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(71) Applicant: **Ruscica, Francesco**
Villa Schioppo Strada Canizzano
I-31100 Treviso(IT)

(72) Inventor: **Ruscica, Francesco**
Villa Schioppo Strada Canizzano
I-31100 Treviso(IT)

(74) Representative: **Bazzichelli, Alfredo et al,**
c/o Società Italiana Brevetti Piazza Poli 42
I-00187 Roma(IT)

(54) **Modular building component for construction of buildings and process and machine for the manufacturing thereof.**

(57) Components for construction of buildings by means of coupling and combining of said components which are produced with a machine and process suited for a series production in the factory, said machine being formed by forming elements which combine in order to obtain a form for the casting of the component in reinforced conglomerate material.

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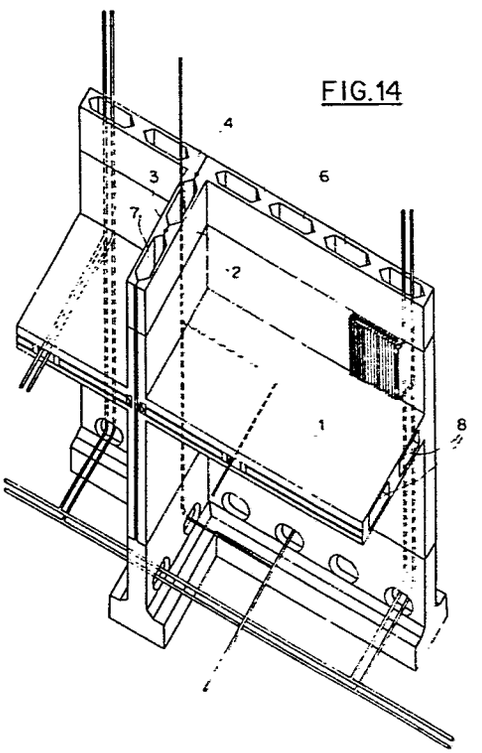
FIG.14



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FRANCESCO RUSCICA

Modular building component for construction of buildings and process and machine for the manufacturing thereof.

This invention relates to a process and a machine for manufacturing pre-equipped modular building components for the construction of buildings, as well as the components so produced.

The building components manufactured through the method and the machine according to the invention allow the construction of buildings through assembly of the components themselves through elements of connection incorporated therein, without the necessity of having to construct the skeleton of the building in the field and of later carrying out, still in the field, the operations for the formation of the rooms.

According to the invention, by means of a new system, the construction of the components for the building takes place completely in the factory, including the

accessory parts such as the fixtures, plumbing work, electric and telephone wiring and the actual raising of the building in the field requires only mounting of the components in a minimum amount of time and with a minimum number of labour out of the factory.

Furthermore, the new system based on this invention allows to manufacture the said components with a production accuracy never obtained so far with the current techniques, so that it may be stated that the building, though with an extremely great flexibility of design and variety of shapes, is manufactured in the factory following a method and working organization similar to that followed for the series manufacturing, in line, of articles of totally different type and of typically mechanical nature, such as, for example, automobiles.

The prior art has employed several different prefabrication systems in the construction of buildings.

The prefabrication systems according to the prior art generally involve the construction in the factory of wall panels or other particular parts of the building, or also the construction in the factory of parts of small buildings which are later assembled in the field.

However, in the first case the construction of the main frame of the building must always be carried out in the field, while in the second case it is possible to build only rather small buildings, which in fact do not require a main frame of particular importance.

Furthermore, in the prefabrication systems according to the prior art, a great accuracy of manufacture is not required, such an accuracy being acceptable in the order of the centimetre plus or minus.

In contrast with the prior art, the system of construction of buildings by means of use of components according to this invention allows the construction in the factory of the entire structure of the building through a type of manufacturing process in the factory which requires an accuracy of the order of the millimetre and does not display limitations, if not of practical order and of design, as far as the dimension of the building to be constructed is concerned.

This is therefore a system of construction which totally differentiates itself from the systems of prefabrication presently used and which furthermore cannot be defined as a system of prefabrication in the sense in which such term is currently intended in the art today.

The term "pre-equipped tridimensional modular construction components", stands for components for the construction of buildings which are ready to be assembled in the field, equipped with channels and cavities for the assembly of the telephone and electric wiring as well as of the plumbing for hydrosanitary facilities, for heating air-conditioning and the like. The components are furthermore provided with window and door openings necessary for the mounting of fixtures for windows and doors. Said components are also pre-equipped with flooring and outside wall covering.

The component according to the invention is formed by a single piece comprising a floor element, two side wall elements and one longitudinal wall element, which latter may be above and below the floor or on both sides of same.

The component is sized according to a modular concept: given a certain modular unit, which by way of example could be of 90 cm, the width, the length and height of the component are multiples of said modular unit.

One characteristic of the component according to the invention is that the height of the component above the floor is equal to a modular unit, while the height of the component below the floor is equal to two modular units. The width of the component may vary from one to more modular units, preferably from one to three units, while it is preferred to maintain the length unchanged which may be, for example, of seven modular units.

The surfaces of the walls facing the floor are smooth, while the surfaces of the side walls facing opposite each other display shapings, which in the assembly back to back of the walls of two components, form vertical cavities. Both surfaces of the longitudinal wall are smooth and the wall may be solid, or display vertical cavities.

The floor displays a longitudinal cavity for each modular unit in width as well as two cavities parallel to the side walls, in communication with said longitudinal cavities.

