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(54) PROCESS FOR MOLDING A SOLID, SINGLE-PIECE AND OPEN BODY WITH AIR-CURABLE FLUID MATERIALS, BODY THUS OBTAINED AND PLANT FOR PRODUCING SUCH BODIES

(57) The process comprises the following steps: using a mold (1) with a molding surface; placing the mold (1) on a rigid base (6); projecting to the mold a first air-curable fluid material in order to form a first homogeneous and impervious layer (2), which defines a main surface of the solid body; projecting to the first layer (2) a second air-curable fluid material which comprises a fiber armature, while forming a second layer (3); curing the curable materials; and separation of the solid body from the mold (1). The process provides for the fabrication of a solid, single-piece and open body which com-

prises said first layer (2), second layer (3) and third layer (4), the latter covering a metal structure (5) of reinforcement. The plant comprises: a portal (19) which can be moved above an area (21) where the molds are laid; an omnidirectional projection nozzle (18), which can be displaced over the portal; a pulse pump 16 for projecting the mortar and which is communicated with the nozzle (18) and with an agitator (14) intended to receive the starting materials.

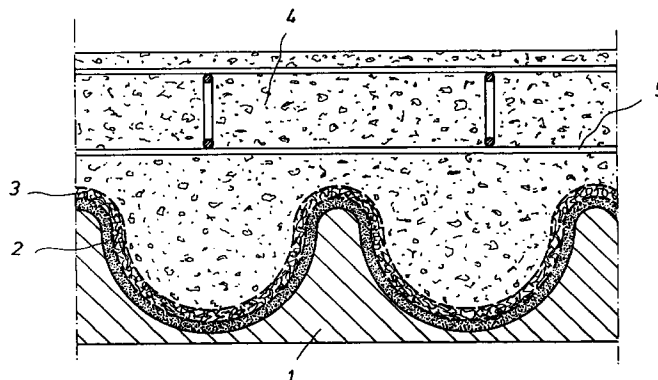


FIG. 1

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Description

[0001] This invention relates to a process for moulding a solid, single-piece and open body, with air-curable fluid materials, body thus obtained and plant for producing such bodies, particularly a process which enables the moulding of different shaped bodies, for different applications made from different materials, such as, for example, panels used in the construction of buildings and the like, boat hulls, vehicle bodywork, cisterns, swimming pools, irrigation channels, piping, indoor chimneys, films of protective paint and/or the decoration of large objects and many more.

[0002] Among such applications, it is worth mentioning the use of panels in the construction industry and, more particularly, some artificial panels that reproduce the shape, texture and colouring of the arrangement of visible work of natural stone walls, ceramic and slate roof tiles (Arabian, flat, etc.), face brick façades and others.

[0003] The technique is very well known to make pieces and panels of artificial stone for the construction industry to replace natural stone and other construction elements, using moulds in which slow-setting cement is compacted with sand that is finer or coarser depending on the piece it is desired to obtain. Façade elements, hewn stone, frames and window brackets, balconies, floor tiles, steps, urban furnishings and the like can be built using this technique. These articles have the colouring of grey, white or coloured concrete mixed with mineral pigments and the texture conferred by the surface of the mould or formwork, usually metallic and smooth, and the fineness of the aggregate.

[0004] These pieces, observed apart, can appear to imitate natural stone, but over large areas they always lose this effect, and therefore in cases of high quality construction, only small sized, complicated shaped pieces, which prove to be resistant to outdoor conditions, can be reinforced and can be made quickly and economically, are used to replace pieces worked in natural stone, in the cited cases of complicated pieces.

[0005] However, using these techniques it is practically impossible to produce large scale and monolithic imitations or reproductions of natural stone walls, such as the walls of rustic, mountain buildings and the roofs thereof, whether they are plates of overlapping slate, or Arabian or flat ceramic roof tiles, etc., wherein the shape, texture and colouring of the construction elements to be reproduced are reproduced exactly, as these features are expensive and difficult to produce with a simple concrete formed in large, metallic moulds.

[0006] Therefore, a simple, economical process would be desirable to make panels for the construction industry, that enabled an exact reproduction of the shape, texture and colouring of a large architectural element already available or designed, wherein said panels would enable resistant building structures to be covered, quickly and economically including outside and

inside walls, intermediate floorings and/or ceilings, roofs, tiling, chimneys, etc., with prefabricated, structural or covering panels, maintaining both a high aesthetic and constructive quality. By means of these industrially prefabricated panels, it is easy to construct buildings having walls and architectural aspects that are practically identical to those obtained by constructing them conventionally with blocks and hewn blocks of natural stone, cut, transferred and positioned on site manually, to form the outside and inside walls of said buildings, as well as the roofs and other elements thereof. Furthermore, these panels can transform the appearance of inside walls, outside boundary walls and other existing works, made from concrete, brick, hollow concrete blocks, etc, into that of natural stone so as to reduce the environmental impact.

[0007] Furthermore, a process that could be applied to making other products would also be desirable, such as those mentioned above, boat hulls, car bodywork, cisterns etc, which when produced using artisan methods require a large, specially skilled work force and long processing times.

[0008] The invention proposes introducing the mentioned advantages; this objective is achieved by means of a process for moulding a solid body, single piece and open with air-hardenable fluid materials, said body having a main surface, and said process being characterised in that it comprises the following steps:

- [a] providing a mould with a negative mould surface of said main surface;
- [b] positioning said mould on a rigid, self-supporting, level adjustable base;
- [c] projecting onto said mould surface, a first air-hardenable fluid material, forming a first homogeneous and impermeable layer, which defines said main surface and a second surface opposed to said main surface;
- [d] projecting onto said second surface of said first layer, a second air-hardenable fluid material which comprises a fibril reinforcement, to form a second resistant homogeneous layer;
- [e] hardening of said hardenable materials which form said solid body; and
- [f] separating said solid body from said mould.

[0009] The invention also refers to a plant for moulding a solid body, single piece and open, with air-hardenable fluid materials which are projected onto moulds; this plant is characterised in that it comprises: [a] an area for housing the moulds; [b] a portal frame provided with running-boards, mounted so it can move above said area which it crosses in a crosswise direction; [c] an omni-directional projection nozzle, held by said portal frame and movable along same; [d] a driving pump for a mass of fine mortar cement, connected to said nozzle; [e] a homogenising and stirring apparatus connected to said driving pump, said stirring apparatus being suitable

to receive cement, fine aggregate, water, polymers and additives in metered doses.

