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(54) **Title**: METHOD AND MACHINE TO MAKE A MODULAR COVERING PANEL AND MODULAR PANEL THUS MADE

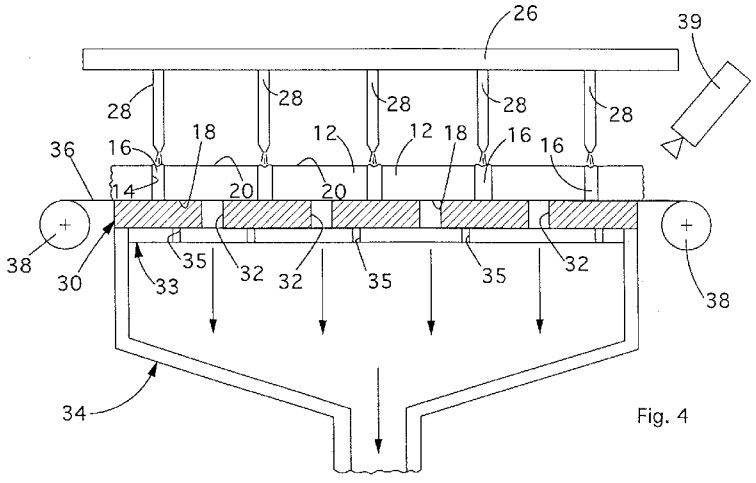

Fig. 4

(57) **Abstract**: A method to make a modular covering panel (10) comprising a plurality of tesserae or tiles (12) having a visible surface (18) and an opposite base surface (20). The tesserae or tiles (12) are distanced from each other according to a predetermined geometry so as to define a plurality of grooves (14) into which a cohesion material (16) is introduced by means of injection or casting, comprises the following steps: a first step of disposing the tesserae or tiles (12) on support elements (30, 56, 60, 62), in which the tesserae or tiles (12) are disposed with the visible surface (18) in direct or indirect contact with the support elements (30, 56, 60, 62); a second step of injecting the cohesion material (16) into the grooves (14) in which there is also, at least at the same time as the introduction of the cohesion material (16), a vacuum suction operation, on the side opposite that of injection, by means of suction means (34), to clamp the tesserae or tiles (12) to the support elements (30, 56, 60, 62).

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"METHOD AND MACHINE TO MAKE A MODULAR COVERING PANEL AND MODULAR PANEL THUS MADE"

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FIELD OF THE INVENTION

The present invention concerns a method and machine to make a modular covering panel consisting of a plurality of tesserae or tiles, able to be laid on an application surface, such as for example a bare wall of a building, possibly put adjacent to other similar panels, to cover and/or decorate the wall.

BACKGROUND OF THE INVENTION

Modular panels to cover and decorate a bare wall are known, substantially consisting of a plurality of mosaic tesserae, tiles, or other decoration elements disposed on the same plane and distanced from each other according to a desired geometry, to perfect intermediate grooves.

To keep the decoration elements in this coplanar and distanced position, and thus supply a modular panel, it is known, during the laying step, to fill said grooves by means of a cohesion material of the cement or epoxy type, but this has a high porosity, with the implicit risk of water and damp infiltration and the formation of mold.

It is also known from the US patent 3.335.048 to make panels in which the tesserae are connected by a mixture based on vulcanizable rubber and cork. The mixture is poured on a mold and subsequently the tesserae are put in the mold with the desired geometry to define the relative grooves. A press acts from above on everything, compressing the tesserae and determining the rise of the mixture along the grooves. The mixture is vulcanized at high temperature, supplying cohesion and structure to the panel. However, this known method has the disadvantage that it also defines in the panel at least a lower layer of vulcanized mixture, which forms between the bottom of the mold and the tesserae and which, if on the one hand it can act as a heat and/or sound insulator, on the other it may not be desired, both in the cases which do not provide this insulation, and due to the need to reduce the bulk in thickness of the panel and also to reduce the costs and the use of the cohesion material.

According to another known solution, the decoration elements are kept in position by means of a paper or a protective film which is glued onto their visible

surface, so that, during the laying step, each modular panel is first attached directly to the bare wall by means of the non-visible surfaces of the decoration elements, and then the protective film is removed.

Alternatively, instead of the paper or the protective film, it is known to provide a support net, predisposed incorporated on the back of the decoration elements, which is attached to the wall together with the modular panel.

In these latter known solutions, after having attached the panels to the rigid wall, the grooves must be filled, by means of cement material or thermosetting resins, for example of the epoxy type. Although the resins are more impermeable than cement products, they are difficult to apply, above all on vertical walls. Moreover, the polymerization of the resins when they are already laid also causes the emission of toxic substances, particularly dangerous for the workers who are using them.

From the international patent application WO-A-2005/092638 by the same Applicant, a method to make covering panels is also known, in which the use of a provisory support is provided, which is then removed, and on which the tesserae are disposed, so as to be able to weld them together with resin. This known method, even though innovative and very valid for making very flexible covering panels, requires the use of particular resins to hold the tesserae together, which may not be advantageous.

Furthermore, the known methods do not allow to obtain desired surface finishes, and/or of the shape and/or of cross section, of the grooves between the tiles or tesserae.

One purpose of the present invention is to perfect a method and a machine to make modular covering panels which do not require, during the laying step, operations to fill the grooves present between the decoration elements of which they are made.

Another purpose is to perfect a method and a machine to make modular covering panels which are easily automated in functioning.

Another purpose of the present invention is to perfect a method and a machine to make, in a simple and economic way, modular covering panels which can be attached to a bare wall quickly, simply and economically, without the tesserae becoming detached, without needing to use particular resins, or touching up and

operations to fill the grooves during the laying step.

Yet another purpose is to perfect a method and a machine to make a modular covering panel with a precise disposition of the tesserae or tiles and an exact definition of the grooves.

A further purpose is to perfect a method and a machine to make a modular covering panel with a particular and desired finish of the grooves, both in cross section and as a geometric development on the plane.

The Applicant has devised, tested and embodied the present invention to overcome the shortcomings of the state of the art and to obtain these and other purposes and advantages.

SUMMARY OF THE INVENTION

The present invention is set forth and characterized in the independent claims, while the dependent claims describe other characteristics of the invention or variants to the main inventive idea.

In accordance with the above purposes, a method according to the present invention can be used to make a modular covering panel, of the pre-assembled, pre-fabricated, pre-grooved or pre-filled type, comprising a plurality of tesserae or tiles having a visible surface and an opposite base surface.

The tesserae or tiles are possibly disposed on the same plane and are distanced from each other according to a predetermined geometry to define a plurality of grooves, possibly also comprising perimeter grooves, which are filled by means of casting or injection, with a cohesion material which connects the tesserae or the tiles with each other.

According to a characteristic feature of the present invention, the method comprises the following steps:

- a first step of disposing the tesserae or tiles on support elements, in which the tesserae or tiles are disposed with the visible surface facing downward, in direct or indirect contact with the support elements;
- a second step to cast or inject the cohesion material inside the grooves in which there is also, at the same time as or a little before the introduction of the cohesion material, a vacuum suction operation, by means of suction means acting on the visible side of the tesserae or tiles, advantageously on the opposite side with respect to the injection side, in order to selectively clamp the tiles or tesserae to

the support elements.

A great accuracy of the injection or casting operation of the cohesion material is thus achieved, since movements, even slight ones, of the tesserae or tiles are substantially prevented.

The method also prevents any dirtying of the visible surface of the tesserae or tiles with the injected or cast cohesion material.

The cohesion material can be of the elastic or flexible field type.

An advantageous solution provides to use a polymer, advantageously elastic, as the cohesion material.