Each building component is provided, on the inside of the thickness of the side walls and in coincidence of the end of each modular unit, with connecting elements which cross said walls from top to bottom, formed by a solid metal bar having, in coincidence with the edge of said side walls, a connecting plate. The connection between components which are adjacent or one over the other, takes place through welding of the respective connecting plates, so as to form a rigid structure, through said connecting elements.

The material in which said components are made is a material which may be casted in the cavity of a mold and which becomes solid in said cavity, thus yielding a monolytic block. Preferably the material comprises a reinforcement of steel bars, wires or net.

A preferred material is concrete, so that the component actually is formed in reinforced concrete.

Other materials may be employed, such as mixtures of hardening resins and different filling materials, to the end of forming lighter structures.

For the construction of the component, in its various arrangements of the longitudinal wall, only one single machine is used, which is formed by a number of form portions for the formation of the cavity in which the casting is carried out for obtaining the part.

By means of said machine a series of operations is carried out of formation of the casting form and

removal of same according to a process which is another aspect of this invention.

According to the process according to the invention, the casting of the hardening material up to a conglomerate is carried out in a cavity formed by form portions arranged in such a way that the floor of the component is in a vertical plane, in contrast with the position that the floor takes up in the component to be assembled, which is in a horizontal position.

Furthermore, due to the tridimensional shape of the component, the problem arises of disassembling the form without damaging the smooth surfaces of the walls and of the floor, since the system requires a very high degree of accuracy in manufacture.

To this end the process according to the invention contemplates to carry out the form disassembly from the component, separating first the form portions from the surfaces of the side walls through a translation movement directed substantially according to the bisector of the three dihedral angles formed by the intersection of one side wall, of the longitudinal wall and of the floor. Form disassembly is later carried out of the inside surface of the longitudinal wall, as well as the surface of the floor, through a translation movement of the form portions according to the bisector of the dihedral angle formed by said wall and said floor.

In the prior art the form disassembly of prefabricated walls took place through separation of the forms in a

direction perpendicular to the wall itself, or through a rotation of the form itself around an axis parallel to the wall itself. Therefore the operation of form disassembly described above according to the invention constitutes per se an operation which is new in this branch in the art.

The machine which is the object of this invention is formed by a number of movable elements which make up the form for carrying out the casting of the component.

Said machine allows, in the movement of its elements, to obtain all the shape variations of the components claimed in the present invention.

The machine, developped in height over three planes, essentially comprises two inner form frames movable vertically between the bottom plane and the base plane, two outer form frames movable horizontally on the base plane, a supporting deck movable vertically above the base plane, a carriage which rests on the supporting deck and is movable horizontally on the base plane, on which the finished component rests and which serves the purpose of providing transportation for same out of the machine, two elevators movable vertically above the base plane and each bearing a carrier for the cores of the longitudinal wall and a carrier for the upper form frame, a group of form frame for the upper edges opposed to the carriage, movable horizontally on the upper plane of the machine, and a box carrier group movable horizontally on the upper plane of the machine, which goes into operation when window and door spaces are to be created in the longitudinal

wall, as well as the
equipment necessary for the casting of the hardening material up to the achievement of a conglomerate.

The structure of the machine is supported on four pillars, the bases of which rest on the bottom plane and which also form the guides for the elements which move in the vertical direction.

The inner form frames are supported in fact by beams, the ends of which slide on said pillars. The elevators also slide guided by said pillars.

In order to manufacture one component, the carriage which carries the surface of the form frame for the formation of the lower edges of the component (in the arrangement of the component rotated by 90° with respect to its normal position) is equipped, on the outside of the machine, with the reinforcement including the connecting elements. The elements of the machine are arranged in the following manner: the beams which carry the inner form frames are lowered on the bottom, so that said inner form frames are beneath the base plane. The supporting deck, provided with tracks in order to accept the carriage, is brought with said tracks at the level of the base plane; the outer form frames, the elevator and the carriages carried on the upper plane of the machine are maintained away from their working position.

The carriage with the reinforcement is caused to slide on tracks and brought above the supporting deck on the inside of the machine. The inner form frames are raised and their form

portions are brought in working position with respect to the carriage. Similarily the outer form frames are brought into working position with respect to the carriage and with respect to the inner form frames, inserting at their place the cores carried by said outer form frames for the formation of the cavities in the floor. Depending on the type of longitudinal wall which it is desired to obtain, the elevator with its core carrying carriage and the upper form frame, and, if the case, the box carrying carriage, are also brought into working position. If it is desired to manufacture a component without the longitudinal wall, in place of the latter elements, the upper carriage is used which carries the form portion for the upper edges of the component.

All the elements are connected together by means of blocking pins in order to fix them into position.

The casting is then carried out, preferably by use of means which cause the whole machine to vibrate and possibly using a heating system for the form portions and when the material has hardened into a conglomerate, the form disassembly of the finished component begins.

The form disassembly is made starting from the inner form frames for the surfaces of the side walls, which are moved away from the finished piece through a translating movement according to the bisector of the dihedral angle, as previously stated with reference to the process according to the invention. The form frames are then moved away from the surfaces of the floor and from the inner

surface of the longitudinal wall, through a movement according to the bisector of the dihedral angle formed thereby, as previously stated with reference to the process according to the invention.