[0010] The solid body, single piece and open, moulded with air-hardenable fluid materials, obtained according to the invention, is characterised in that it has a main surface formed by a first homogenous and impermeable layer of a first air-hardenable material, joined to a second intermediate layer, also homogenous and formed by a second air-hardenable fluid material and provided with a fibril reinforcement which, in turn, is joined to a third layer, also formed by an air-hardenable material which covers a reinforced metallic structure.

[0011] In order to facilitate the comprehension of the foregoing ideas, an embodiment of the subject of the invention will be described below, referring to the accompanying drawings, in which:

Figure 1 is a schematic and partial cross-section of a solid body for the construction, in particular of a tile.

Figure 2 is a front elevation view of a mould used to obtain the solid body of Figure 1.

Figure 3 is a schematic plan view of a plant for carrying out the process that is the subject of the invention.

Figure 4 is a schematic elevation view of part of the plant intended to store, meter and mix the materials required to form the fine mortar cement.

Figure 5 is a partially sectioned view of the omni-directional projection nozzle assembled in a support column and associated with the plant's portal frame.

Figure 6 is a view of the omni-directional projection nozzle according to the previous figure, its two extreme positions being representing by dotted lines.

Figure 7 is a partial frontal elevation view of the portal frame, which supports the omni-directional projection nozzle and the support and movement devices thereof.

Figure 8 is a lateral elevation view of the portal frame, supported on a guide rail raised on pillars.

[0012] Figure 1 illustrates the section of a fragment of panel for the construction industry, which in the present example, constitutes a roof or tiling of Arabian tiles, obtained according to the invention.

[0013] It can be seen that the mould surface of mould 1 which is the surface onto which the moulding materials must be applied, is shaped to complement the main surface of the solid body to be obtained; in the present description, reference is made to this mould surface by means of the expression, negative mould surface of the main surface of the solid body to be obtained. For its part, the main surface of the solid body to be obtained is either the surface intended to be visible (in the case of a tiling) or the functional surface, which in the case of a conduit would be the surface on which the liquid (or

other material) runs.

[0014] There is projected onto the negative surface of the mould 1 a first, homogenous and impermeable layer 2 of a first air-hardenable fluid material, preferably fine mortar cement, incorporating a polymer, mineral colorants or pigments and additives, which define the main surface of the panel; onto the surface of this first layer 2, opposed to the main surface, there is deposited, also by means of projection, a second, homogenous and resistant layer 3, formed by a second air-hardenable fluid material, preferably fine mortar cement, with or without a polymer, to which a fibril reinforcement has been added, consisting of cut fibres of glass filament, preferably of zirconium, but not excluding other organic materials (synthetic, artificial or natural, such as polyesters, acrylics, polyamides, rayon, cotton, wool, jute, coconut, abaca, sisal, etc.) or inorganic materials (metallic, asbestos, etc.)

[0015] As this second layer 3 contains an abundant quantity of cut fibre, it behaves like felt and/or protective felt, which absorbs the impact of the coarse aggregates of a third resistant layer 4 of base concrete to be teamed onto the second layer 3, and prevents such coarse aggregates from pervading to the main surface of the panel, through the first layer 2 that constitutes said main surface, which on the one hand, would degrade the desired aesthetic effect, and on the other hand, could damage the surface of the mould 1.

[0016] The third layer 4 of base concrete includes, preferably, a reinforced metallic structure 5, preferably made from right-angled mesh, which is placed in the mould 1 before, during or after the base concrete is provided onto the free surface of the second layer 3. The metallic structure 5 is placed, according to standards, at a distance no less than 30 mm from the free surface of the third resistant layer 4 of concrete.

[0017] The moulded panel or body thus obtained, is partially illustrated in Figure 1 according to a particular shape embodiment, which includes any possible form of the first layer 2.

[0018] Figure 2 illustrates a mould 1, which is full to produce a panel for the construction industry like the one illustrated partially in section in Figure 1. Figure 2 shows the negative mould 1 which is used to obtain an imitated surface of a stylised tiling composed of Arabian tiles, having the technical and aesthetic features to build a roof for a building, whether or not the building be constructed with outdoor walls and/or indoor walls built with panels made in accordance with the invention. In Figure 2 it can be seen that the mould 1, illustrated therein as an example, is supported on a rigid base 6 formed by panels 6a and 6b associated by a series of small beams 6c.

[0019] The upper part of the edge of the mould 1 has vertical walls 7, removable, movable or foldable, which constitute the side cuts of the actual mould. These rigid bases 6 which are self-supporting and level adjustable are on trolleys, not shown, which can run on rails or the

like. The vertical walls 7 can be provided with means for positioning the metallic reinforcement structure 5 of the third resistant layer 4 of base concrete when same is teemed.

[0020] A possible formulation for the fine mortar cement forming the first impermeable layer 2, or visible surface or functional surface of the panel, is that exposed below:

Material	Parts by weight
Portland cement	38
Fine sand	38
Polymer	5
Water	15
Superflux	1
Pigment	3

these materials are mixed and homogenised in a stirrer at high speed, and a first, homogenous and impermeable layer 2 of the resulting fine mortar mass is applied onto the mould 1.

[0021] In an equal or similar formulation, from which the polymer and the pigment can be omitted, the fine mortar cement is prepared adding a fibril reinforcement to form the second layer 3.

[0022] The base concrete consists of a normal aggregate concrete that can be made "in situ" or acquired from a cementing station, to form the third layer 4.

[0023] The first 2 and second 3 layers are applied by projection, so as to achieve an even, finer thickness, while the third 4 layer is deposited by teeming, filling the whole mould including the metallic reinforcement structure 5.

[0024] Figure 3 shows one of the possible, suitable arrangements of the plant for the practical embodiment of the process.

[0025] The plant comprises a storage area for the materials, as can be seen in Figure 4, which includes a silo 8 for the cement, a silo 9 for the fine aggregate and three cisterns 10 for the water, polymer and the superflux. These silos 8 and 9 and the cisterns 10 are provided with transferring and metering means, such as transport screws 11, hoppers 12, chisel valves 13, scales, flow meters, etc. automated by a computer. The different materials are poured into a homogenising stirring apparatus 14 at high speed and, once the mixture is formed, said apparatus discharges it into the tank 15 of a driving pump 16 (Figure 3), which transfers the fine mortar cement through a conduit 17 as far as an omni-directional projection nozzle 18 movably mounted on a portal frame 19.