The elastic polymer usable can preferably be of the synthetic type.

The elastic polymer can be chosen from the mono or bi-component reactive resins which include the following resins:

1.a) polyurethanes (both aliphatic and aromatic)

1.b) silylated polyurethanes (SPUR)

1.c) silicones

1.d) modified silicones (MS-Polymer)

1.e) acrylics.

According to a particular solution, the elastic polymer can be of the hygro-hardening type.

According to an advantageous embodiment, the method also comprises:

- a third step to control, by means of a video acquisition device, the tesserae connected by the cohesion material, to detect faults or inaccuracies in the introduction of the cohesion material;

- a fourth step of sending the tesserae, connected by the cohesion material, to further workings or to packing or discard, depending on the outcome of the control carried out in the third step.

The method according to the present invention allows to make self-supporting and pre-assembled panels which, during the laying step, do not need any operations to fill the grooves present between the decoration elements which make up the panels.

Moreover, the method according to the present invention allows to make, in a simple and economic way, modular covering panels which can be attached to a bare wall quickly, simply and economically, without the tesserae becoming

detached, without needing to use particular resins, or touching up or operations to fill the grooves during the laying step.

Thanks to the selective constraint of the tesserae or tiles due to suction during the injection of the cohesion material, the method allows to make a modular panel with a precise disposition of the tesserae or tiles and an exact definition of the grooves.

Moreover, thanks to the effective quality control by means of video control, the panels according to the invention all have an excellent finish and do not have defects or inaccuracies in their make-up.

Furthermore, using support elements of an elastically deformable type, these deform in correspondence with the grooves of the tesserae or tiles under the vacuum suction action, during injection or casting, allowing to make a modular panel with a particular and desired finish of the grooves. Similarly, it is possible to use pre-shaped support elements in a manner consistent with the shape of the grooves.

A machine according to the present invention to make a modular panel as described above comprises:

- a first loading station comprising means to position the tesserae or tiles, able to position the tesserae or tiles according to a pre-determined geometry;
- support elements on which the tesserae or tiles are positioned by means of the positioning means according to the pre-determined geometry and each one with the visible surface facing downward;
- a second injection or casting station comprising:

i) injection or casting means, advantageously automated, to inject or cast the cohesion material inside the grooves and

ii) suction means able to carry out a vacuum suction operation to selectively clamp the tesserae or tiles to the support elements during the injection.

According to an advantageous solution, the machine according to the present invention also comprises:

- a third station to control the tesserae connected by the cohesion material, able to determine the sending of the tesserae connected by the cohesion material to further workings or packing or discard;
- automated movement means able to move the tesserae or tiles between the first

loading station and the second injection or casting station and to move the panel obtained in the second injection station between the latter and the third control station; and

- an electronic type control unit able to automatically control in a coordinated manner, according to one or more selectable work programs or cycles, the functioning of the first loading station, the second injection or casting station and the third control station.

The machine according to the invention guarantees high productivity and high quality of the panels produced.

According to the present invention, a modular covering panel comprises a plurality of tesserae or tiles having a visible surface and an opposite base surface. The tesserae or tiles are possibly disposed on the same plane and distanced from each other according to a pre-determined geometry so as to define a plurality of grooves filled with a cohesion material with an elastic polymer base, which connects the tesserae or tiles with each other.

According to a characteristic feature of the present invention, the cross section of the cohesion material in the grooves has an upper edge, in correspondence with the visible surface, having a development of the rectilinear or concave type, and a lower edge, in correspondence with the base surface, having a development of the rectilinear or concave type.

These developments can have advantageous aesthetic effects, for example to create effects of light and shadow or other visual effects, and/or may be advantageous for example to drain water or other liquids along the grooves, as for example in the applications to toilets and washrooms, thus preventing the walls and floors from being flooded or covered in water or damp.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other characteristics of the present invention will become apparent from the following description of a preferential form of embodiment, given as a non-restrictive example with reference to the attached drawings wherein:

- fig. 1 is a three-dimensional view of a panel according to the present invention;
- figs 1a – 1f are enlarged details of different forms of embodiment of the panel in fig.1;

- figs 2a and 2b are plane views of forms of embodiment of the panel in fig. 1;
- fig 3 is a perspective view of a work plane to make the panel in fig 1;
- fig 4 is a front view, partially sectioned, of a part of a machine to make the panel in fig. 1;
- fig 5 is a plane view of the machine part in fig. 4;
- fig 6 is a plane view of a variant of the machine part in fig. 4;
- fig. 7 is a schematic plane view of a machine to make the panel in fig. 1;
- fig. 8 is a schematic plane view of a variant of the machine in fig. 7;
- fig. 9 is an three-dimensional view of another part of a machine to make the panel in fig. 1;
- fig. 10 is a plane view of a panel according to the present invention;
- fig. 11 is a plane view of a variant of the panel in fig. 10;
- fig. 12 is a frontal view, partially sectioned, of a variant of the machine part in fig. 4;
- fig. 13 is a front view, partially sectioned, of a further variant of the machine part in fig. 4.

DETAILED DESCRIPTION OF A PREFERENTIAL FORM OF EMBODIMENT

With reference to fig. 1, a panel 10 according to the present invention is formed by a plurality of tesserae, or tiles, 12, placed side by side according to a predetermined geometric disposition and distanced by a predetermined distance S so as to define a space or gap for so-called grooves 14 between the various tesserae 12.

The grooves 14 between the various tesserae 12 are filled with an elastic polymer 16 which acts as cohesion material between the tesserae 12, keeps everything together, supplying the necessary structural cohesion, so as to define inner ribs between the tesserae 12. The elastic polymer 16 is of the synthetic type, chosen from mono and bi-component reactive resins, advantageously of the hygro-hardening type, chosen from the following resins:

1.a) polyurethanes (both aliphatic and aromatic)

1.b) silylated polyurethanes (SPUR)

1.c) silicones

1.d) modified silicones (MS-Polymer)

1.e) acrylics

On the perimeter of the panel 10, a perimeter groove 15 is also defined, filled with the same cohesion material 16, which surrounds all or part of the panel 10 (figs. 2a and 2b), so as to define a perimeter rib.

The perimeter groove 15 has a width equal to half of the distance S, that is, half the width of the grooves 14, in the case when it surrounds all the sides of the tessera 12 (four perimeter "half grooves" - fig. 2a).

According to a variant, the perimeter groove 15 has a width equal to the distance S, that is, equal to the width of the grooves 14, in the case when it surrounds only two consecutive sides of the tessera 12 (two "whole grooves" - fig. 2b).

In this way, by putting one or more panels 10 side by side during the laying step, in both cases a whole groove is determined, that is, with a width equal to the distance S. The solution with two whole grooves 14 in fig. 2b allows to render the join between two adjacent panels even less visible, and therefore aesthetically more pleasing.

The panel 10 is thus of the pre-assembled or pre-fabricated or pre-grooved or pre-filled type and ready to lay on walls, floors, ceilings of buildings or other surfaces able to be covered.

The geometric disposition, as well as the shape of each tessera 12, can be of the regular type, for example rectangular, and repetitive according to a pre-fixed pattern, as for example for the panel in fig. 10.

For example each tessera 12 has sizes varying from about 10x10 mm to about 100x100 mm.

Moreover, as a further example, each tessera or tile 12 can be a mosaic tessera having sizes of about 20x20 mm.

Alternatively, the tesserae 12 which form the panel 10 can have an irregular shape and define a determined geometric disposition (fig. 11).

Each tessera 12 has a visible surface 18, and a lower surface 20 destined to contact with the wall of the building on which the panel 10 is installed (figs. 1 and 4).

