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(54) High productivity plant for forming ceramic tiles in general.

(57) The high productivity plant for tile manufacture comprises a first ceramic mould part fixed below the vertically movable cross-member of a ceramic press (1), and a plurality of equidistant, aligned identical mould parts (11) which are conjugate with the preceding and are moved with stepwise motion in a direction (A) perpendicular to the vertical plane of press symmetry in which the longitudinal axis of the respective cross-member lies, such that said conjugate mould parts, previously charged with at least one material (31), stop one after another directly below said first mould part.

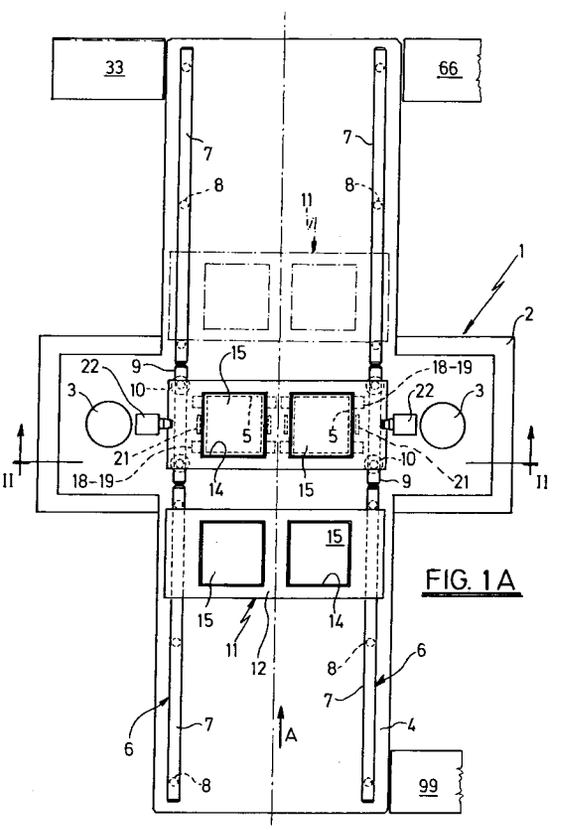

FIG. 1A

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This invention relates to a plant for manufacturing ceramic tiles in general.

In particular, the invention is suitable for forming so-called pressure-glazed tiles, or more generally multi-component tiles such as so-called grained tiles, although there is nothing to prevent it being used for forming materials which do not require glazing, such as fine porcelained stoneware and the like.

As is well known, to form such ceramic tiles, whether they are to undergo subsequent glazing or not, moulds of various types are used, all comprising the following components.

An intermediate plate or die plate with at least one forming cavity for containing atomized clay (with the possible addition of an upper layer of powered ceramic glaze), a lower plate provided upperly with a die to define the bottom of said at least one cavity, and an upper plate provided on its underside with a die which cooperates with the lower die when forming the tiles.

Of said essential components the first two, ie the die plate and lower plate, are positioned on the bed of a convenient ceramic press, whereas the third element or upper plate is associated with the vertically movable cross-member of the press.

In the known art, at least one carriage situated to the side of the press is used to load the clay (and possibly an overlying layer of powdered ceramic glaze) into the mould forming cavity or cavities.

Said at least one carriage is driven with horizontal to-and-fro motion parallel to the upper face of said die plate, such that during its forward travel it fills said cavity or cavities, whereas during its withdrawal travel it levels off the material previously deposited in said cavity or cavities.

This is followed by the pressing stage and the tile discharge, after which a new charging cycle starts.

During said stages the die plate and lower dies move relative to each other, these movements not being described as they are well known to the expert of the art, and are not relevant to the present invention.

What is important to note here is that the press productivity is strictly related to the operating rate of the respective charging carriage, which is however unable to operate at the rate achievable by modern ceramic presses.

Basically, said charging system has operating limits which cannot be overcome, this being in strict contrast with modern manufacturing cycles, which are characterised by a very high production rate.

These limits derive from the fact that the carriage cannot run at high speed, otherwise the forming cavity or cavities are charged irregularly, with well known problems during the subsequent firing of the tile.

To this can be added the fact that this irregular charging also derives from the vibration induced in the carriage when it reverses its running direction at relative high speed.

The carriage also has to be driven at relatively low speed to enable it to discharge the previously formed tile, and also because tiles which has just been formed are particularly sensitive to impact and vibration, especially when of large format.

Consequently there is a well felt need in this sector for means which enable ceramic presses to operate at their maximum rate while at the same time producing tiles with the required characteristics.

The main object of the present invention, as appears from the accompanying claims, is to satisfy said requirement within the context of a rational and reliable structure.

The idea which lies at the base of the invention, and which is implemented by the plant concerned, is to make that mould part provided with the forming cavity or cavities independent, so that it can arrive at a convenient charging station and then be moved into a pressing station.

On this basis, a plurality of identical mould parts (each carrying identical forming cavities) are provided which after charging are moved into the pressing station, are then removed from this latter, and are then unloaded to commence a new cycle.

By this means the pressing station can be operated at a rate never before attained, in view of the fact that the charging of the forming cavity and the discharge of the tiles are effected within said pressing station, which consists for example of a usual hydraulic press.

In addition, with the plant according to the invention tiles can be obtained having unusual aesthetic or ornamental effects, such as tiles with decorative mosaic motifs, or generally tiles carrying differently coloured inserts which are incorporated into and firmly bonded to the base material (clay) of the tile.