[0026] The portal frame 19 runs, by means of motor-

ised running-boards, on rails 20 situated in parallel to each other on both sides of an area 21 where the moulds are housed mounted on the rigid bases 6. Obviously, both the portal frame 19 and the rigid bases 6 can be mobile, or only one of them can be, preferably, the portal frame 19.

[0027] The plant also comprises a base concrete kneader 22, associated with a pump for concrete 23 which receives the concrete from the concrete mixer-truck 24 which is teemed onto the second layer 3 acting as an absorbent barrier to complete the actual mould 1, covering the metallic reinforcement structure 5. A hinged tubular arm 25 is used to deposit the cement and said arm ends in the pouring nozzle, placed next to the omni-directional projection nozzle 18.

[0028] Figures 5 and 6 show an example of the embodiment of the omni-directional projection nozzle 18, which is mounted on a counterweighted arm 25a, which rotates around an axis M by the action of an electric motor 26 (both mounted in a fork-shaped support 27), which rotates around an axis N by the action of an electric motor 28 which, in turn, is installed in a support column 29 associated with the portal frame 19 by means of a truck 30 (see Figures 3, 7 and 8). This truck 30 can move longitudinally on the portal frame 19, around the system's Y axis by the action of the geared motor 31, so that the support column 29 is suitable for moving vertically in the direction of the system's Z axis by the action of the electric motor 32 and the geared motor 32a, at the same time that the truck 30, subject to the movement of the portal frame 19 in the direction of the system's X axis, is also capable of moving in that direction.

[0029] Therefore, the omni-directional projection nozzle 18, owing to its association with the portal frame 19, the support column 29 and the truck 30, can move in the directions X, Y and Z of the system, and in addition, it can rotate around the axis M and N, whereby it is practically omni-directional.

[0030] The portal frame 19 moves on the guide rails 33 supported on pillars 34 in the direction of the X axis by the action of a geared motor 35.

[0031] The electric power of the different geared motors 31 and 35, electric motors 26, 28 and 32, as well as the electric mechanisms (ends of stroke, sensors, etc.) is provided through flexible cables housed in hinged trays 36 made of insulating material.

[0032] The process, carried out with the plant of Figure 3 is as follows:

[0033] The Portland cement and the fine aggregate are metered from the silos 8 and 9 and, together with the water, supplied from the mains or from one of the cisterns 10, the polymer and the superflux, also supplied from the other cisterns 10, are all put into the high speed homogenising stirring apparatus 14, from which the fine mortar cement mixture, once it is made, is discharged into the tank 15 associated with the driving pump 16 which leads the mixture forming the first fluid

material, as far as the omni-directional projection nozzle 18, which evenly projects the mixture onto the mould 1, passing over it successively, crosswise, longitudinally, diagonally and in other directions, enabled by the movement of the portal frame 19, on its own, or in combination with the movement of the projection nozzle 18 along said portal frame, until the first, homogenous and impermeable layer 2 is formed defining the main surface of the panel for the construction industry.

[0034] Next, the second layer 3, or absorbent barrier (forming the second fluid material) is deposited, which comprises the same fine mortar cement as the first layer 2, from which the colouring and the polymer can be omitted, and in which the mortar can incorporate the fibril reinforcement consisting of fibres, cut "in situ" in the actual omni-directional projection nozzle 18 by means of a guillotine attached thereto, from bundles of filaments that reach therein from an exterior coil. In an equivalent embodiment, the fibril reinforcement can be added in the form of fibre cut in the stirrer 14, or in the tank 15, and mixed with the fine mortar cement before it is fed into the driving pump 16. The fibril reinforcement can also be constituted by continuous filaments, fabric, non-woven fabric, laps, lap robe, mesh, etc.

[0035] Finally, the third resistant layer 4 of base concrete, produced in the stirrer 22 or supplied by the cement-mixer truck 24, is deposited onto the absorbent barrier layer 3 by means of the driving of the pump for concrete 23 and the crosswise movement of the hinged tubular arm 25 as far as the pouring nozzle, placed next to the omni-directional projection nozzle 18, which describes the same basic movements as the omni-directional projection nozzle 18. The third resistant layer 4 completes the service volume of the actual mould 1, covering the metallic reinforcement structure 5.

[0036] The plant in Figure 3 shows some square-shaped spaces corresponding to the position of the moulds in the different operational phases, where A corresponds to the mould's position during the projection of the first layer of fine mortar; B corresponds to the position of the projection of the fine mortar with fibre onto a mould onto which the first layer of fine mortar has already been deposited; C corresponds to the depositing of the third resistant layer 4 of base concrete; D corresponds to the positioning of the metallic reinforcement structure 5 not formed of right-angled mesh; E corresponds to the stacking position of the mould 1 and the panel's heat curing position by means of the panel's heating equipment g; F corresponds to the turning and form removal phase and G corresponds to the stacking position and wet post-curing position. The arrow H indicates the direction in which the full mould exits the moulding area. The order, distribution and number of such square spaces depend on the size of the panel to be obtained and on the way that the application sequence of the various layers has to be carried out in each case, which will vary if there is only one mould, two or more.

[0037] Obviously, in the case of the panels for the construction industry, and possibly in other cases, the moulded body can comprise electrical or fluid conduits and have openings for doors and windows, as well as ensemble arrangements with other elements and means for the handling thereof.

[0038] Finally, a form removal arrangement has also been provided comprising a structure from which at least two flexible rings hang, such as belts, slings, etc., mounted on respective motorised pulleys, which clasp the mould and obtained panel, with sufficient clearance and, by the action of the pulleys, allow the assembly to turn over and said panel to be removed by gravity.

Claims

1. Process for molding a solid, single-piece and open body, with air-curable fluid materials, said body having a main surface, characterised in that it comprises the following steps:

- [a] providing a mould (1) with a negative mould surface of said main surface;
- [b] positioning said mould (1) on a rigid, self-supporting, level adjustable base (6);
- [c] projecting onto said mould surface, a first air-hardenable fluid material, forming a first homogenous and impermeable layer (2), which defines said main surface and a second surface opposed to said main surface;
- [d] projecting onto said second surface of said first layer (2), a second air-hardenable fluid material which comprises a fibril reinforcement, to form a second resistant homogenous layer (3);
- [e] hardening of said hardenable materials which form said solid body; and
- [f] separating said solid body and said mould (1).