When filled with the cohesion material 16, each groove 14 and perimeter groove 15 has an upper edge 22, associated with the visible surface 18 of the

tesserae 12 and therefore this is also normally visible, and a lower edge 24, in correspondence with the lower surface 20 of the tesserae 12.

The upper edge 22 can have a rectilinear development (figs. 1b and 1d) or concave (figs. 1a, 1c, 1e and 1f), according to aesthetic requirements and the production needs of the panel 10.

The lower edge 24 can have a rectilinear development (figs. 1b, 1c and 1f) or concave (figs 1a, 1d and 1e), according to aesthetic requirements and the production needs of the panel 10.

According to the invention, any combination is possible of the types of edges 22 and 24, of which figs 1a – 1f illustrate some embodiments, to give a non-restrictive example. In particular, in figs 1e and 1f it can be seen that the upper edge 22 can be made even half-way on the space of the groove 14. Other dispositions of the edges 22 and 24, even if not illustrated, can however be provided and are included within the field of the invention.

The solutions illustrated in figs. 1a – 1f are also applicable to the perimeter grooves 15.

A machine to make the panel 10 according to the invention is schematically shown in fig. 7 and is indicated with the reference number 41.

This machine 41 consists, in this case, of three stations 44, 46 and 48, loading station, injection or casting station and discharge station respectively, which are served in a continuous way by a turret 42 disposed centrally and rotating, as indicated by the arrow R. A control unit 43 of the electronic/computer type, in which one or more control and command programs are loaded, selectable according to the needs of production, is able to control the three stations 44, 46 and 48 and the turret 42.

The loading station 44 serves to load the tesserae 12 to be assembled on a work plane, grid or tray 30, advantageously by means of a loading device 51 as indicated by the arrow F, and also to control the tesserae 12 by means of a television camera 45, to check for breakages, cracks or other faults.

The turret 42 transports the plane 30 with the tesserae 12 to the injection or casting station 46 which serves to assemble and glue, by means of casting or injection using the elastic polymer 16, the tesserae 12 so as to determine the panel 10. If the television camera 45 detects defective tesserae 12 in the first

station 44, the turret 42 transports them to the station 46 just the same, but at the same time a signal is sent to the control unit 43, which consequently inhibits the gluing of the tesserae 12. From the station 46 the tesserae 12 are sent to the discharge station 48 where, as indicated by the arrow D, they are sent to be discarded.

If the finished panel 10 is defined in the station 46, the turret 42 moves it to the third station 48 which serves to control and discharge the assembled panel 10.

Here, another television camera 47 controls the finished panel 10, according to a predetermined control program loaded in the memory, or defined by the control unit 43.

If in the third station 48 the panel 10 has gluing faults, smudges of polymer or other, the television camera 47 detects this condition and signals it to the control unit 43 which commands the panel 10 to be sent to a manual touch-up step, if possible, or to be discarded, as indicated by the arrow D.

If in the third station 48, the control of the television camera 47 indicates that the panel 10 satisfies predetermined quality standards, it is sent to the subsequent working steps and packing, as indicated by the arrow G. A finishing step, for example using a spatula or scraper to eliminate any possible small residues of elastic polymer 16, is also possible after station 48.

Fig. 8 shows a variant of the machine 41 in fig. 7, in which, as well as the third station 48, there is also a fourth station 50 for discarding the tesserae 12 which station 44 detected as defective or for discarding or touching up the panels 10 detected as defective or to be finished, in station 48. In this way, the operation of sending the panels 10 which pass the quality check for subsequent workings and packaging, and the operation of sending the panels 10 or the tesserae 12 which do not pass the quality check for touching up or to be discarded are divided between two distinct stations 48, 50.

The tesserae 12 are loaded and disposed on the work plane 30, with their visible surfaces 18 facing downward and in direct or indirect contact with the work plane 30 (fig. 4) and over them, from above, the casting or injection of polymer 16 takes place, as illustrated in the description which follows.

According to an advantageous solution shown in fig. 3, the work plane 30 is a grid which has a plurality of seatings 30a, each one to accommodate a tessera 12,

according to the precise geometric disposition desired for the final panel 10. The seatings 30a are flared so that the tesserae 12 can be inserted, in an univocal way, with the visible side 18 facing downward. The seatings 30a also are distanced so that, once the tesserae 12 are positioned and the elastic polymer 16 has been cast inside the grooves 14 and 15, inner and perimeter ribs of the desired width are automatically formed.

Figs. 4 and 5 show a form of embodiment of the machine part 41 in correspondence to the station 46, where the injection or casting of the elastic polymer 16 is carried out.

Here there are two nozzle bearers 26, moveable orthogonally with respect to each other, as indicated by the arrows P and Q, which move the nozzles 28 in order to inject the elastic polymer 16 into the grooves 14 and 15 of the tesserae 12 disposed in the work plane 30. The two nozzle bearers 26 move, above the work plane 30, following a matrix corresponding to the geometric development of the grooves, with everything being controlled by the control unit 43.

Alternatively, the nozzles 28 could be fixed above the work plane 30 with the tesserae 12, and the latter can be movable below, for example by means of a conveyor belt, according to a predefined movement to obtain the desired geometry of the filled grooves 14 and 15.

For the operation of casting or injection, another variant of the invention provides to use a single robotized arm 40 which carries a relative nozzle 28 to inject the polymer elastic 16 (shown in several positions, in a continuous line and in a broken line in fig. 6) which is commanded by the control unit 43 according to one or more production programs, to inject the polymer elastic 16 into the grooves 14 and 15.

For example, it is advantageous to load a relative drawing or vector "file" into the memory of the control unit 43 which shows with a plane view the development of the geometric disposition of the tesserae 12 and of the grooves 14 and 15 and to command the movement of the robotized arm 40 according to precise coordinates deriving from it.

In this way the grooves 14 determined by an irregular disposition and shape of the tesserae 12, as for example in fig. 11, can also be filled quickly, precisely and automatically.

As can be seen in fig. 4 the work plane 30, in the station 46, during the casting or injection operation, is in its turn disposed above a suction plane 33, in operative association with a vacuum pump 34.

The vacuum pump 34 serves to maintain, selectively and in a manner controlled by the control unit 43, a determinate degree of suction and vacuum which keeps the tesserae 12 adherent and constrained on the work plane 30 during the injection or casting of the elastic polymer 16.

As can be seen, the work plane 30 has holes 32, in correspondence with each tessera 12, through which the suction action of the vacuum pump 34 is carried out on the tesserae 12. In turn, the suction plane 33 has suction holes 35, to allow everything to work.

Alternatively the suction effect can be achieved by means of small suckers, which function as a suction mean 34, one for each of the tesserae 12.

The use of suction during injection or casting increases the precision of the working and the exact alignment of the tesserae 12. Moreover, in this way the tesserae 12 are clamped to the work plane 30 and the elastic polymer 16 cast or injected does not also drip onto the visible face 18 of the tesserae 12, thus preventing them from getting dirty.

For the suction to be effective, it is advantageous that the seating 30a of each of the tessera 12 in the work plane 30 is provided with packings to ensure a seal.

Alternatively, the work plane 30 itself can be made of a material compatible with the maintenance of the vacuum (rubber, silicone etc.) or it can even be made of thermoformable material provided it is modeled around each panel 10 and under the action of the vacuum it allows it to be sealed.

Between the tesserae 12 and the work plane 30 a film or sheet of transparent paper 36 can advantageously be interposed, both with transpirant properties, to allow suction, and also non-adhesive to the elastic polymer 16, that is, inert with respect to the latter, to prevent the work plane being glued to the tesserae 12 once the polymer 16 has been injected or cast.