The characteristics and constructional merits of the invention together with its operation will be apparent from the detailed description given hereinafter with reference to the accompanying figures, which illustrate a particular preferred embodiment thereof by way of non-limiting example.

Figures 1A and 1B are a top plan view of the invention.

Figure 2 shows part of the section II-II of Figure 1A to an enlarged scale.

Figures 3 and 4 partly sectional side views in the directions III and IV of Figure 1B respectively.

Figure 5 is a section on the line V-V of Figure 3,

with those members lying above the movable mould parts being omitted for clarity.

Figure 6 shows the detail contained in the circle VI of Figure 5 to an enlarged scale.

Figure 7 is a view similar to the preceding, but taken on the line VII-VII of Figure 3.

Said figures, and in particular Figures 1A and 2, show a hydraulic ceramic press, indicated overall by 1, from the bed 2 of which there rise two robust cylindrical columns 3 on which a vertically movable cross-member is slidingly mounted. This latter is not shown for reasons of clarity, and also because it is of known type.

To the underside of said cross-member there is fixed a first ceramic mould part, also not shown as it can be of any known type provided it is suitable for "mirror" or "movable die plate" forming.

Preferably, said first mould part is of the same form as the counter-die illustrated and described in Italian patent application 46813 A/89 filed in the name of the present applicant.

Basically, said counter-die is provided with cavities in which respective exposed-face dies, ie those forming the exposed face of the tiles, are mounted to occupy a first position in which they enable the clay contained in the cavities of the underlying die to be transferred into the cavities of the counter-die, and a second position in which they deposit the formed tiles on the lower dies. Reference should be made to the aforesaid document for further details.

As can be seen in Figure 1A, on said bed 2 there is a horizontal bench 4 which straddles that vertical plane of symmetry of the press 1 in which the axes of the columns 3 lie.

On said bench 4 between said columns 3 there are two blocks or anvils 5 (Figure 2) which cooperate with said first mould part during the pressing stage (as will be apparent hereinafter).

It should be noted that a single anvil 5 or three or more anvils can be provided.

Two mutually parallel, horizontal slide tracks 6 in the form of cylindrical bars (Figure 2) are provided on one side and the other of said anvils 5 parallel to the longitudinal edges of the bench 4 (Figure 1A).

Each track 6 comprises two opposing end portions 7 fixed to the bench 4 by pillars 8, and a central portion 9 supported by a pair of hydraulic dampers 10.

These latter are not shown in detail as they are the usual type used in this sector.

Said tracks 6 are provided to allow the support and sliding (in the direction A indicated in Figure 1A) of a plurality of identical movable mould parts 11 conjugate with the mould part associated with the movable cross-member of the press 1. Each movable mould part 11 comprises a plate 12 (Figure 1A) provided lowerly with two support seats 13 (Figures 6, 7) for engagement with the guides 6 in freely resting and freely sliding engagement.

The plate 12 comprises two adjacent forming cavities 14 closed lowerly by respective reverse-face dies 15, ie those which form the rear or laying face of the tiles.

Each die 15 is received in the respective cavity 14 as a freely sliding fit, and is guided relative to the plate 12 by the means described hereinafter with reference to Figures 2, 5, 6 and 7.

These figures show that to each die 15 there are fixed two downwardly extending side plates 17 parallel to the direction of movement A of the movable mould parts 11.

Each plate 17 comprises at least two outer lateral blocks 18 provided with respective vertical through holes through which corresponding guide rods 19 slidingly pass, these latter extending from the overlying plate 12.

Between said two rods 19 there is a support 20 (Figure 7) fixed to the underside of the plate 12 and provided on that face facing the respective plate 17 with a permanent magnet 21.

This latter is also shown in the central part of Figure 1A and in Figure 1B, its main purpose being to support the die 15 during the transfer of the movable mould part 11, which is supported as stated. Any mechanical, electrical, pneumatic or hydraulic device can be provided for driving the mould parts 11 along the tracks 6.

What is important is that said device drives the mould parts 11 with stepwise motion such that said mould parts 11 (suitable spaced apart as shown in Figure 1A) stop one after another exactly above the anvils 5.

The plan outline of these latter is smaller than the outline of the cavity 14, as can be seen in Figure 1A, the cavities 14 being filled with at least one material (as described hereinafter) before arriving at the press 1.

The pressing stage of the plant according to the invention will now be described, but ignoring for the present the filling of the cavities 14 and the relative means shown in Figure 1B.

Each time a mould part 11 reaches the press 1, where it is temporarily halted, it is retained and centered by two lateral guide and positioning devices 22 (Figure 1A).

After this, the cross-member of the press 1 is made to descend, by which the corresponding mould part rests against the plate 12, which itself descends against the resistance offered by the dampers 10.

During this stage the die 15 rests against the respective anvil 5, to produce the effect of the dies 15 pushing against the dies associated with the

cross-member, with the known advantages which this brings.

The descent of the plate 12 ends when its upper face is substantially coplanar with the upper face of the die 15, after which the cross-member is raised.

Simultaneously the mould part 11 rises under the force of the dampers 10, with the dies 15 remaining in their previously attained position by virtue of the magnets 21.

Although not shown, the formed tiles are substantially at the level of the upper face of the plate 12.

After these stages, the line of mould parts 11 moves through a further step so that the position occupied by the previously pressed mould part 11 is taken by the immediate next mould part.

