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(54) Method for forming uniformly compacted ceramic tiles, means for its implementation, and tiles produced thereby.

(57) A method for moulding uniformly compacted tiles comprises forming a test tile (11), measuring the hardness or compactness of said test tile at a large number of points on its surface, locally varying the thickness of the punch (1) for forming the reverse face of the tile in those regions of the punch corresponding to those tile hardness values which most differ from the mean value of the largest number of measurements of approximately equal value.

Said three operations, namely forming, measuring and varying, are then repeated until a substantially uniformly compacted tile (111) is obtained, after which other tiles (111) are continuously moulded until the pressing conditions change.

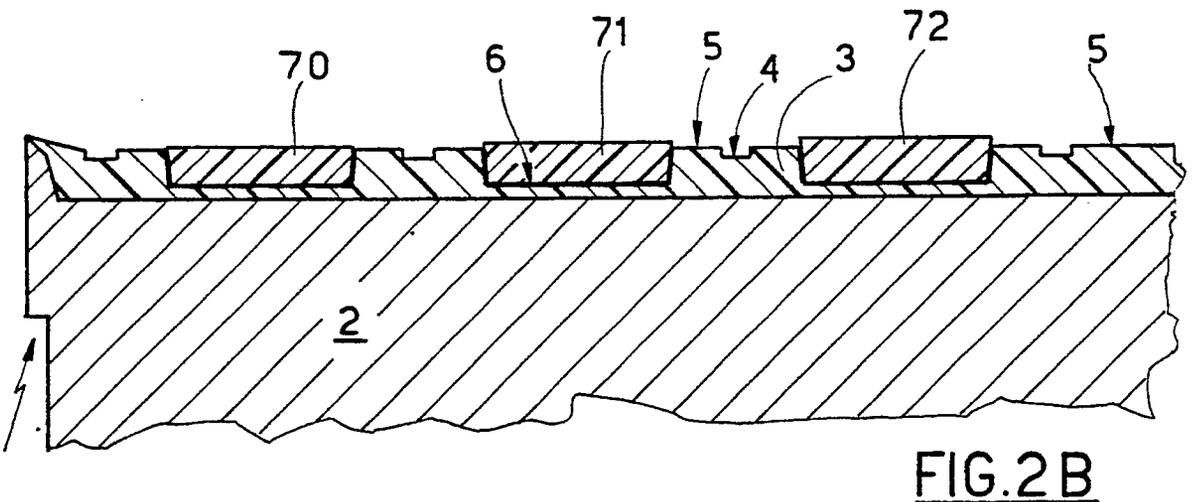

FIG.2B

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METHOD FOR FORMING UNIFORMLY COMPACTED CERAMIC TILES, MEANS FOR ITS IMPLEMENTATION, AND TILES PRODUCED THEREBY

This invention relates to a method for uniformly compacting ceramic tiles in general, and the means for its implementation.

In the known art, ceramic tiles are formed by suitable forming moulds, after which they are fired using methods or systems which it would be superfluous to describe herein.

The regularity of the tile edges after firing is greater the greater the uniformity of the compaction to which the tiles have been subjected during their formation.

In other words, if the tile has been uniformly compacted it undergoes homogeneous shrinkage during firing, whereas if the same tile has been non-homogeneously compacted it undergoes differential shrinkage during firing.

In the first case the edges of the fired tile are regular, whereas in the second case they are irregular.

For example, in the case of a straight-edge tile compacted non-homogeneously, as usually happens in the known art, its edges are no longer straight after firing, or mutually perpendicular.

When such pieces are fitted together or installed, their overall appearance is relatively poor, particularly in the case of large formats.

This also applies to tiles of special format, such as those having curved edges or straight edges inclined to each other at angles other than a right angle.

In spite of the various attempts made up to the present time, means are still not available for compacting tiles in a substantially uniform manner.

This is because the compaction of the clay does not only depend on the manner in which the clay is pressed or on the means used for this, but also depends on other factors which are difficult to simultaneously overcome in order to make the tile pressing homogeneous.

Such non-homogeneous pressing can be due for example to a non-uniform particle size of the clay fed into the forming cavity in the mould, to different densities within the layer of clay fed into the mould, to a non-uniform thickness of said layer, and to relative settling or displacement of the parts which define the forming cavity.