The paper 36 is automatically fed from feed rolls 38 of strips of paper and the correct feed can be controlled by a television camera 39 which, detecting the presence or absence of the elastic polymer cast on the paper 36, and therefore the possible dirtying of the paper 36, moves the feed strip 38 on by one step.

Alternatively, in order not to use the paper 36, it is possible to make the work plane 30 conformed as a tray, grid or mold shaped according to requirements, of a material which does not adhere to the elastic polymer 16, that is, inert with respect to it.

To obtain the desired concave development of the upper edge 22 the invention provides, according to an advantageous form of embodiment, to make the work plane, indicated by 60 in fig. 12, on which the tesserae 12 rest during the injection, of an elastically deformable material and preferably inert with respect to elastic polymer 16, such as a material with a silicone base.

To this end it is also possible to use the work plane 30 if it is made of an elastically deformable material.

The use of the paper 36 can also be seen as an auxiliary element also in this variant.

When the vacuum pump 34 is working, the elastically deformable material deforms in correspondence with the grooves 14, due to the thrust of the tesserae 12 sucked downward, determining the raising of protuberances 61, inside the grooves 14, which once the polymer 16 has been cast determine the desired concave development for the upper edge 22. The suction power determines a greater or lesser raising of the protuberances 61, and therefore the formation of the upper edge 22 to a height which can be aligned with the visible surface 18 or recessed, for example to half of the groove 14 (see the examples in figs. 1a – 1f).

In this case, in order to make the desired development of the upper edge 22 of the filled grooves 14, it is essential, during the injection, to have the disposition of the tesserae 12 with the visible surface 18 facing downward, in direct or indirect contact with the silicone based plane 30, depending on whether there is paper 36 or not.

The same effect is used to make the desired development of the filled perimeter grooves 15.

An advantageous embodiment of the invention provides that the positioning device 51 in correspondence with the loading station 44 is of the automated type and controlled by the control unit 43.

The device 51, in a traditional way, can be an automatic loader which makes the tesserae 12 drop onto a grid or directly onto the work plane 30, as in fig. 3. A

vibrating plate cooperating at the lower part with the grid or work plane 30 gradually determines the insertion of the tesserae 12 into the seatings 30a endowed with flared holes, configured so as to allow a univocal direction of insertion of the tesserae 12.

According to an alternative solution shown in fig. 9, the device 51 comprises a plurality of manipulators with suckers 54, moved by a manipulator-bearing head 52 disposed cantilevered above a tesserae-bearing tray 56, made of cavities or seatings 58, disposed according to the desired geometric disposition with which the panel 10 is to be made.

The manipulator-bearing head 51 is able to move in the three main directions, as indicated by the set of three orthogonal axes X, Y and Z, in order to position the tesserae 12 exactly in the various cavities or seatings 58.

Alternatively, the manipulators 54 could be fixed and the tesserae-bearing tray 56 below could move, according to a prefixed pattern consistent with the desired grooves 14 and 15 to be made.

The cavities 58 are disposed distanced at a distance consistent with the distance S desired between one tessera 12 and the other in the final panel 10.

The sizes of the cavities 58 are coordinated with those of the tesserae 12, advantageously slightly bigger in width and length for easier positioning.

The cavities 58 are not as deep as the thickness of the tesserae 12, so as to leave the space needed for the injection of the elastic polymer 16 into the grooves 14.

The bottom of each of the cavities 58 has suction holes 32, for the suction to the station 46.

Each of the manipulators 54 picks up a relative tessera 12 and deposits it exactly in a corresponding cavity 58.

Once filled, the tray 56 is transported to the subsequent station 46.

Instead of using the tray 56, in this case too it is possible to use a grid or work plane 30 as described above.

Other forms of embodiment of the loading device 51 known in the state of the art are applicable to the present invention.

Another variant of the invention, advantageous when there is a need for stacking, packaging or stocking, provides to dispose the tesserae 12 in trays 62

made of polystyrene or other comparable material (fig. 13), which is light, at least partly transpirant for suction and inert with respect to the elastic polymers used. The trays 62 have housing seatings 63 for the tesserae 12, disposed consistently with the desired final geometry of the panel 10, lateral shoulders 65 to define the perimeter grooves of the panel 10 and suction holes 32 for suction during the vacuum injection step of the elastic polymer 16.

The advantage of using the polystyrene trays 62 is that, once they have been filled with the tesserae 12 and the injection of elastic polymer 16 has been carried out, everything is already ready to send for packaging, subject to possible surface finishing, with the polystyrene material acting as an effective spacer and distancer between one panel 10 and another and thus allowing to stack the tesserae 12 without the risk of spoiling the visible surface 18 thereof.

The machine 41 functions as follows.

In the loading station 44, there is a first loading step, arrow F, of the tesserae 12.

In this step the tesserae 12 are controlled by the television camera 45.

In the first step, according to a first solution, the tesserae 12 can be disposed manually, or by means of the loading device 51, in the embodiment with the vibrating plate or by means of the manipulators 54, in a manner consistent with said predetermined geometry, in which the tesserae 12 are disposed with the visible surface 18 facing downward in one of the work planes 30, 60 or trays 56, 58, 62 as described above.

According to the invention, in the second injection station 46, the paper 36 can be used, or as an alternative it may be provided that the material of the work plane 30 is inert with respect to the elastic polymer 16.

In the second injection station 46 an automated injection or casting step of the elastic polymer 16 which has not yet been catalyzed inside the grooves 14 and 15 is carried out and the subsequent catalyzing of the polymer itself. At the same time as the injection, there is the vacuum suction, by means of the vacuum pump 34, to selectively clamp the tesserae 12 during injection, to prevent them moving freely.

In the third control station 48, there is a third control step, by means of a television camera 47, to control the tesserae 12 connected by the elastic polymer

16, in order to detect defects or inaccuracies in the injection.

There is finally a fourth step of sending the panel 10 consisting of the tesserae 12 connected by the elastic polymer 16 to further workings or packaging or for discard, as indicated by the arrows G and D, depending on the outcome of the control carried out in the third step.

If the polystyrene tray 62 is used, the panel 10 is at this point already ready for stacking and stocking or sending to the client.

In the variant shown in fig. 8, as we said, there is a supplementary touching-up station 50.

It is advantageous that the elastic polymer 16, which acts as a filling liquid, is cast in one direction only and, being self leveling, it distributes itself in the orthogonal grooves 14. A vibrating device can help the distribution of the elastic polymer 16 in the grooves 14.

Once the panel 10 has been made, according to one of the ways described above, it must be seasoned in a suitable stocking area, without removing the tray which, once the seasoning is complete, can act as a protective element for the surface of the mosaic from production up to the moment it is laid.

It is clear that modifications and/or additions of parts and/or steps may be made to the panel 10, to the machine and to the method as described heretofore, without departing from the field and scope of the present invention.

It is also clear that, although the present invention has been described with reference to some specific examples, a person of skill in the art shall certainly be able to achieve many other equivalent forms of method and machine to make a modular covering panel, and a modular panel thus made, having the characteristics as set forth in the claims and hence all coming within the field of protection defined thereby.

CLAIMS

1. Method to make a modular covering panel (10) comprising a plurality of tesserae or tiles (12) having a visible surface (18) and an opposite base surface (20), said tesserae or tiles (12) being distanced from each other according to a predetermined geometry so as to define a plurality of grooves (14) into which a cohesion material (16) is introduced by means of injection or casting, characterized in that it comprises the following steps:

- a first step of disposing the tesserae or tiles (12) on support elements (30, 56, 60, 62), in which the tesserae or tiles (12) are disposed with the visible surface (18) in direct or indirect contact with the support elements (30, 56, 60, 62);

- a second step of injecting or casting the cohesion material (16) into the grooves (14), in which there is also, at least at the same time as the introduction of the cohesion material (16), a vacuum suction operation, on the side opposite that of injection, by means of suction means (34), to clamp the tesserae or tiles (12) to the support elements (30, 56, 60, 62).