When the mould parts reach the downstream end of the bench 4 (at the top in Figure 1A), a suitable device removes the formed tiles.

In Figure 1A said discharge device is indicated schematically by 33, although there is nothing to prevent the tiles being discharged at the upstream end of the means for charging the forming cavities 14, these means being shown in Figure 1B. It should be noted that the press can be operated at its maximum production rate, because the charging of the material to be pressed and the discharge of the formed tiles take place at points outside the operating region of the press.

Figure 1B shows a bench 40 the opposing ends of which are connected to the bench 4 by convenient transfer means indicated by 66 and 99 respectively.

On said bench 40 there are two mutually parallel longitudinal tracks 60 along which a line of mutually contacting mould parts 11 is driven with stepwise movement in the direction B indicated in Figure 1B.

Each track 60 comprises two opposing end portions 70 and a central portion 90, the former being fixed to the bench by pillars 80, and the latter being supported by a pair of hydraulic dampers 100.

As can be seen in Figure 1B, between said two tracks 60 there is a longitudinal series of equidistant transverse pairs of blocks 50, these pairs being distributed at a pitch equal to the width of the plates 12, or in other words equal to one movement step of these latter along the tracks 60.

As can be seen in Figures 3 to 5, with each block 50 there is lowerly associated a height adjustment device 16, which is fixed below the bench 40.

Said device 16 is preferably of the type illustrated and described in Italian patent application 46814 A/90 filed in the name of the present applicant, to which reference should be made for further details.

As can be seen in Figures 3, 5, 6 and 7, two small longitudinal cylindrical bars 23 and two permanent magnets 24 are provided on the upper face of the blocks positioned upstream of a compacting device 101 (see Figures 1B, 4), which is described hereinafter.

Said bars 23 are partially contained in respective seats with an open ring cross-section, so that they project slightly beyond the upper face of the block 50 (Figures 6, 7), where they provide a limited contact support for the dies 15. The reasons for this will be apparent hereinafter.

It should be noted that the blocks 50 at the compacting device 101 (Figure 4) and the blocks 50 downstream of this latter are not provided with said bars 23 and magnets 24.

As can be seen in Figure 3, above the upstream end of the bench 40 there is a hopper 25 which is associated at its top with a silo 26 and is provided at its bottom with a discharge port with an adjustment gate 27. There is also associated with said discharge port on its downstream side an automatically height-adjusted scraper 28 for removing material particles present on the upper face of the plates 12 in transit. Although not shown, a suction unit is preferably provided in combination with the scraper 18 to remove excess material present on the plates 12.

It should be noted that the hopper 25 can contain either atomized clay or clay mixed with ceramic glaze or a mixture of materials having considerably different particle sizes, for example a mix of the type used for producing so-called grained tiles. Downstream of said hopper 25 there can be provided further hoppers, one of which is indicated schematically by 250 in Figure 1B, and which are used as required, and/or as specified hereinafter.

For example, the hopper 250 can contain a ceramic finishing mix to be deposited on the base clay previously fed into the cavities 14 by the hopper 25.

The same hopper 250 or another hopper downstream of this latter can contain a powdered ceramic glaze to enable the invention to be used in the manufacture of so-called pressure-glazed tiles.

Again, the hoppers downstream of the hopper 25 could be dispensed with if simple support tiles are to be manufactured, ie tiles to be glazed after firing, or grained tiles to be smoothed after firing, or fine porcelained sandstone tiles which do not need to be smoothed or glazed.

Thus the invention, besides offering high productivity by virtue of the fact that the production rate of the press 1 is in no way dependent on the charging of the forming cavities or the discharge of the formed tiles, also offers considerable versatility

in its use, enabling it to produce both tiles of the aforesaid type and tiles with unusual aesthetic and ornamental characteristics. This will be apparent hereinafter.

With reference to Figure 3 it can be seen that those mould parts 11 arriving below the hopper 25 have their dies 15 raised, to enable the previously formed tiles to be discharged (as already stated).

Hence to again load the cavities 14 the dies 15 must be lowered.

The permanent magnets 24 are provided for this purpose, however they can be replaced by suitable electromagnets.

In this respect, just before a plate 12 arrives below the hopper 25, the magnets 24 pull the dies 15 resting on the underlying slide bars 23 downwards against the retention action of the magnets 21 (Figures 1A, 7). These bars define the maximum depth of charging of the cavities 14 in combination with the devices 16 which adjust the height of the blocks 50.

The same thing occurs when the plates 12 reach the hopper 250, where magnets corresponding to 24 lower the dies 15 containing the previously deposited material (such as clay), in order to free the upper region of the cavities 14, in which a further material (such as a powdered ceramic glaze) is to be deposited.

It should be noted that the devices 16 are controlled by an electronic control unit which enables them to be adjusted as required, ie according to the tiles to be produced.

After the charging, the mould parts 11 can be either fed directly to the press 1 or subjected to further operations at the compacting device 101.

As can be seen in Figures 1B and 4, the compacting device comprises two columns 102 (Figure 1B) on which a cross-member 103 (Figure 4) comprising a lower punch 104 is slidingly mounted.

The punch 104 has a plan outline which is larger than that of the cavities 14, in correspondence with which it comprises at least one lower projection 29 (Figure 4) which can be of any shape.

When a plate 12 arrives between the columns 102, where it stops and is centered by the devices 220 (Figure 1B), the punch 104 is enabled to descend in order to urge the plate 12 downwards against the action of the dampers 100.