The groups which form said inner form frames are then again lowered beneath the base plane. All the other form frames are then moved away and the carriage which carries thereon the finished piece, is brought outside of the machine and sent, possibly, to an oven for conditioning of the component, which is later equipped with finishings and the electric and plumbing parts.

The use of the supporting deck which, once it has received thereon the carriage with the reinforcement, may be raised above the baseplane, allows to achieve in the same machine components with a different number of modular units and furthermore the use of the elevator allows to manufacture a component with the longitudinal wall solid or hollow, arranged in different positions on the mating of the modular units of the component itself.

Having described the invention in general and indicating its various essential aspects, reference is now made to the enclosed drawings for a detailed description of a preferred embodiment of the components and of the machine.

In the drawings:

Fig. 1 shows a component according to the invention;

Fig. 2 shows another component according to the invention;

Fig. 3 shows a component with its cross section taken through the floor;

Fig. 4 shows a component without the longitudinal wall;

Fig. 5 shows two components according to Fig. 4, one over the other;

Fig. 6 (a) to Fig. 6(l) show the components which may be manufactured with the machine according to the invention in a schematic way;

Fig. 7 shows in detail an edge of the side walls and of the floor of one component;

Fig. 8 shows the connecting element embedded in a component according to the invention;

Fig. 9 is a detailed view from the top of the component with the connecting element;

Fig. 10 is a detailed side view of the component with the connecting element incorporated;

Figs. 11(a) and 11(b) show an example of building achieved with the components according to the invention;

Fig. 12 is an example of joining of the components;

Fig. 13 shows an example of joining of components with the plumbing work inserted;

Fig. 14 shows an example of joining of components with a heating section inserted;

Fig. 15 is a general view of the machine, in the direction of the X axis of the component;

Fig. 16 is a general view from the top of the machine, that is in the direction of the Z axis of the component;

Fig. 17 is a general view of the machine in the direction of the Y axis of the component;

Fig. 18 shows the carriage of the machine which forms the lower form frame for the formation of the component;

Fig. 19 is a detailed view of the representation of Fig. 15;

Fig. 20 is a detailed view of the representation of Fig. 17 and shows the group of the outer form frame;

Fig. 21 is a view which shows the group of elevators, as well as the core bearing carriage and the upper form frame carriage;

Fig. 22 is a plan view of the group shown in Fig. 21;

Fig. 23 is a top view of the first upper carriage in alternative to the upper form frame shown in Figs. 21 and 22;

Fig. 24 shows the second upper box carrying carriage; and

Figs. 25, 26, 27 and 28 illustrate the process according to the invention.

Detailed description

Description of the component

With reference to figures from 1 to 10, the component will now be described according to the invention, which may vary in sizes depending on the number of modular units of which it is formed and which may vary in shape as the position varies of the longitudinal wall, including the form without said longitudinal wall.

In the various figures similar elements are indicated with like reference numbers.

With reference in particular to figure 1, 2 and 3, a component according to the invention comprises, in one single solid piece, a floor element 1, two side walls 2, 3 and a longitudinal wall 4, which may also be absent.

The component displays a geometrical appearance clearly defined and easily visible in the figures. However, as we are speaking of a tridimensional object, a reference to its parts and its surfaces could result difficult to understand. Therefore, throughout the whole description, in the drawings and in the claims reference will be made to the directions defined by the axes X, Y Z indicated in the figures 2 and 3. In the normal position of the component, as shown in figures 1 and 2, the axes X and Z are axes which lie in a horizontal plane, while axis Y

indicates the vertical direction. In the manufacture of the components in the machine according to the invention which will be described later, the position of the component is instead rotated by 90° around the X axis, whereby on the inside of the machine the axes X and Y lie in a horizontal plane and the axis Z represents the vertical direction. It is therefore intended that the directions of the axes X, Y, Z are integral with the component, as shown in figure 2 and this orientation of the axes is maintained coherently throughout the whole description, in the drawings and in the claims.

With reference to the component, we define as width its extension in the direction of the Z axis or transversal direction, as length its extension in the direction of the X axis or longitudinal direction and as height its extension in the direction of the Y axis or vertical direction.

As previously stated, the component is dimensioned according to a modular concept. Given an M modular unit, which by way of example may be indicated as 90 cm, the width of the component may be of one or more such modular units, while the length will always be a multiple of such modular units. Preferably the width will be from one to three modular units, while the length will preferably be of six or seven modular units. As for the height of the side walls 2 and 3 and of the longitudinal wall 4, it is a characteristic of the component according to the invention that on one side of the floor said height is equal to one modular unit, while beneath the floor 1, said height is of two modular units. The thickness of floor 1 divides the

upper modular unit from the two lower modular units.

The imaginary line, indicated in 5 in figures 1 and 3, is here defined as "intermodular line".

The longitudinal wall 4, which may be either only above the floor, or only beneath the floor, or on both sides of the floor, may assume different positions, but it is always in coincidence of an intermodular line 5, included the extreme position on an end modular line, as shown in figures 2 and 3.

Furthermore, said longitudinal wall may also be solid, as indicated in figure 2, or provided with vertical through cavities 6, as indicated in figure 1.

The hollow wall shown in figure 1, which is particularly intended to have one surface facing towards the outside of the building formed by the various components, may assume three positions with respect to an intermodular line 5, that is a symmetric position with respect to said line, or on one side or the other thereof.

Therefore, it may be placed on the inside of the modular unit or at the outside thereof, as shown for example in figure 1.