2. Method as in claim 1, characterized in that in the first step a control operation is also provided, by means of a video acquisition device (45), to control the tesserae or tiles (12) in order to verify the integrity thereof and/or the presence/absence of defects.

3. Method as in claim 1 or 2, characterized in that it comprises a third control step, by means of a video acquisition device (47), to control the tesserae (12) connected by the cohesion material (16), in order to detect defects or inaccuracies in the injection of the cohesion material (16).

4. Method as in claim 3, characterized in that it comprises a fourth step of sending the tesserae (12) connected by the cohesion material (16) to further workings or to packaging or to discard, depending on the outcome of the control performed in the third step.

5. Method as in any claim hereinbefore, characterized in that the support elements (30, 56, 60, 62) are also able to define, in cooperation with the tesserae or tiles (12), one or more perimeter grooves (15) along at least part of the perimeter of the modular panel (10), and in that, in the second step, it is provided to fill the perimeter grooves (15) by means of the cohesion material (16).

6. Method as in claim 5, characterized in that the cohesion material (16) is cast or

injected or disposed along the perimeter of said panel (10) for a width equal to half of the width (S) of said grooves (14), so as to define the perimeter grooves (15).

7. Method as in claim 5, characterized in that the cohesion material (16) is cast or injected or disposed only along two consecutive sides of the perimeter of said panel (10) for a width equal to the width (S) of said grooves (14), so as to define the perimeter grooves (15).

8. Method as in any claim hereinbefore, characterized in that the cohesion material is based on an elastic polymer (16).

9. Method as in claim 8, characterized in that said elastic polymer (16) is chosen from among mono or bi-component reactive resins comprising the following resins:

1.a) polyurethanes (both aliphatic and aromatic)

1.b) silylated polyurethanes (SPUR)

1.c) silicones

1.d) modified silicones (MS-Polymer)

1.e) acrylics.

10. Method as in claim 8 or 9, characterized in that in the second step it provides to fill the grooves (14) by means of an elastic polymer that is not yet catalyzed, and to subsequently catalyze the elastic polymer (16).

11. Method as in claim 8, 9 or 10, characterized in that said elastic polymer (16) comprises colored pigments incorporated inside it.

12. Method as in claim 4, characterized in that in the fourth step the tiles or tesserae, connected to each other by the cohesion material (16), are removed from the support elements (30, 56, 60, 62).

13. Method as in claim 4, characterized in that in the fourth step the support elements (62) are kept assembled with the tiles or tesserae (12) connected by the cohesion material (16), the support elements consisting of at least a tray (62) able to function as a partial packaging for the panel (10) and made of a low-density polymer material and substantially inert with respect to the cohesion material (16).

14. Method as in any claim hereinbefore, characterized in that in said second step said cohesion material (16) is injected into at least said grooves (14) by means of

a plurality of nozzles (28) disposed above said support elements (30, 56, 60, 62).

15. Method as in claim 14, characterized in that the nozzles (28) are fixed and the support elements (30, 56, 60, 62) are able to be moved below the nozzles (28).

16. Method as in claim 14, characterized in that the nozzles (28) are able to be moved, above the support elements (30, 56, 60, 62), automatically by means of relative nozzle-bearing heads (26).

17. Method as in any claim hereinbefore, characterized in that in said second step said cohesion material (16) is injected into said grooves (14) by means of a single nozzle (28) moved automatically by a robotized member (40).

18. Method as in any claim hereinbefore, characterized in that in said first step, each of the tesserae or tiles (12) is positioned in a suitable seating (30a) of a grid that functions as a support element (30), by means of an automatic loader of tesserae or tiles (12), able to cooperate with a vibrating device acting on the support element (30) in order to direct correctly the tesserae or tiles (12) in the seatings (30a).

19. Method as in any claim hereinbefore, characterized in that in said first step each of the tesserae or tiles (12) is positioned in a suitable seating (58) of the support elements (56) by means of relative manipulator means (54), which are able to be moved automatically by means of a manipulator-bearing head (52).

20. Method as in any claim hereinbefore, characterized in that the disposition of the tesserae or tiles (12) in the first step is consistent with said predetermined geometry.

21. Method as in any claim hereinbefore, characterized in that the support elements consist of a work plane (60) made of elastically deformable material and inert with respect to the cohesion material (16), wherein in said second step the suction operation determines the selective deformation, by the tesserae or tiles (12) subjected to suction, of the work plane (60) in correspondence with at least the relative grooves (14), so as to achieve protuberances (61) able to define, in cooperation with the cohesion material (16) injected or cast, an upper edge (22) of the filled grooves (14).

22. Method as in any claim hereinbefore, characterized in that in the second step an operation is provided to deposit a film (36) made of a material having transpirant properties and with low or zero inertia with respect to the cohesion

material (16), between the support elements (30) and the tesserae or tiles (12).

23. Method as in any claim hereinbefore, characterized in that in the second step a control operation is provided, by means of a video acquisition device (39), by means of which control operation the presence/absence of cohesion material (16) on the film (36) is controlled, and according to said control operation it is determined to replace or not at least part of the film (36).

24. Method as in any claim hereinbefore, characterized in that at least said first and said second step are controlled and commanded automatically, according to one or more predetermined work programs or cycles that can be selected by means of a control unit (43) of the electronic type.

25. Method as in claim 3, 4 and 24, characterized in that the third and fourth step are also controlled and commanded by the control unit (43).

26. Machine to make a modular covering panel (10) comprising a plurality of tesserae or tiles (12) having a visible surface (18) and an opposite base surface (20), said tesserae or tiles (12) being distanced from each other according to a predetermined geometry so as to define a plurality of grooves (14) able to be filled with a cohesion material (16), characterized in that it comprises:

- a first loading station (44) comprising positioning means (51) to position the tesserae or tiles (12), able to position the tesserae or tiles (12) according to the pre-determined geometry;
- support elements (30, 56, 60, 62) on which the tesserae or tiles (12) are positioned in direct or indirect contact by means of the positioning means (51), according to the pre-determined geometry; and
- a second injection or casting station (46) comprising:

i) injection means (28) to inject the cohesion material (16) inside the grooves (14) and

ii) suction means (34) able to carry out a vacuum suction operation to clamp the tesserae or tiles (12) to the support elements (30, 56, 60, 62) during the injection.

27. Machine as in claim 26, characterized in that it also comprises:

- a third control station (48) to control the tesserae (12) connected by the cohesion material (16), able to determine the sending of the tesserae (12) connected by the cohesion material (16) to further workings or packing or discard;

- automated movement means (42) able to move the tesserae or tiles (12) between the first loading station (44) and the second injection or casting station (46) and to move the panel (10) obtained in the second injection or casting station (46) between the latter and the third control station (48); and
- an electronic type control unit (43) able to automatically control in a coordinated manner, according to one or more selectable work programs or cycles, the functioning of the first loading station (44), the second injection or casting station (46) and the third control station (48).

28. Machine as in claim 26 or 27, characterized in that in the second injection or casting station (46), the suction means (34) are positioned below a support plane (33) provided with suction holes (35), on which plane (33) the support elements (30, 56, 60, 62) that carry the tesserae or tiles (12) are positioned.

29. Machine as in claim 26, 27 or 28, characterized in that in the second injection or casting station (46), the automated injection means (28) are positioned above the support plane (33).

30. Machine as in any claim from 26 to 29, characterized in that the first loading station (44) comprises at least a video acquisition device (45) to verify the integrity and/or the presence/absence of defects in the tesserae or tiles (12).