In this manner the material 31 is compressed between the dies 15 (resting against the underlying blocks 50) and the punch 104, the projections 29 of which create a corresponding number of conjugate impressions 30 in the material 31 (Figure 4).

It should be noted that Figure 4 shows the configuration of the invention on termination of said compacting stage.

It should also be noted that the power of the compacting device 101 is less than that of the press 1, ie it is sufficient to compact the material 31 to the extent that the impressions 30 retain their shape during the subsequent forward movement of the plate 12.

When the plate 12 leaves the device 101 and again stops, a feed unit 32 (Figure 1B) applies identically shaped inserts (not shown) to the impressions 30.

Said inserts (formed separately as small tesseras compatible with the material 31) have a different colour or tonality from that of the material 31, and can all be of the same colour or different colours. Several devices 32 arranged in series can be provided, the degree of compaction of said preformed inserts being for obvious reasons substantially the same as that achieved by the device 101.

In this manner, at the end of the production cycle tiles with new and unusual ornamental effects are obtained within a wide range of possibilities in view of the interchangeability of the punch 104 carrying the projections 29.

After firing, such new tiles can be marketed in their semifinished state or can be previously smoothed.

According to the invention, other new products can also be obtained, such as mosaic tiles. This can be achieved for example by providing a feed unit similar to the unit 32 which feeds a series of small preformed tesseras of identical or non-identical shape directly into the cavities 14 against the dies 15 in either regular or non-regular distribution.

A layer of suitable material such as atomized clay or another material compatible with the constituent material of the tesseras is then deposited in the same cavities 14, to lightly cover the tesseras and fill the spaces between them.

The mould parts filled in this manner then reach the press 1, and the product obtained after firing is smoothed to produce the mosaic effect provided by said inserts.

Finally, with reference to Figure 1B, said feed unit similar to the unit 32 is preferably positioned upstream of the clay hopper 25.

The merits and advantages of the invention are apparent from the aforegoing description and accompanying figures. The invention is not limited to the single embodiment described and illustrated, but covers all technical equivalents of the aforesaid means and their combinations if implemented within the context of the following claims.

Thus for example, instead of the punch 104 (Figure 4) a bell-shaped member can be provided connected to a suction vessel and arranged to rest against the temporarily stationary underlying plate 12, at which point a high vacuum is instantaneously induced to pull the dies 15 and the overlying ma-

terial 31 upwards.

The inner lower face of said bell-shaped member would be provided with projections similar to the projections 29.

On this basis the blocks 50 associated with the device 101 (Figure 4) can be omitted, as can the other blocks 50 positioned downstream of said device 101.

However, the blocks 50 positioned downstream of the device 101 are particularly convenient, both because they enable the range of application of the invention to be increased, as is apparent from the aforegoing, and because the downstream part of the press table 40 can be equipped with further devices similar to those present in the upstream part of this table, such further devices being normally excluded but being used during the maintenance and adjustment of the corresponding upstream devices.

Claims

1. A high productivity plant for tile manufacture, characterised by comprising a first ceramic mould part fixed below the vertically movable cross-member of a ceramic press (1), and a plurality of equidistant, aligned identical mould parts (11) which are conjugate with the preceding and are moved with stepwise motion in a direction (A) perpendicular to the vertical plane of press symmetry in which the longitudinal axis of the respective cross-member lies, such that said conjugate mould parts, previously charged with at least one material (31), stop one after another directly below said first mould part.

2. A plant as claimed in claim 1, characterised in that said conjugate mould parts (11) each comprise a plate (12) provided with at least one forming cavity (14), at least one forming die (15) slidingly contained within said cavity (14), means (18, 19) for guiding and centering said at least one die (15), and retention means (17, 21) for keeping this latter associated with its plate (12).

3. A plant as claimed in the preceding claims, characterised in that said retention means (17, 21) comprise a metal member (17) fixed below and to the side of said die (15) in a direction parallel to said direction (A), and a facing magnetic member (21) fixed below said plate (12).

4. A plant as claimed in the preceding claims, characterised in that for the sliding of said conjugate mould parts (11) there are provided two mutually parallel bars (6) on which respective engagement seats (13) provided below said plate (12) rest, each bar comprising an upstream and a downstream end portion (7) which lie at a fixed height, and an intermediate portion (9) located in correspondence with said press (1) and lying on damper devices (10).

5. A plant as claimed in the preceding claims, characterised in that with the vertically movable intermediate portions (9) of said bars (6) there are associated respective devices (22) for centering and retaining the conjugate mould parts (11) temporarily at rest below the cross-member of the press (1).

6. A plant as claimed in the preceding claims, characterised in that at least one anvil (5) having a plan outline smaller than that of said at least one die (15) and acting as a support for this latter during pressing is provided on the bed of the press (1) below the path followed by said conjugate mould parts (11).

7. A plant as claimed in the preceding claims, characterised in that a device (33) for discharging and removing the previously formed tiles is provided at the downstream end of said pair of bars (6).

8. A plant as claimed in the preceding claims, characterised in that for feeding said at least one material (31), such as atomized clay, there is provided a hopper (25) lowerly comprising flow regulator means (27) and means (28) for removing excess material, said hopper (25) being positioned above a pair of mutually parallel bars (60) lying to the side of and parallel to the preceding (6).

