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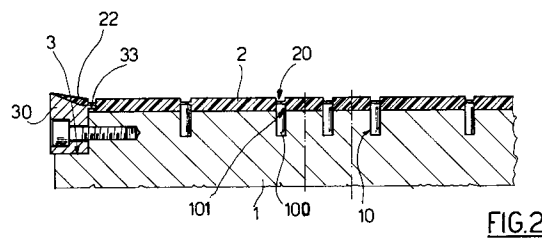
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**AT BE CH DE DK ES FR GB GR IE IT LI LU MC
NL PT SE**(71) Applicant: **MASS S.p.A.**
12 Via Contarella
I-42019 Scandiano (Reggio Emilia)(IT)(72) Inventor: **Bardelli, Lodovico**
20/B, Via Chiozzino
I-42019 Scandiano, Reggio Emilia(IT)(74) Representative: **Corradini, Corrado et al**
Studio Ing. C. CORRADINI & C. S.r.l.
4, Via Dante Alighieri
I-42100 Reggio Emilia (IT)(54) **Reverse-face ceramic die.**

(57) A reverse-face ceramic die comprises a metal base block (1) the front face of which is covered with a layer (2) of relatively soft material such as vulcanized rubber, the active surface of this latter being provided with an ordered multiplicity of depressions (20) for forming the support feet on tiles, said depressions having in plan view a shape without sharp corners and a surface area of between 7 and 38 mm², at said depressions said layer assuming the form of a thin film having a thickness of between 0.07 and 0.25 mm and arranged to rest against a rear fixed counteracting member (100) of hard material.

**FIG.2****EP 0 570 038 A1**

This invention relates generally to the manufacture of ceramic tiles, and more particularly relates to a forming die for association with ceramic molds in general.

More specifically, the invention relates to a reverse-face die, ie for forming the rear or laying face of ceramic tiles.

More particularly, the invention relates to a reverse-face die of the type in which its active surface consists of a layer of relatively soft material, typically vulcanized rubber.

To avoid undesirable repetition and/or errors of interpretation, it should be noted that the die of the invention can be used on any type of ceramic mold, both of the entering punch and of the movable die-plate type, the description of which will not be given as they are well known to the expert of this specific sector, and because they do not form a characterising part of the invention.

The die of the invention can have in plan view any size and any configuration.

Moreover, the characterising elements of the present invention are suitable for any reverse-face die with its active face consisting of a layer of vulcanized rubber or the like which covers a rear metal block, including the die, known colloquially as a "draught", and described in Italian Patent Application No. 46843 A/89 filed in the name of the present applicant.

As is well known, a pressing process using such rubber-covered dies results in tiles which are compacted more uniformly than those obtained by a process using dies with a metal active surface.

It is also known that because of said greater compacting uniformity, on termination of the firing cycle the tiles have good physical, geometrical and mechanical characteristics, for reasons well known to the expert of this sector.

Although these known dies have the aforesaid advantages and other advantages which need not be described herein, they have proved unsatisfactory in manufacturing modern or current ceramic products.

Examples of ceramic products include:

- tiles of relatively large dimensions and relatively small thicknesses;
- tiles with two or more components, such as so-called "grained" tiles;
- and tiles with at least two components where said two components consist of materials having considerably different particle sizes.

For example the first of these three products could be represented by a right-angled tile produced by pressing a pulverulent material such as atomized clay, and having sides of 45 x 45 cm or 30 x 60 cm and an overall thickness (ie including the characteristic support feet) for example between 4.5 and 6.5 mm, to which reference will be

made hereinafter.

The second product (grained) is usually produced by pressing a mixture of (at least) two granular materials of virtually equal average particle size, but of different colour.

A typical product of the third type is prepared by pressing a mixture comprising (for example) the two granular materials used for the "grained" tile, plus a type of grit of one or more colours different from those of said two granular materials.

Said grit has an average particle size much larger than these latter, said grit being usually prepared by grinding tiles formed and fired specifically for this use.

Said granular materials have a round shape and relatively low hardness, whereas said grit has sharp edges and a considerably greater hardness than said granular materials.

Basically, said third type of ceramic product has an appearance very similar to that of marble-like paving tiles.

The problems which occur when manufacturing such ceramic products using said dies covered with rubber (or with an equivalent elastomer), these being currently of widespread use, are due to the fact that the tiles present regions of relatively very different compaction.

The regions of greater compaction are located at the tile support feet.

In the known art, in most cases said feet are formed by a plurality of impressions in the active face of the rubber layer covering the die, these usually being of right-angled shape (square or rectangular).