31. Machine as in claim 27, characterized in that the third control station (48) comprises at least a video acquisition device (47) to detect defects or inaccuracies in the injection or casting of the cohesion material (16).

32. Machine as in any claim from 26 to 31, characterized in that the second injection or casting station (46) comprises a plurality of nozzles (28) disposed above the support elements (30, 56, 60, 62) for the injection or casting of the cohesion material (16).

33. Machine as in claim 32, characterized in that the nozzles (28) are fixed and the support elements (30, 56, 60, 62) are able to be moved below the nozzles (28).

34. Machine as in claim 32, characterized in that the nozzles (28) are able to be moved above the support elements (30, 56, 60, 62) automatically by means of relative nozzle-bearing heads (26).

35. Machine as in any claim from 26 to 31, characterized in that the second injection or casting station (46) comprises a single nozzle (28) moved

automatically by a robotized member (40) to inject the cohesion material (16) into the grooves (14).

36. Machine as in any claim from 26 to 35, characterized in that the first loading station (44) comprises a loading device (51) to load the tesserae or tiles (12) and a vibrating plate which are able to cooperate in order to dispose automatically each of the tesserae or tiles (12) in a suitable seating (30a) of a grid that functions as a support element (30), the seatings (30a) being shaped so as to determine a preferential direction of insertion of the tesserae or tiles (12).

37. Machine as in any claim from 26 to 35, characterized in that the first loading station (44) comprises a loading device (51) having manipulator means (54), which are able to be moved automatically by means of a manipulator-bearing head (52) so as to position each of the tesserae or tiles (12) in a suitable seating (58) of the support elements (56).

38. Machine as in any claim from 26 to 35, characterized in that the support elements consist of a work plane (30) made of material having properties with low or zero inertia with respect to the cohesion material (16) and provided with holes (32) for suction.

39. Machine as in any claim from 26 to 35, characterized in that the support elements consist of a work plane (60) made of elastically deformable material inert with respect to the cohesion material (16), said work plane (60) being provided with holes (32) for suction and being able to deform under the combined action of said suction means (34) and said tesserae or tiles (12), in order to achieve protuberances (61) that protrude upward, by means of which at least the upper edge (22) of the grooves (14) is defined.

40. Machine as in any claim from 26 to 35, characterized in that the support elements consist of a tray (56) comprising a plurality of seatings, or cavities (58), ordered in a manner consistent with said predetermined geometry, in each of which one of the tesserae or tiles (12) is able to be housed, each seating or cavity (58) also having holes (32) for suction.

41. Machine as in any claim from 26 to 35, characterized in that the support elements consist of a tray (62) able to function as a partial packing for the panel (10) and made of a low-density polymer material substantially inert with respect to the cohesion material (16), the tray (62) being provided with holes (32) for

suction and having pre-formed protuberances (64) by means of which the upper edge (22) of the grooves (14) is defined.

42. Machine as in any claim from 26 to 35, characterized in that it comprises at least a film (36) made with a material having transpirant properties and with low or zero inertia with respect to the cohesion material (16), and feed means (38) able to selectively feed the film (36) in a position between the support elements (30) and the tesserae or tiles (12).

43. Machine as in claim 42, characterized in that the second injection or casting station (46) comprises at least a video acquisition device (39), by means of which the presence/absence of cohesion material (16) on the film (36) is controlled and according to said control operation it is determined to replace or not at least part of the film (36).

44. Machine as in any claim from 26 to 43, characterized in that the cohesion material (16) has an elastic polymer base.

45. Machine as in claim 44, characterized in that said elastic polymer (16) is chosen from among the mono or bi-component reactive resins comprising the following resins:

1.a) polyurethanes (both aliphatic and aromatic)

1.b) silylated polyurethanes (SPUR)

1.c) silicones

1.d) modified silicones (MS-Polymer)

1.e) acrylics.

46. Machine as in claim 44 or 45, characterized in that said elastic polymer comprises colored pigments incorporated inside it.

47. Modular covering panel (10) comprising a plurality of tesserae or tiles (12) having a visible surface (18) and an opposite base surface (20), said tesserae or tiles (12) being distanced from each other by a length (S), according to a predetermined geometry, so as to define a plurality of grooves (14) filled by a cohesion material (16), characterized in that the cross section of the cohesion material (16) at least in the grooves (14) has an upper edge (22), in correspondence with the visible surface (18), having a rectilinear or concave development, and a lower edge (22), in correspondence with the base surface (20), having a rectilinear or concave development.

48. Panel as in claim 47, characterized in that the cohesion material (16) has an elastic polymer base.

49. Panel as in claim 48, characterized in that said elastic polymer (16) is chosen from among the mono or bi-component reactive resins comprising the following resins:

1.a) polyurethanes (both aliphatic and aromatic)

1.b) silylated polyurethanes (SPUR)

1.c) silicones

1.d) modified silicones (MS-Polymer)

1.e) acrylics.

50. Panel as in claim 47, 48 or 49, characterized in that said elastic polymer comprises colored pigments incorporated inside it.

51. Panel as in any claim from 47 to 50, characterized in that each of the tesserae or tiles (12) has sizes varying from about 10x10 mm to about 100x100 mm.

52. Panel as in any claim from 47 to 51, characterized in that each of the tesserae or tiles (12) is a mosaic tessera having sizes of about 20x20 mm.

53. Panel as in any claim from 47 to 50, characterized in that each of the tesserae or tiles (12) has an irregular shape.

54. Panel as in any claim from 47 to 53, characterized in that it also comprises said cohesion material (16) along at least part of its perimeter, to define a filled perimeter groove (15).

55. Panel as in claim 54, characterized in that the perimeter groove (15) extends along the whole perimeter, having a width equal to about half said distance (S).

56. Panel as in claim 54, characterized in that the perimeter groove (15) extends along two consecutive sides of the perimeter only, having a width equal to about the distance (S).

57. Panel as in claim 54, characterized in that the filled perimeter groove (15) has an upper edge (22), in correspondence with the visible surface (18), having a rectilinear or concave development, and a lower edge (22), in correspondence with the base surface (20), having a rectilinear or concave development.

58. Panel as in any claim from 47 to 57, characterized in that the tesserae or tiles (12) are disposed on the same plane.

59. Use of an elastic polymer (16) as a cohesion material, which is introduced by

means of injection or casting into the grooves (14) defined by tesserae or tiles (12) of a modular covering panel (10), said elastic polymer chosen from among the mono or bi-component reactive resins comprising the following resins:

1.a) polyurethanes (both aliphatic and aromatic)

1.b) silylated polyurethanes (SPUR)

1.c) silicones

1.d) modified silicones (MS-Polymer)

1.e) acrylics.