9. A plant as claimed in the preceding claims, characterised in that between said two pairs of mutually parallel bars (6) and (60) there are provided first transfer means (66) for transferring the conjugate mould parts (11) from the former (6) to the latter (60), and second opposing transfer means (99) acting inversely to the preceding.

10. A plant as claimed in the preceding claims, characterised in that downstream of said hopper (25) there is provided at least one further hopper (250) for containing a material different from that contained in the first (25), such as powdered ceramic glaze.

11. A plant as claimed in the preceding claims, characterised by comprising at least one device for inserting into the cavity (14), directly

onto the die (15), at least one partly compacted preformed tessera having a plan outline smaller than that of said die (15).

12. A plant as claimed in the preceding claims, characterised in that downstream of said at least one device for inserting said at least one tessera there is provided a hopper for completing the filing of the forming cavity (14) with a material compatible with said tessera, such as atomized clay.

13. A plant as claimed in the preceding claims, characterised in that between said second pair of parallel bars (60) there is provided a longitudinal series of blocks (50) which are situated below the path followed by said conjugate mould parts (11) in a position corresponding with said hoppers (25, 250, ...) and with said device for inserting at least one tessera, said blocks (50) being adjustable in height and being provided upperly with means (23) for providing a temporary resting region for the overlying dies (15), and with magnetic means (24) for pulling these towards the respective blocks (50).

14. A plant as claimed in the preceding claims, characterised in that downstream of said hopper (25) there is provided a compacting device (101) for said at least one material (31), with said device (101) there being associated two portions (90) of said bars (60) which are mounted on elastic supports (100), two lateral guide and retention devices (220) for said conjugate mould parts (11), and at least one height-adjustable central block (50) acting as a support for the dies (15) during said compaction.

15. A plant as claimed in the preceding claims, characterised in that said compaction device (101) comprises a vertically movable punch (104) arranged to rest against said plate (12) and provided on its underside with at least one projection (29) for creating a corresponding impression (30) in the material (31).

16. A plant as claimed in the preceding claims, characterised in that said compacting device (101) comprises a vertically movable bell-shaped member to be connected to a suction vessel and arranged to rest against said plate (12), and being provided internally with at least one downward projection.

17. A plant as claimed in the preceding claims, characterised in that downstream of said compacting device (101) there is provided at least one unit (32) for introducing into said at least one impression (30) an identically shaped insert consisting of a material compatible with the material (31) in which said impression is formed, and having a tonality different from that of said material (31).