The longitudinal wall without cavity, as shown in figure 2, is instead always on the inside of the modular unit.

When the longitudinal wall 4 is present both above and below the floor, the upper part of the wall and the lower part of the wall may be in different positions, still

maintaining the above indicated conditions.

In a particular case the longitudinal wall 4 is completely absent, as shown for example in figure 3.

In any case, the surfaces of the floor, the surfaces of the side walls 2 and 3 facing towards the floor and both the inside and the outside surfaces of the longitudinal wall are smooth.

On the contrary, the outside surfaces of the side walls 2 and 3 are shaped, as shown in the figures, so as to present a vertical channel 7 in each modular unit. In the back-to-back assembly of a side wall with a side wall of another component, a wall is formed by the components provided with vertical cavities. The side walls 2 and 3 are reinforced by means of ribs 8 which do not however close said channels 7.

The floor 1 contains in each modular unit a longitudinal through cavity 8 directed in the sense of the length, that is according to the X axis. Such cavities are open at the ends, whereby they are in communication with the vertical channels 7 of the side walls 2 and 3.

Furthermore in the floor through transversal cavities 9 are present having the direction of the Z axis which place longitudinal cavities 8 of one same component or components placed side-by-side in communication with each other. The vertical channel 7 of the side walls 2 and 3, the vertical cavity 6 of the longitudinal wall 4, the cavities 8 and 9 of the floor serve the purpose of receiving the pipes

of the hydrosanitary or thermal facilities,

as well as to allow the conditioning and natural cooling, directly employing vector fluids or inserting tubing in the appropriate cavities.

The thickness edges of the side walls and of the floor, indicated respectively in 10 and 11, extending in the direction of the axes X and Y, are formed with grooves, as shown in figure 7, which, mated with similar grooves of another associated component, form cavities or tubing for the insertion of conductors for the electrical and telephone systems and the like. As can be seen in figure 7, groove 12, which may be used for the electrical system, opens out at the level of the upper edge of side wall 2, towards the inside through the exit or mains branching box 13, while groove 14, which may be used for example for the telephone system, opens out through hole 15 on the surface of floor 1, in the vicinity of wall 2. The edge 11 of the floor displays a channel 16 for directing the cables from one side to the other of the floor.

The upper edge 17 of the side walls 2 and 3 displays also a groove 18 for directing cables from one end to the other of the wall.

A similar groove 19 is arranged on the lower edge 20 of the walls 2 and 3. At the junction point between the thickness edges 10 and 11 respectively of one side wall and of the floor, a recess 21 is formed which may be used as a support for a possible auxiliary beam 22, as indicated in figure 12.

A characteristic of the component according to the invention consists of the connecting element 23 (see figure 8) which serves the purpose of connecting various components between each other for the assembly of buildings, which connecting element 23 is embedded within the side walls 2 and 3at the end of the modular width. Therefore each component may be provided with two connecting elements 23, for each module, as indicated in figures from 1 to 3.

As can be seen in figure 8, each connecting element 23 is formed by a steel rod 24 embedded in side walls 2 and 3 and having the direction of the Y axis. It is clearly obvious that said rod 24 is connected with the rest of the reinforcement, if present, of the component.

Two cups 25 provided with a plate 26 are connected to the ends of the rod, the cup being sunk in the wall and the plate 26 being on the level with the upper edge 17, or respectively lower edge of the same side wall. The cup 25 displays at its centre a hole 27.

In figures 9 and 10 the connecting element is shown as mounted in the side wall and by way of example the arrangement is shown in detail of the connecting element 23 in coincidence of the upper edge 17, it being clearly understood that the lower edge is arranged in the same way.

As previously stated, the connecting element 23 practically is integral with the component and in order to connect two different components together, the procedure is as follows:

When two components are placed side by side, in any arrangement, tneir connecting plates result juxtaposed on one side and accessible on the top. Welding is carried out of the juxtaposed sides of the plate 26, thus making the two components integral. It is therefore obvious that to each plate of a first component other two components may be integrally added by means of their plates. When it is desired to connect two components one over the other, the lower plate 26' of the connecting element 23' of the upper component, will be placed over the upper plate 26 of the lower component. The two components are made integral by means of welding 139 of the side of the plates adjacent the groove 18, by means of a welding instrument inserted through the exit or branching box 13, already described before, which is on the upper edge 17 (as well as on the lower edge not represented of the upper side wall) of the component. In placing the components one over the other it is also possible to insert a centering and blocking body 140 inside cups 25, 25' of the respective connecting elements 23, 23'.

Said body 140 is provided with a through hole 141 which alignes with the holes 27, 27' of the elements 23, 23'. Such alignment allows, using hollow rods 24, 24', to pass, if desired, prestressed cables which cross heightwise a series of components one over the other.

It should be also understood that connecting elements similar to those indicated in 23, may be arranged at modular intervals in the longitudinal wall 4, as indicated in 142 in figure 1.

It is possible in this way to assemble according to various arrangements components together which are similar or different according to what has been described previously, so as to obtain a structure and an architecture of a building in an extremely versatile and fast way.

Merely by way of example, in figure 5 the placing of two components one over the other is shown without the longtiduinal wall of the type shown in figure 4, in which it should be observed, after what has been stated previously, that the junction between the two components takes place at a level equal to a module above the floor. This is a characteristic which remains unchanged no matter what the combination of the components is according to the invention and this forms an original characteristic of this invention, which differentiates itself from the prior art, since the junction between various components of the prefabricated type took place always either in correspondence of the level of the floor or of the ceiling, or in coincidence of the junction of one wall with the floors.