Again, the feeding of the clay can vary with variation in the production rate of the corresponding ceramic press, and these factors, which are difficult to control or quantify, have hindered all attempts at producing a virtually uniformly compacted tile.é

The main object of the present invention is to provide a method and the means for its implementation, by which perfectly compacted tiles can be formed, to thus comprise regular edges after firing.

The method according to the invention comprises forming a ceramic test tile; measuring the compactness or hardness of the test tile at a plurality of points on one face of the tile; locally varying, in the sense of increasing or reducing, the thickness of the punch for forming the reverse face of the tile in those regions of the punch corresponding to those tile hardness values which most differ from the mean value of the largest number of measurements of approximately equal value; repeating said three operations until a substantially uniformly compacted tile is obtained; and continuously forming other tiles until the pressing conditions change.

The means proposed for implementing the method of the invention consist of a punch and a forming mould provided therewith, and in particular a punch for applying the trademark, ie for forming the reverse face of the ceramic tile.

The punch according to the invention is provided on its working surface with a plurality of small recesses of preferably identical shape, such as rectangular, with which a plurality of interchangeable inserts having different characteristics or properties are associated.

Said inserts are arranged to be inserted practically as an exact fit into said recesses, said inserts being preferably of the same material as the working surface of the punch. This surface can be of metal, but in a preferred embodiment of the invention is of rubber.

If said working surface is of rubber, the interchangeable inserts can have different thicknesses and possess the same elastic characteristics as the working surface of the punch, or can have the same thickness and be produced from elastomers having elastic properties which differ from those of the working surface of the punch.

Again, said recesses are preferably provided over the entire working surface of the punch, and are preferably regularly distributed thereon.

The characteristics and merits of the invention will be better understood from the description given hereinafter with reference to the accompanying exemplifying figures, which illustrate a preferred embodiment of a punch for implementing the method according to the invention.

Figure 1 is a perspective view of a punch according to the invention, with all the recesses shown free or empty for clarity.

Figure 2A shows part of the section on the line II-II of Figure 1 to an enlarged scale, with a

standard insert, ie one having a thickness equal to the recess depth, inserted into one of the recesses.

Figure 2B is a view similar to the preceding, showing the same punch modified in order to uniformly compact the ceramic tiles.

Figure 3A is an enlarged section through that tile part produced by the punch part shown in Figure 2A when standard inserts are inserted into the recesses.

Figure 3B is a section similar to that of Figure 3A, but showing the same tile part when uniformly compacted by the modified punch part shown in Figure 2B.

Said figures, and in particular Figure 1, show a reverse face punch 1, ie for forming the reverse or laying face of the tiles, and with which a ceramic mould of any known type is to be associated in known manner.

The punch 1 can be fixed in any known manner, for example mechanically or magnetically, and be arranged at the top or the bottom of the corresponding forming cavity. This is well known to the expert of the art.

The working surface of the punch 1 can be of metal or be of rubber or another equivalent elastomer.

In the illustrated example (see Figures 2A, 2B) the punch 1 comprises a metal connection base 2 provided upperly with a cavity in which a rubber layer 3 is fixed in any known manner.

In the illustrated case the punch 1 is of rectangular shape, and more specifically square, but there is nothing to prevent the characterising elements according to the invention being used for any other format, whether of large or small dimensions, or with special shapes, including those comprising curved or arched edges.

As can be seen in Figure 1, on the rubber layer 3 there is provided a regular grid of small identical grooves 4, which in the illustrated case are arranged parallel to the pairs of opposing sides of the punch 1.

The purpose of said grooves 4 will be apparent hereinafter, they defining a plurality of raised portions or projections indicated by 5. As can be seen from Figure 1, some of the projections 5 are provided concentrically with respective square recesses 6 with radiused corners, and identical with each other in both shape and depth.

The dimensions of said grooves 4, projections 5 and recesses 6 are not particularly critical, and depend obviously on the format of the punch 1 and the thickness the rubber layer 3.

For example, for a 35 x 35 cm punch with a 4 mm rubber layer, the following millimetre dimensions can be used:

- groove depth 0.4-0.6
- grove width 2-5
- projection size 28-36
- recess size 22-30
- recess depth 3.

At this point it should be noted that the recesses 6 shown in Figure 1 are arranged in marginal groups along the lateral bands of the punch, whereas the projections are grouped substantially along the diagonals of the punch.