A typical foot has side dimensions of 2 x 2 cm, these dimensions often increasing as the tile format increases.

In other cases the feet are formed as a network of narrow crossing grooves either parallel or not parallel to the die edges, which are provided in the active face of the rubber layer covering the die and having a width of about 3-4 mm.

A die of this type is described for example in the document cited in the introduction.

As already stated, tiles prepared by said known dies are relatively much more compact at the feet than in the surrounding regions.

This is due to a combination of two factors, the first being that the depressed regions (impressions) in the rubber layer which form the feet are thinner and hence harder (or less soft) than the adjacent impressions, and the second being that said regions are of relatively large surface area.

Because of said relatively large surface area of said regions, during the pressing of the material or materials to be compacted, the material finds difficulty in moving laterally, ie in migrating towards the adjacent regions, with the result that the tile is

much more compacted at the feet.

The aforesaid is valid, although to a lesser extent, even in those tiles produced by a die of the cited document. This is because during pressing, the material may be subjected to a certain migration in a direction transverse to the rather narrow grooves provided for forming these feet, whereas said migration is practically non-existent in a direction parallel to said grooves.

The problems deriving from this differential compaction can be summarized as follows.

Generally, during tile firing said differential compaction gives rise to differential shrinkage and hence differential internal tensions which often produce defects such as lack of planarity, non-linearity and non-perpendicularity of the sides, and small surface fissures, in particular in the case of tiles of large format.

Said differential compaction also results in differential porosity of the exposed face of the tile, and hence a different capacity for absorption in its various regions, to the detriment of regular distribution and optimum bonding of glazes.

In other words both in the case of coloured glazes and in the case of transparent glazes said different absorption gives rise to regions of different tones and/or of differing brightness, said differential porosity being visible on those tiles which are not to be glazed after firing.

It goes without saying that such drawbacks are aggravated the greater the density difference between the more compact and the less compact regions, and the smaller the tile thickness.

This contrasts with the current tendency of the ceramic industry, which is to produce high-quality tiles of relatively large dimensions and small thicknesses, as stated in the introduction.

However the aforesaid problems do not allow tiles of the desired thinness to be obtained.

The usual tiles of medium-large format, such as a 45 x 45 cm sided tile of the type stated in the introduction, has an overall thickness, ie including the feet, of about 9-10 mm, whereas it would be desirable to achieve overall thicknesses of between 4.5 and 6.5 mm.

In addition, with reference to the initially mentioned tile of two or more components, such as so-called grained tiles, the said differential compaction, and hence the corresponding differing surface porosity, mean that these tiles, once laid, either as they are or smoothed, absorb dust, moisture and dirt differently, so that with the passage of time ugly shadowing appears.

In addition the initially mentioned marble-like paving tiles obtained with the known reverse-face dies have a further drawback.

This is that a relatively large number of feet comprise projections extending to different heights,

with the result that the resting regions of these feet do not lie in the same plane. These projections are merely portions of pieces of the grit mixed into the material to be compacted, these during pressing become located at the depressions which are to form the feet but are not crushed by the compression forces in play because of the fact that they rest on yieldable material (the rubber covering the die), and because the rubber thickness at said depressions is of the same order of magnitude as the rubber thickness in the regions adjacent to the depressions.

Basically, when such tiles pass through the roller firing kiln, they rest on said projections and hence on only a part of the feet, with the result that the tile tends to undergo undesirable undulation or dishing, and can also suffer cracking, both because it rests as stated and because when it reaches the firing temperature (exceeding 1000 °C) it is practically in the pasty state and hence very delicate.

The main object of the present invention is to provide a reverse-face die which practically completely eliminates the aforesaid drawbacks.

This object is attained as defined in the accompanying claims.

In it, those depressions provided in the rubber layer for forming the tile support feet have a fairly small surface area in plan view, and at said depressions the rubber layer assumes the form of a thin film which is supported by a rear counteracting member of hard material.

According to a preferred embodiment, said depressions have a plan shape without sharp corners, for example they are circular with an area of between 7 and 30 mm².

Said members can consist of metal pegs fixed to the block to which the reverse-face layer is attached, said thin rubber film located at each peg having a thickness of between 0.07 and 0.25 mm.

The thickness of the rubber layer and the depth of the depressions are not particularly critical.

All the objects of the invention are attained by the aforesaid means.

In this respect, the use of depressions with a fairly small plan shape means that during pressing, the material to be compacted can move laterally without encountering excessive resistance, hence migrating towards the adjacent regions where the rubber thickness is greater.