This fact is not a simply geometrical difference, but the junction 28, so-called "interplane", confers to the entire structure of the building a structure of resistance which is by far superior to that obtainable with the present construction systems of the prefabrication type.

Said "interplane" junction allows to achieve structural nodes which ensure the stability of the building, although in absence of a continuous frame, for example of reinforced concrete.

According to what has been described previously, the component according to the invention, though defined in an extremely rigorous way with respect to a series of characteristics, may vary in the arrangement of the longitudinal wall, which allows to carry out architectural designs with great freedom of choice, still having a fundamental component to work with having constant characteristics.

It should be stressed that the variability in shape and dimension of the component may be obtained through a single machine according to the invention, which will be hereinafter described

In figure 6, the various arrangements are shown which are obtainable for the longitudinal wall 4. The representation of figure 6 is a schematic representation and shows a component formed by three modular M units. In said schematic representation a sidewall 2 is shown in front, while the floor 1 is seen in transversal cross section; the longitudinal wall 4 is also shown in transversal cross section. Only the figures 6(a), 6(b) and 6(c) bear reference numbers, the other being of clear interpretation.

Longitudinal wall 4 indicated in figure 6 may be intended both as a wall provided with vertical through cavities 6 (outside wall), and as solid wall (interwall or partition), the machine allowing the execution both of one as well as of the other form.

Figure 6(a) shows a component without the longitudinal wall.

Figure 6(b) shows a component having the longitudinal wall aligned on one end.

Figure 6(c) shows a component having a longitudinal wall 4 placed at one end above floor 1 and on an intermodular line, at a distance of one module, beneath floor 1.

Figures 6(d) to 6(h) shown other possibilities of arrangement of the longitudinal wall.

Figures 6(i) up to 6(l) show the case wherein the longitudinal wall is present only on one side or the other of the floor.

It is obvious that the shapes of the specular components with respect to those shown in figure 6 may be equally used by the architect, since the structure of the components appears perfectly symmetric with respect to this possibility of use. Furthermore the components could also be used upside down, since this does not alter the symmetry of the connecting elements.

Simply by way of example in figures 11(a) and 11(b) two structures have been shown of a building which may be built with the components according to the invention.

In figure 12 the joining is stressed of two components with the side walls 2 and 3 arranged back to back. It is seen that the walls form vertical cavities by effect of the union of vertical channels 7. Even though not represented in an explicit way, it can be seen that cavities 8 in the floors of the two associates components are in continuity.

Figure 12 also shows an auxiliary beam 22 mounted in recess 21 which could be used for particular architectural solutions, such as the doubling of the distance between walls 2 and 3, the assembly of stairs and the like.

Figure 13 shows how the cavities formed by channels 7 of the walls and the cavities 8 of the floors may be used for assembling hydrosanitary plumbing 28.

In figure 14, still by way of example, the insertion is illustrated of a heating system using the vertical cavities 6 of the longitudinal walls 4, the cavities 7 of the side walls 2 and 3 and the cavities 8 of the floors 1.

Although not represented in the figures, it is easily understood how a system of conductors for energy or communication may be distributed in all the ambients of the building. To this end, the exits 13 have a particular interest and may be used as actual mains branching boxes for the electrical connections and the distribution of energy. As will be described further on in the description of the machine, the recess for the branching box 13 may be accomplished in the position at the limit of the extension of the module, or may also be left out, according to requirements. This characteristic is of great utility for the versatility of solutions which are possible.

Furthermore, as indicated in figures 1 and 2, longitudinal wall 4 may display, above or either below floor 1, an opening for door or window space 29, indicated with a discontinued line which covers one or more modular distances in the sense of the height and length (X axis),

for the doors and/or windows through said longitudinal wall 4.

Description of the process

For obtaining the component described above, a forming process is used which has original characteristics with respect to the rules of execution of casts currently followed in the art, and which allows the production in series of the component in a machine.

The problem which is at the base of the new process is that of obtaining the piece without ruining the surfaces of any of its parts during the form disassembly.

It is in fact necessary that the execution of the piece takes place within tolerances of the order of the millimetre, on the contrary to what has up to today been done in the industry of constructions, wherein factory tolerances are of the order of several millimeters or of the centimeter.

In order to solve this problem, a characteristic of the process is the manufacturing of the piece in a position rotated by 90° around the longitudinal X axis, whereby the floor 1 appears placed substantially in a vertical plane and the longitudinal wall 4 is placed in a horizontal plane, above the floor.

The newly finished component results as resting on the edge 9 of floor 1 and on edges 10 of the side walls 2 and 3.

It should be noted at this point that the surfaces of the

floor, as well as the surfaces facing towards the floor of the side walls 2 and 3 and of the longitudinal wall 4 are defined as inner surfaces. The surfaces of walls 2 and 3 facing in the opposite direction are defined as outer surfaces of said walls, while the surface facing in the opposite sense of the longitudinal wall 4 is defined as upper surface of said wall, since it assumes such asset within the manufacturing machine. It is however still intended that any reference to the X, Y, Z is to be considered as if these axes were integral with the component itself, as indicated in figure 2.

With reference to figures 25, 26 and 27 the form portion for the formation of the surface of the floor is indicated in 30, while in 31 and 32 the form portions are indicated for the formation of the inner surface of the parts of side walls 2 and 3 which are on the same side with respect to the floor.