This is in no way to be considered limitative, in that the recesses 6 can be provided over the entire working surface of the punch, or more precisely in all the recesses 5.

It should also be noted that the particular distribution of the recesses 6, as illustrated and described, is typically suitable for reverse face punches intended to cooperate with obverse face punches (ie those for forming the exposed face of the tile) with flat working faces. In contrast, recesses 6 are provided preferably over the entire working surface of the reverse face punch 1 if this is to cooperate with an obverse face punch with its working surface relief-patterned, for example embossed.

It should also be noted that the distribution of the recesses 6 as shown in Figure 3 derives from the fact that the loading of the clay into the forming cavity is non-uniform both along those edges of the forming cavity parallel to the running direction of the loading carriage and along those edges perpendicular thereto. This is well known to the expert of the art.

According to the invention, with said recesses 6 there is associated a plurality of interchangeable inserts 7, of which only one is shown in Figure 1, and which are intended to be inserted, practically as an exact fit, into said recesses 6.

Specifically, each recess 6 has available a set of identically shaped inserts 7 which differ in thickness by 0.1-0.2 mm from each other.

Thus, by inserting said different-thickness inserts 7, recesses 6 of different depths can be obtained, and be suitably distributed, for example in rows parallel to the sides of the punch 1.

The inserts 7 are of rubber construction, however if the surface of the punch 1 is of metal the inserts will also be of metal.

Tile different-thickness rubber inserts are of the same material as the layer 3 and, according to an alternative embodiment, the inserts associated with each individual recess 6 can all have substantially the same thickness, but have different elastic characteristics.

Again, in the case of inserts with different elastic characteristics, recesses of different depths can be obtained.

What is important is that in all cases the working face of the insert 7 must never lie below the base wall of the groove 4, either when the insert is

at rest or when the insert is undergoing pressing.

In this respect, with reference to Figures 3A and 3B, seeing that the grooves 4 are provided to form corresponding ribs 44 on the reverse face of the tile 11 or 111, and also that these latter represent the surface by which the tile rests on the rollers of the single-layer firing kiln, if the aforesaid dimensional characteristic is not respected, projections would be created which jut beyond said ribs 44, leading to tile transport problems. It should be noted that the recesses 6 can also hue any shape other than that shown.

Again, instead of the grooves 4, impressions of another shape or type can be provided between the recesses 6, which other impressions could for example be the usual cavities for forming the characteristic feet of ceramic tiles.

The procedure for producing a uniformly compacted tile 111 (see Figure 3B) according to the invention is as follows.

A usual forming mould is fitted with the described reverse face punch (or punches) 1, in the recesses 6 of which respective standard inserts are inserted. Standard inserts 7 are those inserts having a thickness equal to the depth of the recesses 6. This is well illustrated to the right of Figure 2A.

The mould forming cavity (or cavities) is filled with clay in the usual manner, and then pressed to obtain the test tile indicated by 11 in Figure 3A, and which will probably not be uniformly compacted for the reasons given heretofore.

In said Figure 3A, the reference numerals 44, 55, 77 indicate those parts or regions of the tile 11 which have been shaped or formed by the corresponding parts 4, 5 and 7 of the punch 1.

The tile formed in this manner is placed on a test bench, where the tile hardness or compactness is measured with a suitable instrument such as a penetrometer or durometer. These measurements are preferably made in all the regions 55 and 77 of the tile.

The thickness of the punch 1, or rather the pattern of its working face, is then modified locally on the basis of these readings or measurements.

This is done by placing inserts of thickness different from the standard in those recesses 6 corresponding to those regions 77 of the tile 11 having hardness values which most differ from the mean value of the largest number of measurements of approximately equal value.

Specifically, inserts of greater thickness are placed in those recesses 6 corresponding to tile regions of lesser hardnesses, and inserts of lesser thickness are placed in those recesses 6 corresponding to greater hardnesses.

This applies particularly, and in a totally general sense, to a reverse face punch 1 associated with an obverse face punch (not shown) with a flat working face. In this respect, from the many tests carried out with a punch 1 according to the invention, it has been found that usually it is necessary to modify, in the sense of increasing, the punch thickness only locally, typically along the lateral bands, as most of the central region of the tile has substantially uniform compactness. After the punch 1 has been modified in this manner a further test tile 11 is formed and subjected to hardness measurements. If the measurements have remained more or less unchanged, tiles are then formed continuously and fed to the usual process cycles. Because of its uniform compacting, the tile has perfectly regular edges after firing, ie they are perfectly straight and mutually perpendicular.