18. Tiles produced by a plant claimed in the preceding claims.

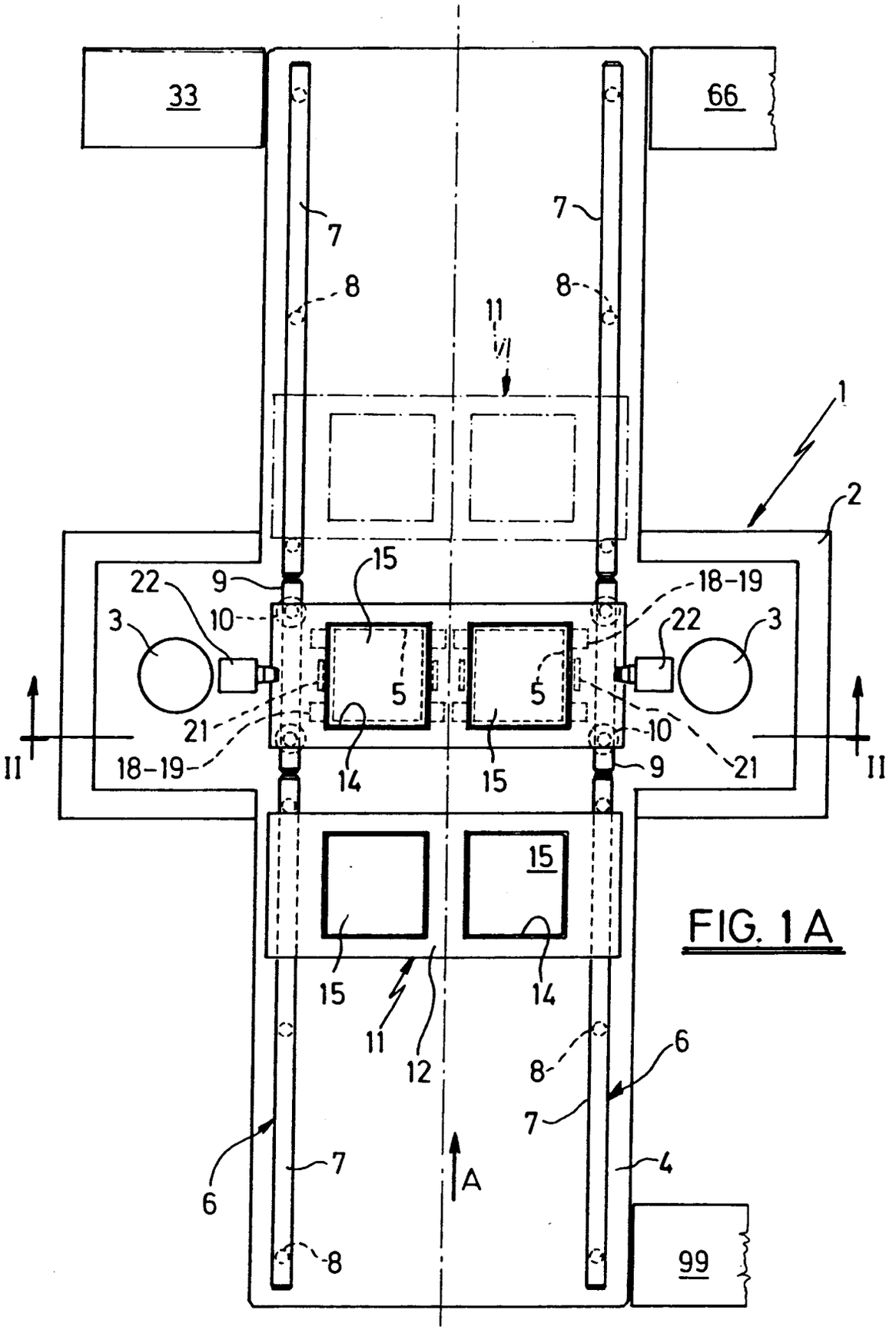
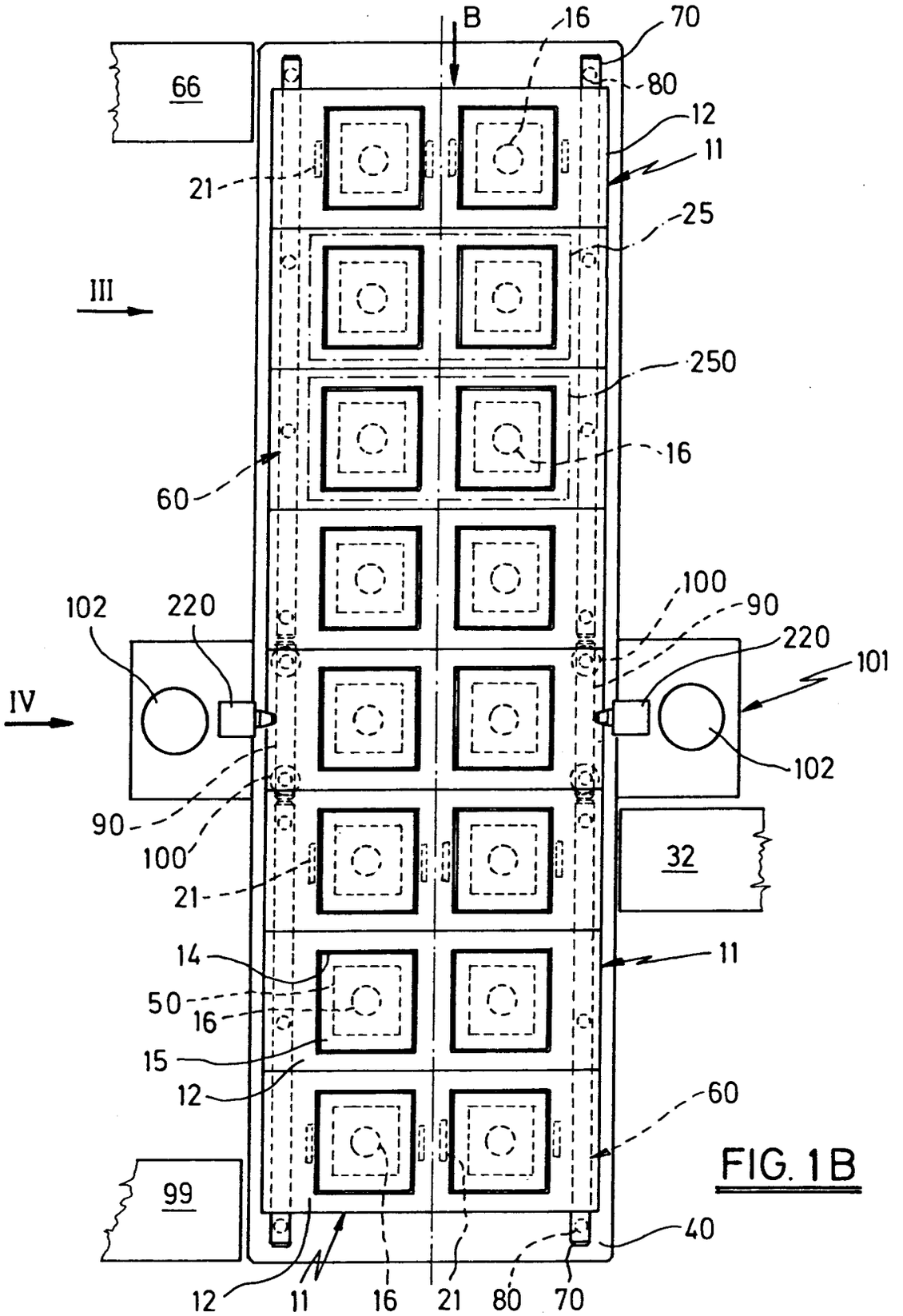