In figure 25 the axes X, Y and Z are indicated in the position which the component to be formed assumes with respect to the form portions 30, 31, 32. It is seen that the component appears rotated by 90° with respect to the position shown in figure 2.

It is intended that a group of forms similar to that shown in figures 25, 26, 27 is arranged on the other side of the form portion 30, in symmetrical position in order to form the other surface of the floor and the inner surfaces of the parts of sidewalls which are on the other side of the floor.

For simplicity, reference is however made only to the group

of forms 30, 31, 32 shown in figures from 25 to 27. Furthermore for ease of illustration, these figures do not show the form portion for the inner surface of the longitudinal wall, which will be in an X, Y plane above the other form portions.

According to the process of the invention, when the piece has been formed in contact with the form portions 30, 31, 32 and has sufficiently hardened, the form frames carrying the form portions are moved in order to disassemble the form or free the finished component.

To this end the form portions 31, 32 are first moved through a translation movement in the direction of the bisector of the dihedral angles formed by said forms 31, 32, by form 30 and by the form for the formation of the inner surface of the longitudinal wall (not shown). Such a direction is indicated in a discontinuous line in 33. In other words said translation is a movement the vector of which presents components with respect to all three of the axes X, Y, Z.

The situation is illustrated in figure 26, wherein it can be seen that the forms 31, 32 are brought in the illustrated position, starting respectively from the starting position 31', 32' according to the directions of the arrows 34.

The entire group of the form portions 30, 31, 32 is then moved towards the bottom through a translation movement according to the bisector of the 90° angle formed by the form 30 and by the form for the formation of the inner surface of the longitudinal wall (not shown). In other

words, said movement may be represented by a vector 35 (figure 27) having components in the direction of the Y axis and of the Z axis, directed towards the bottom, and not having components with respect to the X axis, in other words parallel to plane Z, Y.

The situation is illustrated in figure 27, wherein it can be seen that the form 30 passes from one starting position indicated in 30', to the position illustrated, integrally with the other two forms 31, 32.

It should be noted that in order to avoid a dragging of the side ends of the form 30 on the surfaces of the side walls during the translation just described (figure 27), the sheet plates which form the form portions 30, 31, 32 are shaped, in coincidence of the vertex where they meet, in the way schematically illustrated in figure 28.

In figure 28 it can be seen that after the translation of form 31, form 30 remain moved away from the side wall by a distance d.

In the next translation of the group of forms 30, 31, 32 towards the bottom, in the direction of the bisector of the right angle formed by the floor and by the longitudinal wall, no point of the forms 30, 31, 32 will be in contact with the surfaces of the sidewalls 2, 3 so that said forms may move in a parallel way with respect to said sidewalls 2 and 3 without any dragging therewith.

In this way an operation is carried which avoids any dragging of the forms on the surfaces of the formed

component and ensures the desired manufacturing tolerances.

Description of the machine

As previously stated, the machine is composed of a series of elements movable between a position of formation of the form for the casting of the component and a position of form removing for the extraction of the finished component from the machine.

These elements may be classified in two groups, i.e. a first group of elements which take part all together and always in the manufacturing of the component, no matter what the position of the longitudinal wall is, and a second group of elements which operate only depending on the desired position of the longitudinal wall.

Reference is made to figures 15, 16, 17 which show the machine in a general view, with the component to be manufactured represented in section. In said figures the axis X, Y, Z are shown, which, as previously stated, are referred to the component.

The machine is built on three planes, that is a bottom plane 36, a base plane 37 and an upper plane 38. Said planes are materially formed, respectively by the bottom of an excavation beneath the ground level, by the level of the ground itself and by a frame of upper girders 39.

The upper girders 39 are carried by four pillars 40, 41, 42, 43 which rest on the bottom plane 36. Having stated the foregoing, the various elements of the machine will be now described in detail.

a) Guiding and supporting pillars

Said pillars 40, 41, 42, 43, in addition to serving the purpose of supporting the upper girders 39, also serve the purpose of acting as guides for the sliding of the ends of the supporting beams of the inner form frame movable in a vertical direction. To this end said pillars are of square section (see figure 16) in order to be able to mate with grooved wheels 44 carried by said ends 45, 46, 47, 48 of the beams.

The part of the pillars 40, 41 above base plane 37 is covered with a hull 49, 50, which serves the purpose of guiding the elevators which are movable between said base plane 37 and the upper plane 38, as will be further described later. The pair of pillars 42, 43 for the same purpose has two further pillars 51, 52 which rest on base plane 37.

b) Horizontal beams

A horizontal beam 53 is integral with the ends 45, 46 guided by the pair of pillars 40, 41, while a horizontal beam 54 is integral with its ends 47, 48 guided by the pair of pillars 42, 43. Said beams extend according to the direction of the longitudinal Y axis.

Pillars 53, 54 serve the purpose of supporting the inner form frames respectively indicated in 55 and 56, which may move between a position lowered towards bottom plane 36, wherein the inner form frames carried by each beam are lowered below the base plane 37, and other positions

substantially at the level with baseplane 37, wherein the inner form frames are carried into working positions.