However, if after said first punch modification the tile 11 is still compacted non-homogeneously, the punch is further modified one or more times in the aforesaid manner until a uniformly compacted tile is obtained.

Said tests and modifications have to be made each time the mould production rate is changed or the clay formulation or mixture varied.

In any event, using the aforesaid method tables can be prepared for a particular type of punch, to which reference can be made when at least one of the parameters which can influence the uniform compactness of the tiles varies.

In other words, after said tables have been prepared, the forming press need be halted only for the time required to change the inserts 7 when changing from one type of production to another.

The final punch, ie that modified for the purpose of uniformly compacting the tiles 111, is partly shown in Figure 2B in which the reference numerals 70, 71, 72,... indicate those inserts having a thickness other than the standard.

Correspondingly, in Figure 3B the reference numerals 700, 710, 720,... indicate the regions of the tile 111 which have been compacted by said inserts 70, 71, 72.

Finally, modifications can be made to the invention provided they fall within the following claims.

Claims

1. A method for forming uniformly compacted ceramic tiles, characterised by comprising the following operational stages:
- forming a ceramic test tile (11) within a forming cavity of a ceramic mould;
- measuring the hardness or compactness of said test tile at a plurality of points on its surface;
- locally varying, in the sense of increasing or reducing, the thickness of the punch (1) for forming the reverse face of the tile, in those regions of the

punch corresponding to those tile hardness values which which are respectively lower and greater than the mean value of the largest number of measurements of approximately equal value;
- repeating said three operations, namely forming, measuring and varying, until a substantially uniformly compacted tile (111) is obtained;
- continuously forming other tiles (11) until the pressing conditions change.

2. A punch for implementing the method claimed in claim 1, and particularly a reverse face punch (1) comprising in its working face cavities (4) for forming support elements (44) for said tiles, characterised by comprising a plurality of identically shaped recesses (6) interposed between said cavities (4) and distributed practically over the entire working face of the punch (1), with each individual recess there being associated a set of interchangeable inserts (7) which can be inserted practically as an exact fit into the respective recess and have characteristics which differ from those of the constituent material of the working face of the punch.

3. A punch as claimed in claim 2, characterised in that said recesses (6) are distributed regularly or uniformly over the entire working face of the punch (1), said working face and said inserts (7) being formed of the same material.

4. A punch as claimed in claims 2 and 3, characterised in that said working face and inserts are of metal, said recesses having the same depth and the inserts associated with each individual recess having slightly different thicknesses.

5. A punch as claimed in claims 2 and 3, characterised in that said working face and inserts are of elastomer, said recesses having the same depth and the interchangeable inserts associated with each individual recess having different thicknesses.

6. A punch as claimed in claims 2 and 5, characterised in that the inserts associated with each individual recess have a thickness practically equal to the recess depth and are formed of elastomer materials which, with the exception of one, are different from each other and from that which forms the working face of the punch.

7. A punch as claimed in claims 2 to 6, characterised in that the minimum thickness of said interchangeable inserts when subjected to the forming pressure is at least equal to the depth of the respective recess (6) less the depth of the cavity (4) for forming the support elements (44) for the tile (111).

8. A punch as claimed in claims 2 and 7, characterised in that at least those recesses distributed along the perimetral band of the punch working face have depths which differ from those of the central recesses.