By this means there is a much more uniform or homogeneous tile compaction than in the known art, the hardness difference between the more compacted regions and the less compacted regions being much less, for equal operating conditions, than with known dies.

In addition, the total area of the greater compaction regions is considerably reduced. This has

been ascertained from tests on a die prototype according to the invention.

Again, because of said more uniform compaction there is a much lower risk of the tile having the aforesaid defects due to shrinkage during firing.

In addition, the combination of said more uniform compaction and said lesser hardness difference between the more compact and less compact regions means that the surface porosity of the tile is practically uniform and homogeneous, resulting in virtually regular and optimum glaze distribution.

With reference to the first two of the three types of product mentioned in the introduction, and by virtue of these latter considerations, the following can be obtained:

- tiles of large format and small thickness, with 45 x 45 cm side dimensions and between 4.5 and 6.5 mm thickness; and
- so-called grained tiles;

in that said problems due to differential compaction are practically completely eliminated by the invention.

In addition, with the die of the invention multi-component tiles can be obtained, in which at least one component is a relatively coarse-grained material such as grit, with the tile resting feet practically coplanar. This is because if a piece of grit finds itself at one of the depressions for forming the feet, this piece of grit is either crushed or is embedded in the overlying granular or pulverulent material, seeing that the base of the depression consists of a film which is practically unable to receive said piece of grit (by deformation), and seeing that the penetration of said piece into said film is prevented by the rear peg.

Finally, according to an advantageous improvement of the invention the rear face of the rubber layer comprises a plurality of small impressions in which a gaseous mass such as air is trapped.

The purpose of said rear impressions is to improve the adaptation of the membrane and hence the compacting of the tile, both when the forming cavity is loaded non-uniformly and when the material loaded into said cavity has a particularly coarse-grain component.

Finally, said trapped gaseous mass enables the high forces in play during pressing to be used for heating the active face of the die.

The features and constructional merits of the invention will be apparent from the detailed description given hereinafter with reference to the figures of the accompanying drawings, which show three preferred embodiments thereof by way of non-limiting example.

Figure 1 is an exploded partial perspective view of a die according to the invention.

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

constituent elements of the die are shown assembled.

Figures 3 and 4 are two views similar to Figure 2 showing two alternative embodiments of the invention.

It should firstly be noted that in the figures certain dimensions are shown considerably greater than reality, for reasons of clarity.

As shown in Figure 1, the die comprises a usual metal block 1 to be fixed to a plate (for example the lower plate) of a usual ceramic press. This fixing is by suitable means of mechanical or electromagnetic type, not shown because of known construction.

The active face of the block 1, which is the upper face in the figures, is provided with an ordered multiplicity of small identical cylindrical impressions 10.

The impressions are distributed regularly as can be seen in Figure 1, the distance between adjacent rows or columns of said impressions 10 not being in any way a limiting factor as said distance can vary according to requirements, for example on the basis either of the material to be compacted, or the plan dimensions of the die, or the final tile thickness.

Into said impressions 10 there are partially inserted, as an exact fit, respective metal cylinders or pegs 100, the projecting upper parts of which are received, as an exact fit, in conjugate impressions 101 (see Figures 2 to 4) in the lower face of a sheet 2.

This latter, which is formed separately in known manner, consists of vulcanized rubber or another equivalent elastomer, and is fixed to the block 1 in the following manner.

For this purpose (see Figure 1) the block is provided with a step-shaped upper perimetral recess 3, the horizontal face of which acts as a support for a perimetral series of bars 30, its vertical face being provided with a series of threaded holes 31 into which a corresponding number of screws 32 are screwed after passing through said bars 30.

To fix the sheet 2 onto the block 1, each bar 30 is provided with an inner upper ledge 33, which fits into a corresponding conjugate groove in the sheet 2.

The top of said groove extends into a lip 22 with a cross-section in the form of a point which practically reaches the outer upper edge of the bar 30 to cover its upper face, which is inclined downwards in an inward direction.

With said lower impressions 101 in the sheet 2 there correspond an equal number of upper coaxial cylindrical impressions indicated by 20, the upper face of the sheet being provided with a perimetral series of further impressions 20, positioned above

the ledges 33 of the bars 30 (see Figures 1-4).

The aforescribed elements are common to the three embodiments shown in Figures 2 to 4.