Said beams 53, 54 therefore have the function of supporting the inner form frames and of guiding same in vertical direction.

c) Supporting deck

The supporting deck indicated in 58 (figures 15, 17 and 19), is formed by two horizontal beams 59, 60 placed according to the direction of the Y axis and by a horizontal beam 61 placed according to the direction of X axis. The supporting deck 58 is rested with the horizontal beams 59, 60 on two movable resting points formed by two hydraulic jacks (one of which is indicated in 62 in figure 15) and guided by means of two vertical extensions beneath each beam 59, 60 indicated in 63, 63', 63", which extensions slide in corresponding guides 64, 64', 64" fixed on the bottom plane 36 and provided with grooved wheels.

The supporting deck 58 therefore is capable of moving in a vertical direction between a position which is more or less at the level of base plane 37 and a position above the latter, by means of hydraulic jacks 62. As will be described more in detail further on, the different working positions of the supporting deck allow to manufacture components with a number of different modules in width.

The supporting deck is further provided with appendixes 65, 65', 65", which serve the purpose of positioning the inner form frames 55, 56 exactly with respect to the supporting

deck 58, as will be described more in detail further on.

The supporting deck 58 is provided on each of its beams 59, 60 with a track in order to receive the carriage.

d) Lower carriage

The carriage indicated in 66 is shown in detail in figure 18 and is the element of the machine which supports the component to be manufactured indicated generally in 67 in figures 15, 16, 17. The carriage is formed by two wings 68, 68' and by a rib 69 and as seen in a plan view, has the shape of an H. The carriage is provided beneath the wings 68, 68' with wheels which travel on tracks. The upper surface of the carriage is provided with an engraving which is the casting form of the edges 9, 10 respectively of floor 1 and of side walls, 2, 3 of the component.

The carriage is initially positioned outside the machine and in this position is equipped with the reinforcement of the component, which is fixed to the carriage. As previously stated, said reinforcement includes steal nets, rods, and wires, and is self-sustained on the carriage. The carriage is then caused to move horizontally (in the direction of the Y axis), so that it is brought above the supporting deck 58, in the position shown in figure 15. In such a position, the carriage is blocked on the supporting deck by means of pin devices (schematically indicated in 17 in figure 15) so that the carriage 66 is made integral with supporting deck 58 and rests on same.

During the entrance of the carriage 66 into the machine, the horizontal beams 53, 54 supporting the inner form frames 55, 56 must be in the lower position in the vicinity of bottom plane 36, in order to allow the passage of the carriage itself. Then the inner form frames 55, 56 are raised in the space between the wings 68, 68' and the rib 69 of the carriage 66, positioning around the reinforcement, in order to form the form frame for the casting of the component.

Once the casting has been performed and after having lowered again the inner form frames 55, 56 beneath the base plane 37, the carriage may be caused to exit from the machine along with the finished component supported thereon.

e) Inner form frames

The inner form frames indicated generally in 55, 56 serve the purpose of assembling for the casting step the forming surfaces for obtaining on one side a surface of the floor and the inner surface of the longitudinal and side walls, and, on the other side, the other surface of the floor and the inner surface of the longitudinal and side walls which are on that same side. As previously stated, the floor is formed in the machine in a vertical position. In figure 15 the section can be seen of the floor with its longitudinal cavities of the component 67.

There is therefore an inner form frame for each side of floor. These are substantially equal, except for the fact that they have a different depth in the direction

of the Y axis (figure 15), since, as previously stated, the depth, that is the height, of the side walls will be equal to a modular unit on one side of the floor, while it will be equal to two modular units on the other side of the floor. For ease of description reference will therefore be made to only one of the two groups of inner form frame, the description being valid for the other group as well.

The inner form frame 55 comprises: a supporting framework 71 connected rigidly to the respective horizontal beam 53; a U shaped framework 72 placed at the sides, on the front (figure 16) and on the top (figure 15) with respect to the supporting framework 71 and connected to the latter by means of a system of connecting rods 73 and hydraulic pistons 74; a form backing case 75 connected rigidly to the U shaped framework 72 and which carries metal sheets for forming a surface of the floor and the inner surface of the longitudinal wall, said metal sheets, or form portions, being perpendicular with respect to each other; two side form backing cases respectively 76, 76' carrying the metal sheets or form portions for the inner surfaces of the side walls and connected to the U shaped framework 72 by means of a system of connecting rods 77 and hydrualic pistons 78.

The connecting rods 73 which connect the supporting framework 71 and the U shaped framework 72 form a system in the shape of a linked parallelogram so that, in cooperation with guides 143, after an actuation of hydraulic pistons 74, the U shaped framework 72 moves with respect to the supporting framework 71 following

a translation movement directed according to the bisector of the 90° angle formed by the forming metal sheets carried by said U shaped framework 72. This avoids, during the form disassembly of the finished component, any movement of dragging between said metal sheets and the piece itself.

The connecting rods 77 which connect the cores 76, 76' with the U shaped framework 72 also constitute a linked parallelogram so that upon actuation of the hydraulic piston 78, the cases 76 or 76' move with respect to U-shaped framework 72 according to a translation movement directed along the bisector of the dihedro angles formed by the three forming metal sheets perpendicular to each other. This also avoids dragging of the forming metal sheets of the cases 76, 76' on the inner surfaces of the side walls.

In the operation of the machine when it is desired to perform a form disassembly, first the cases 76, 76', which approach, with the above mentioned translation movement, the U-shaped framework 72, are moved away from the finished component. Then the U shaped framework 72 is translated according to the movement described above, said U-shaped framework carrying along with itself also the side cases 76, 76' already separated from the piece.