2. Process according to claim 1, characterised in that it comprises a step to cover said second, resistant, homogenous layer (3) with a third, fluid material for finishing, also air-hardenable, said covering stage forming a third layer (4).
3. Process according to one of the claims 1 to 3, characterised in that said fluid materials are selected from a group formed by synthetic resins, cement mortars, concrete and mixtures thereof.
4. Process according to claim 3, characterised in that said fluid materials are reinforced with filaments, laps, fabric, fibres, metallic structures or mixtures thereof.
5. Process according to claim 1, characterised in that said negative mould surface is constituted by a syn-

thetic material, preferably polyester or elastomer.

6. Process according to claim 1 or 2, characterised in that

[i] said first air-hardenable fluid material comprises a fine mortar cement, a polymer, colorant and additives;

[ii] said second fluid material comprises fine mortar cement with a fibril reinforcement;

[iii] it comprises a step of providing a metallic reinforcement structure (5);

[iv] said third fluid material for finishing comprises base concrete, and covers said metallic reinforcement structure (5);

[v] comprises a vibration stage, which affects at least said metallic reinforcement structure (5); and

[iv] said separation stage of said solid body from said mould is carried out by turning over.

7. Process according to claim 6, characterised in that said covering stage with said third fluid material for finishing, is carried out in a first phase before the step of providing said metallic reinforcement structure (5) and a second phase subsequent to said providing step.

8. Process according to claim 6, characterised in that said covering step with said third fluid material for finishing, is carried out in one single phase subsequent to the step of providing said metallic reinforcement structure (5).

9. Process according to claim 6, characterised in that said step of covering with said third fluid material for finishing, is carried out in one single phase before the step of providing said metallic reinforcement structure (5) and while this is being provided, said structure is vibrated.

10. Process according to claim 6, characterised in that it comprises the use of a high speed stirrer apparatus (14) to obtain a homogenous mixture of said fine mortar cement, polymers, colorants and additives; said mixture passing next into a driving pump (16) which transfers it to an omni-directional projection nozzle (18) which projects the mixture onto said mould surface.

11. Process according to one of the claims 1 to 9, characterised in that the incorporation of said fibril reinforcement in said second fluid material takes place in said stirrer (14) and/or in said omni-directional projection nozzle (18)

12. Solid, single piece and open body, moulded with air-curable fluid materials, characterised in that it

has a main surface formed by a first, homogenous and impermeable layer (2) of a first air-hardenable material, joined to a second intermediate layer (3), also homogenous and formed by a second air-curable fluid material and provided with a fibril reinforcement which, in turn, is joined to a third layer (4), also made of air-curable material, which covers a metallic reinforcement structure (5).

13. Body according to claim 12, characterised in that said third air-curable fluid material is selected from the group formed by the fine mortar cement, concrete and/or mixtures thereof.

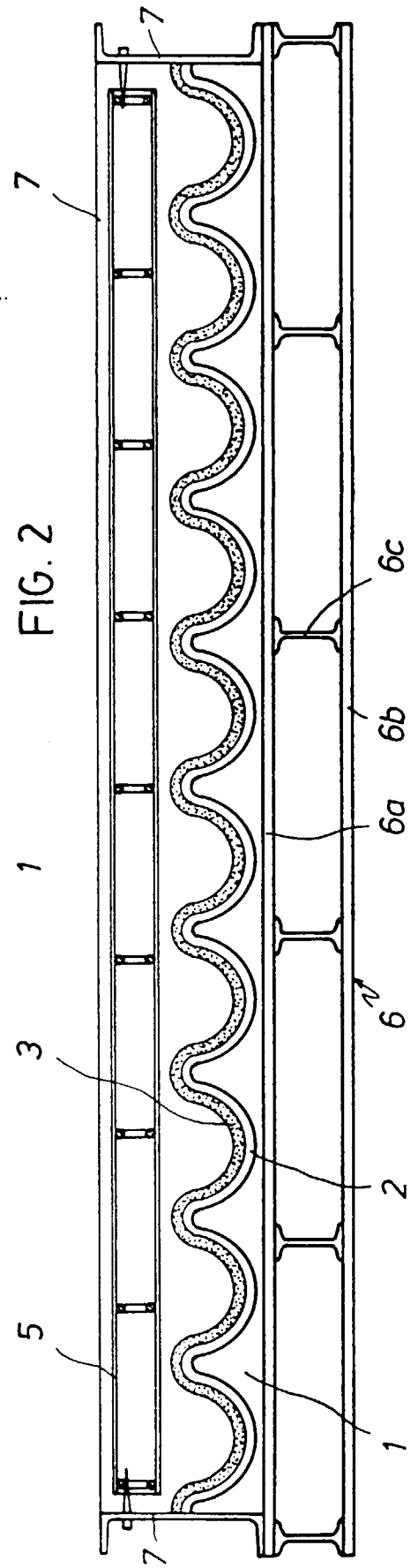
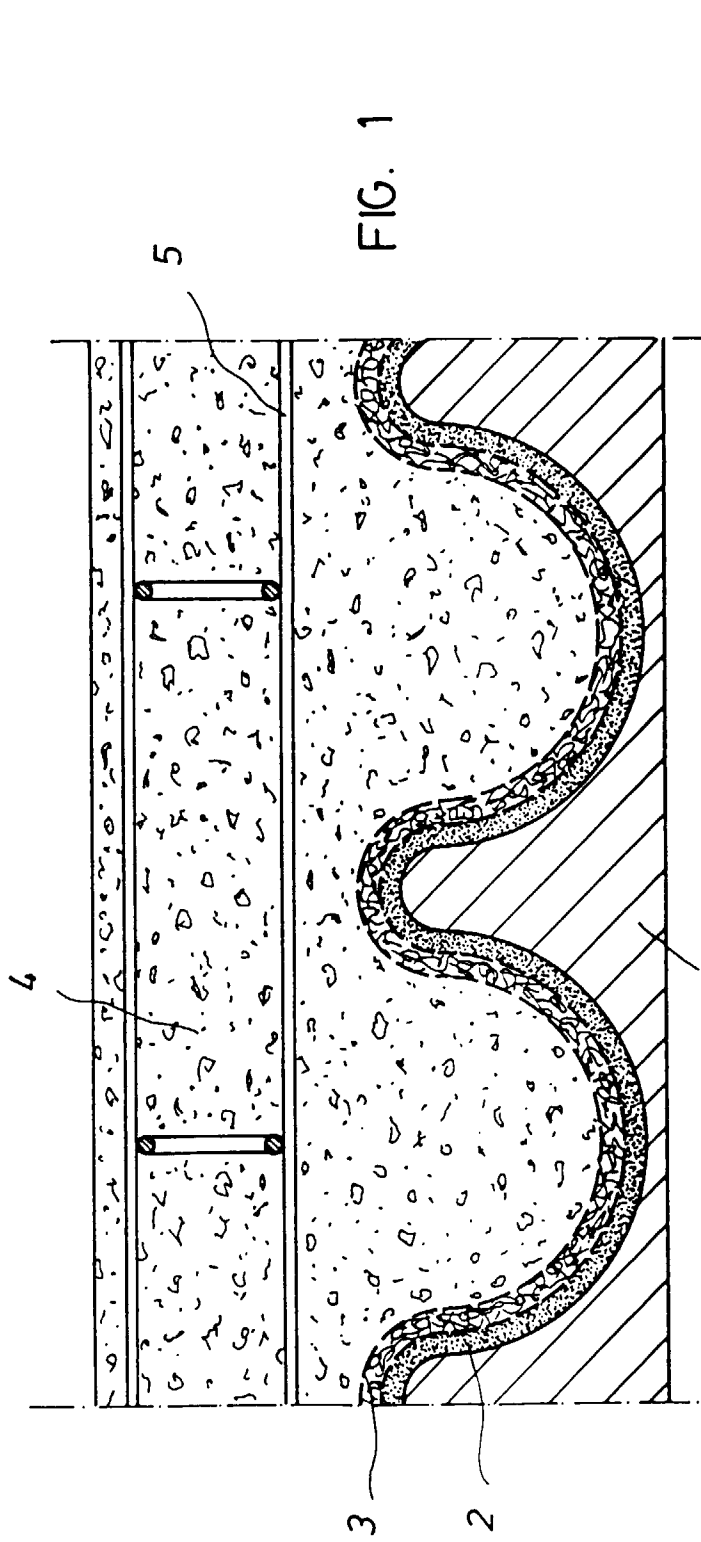
14. Plant for producing a solid, single piece and open body, with air-curable fluid materials which are projected onto moulds, characterised in that it comprises [a] an area (21) for housing the moulds; [b] a portal frame (19) provided with running-boards, movably mounted above said area (21) which it crosses in a crosswise direction; [c] an omni-directional projection nozzle (18), held by said portal frame and movable along same; [d] a driving pump (16) for a mixture of fine mortar cement, connected to said nozzle (18); [e] a homogenising and stirring apparatus (14) connected to said driving pump (16), said stirring apparatus (14) being suitable to receive cement, fine aggregate, water, polymers and additives in metered doses.