Specifically, Figure 2 shows the characteristic elements of the invention associated with a usual reverse-face die, whereas in Figure 4 these characteristic elements are associated with a die in accordance with the document cited in the introduction, and Figure 3 shows a modification of Figure 2. In this modification the lower face of the sheet 2 is provided with an ordered multiplicity of small preferably identical cylindrical impressions 21.

Said impressions 21 can be recesses of shape other than cylindrical, such as hemispherical.

In the illustrated example, the sheet 2 has a thickness of about 4.5 mm and the impressions 20 have a depth of about 0.55 mm, however these dimensions are not particularly critical.

The front impressions 20 do not need to be excessively deep, and in addition are slightly flared for the reasons well known to the expert of the art.

Again with reference to Figure 3, the rear impressions 21 have a diameter and depth preferably of between 0.5 and 1.2 mm.

Finally from tests carried out, it has been found that the optimum base area of the front impressions 20 is between 7 and 38 mm² and the optimum thickness of the rubber film defining said base is between 0.07 and 0.25 mm.

With regard to said small rear impressions 21, the purpose of which was stated in the introduction, any gaseous mass such as air, inert gas or another can be trapped within them.

In addition to improving the adaptation of the membrane 2 during pressing and hence improving the tile compaction, said trapped gaseous mass has the advantage of utilizing the considerable forces in play to heat the active face of the membrane. This is by virtue of the fact that the cyclic compression of said mass results in its heating, this then heating the membrane.

As is well known to the expert of the art, ceramic molds have to be heated for various reasons, mainly to prevent the die active faces becoming encrusted and to facilitate removal of the formed tiles, this depending on the moisture content of the material to be compacted and which can vary several times during a working day, hence by virtue of the foregoing the necessary heat for the die (after it reaches working temperature) can be provided by said trapped gaseous mass, instead of by electrical resistance heaters.

This represents a considerable electricity saving in that after being used to provide the necessary heat at the beginning of a pressing period, the resistance heaters can be switched off once the mold has reached working temperature. Hence a

ceramic mold provided with dies of the invention can comprise a smaller number of resistance heater elements, so simplifying mold construction.

Finally, it should be noted that by suitably choosing the dimensions, number and distribution of said small rear impressions 21, the type of gas trapped in them and the formulation (and hence elastic properties) of the constituent elastomer of the sheet 2, virtually optimum temperatures can be maintained (after the working temperature has been reached) for the specific ceramic products being manufactured.

The merits and advantages of the invention are apparent from the foregoing and from an examination of the accompanying figures.

Claims

1. A reverse-face ceramic die, of the type comprising a metal base block (1) the front face of which is covered with a layer (2) of relatively soft material such as vulcanized rubber, the active surface of this latter being provided with an ordered multiplicity of depressions (20) for forming the support feet on tiles, characterised in that said depressions have in plan view a shape without sharp corners and a surface area of between 7 and 38 mm², at said depressions the rubber layer (2) assuming the form of a thin film having a thickness of between 0.07 and 0.25 mm and arranged to rest against a rear fixed counteracting member (100) of hard material.
2. A die as claimed in claim 1, characterised in that said depressions (20) have a circular plan shape, said counteracting members (100) consisting of metal cylindrical bodies with their circular cross-section equal to the base of said depressions, said cylindrical bodies being partly received in respective conjugate impressions (10) provided in the block (1), and partly inserted into respective conjugate impressions (101) provided in the rear face of said layer, coaxial to said depressions.
3. A die as claimed in the preceding claims, characterised in that the rear face of said layer (2) is provided with an ordered multiplicity of small identical impressions (21) in which a gaseous mass is trapped.
4. A die as claimed in claim 3, characterised in that said small impressions (21) are cylindrical and have a depth and diameter of between 0.5 and 1.2 mm.

5. A die as claimed in claim 3, characterised in that said gaseous mass consists of inert gas.
6. A ceramic mold provided with at least one reverse-face die in accordance with claims 1 to 5. 5