FIG. 1A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III
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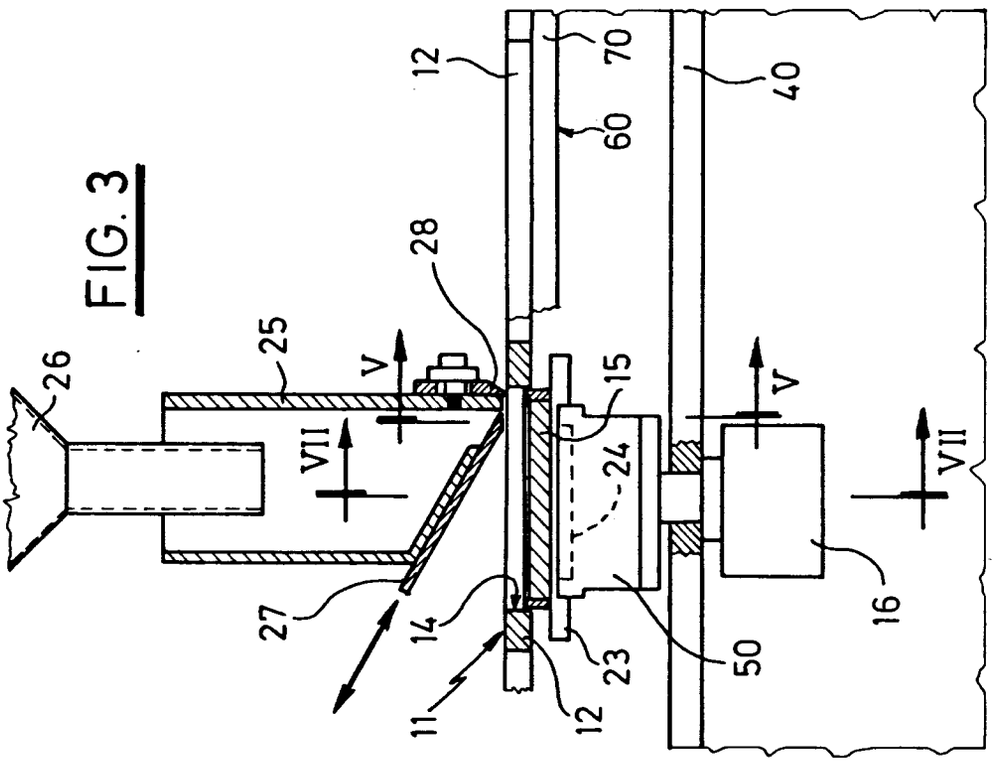
FIG. 1B

FIG. 3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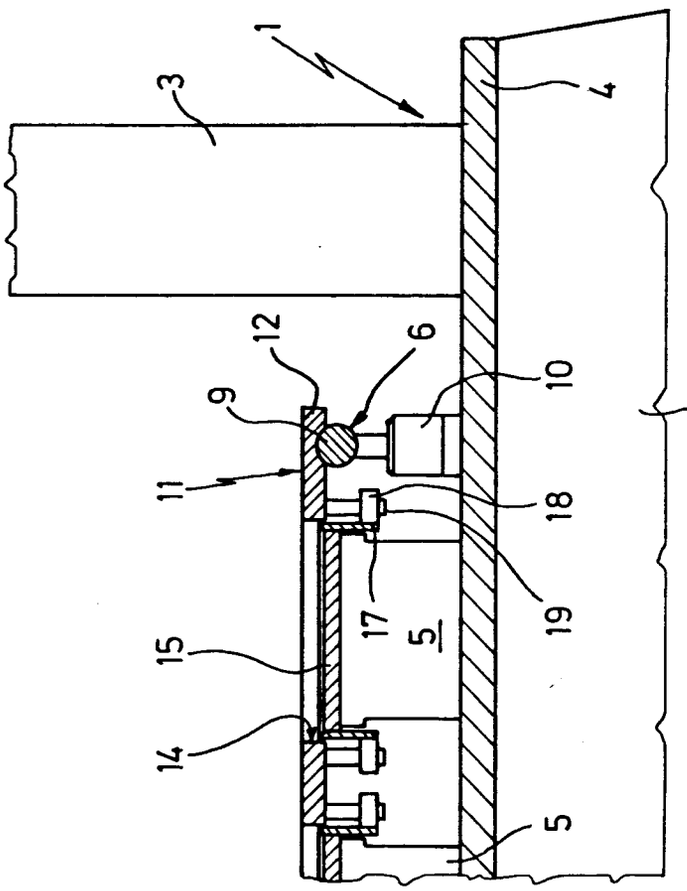
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FIG. 2