15. Plant, according to claim 14, characterised in that said area (21) for housing the mould has two parallel tracks (20) on either side thereof, on which said running-boards of the portal frame (19) run, provided with motorised means.

16. Plant according to claim 14, characterised in that it comprises some rigid, self-supporting and level adjustable bases (6) suitable for receiving the positioning of the moulds (1).

17. Plant according to claim 16, characterised in that said rigid bases (6) have on the edges thereof vertical removable and/or movable walls (7), for closing the mould (1).

18. Plant according to claim 14, characterised in that it comprises a base concrete kneader (22), associated with a driving pump (16) which allows the access of said concrete as far as a pouring nozzle, adjacent to said omni-directional projection nozzle (18).



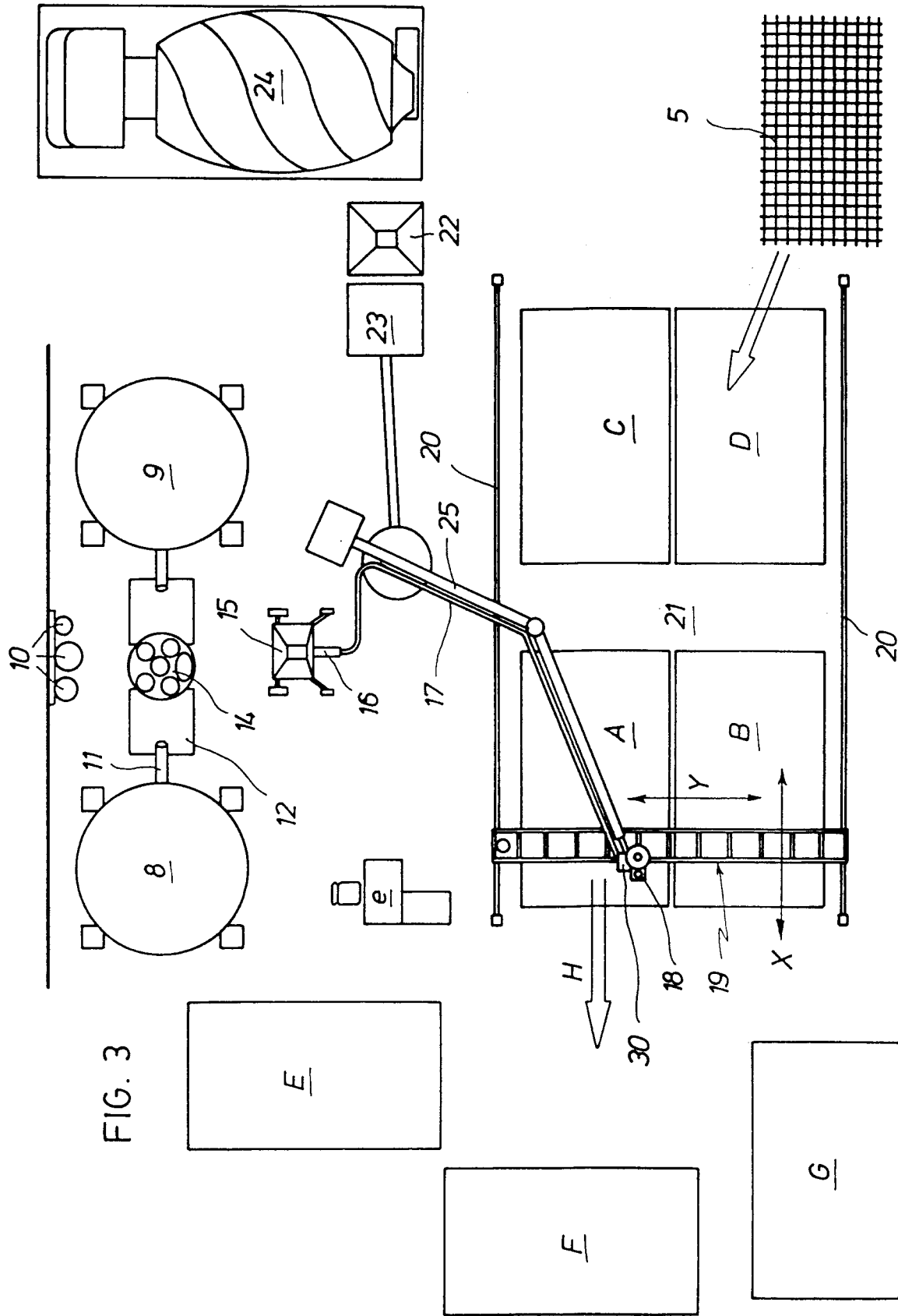


FIG. 4

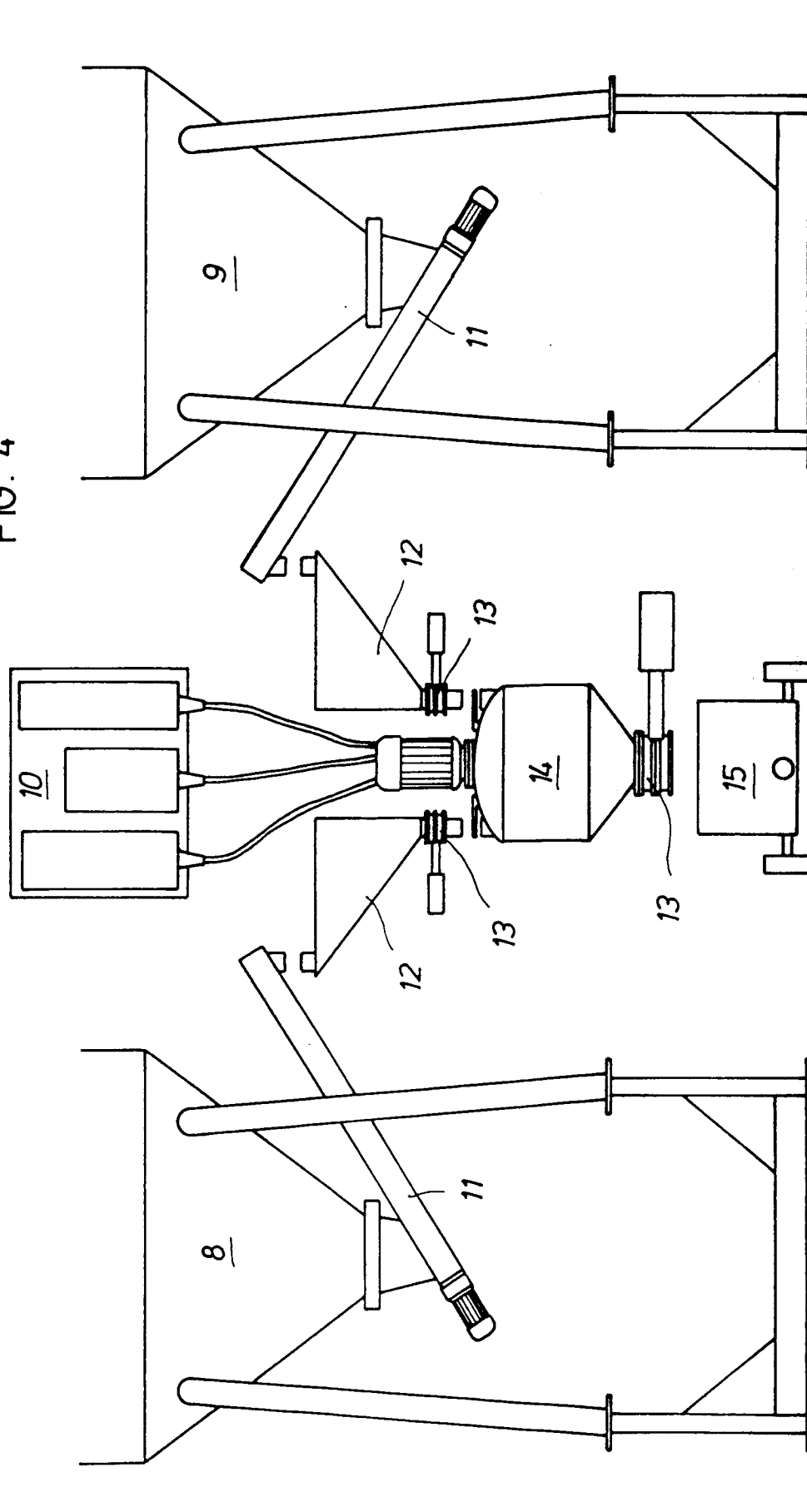


FIG. 6

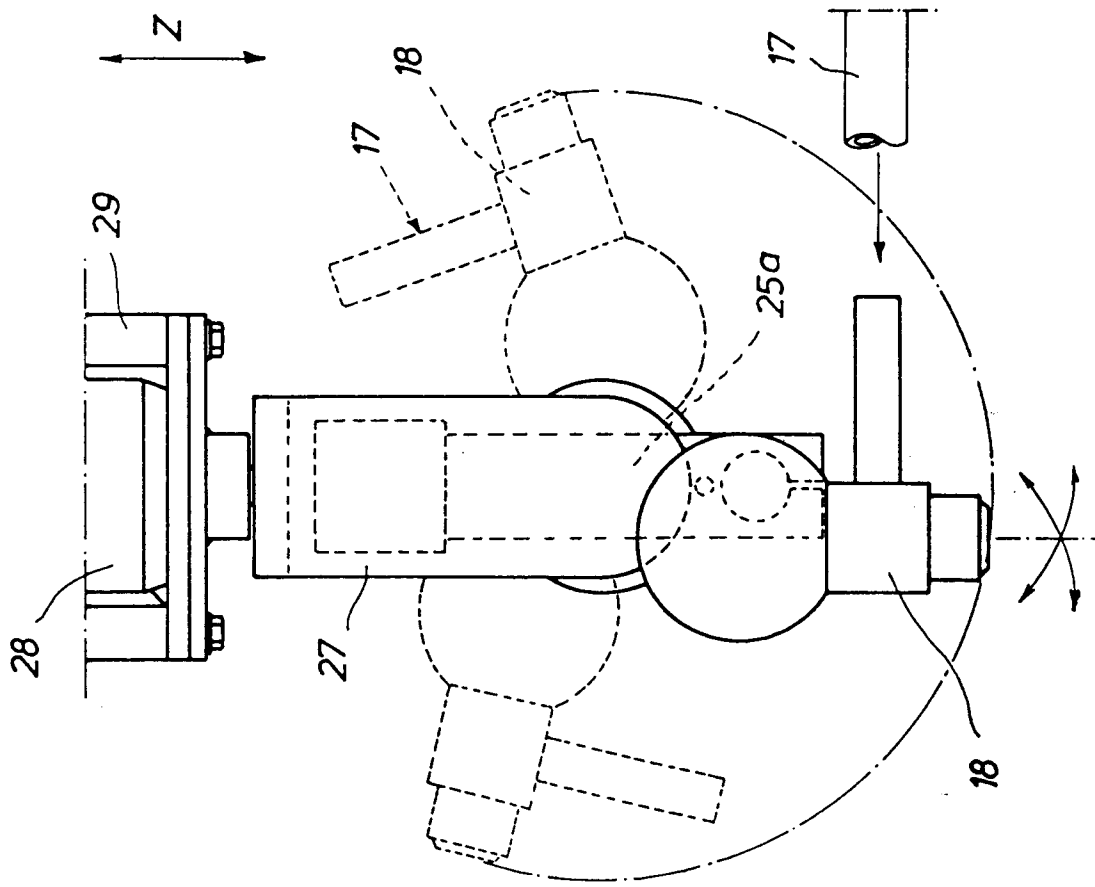


FIG. 5

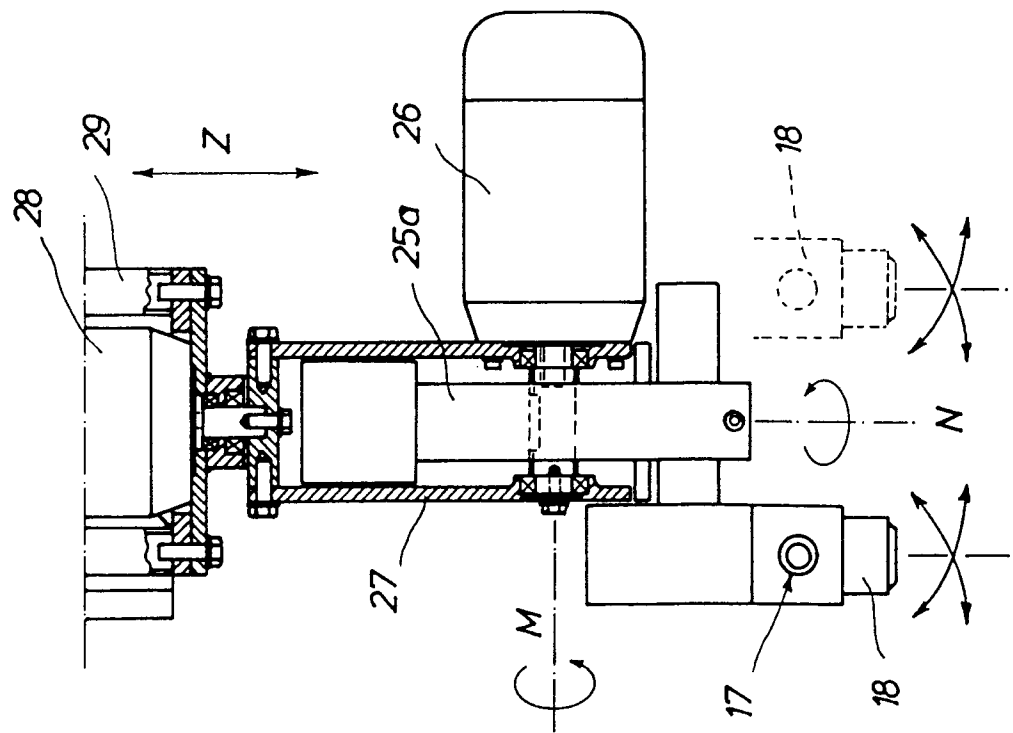
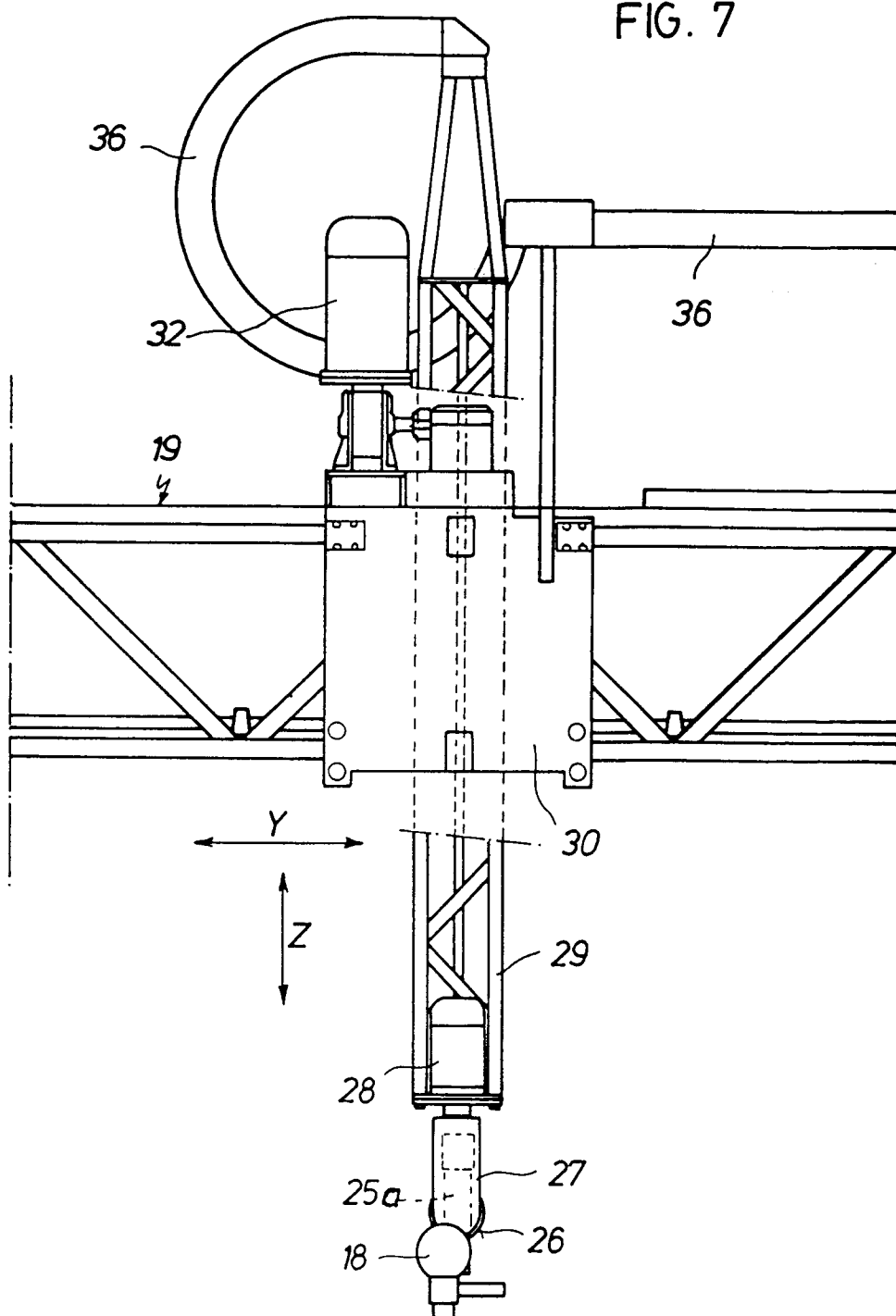
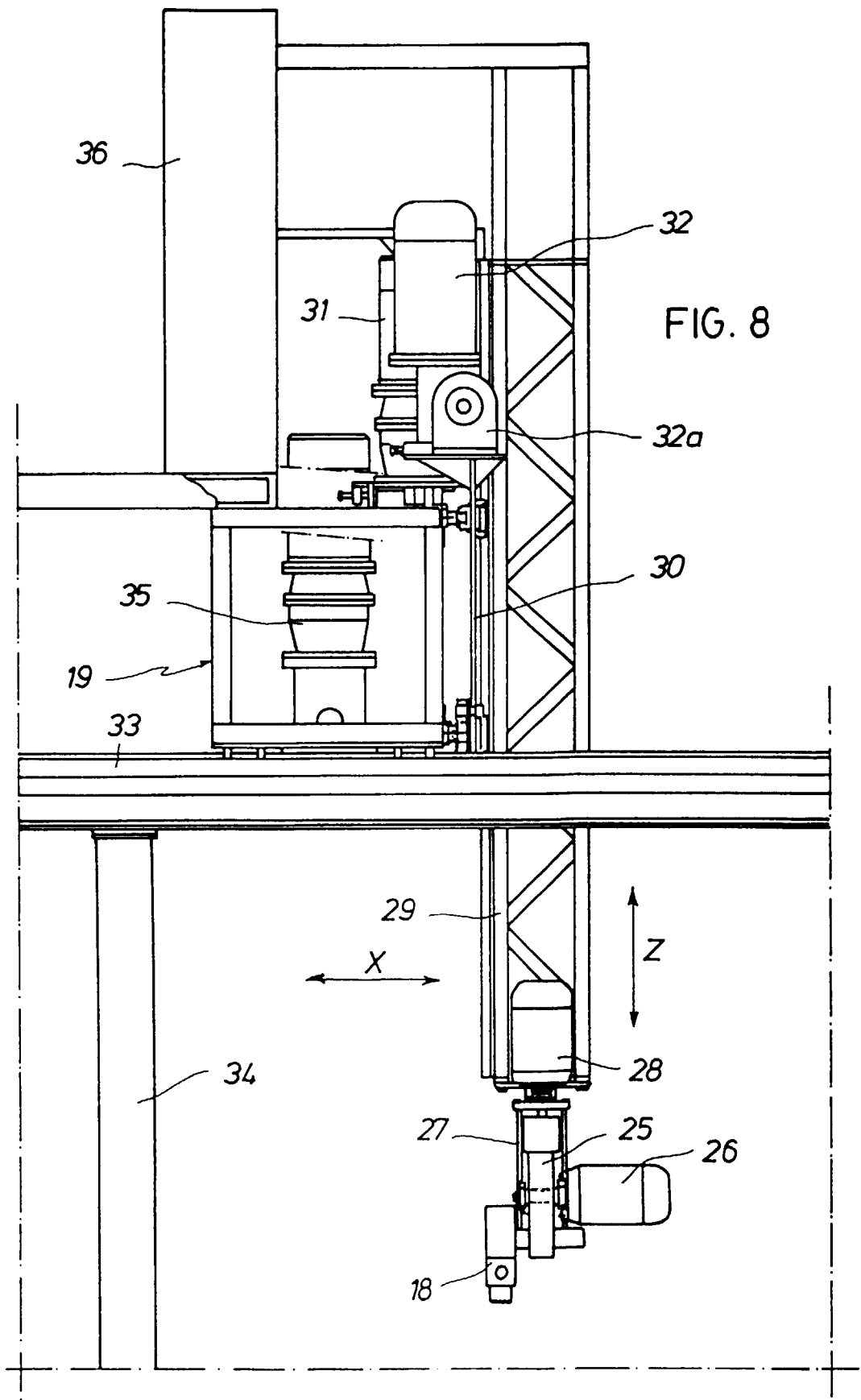