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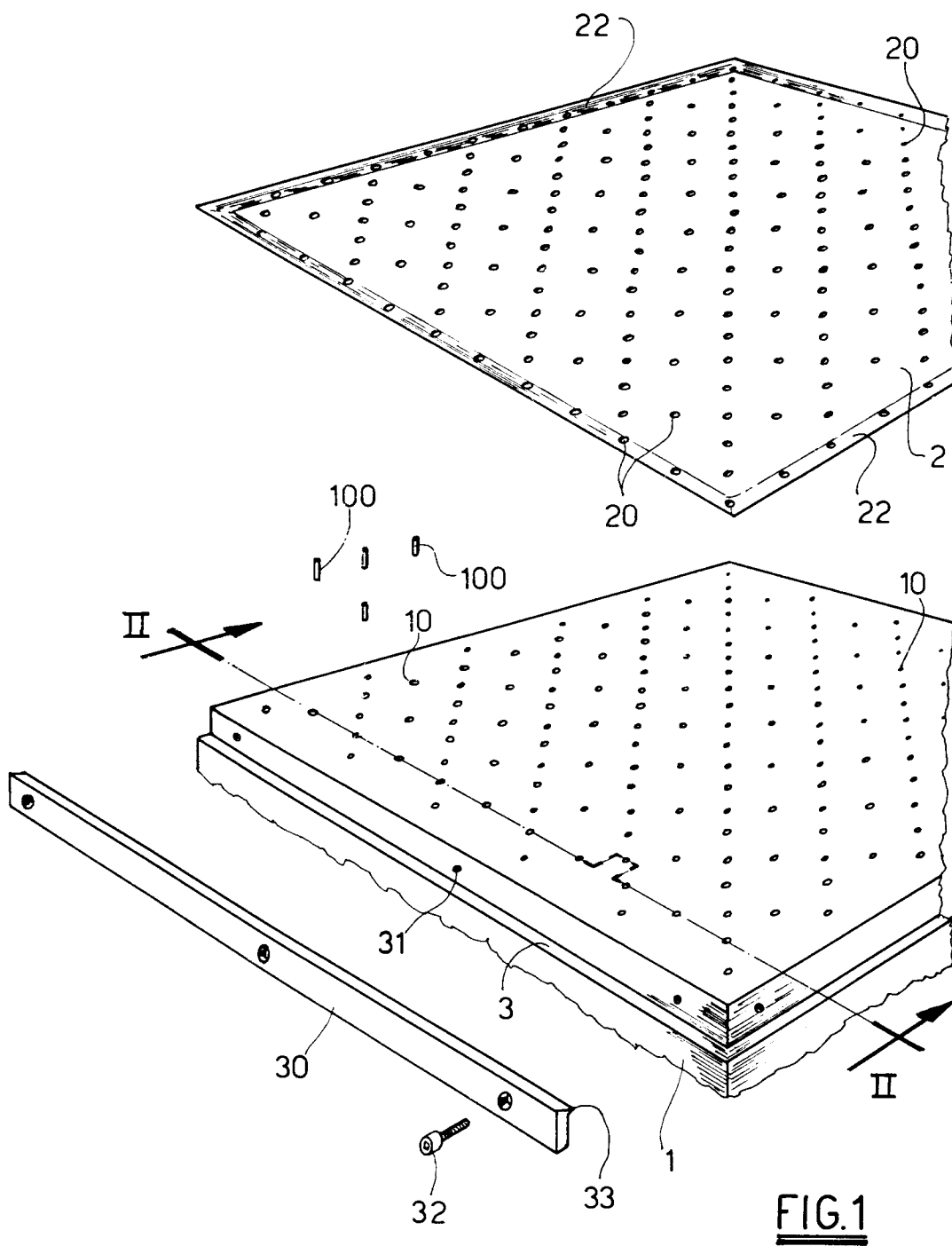
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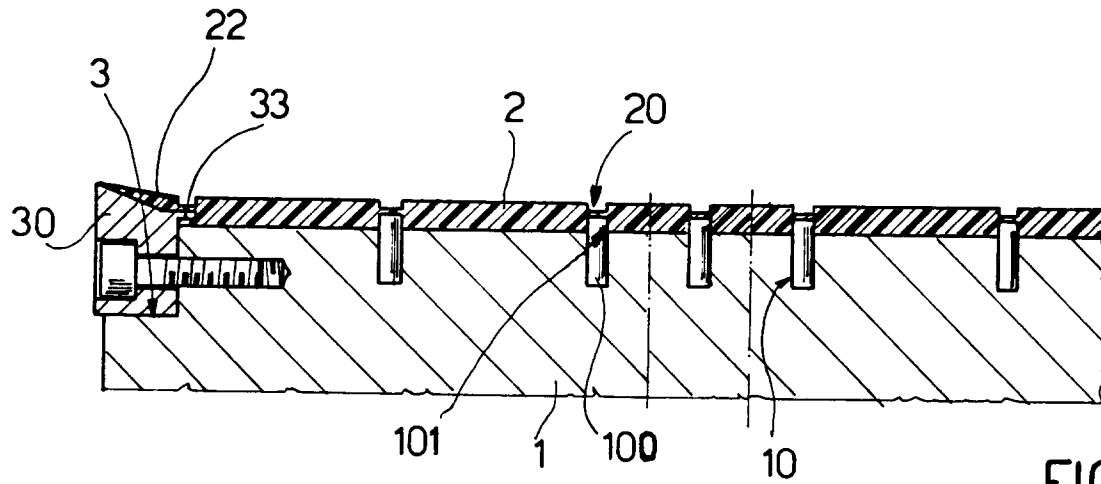