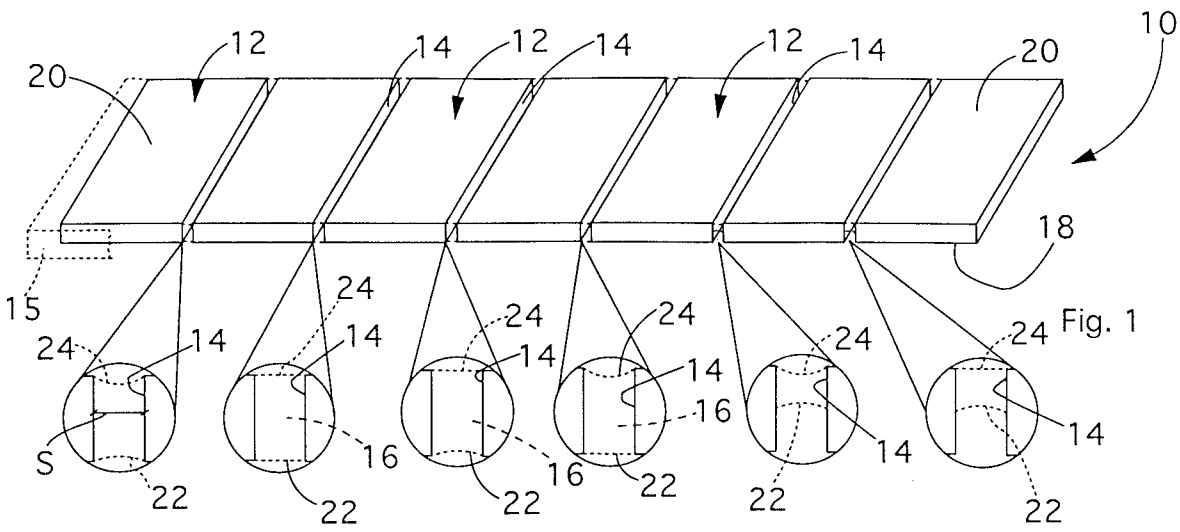

Fig. 1

Fig. 1a Fig. 1b Fig. 1c Fig. 1d Fig. 1e Fig. 1f

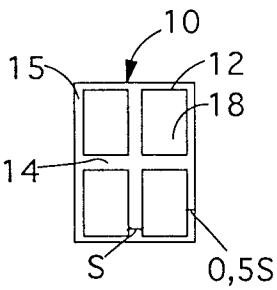

Fig. 2a

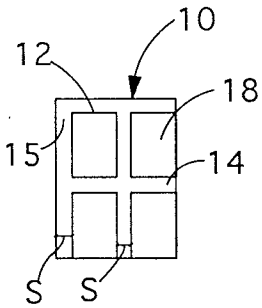

Fig. 2b

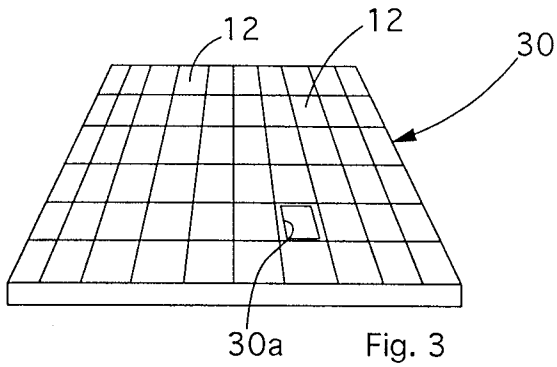

Fig. 3

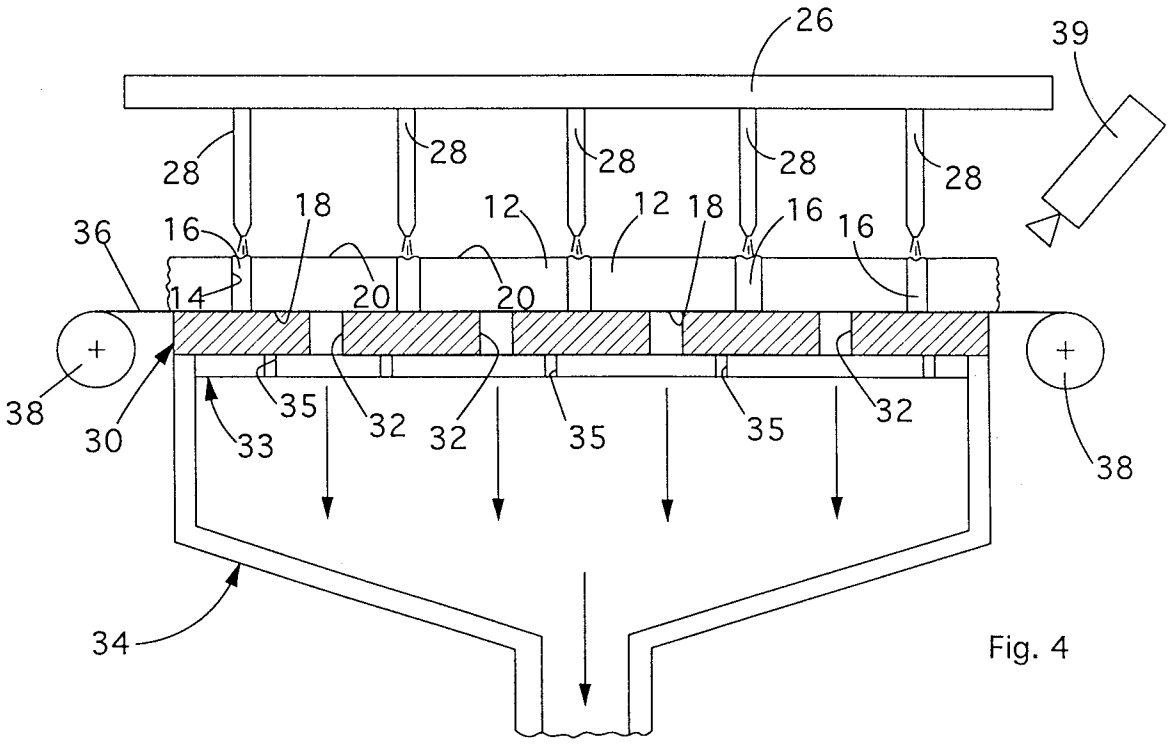

Fig. 4

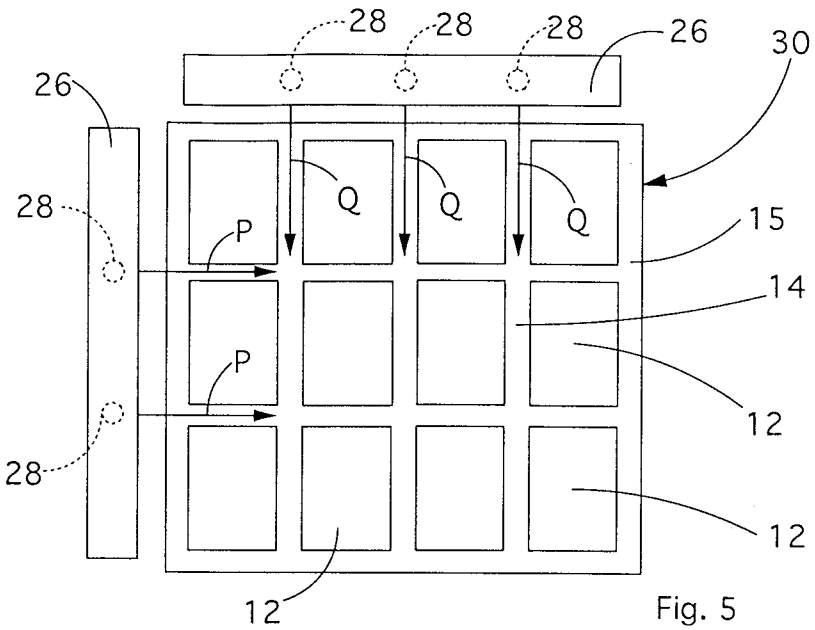

Fig. 5