FIG. 7





INTERNATIONAL SEARCH REPORT

International application No.
PCT/ES 97/00192

A. CLASSIFICATION OF SUBJECT MATTER ⁶ : IPC⁶: B28B 7/00, B28B 19/00		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) IPC⁶: B28B7/00, 7/22, 1/16, 19/00, 15/00		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPODOC, CIBEPAT, WPI, PAJ		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US4754589 A (LETH) 5 July 1988 (07.05.88) The whole document	1-4,6,11-14
A	EP 0601182 A (DAIKEN) 15 June 1994 (15.06.94) Page 3, line 30 - page 4, line 19; page 5, line 31 - page 6, line 32; Claims 1 and 5; figures 3 and 5	2-4,6
A	FR 2540033 A (HUMARBO) 3 August 1984 (03.08.84) Page 3, line 31 - page 4, line 10; page 5, lines 1-8; figure 2	14-18
A	EP 0631887 A (SEKISUI) 4 January 1995 (04.01.95) Column 5, lines 14-44; column 9, line 40 - column 10, line 24, claims 1 and 13; figures 1 and 2	2,3,6,12,13
A	ES 1034840 U (FRADERA) 1 August 1996 (01.08.96) Page 3, lines 21-39; claims 1 and 2	3,12,13
A	GB 2164072 A (McNEIL) 12 March 1986 (12.03.86) Page 1, lines 5-33	1-4,6,12,13
☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
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Date of the actual completion of the international search 22 December 1997 (22.12.97)		Date of mailing of the international search report 13 January 1998 (13.01.98)
Name and mailing address of the ISA/ S.P.T.O.		Authorized officer
Facsimile No.		Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)