FIG. 2

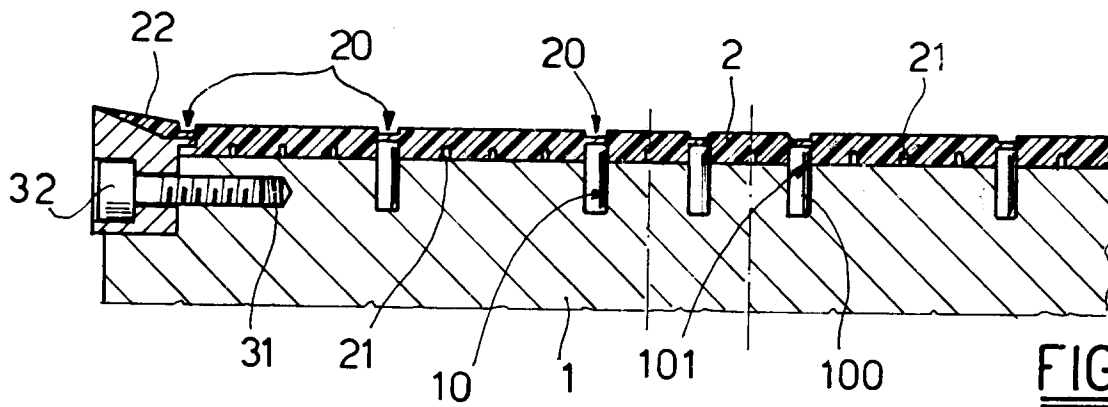


FIG. 3

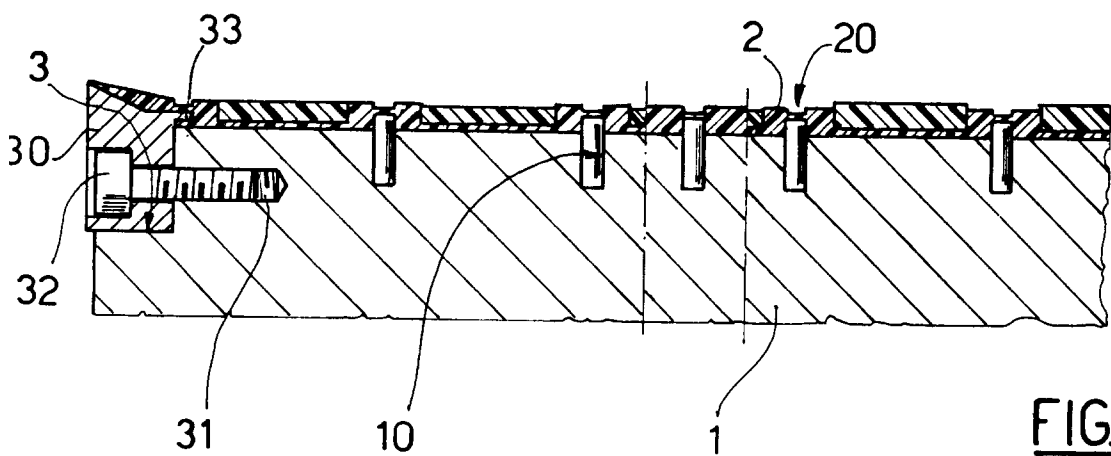


FIG. 4



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EUROPEAN SEARCH REPORT

Application Number

EP 93 20 1065

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A,D	EP-A-0 400 704 (MASS S.P.A.) * the whole document *	1,6	B28B3/02

A	US-A-2 156 149 (H. R. FEICHTER) * the whole document *	1,6	

A	DE-A-2 155 082 (AGROB AG) * the whole document *	1,6	

A	GB-A-502 806 (F. HUMPHRIS) * the whole document *	1,6	

A	BE-A-429 228 (A. ANTOINE) * the whole document *	1,3-6	

			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			B28B B30B
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 19 JULY 1993	Examiner GOURIER P.A.
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure F : intermediate document			
T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			