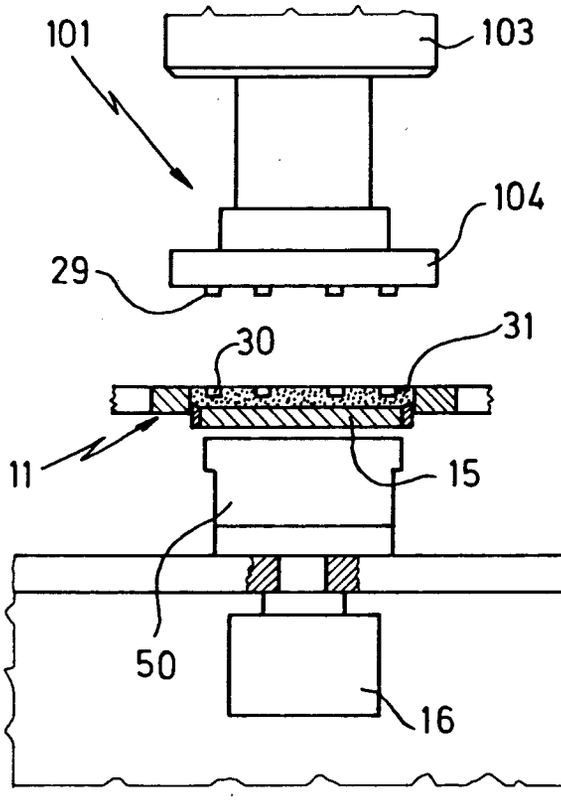
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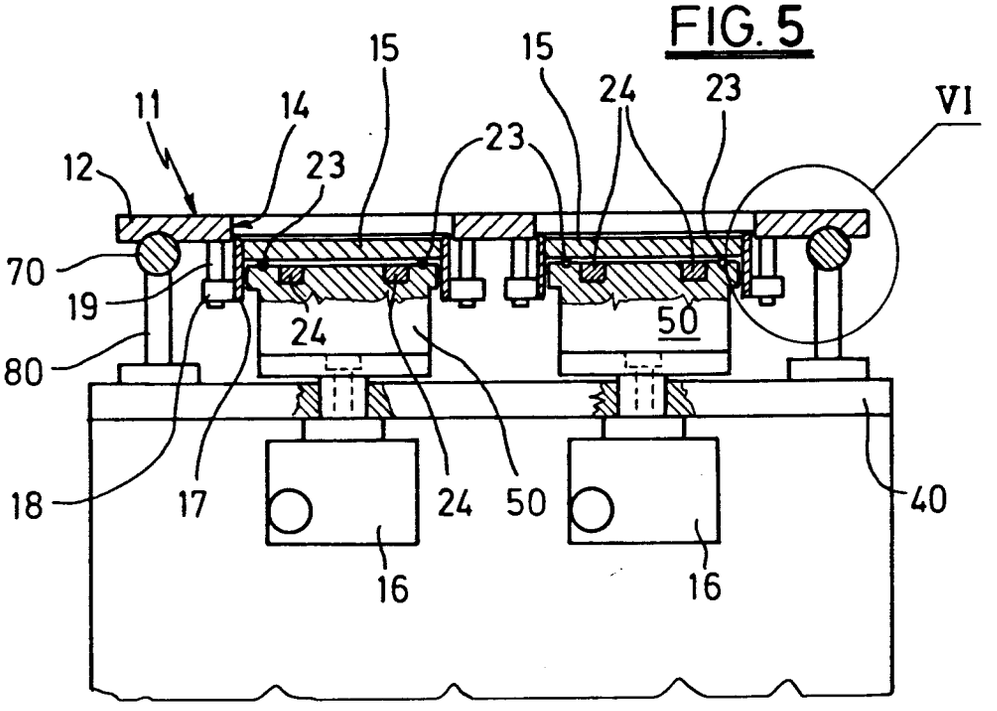
FIG. 4

FIG. 5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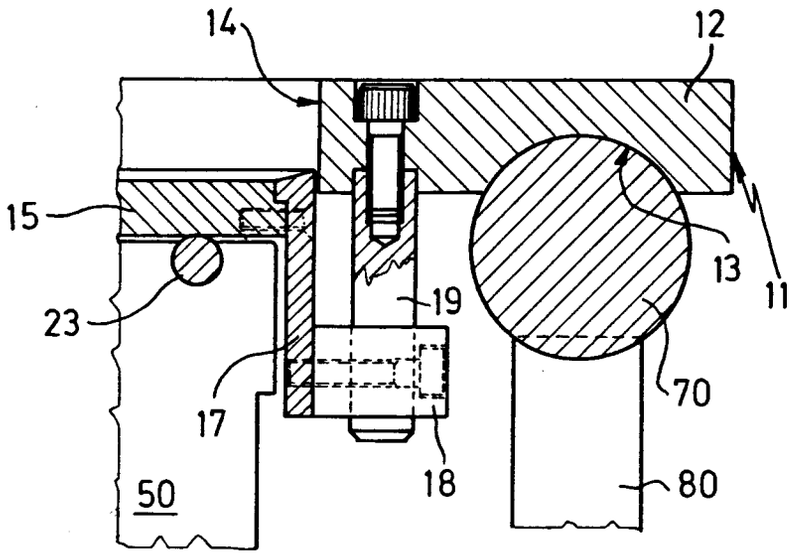
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FIG. 6

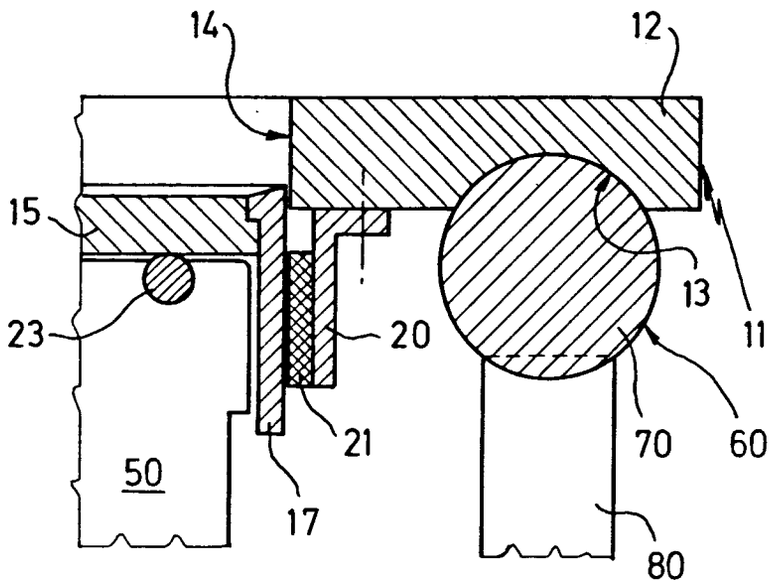
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FIG. 7