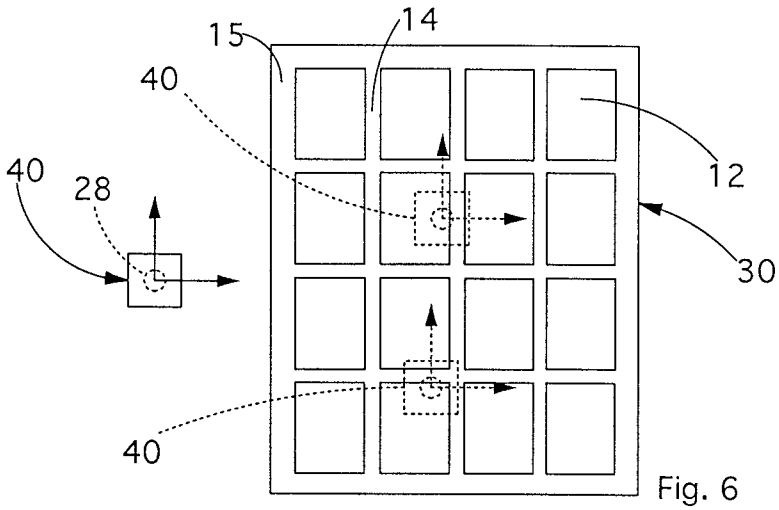

Fig. 6

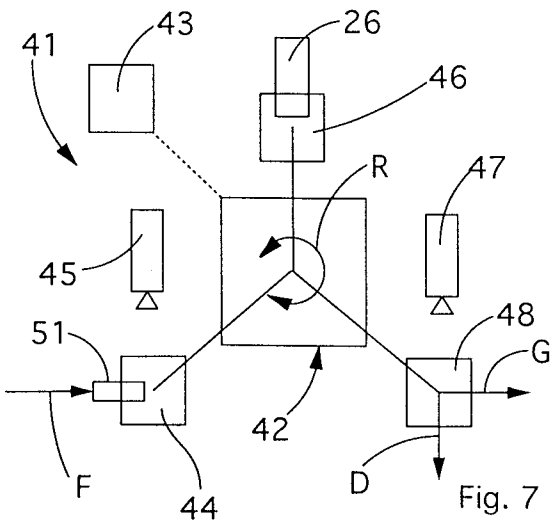

Fig. 7

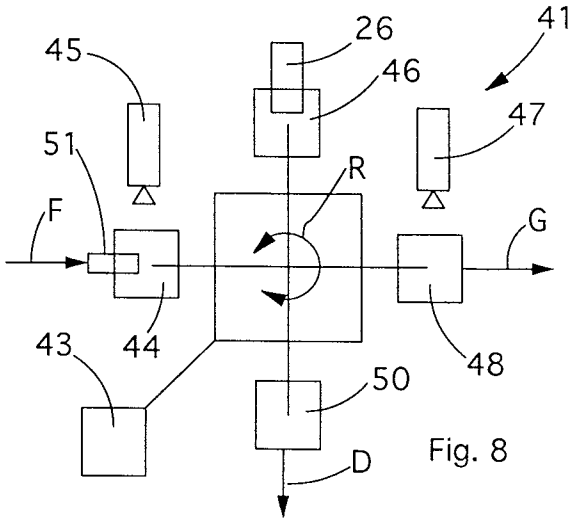

Fig. 8

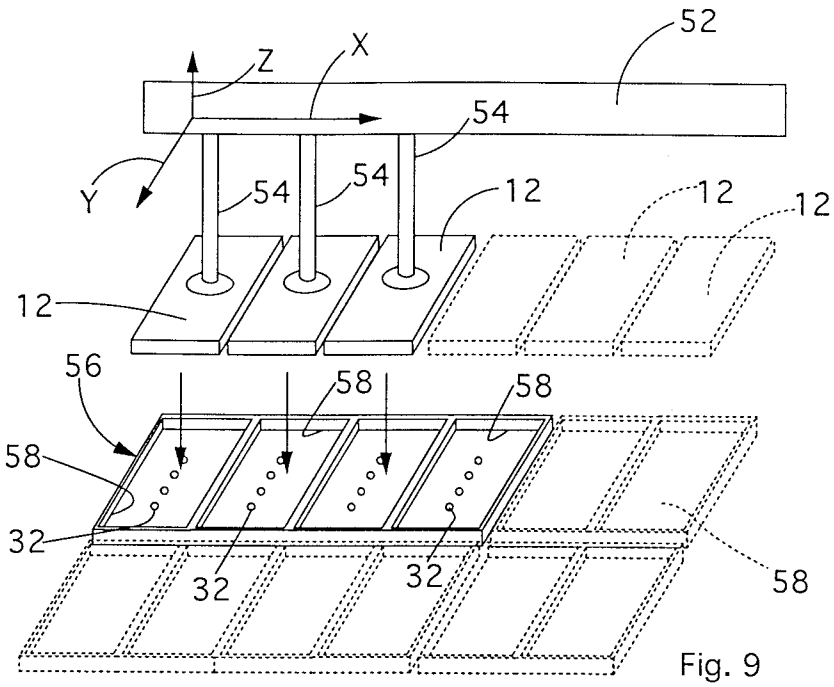

Fig. 9

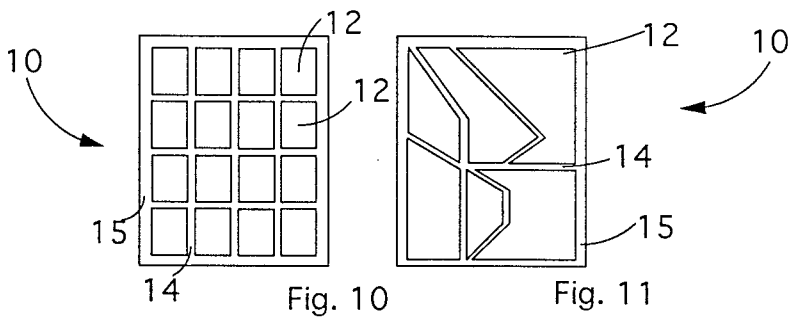

Fig. 10 Fig. 11

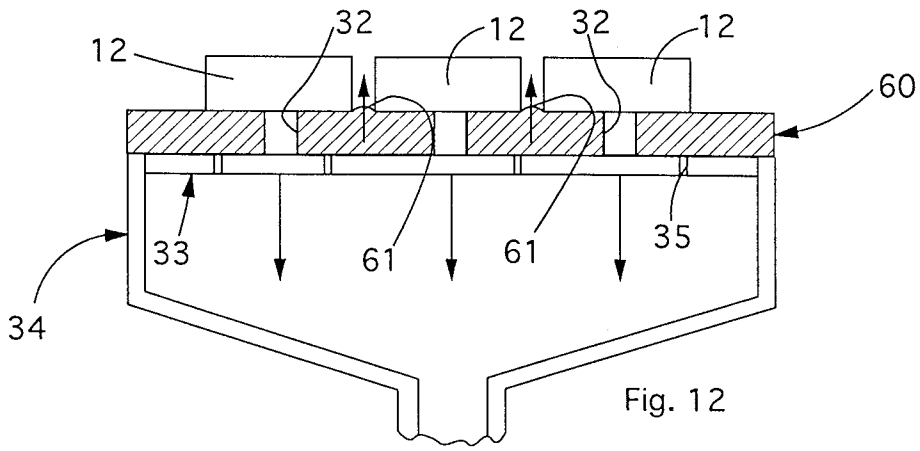

Fig. 12

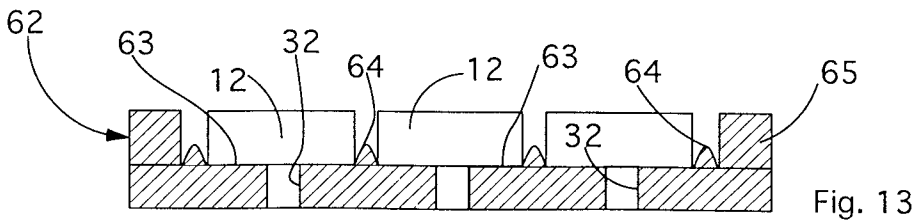

Fig. 13