9. A ceramic tile forming mould, characterised by comprising at least one reverse face punch claimed in claims 2 to 8.

10. Ceramic tiles obtained by the method claimed in claim 1 and by the means claimed in claims 2 to 9.

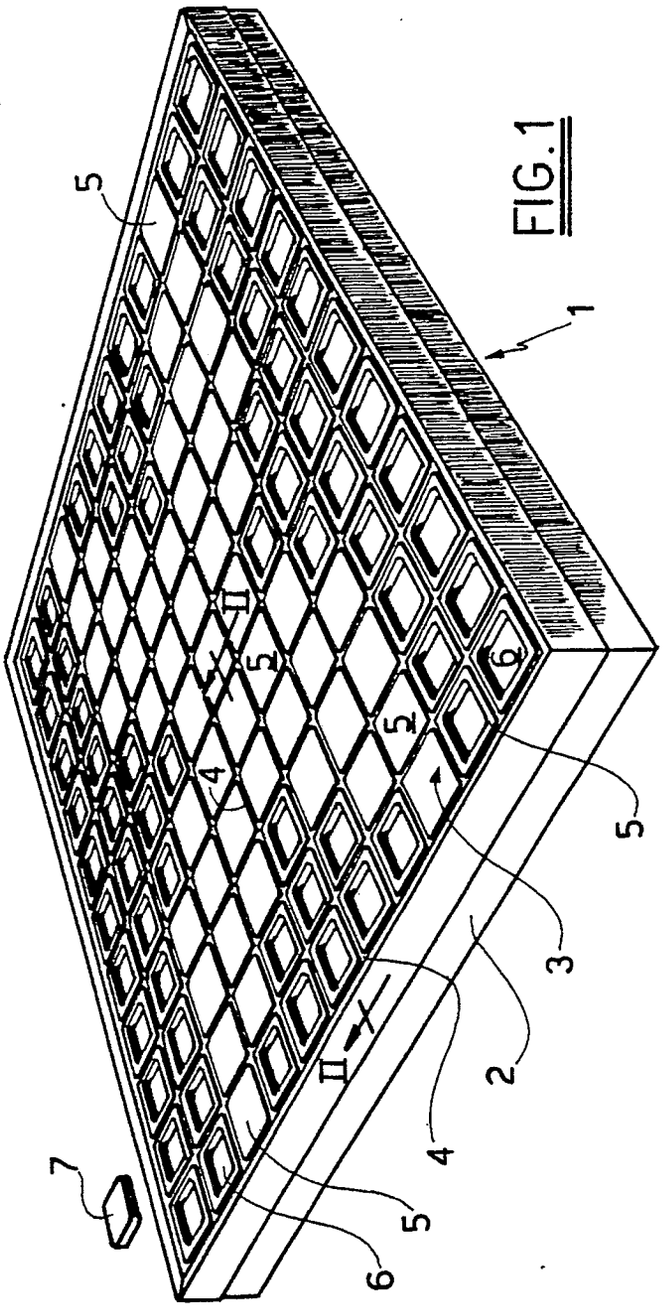

FIG.1

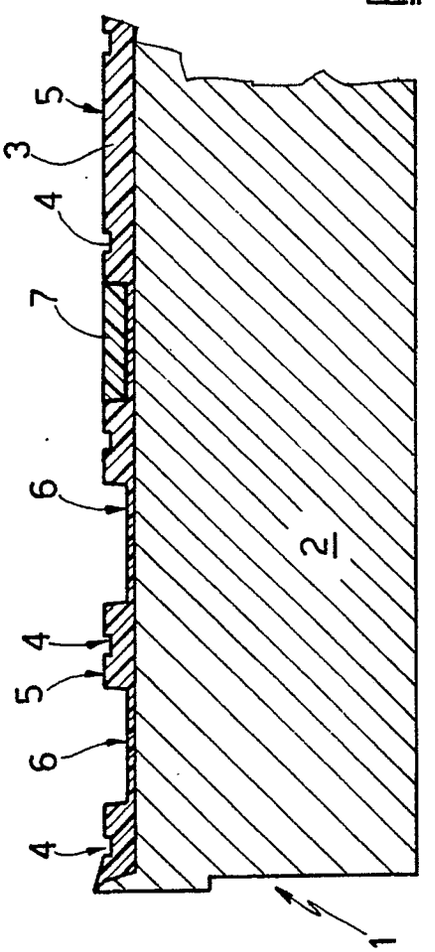

FIG.2A

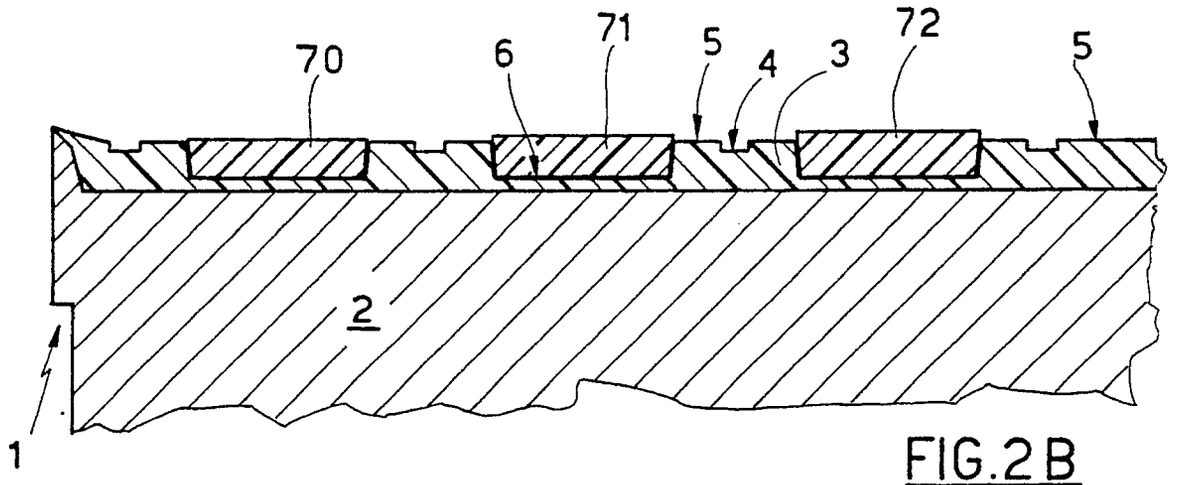

FIG.2B

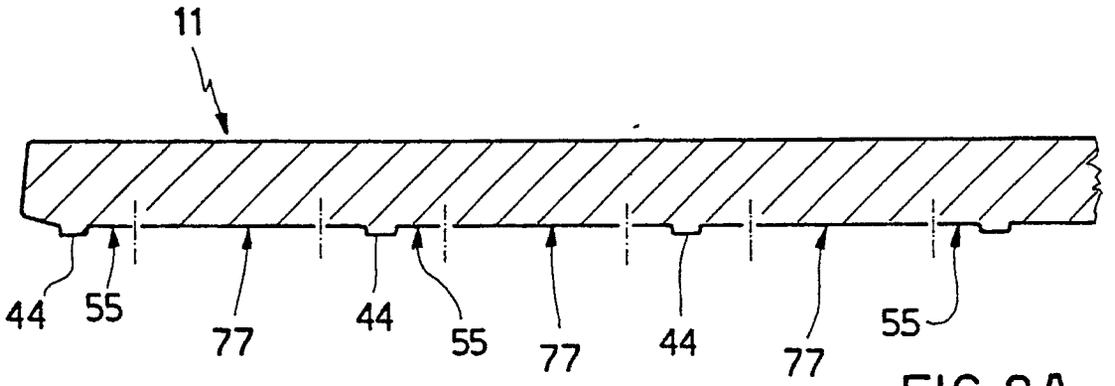

FIG.3A

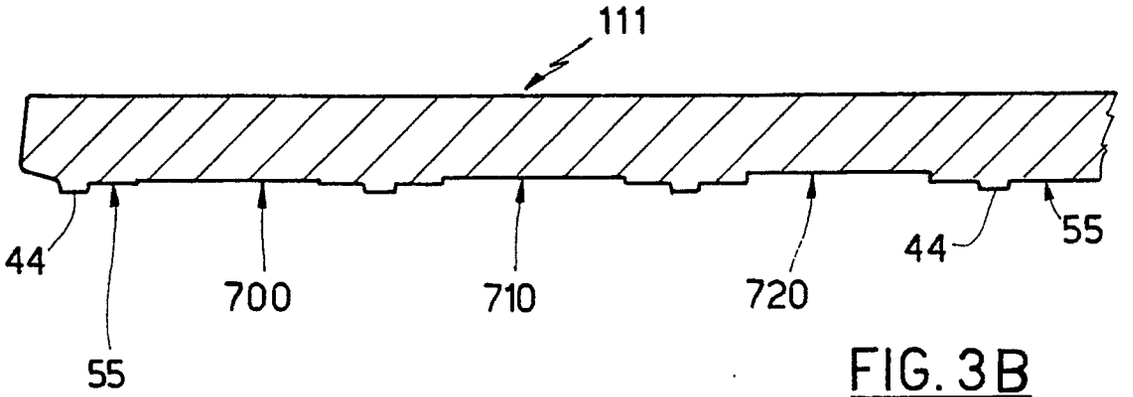

FIG.3B