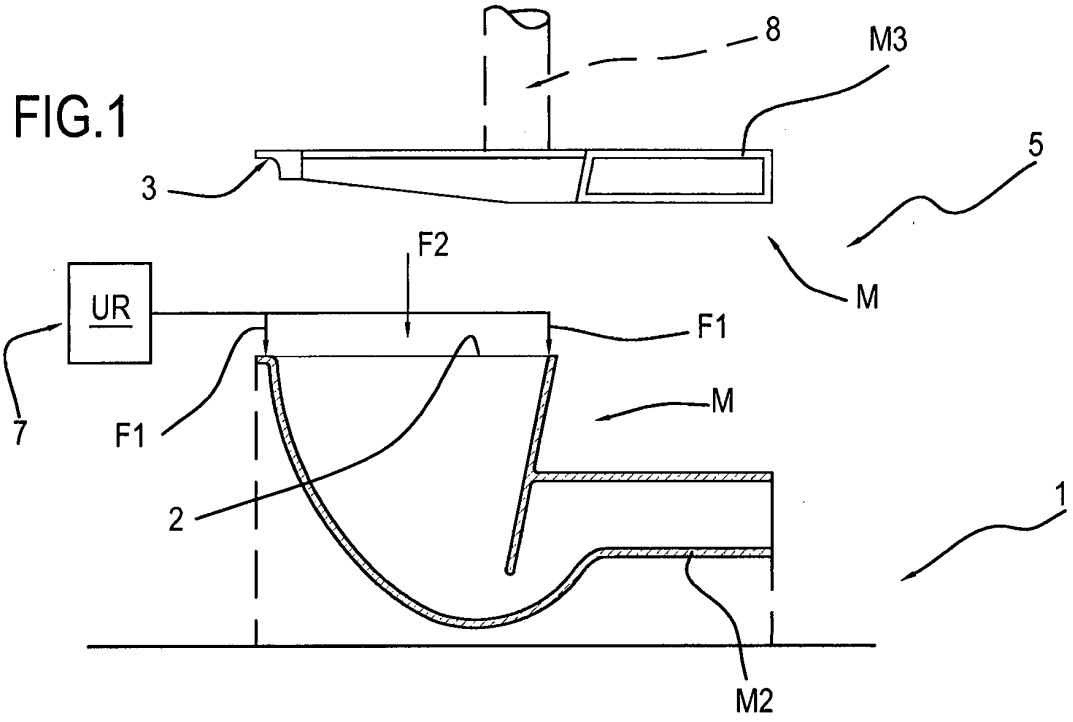


FIG.2

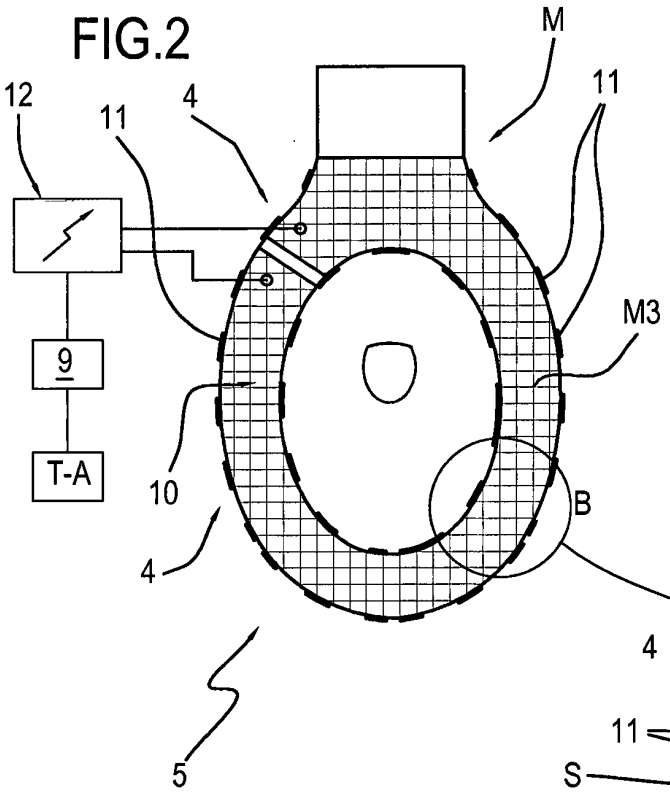
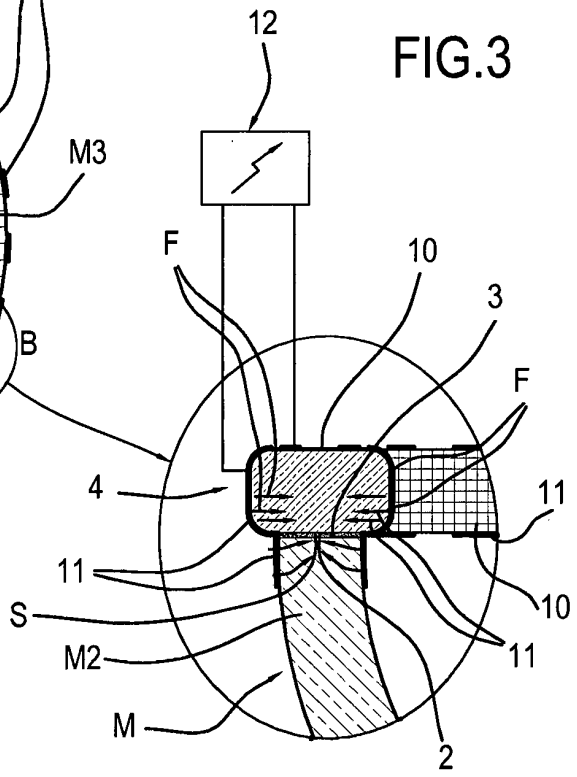


FIG.3



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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