As previously stated, the inner form frame 55 is rigidly connected to the horizontal beam 73 and therefore may be lowered towards the bottom plane 36 by the ends 45, 46 of said beam 53 being guided on pillars 40, 41. Such movement is carried out by means of a motor 79 (figure 16), which actuates through appropriate devices

80 of mechanical transmission, a group of three movable supports 81, 81', 81" which operate through a worm screw. Two of said worm screw movable supports sustain the supporting framework 71, while the third support 81 directly sustains the horizontal beam 53. By raising or lowering the movable supports 81, 81', 81", the raising or lowering is determined of the inner form frame 55.

As previously stated in the description of the supporting deck 58, this is equipped with appendixes 65. Said appendixes serve the purpose of engaging legs 82 integral with the U shaped framework 72 and which extend towards the bottom therefrom. In the illustrated embodiment said legs 82 are in a number of three and are respectively connected to the central part and to the side parts of U shaped frame-work 72. Appendixes 65, 65', 65" of the supporting deck and the legs 82 of the U shaped framework serve through coupling by means of holes 83 on legs 82 and pins 84 on appendixes 65, the purpose of fixing the position of the inner form frame 55 with respect to the supporting deck 58. In this preferred embodiment of the machine, appendixes 65 display three groups of pins 84, 84', 84" which have the purpose of fixing the related position of the supporting deck 58 and of the inner form frame 55 for manufacturing a component having a width respectively of one, two or three modular units. In fact, the working position remaining constant of the form frame 55 shown in figure 15, the supporting deck 58 may be raised by means of jack 62, increasing its height by a quantity equal to one or two modular units. In such case mating between the inner form frame 55 and the supporting deck 58 will take place on a lower group of

pins 84' or 84" and the carriage 66 will be placed higher up exactly by the same amount of one or two modular units. In this way the form cavity formed by the inner form frames 55, 56 and the carriage 66 will have a width (in the sense of the Z axis), respectively of one or two modular units. It will be therefore possible to manufacture according to the example of machine described in the figures, components having a length which ranges from one to three modular units.

The number of pins for each group 84, 84', 84" of the appendix 65 (five in figure15) serves the purpose of establishing the related position between the supporting deck 58, and therefore carriage 66, and the inner form frames 55, 56 when, keeping the number of modular units constant in the sense of the width of the component, longitudinal walls must be manufactured of the component having different depth (hollow or solid wall), or different positions with respect to the intermodular line, as previously stated above. The appendixes 65, 65', 65" connected to the horizontal beam 61 or rib of the supporting deck 58, serve the purpose of pin blocking of both groups 55, 56 of inner form frame. In fact each appendix has on one face the pins for blocking the legs 82 integral with the internal form frame 55 and on the other surface (see figure 17) has pins for blocking the legs of the internal form frame 56.

f) Outer form frames

With the term outer form frames the group is intended which carries the surfaces or forming metal sheets for the

formation of the outer surfaces of the side walls 2 and 3 of the component, as well as for the formation of edges of said walls indicated in 17 in figure 1.

Particular reference is made to figures 16, 17 and 20 and it will be obvious that there are two groups of outer form frames 102, 102' per each of the side walls 2 and 3 which are equal with respect to each other, whereby like reference numbers will be used for both groups.

Each group of outer form frame comprises a main framework 85, which is fixed on the base plane of the machine, that is it is fixed at the ground level. Tubular guides 86 and hydraulic pistons 87 are integral with one end of the framework 85 and carry at their other end form backing cases 88, 88', 88" carrying the metal sheets or forming surfaces for the outer surfaces of the said side walls of the component. By actuating the hydraulic pistons 87 the form backing cases 88, 88', 88" can therefore be moved in the direction of the X axis, guided by guide 86. The three form backing cases 88, 88', 88" can therefore be moved independently one from the other.

The preferred form of embodiment of the machine represented in the figures is capable of manufacturing components according to the invention having a width which ranges from one to three modular units. When it is desired to manufacture a component having a width of one modular unit, only the form backing case 88 is used, which is then caused to advance in order to make the casting form, while the other two form backing cases 88', 88" are left behind. It will be understood that for a component of width equal to two modular units,

form backing cases 88, 88' will be used and for a component of width equal to three modular units all three form backing cases 88, 88', 88" will be used, as shown in figures 17 and 20. In the working position, said form backing cases 88, 88', 88" are made integral one with the other by means of pins 89 and by means of pin 90 the entire assembly is made in turn integral with supporting deck 58.

When it is desired to form a longitudinal wall at one end of the component a small supplementary form backing case 91 is used (figure 20) actuated by a hydraulic piston 92 for the formation of the edge of said longitudinal wall. Said supplementary form backing case 91 is also fixed to the group of outer form frames by means of a pin 93.

The framework 85 of the outer form frames comprises also cores 94, 94', 94" for the formation of the longitudinal cavities 8 (figure 3) of floor 1. Said cores 94, 94', 94", which, as stated before, must form a cavity 8 for each modular unit of width of the component, are guided on tracks carried by the framework 85 and slide over said tracks by means of wheels 95 moved by oleodynamic motors 96 integral with the cores themselves. As can be better seen in figure 16, core 94 by sliding over the tracks of framework 85 is capable of penetrating through an opening in the form 88 which it faces, so as to place itself between the forming metal sheets of the inner form frames 55, 56 for the formation of floor 1. To this end the cores 94, 94', 94" have a shape which is slightly tapered towards the end closest to the machine in order to simplify their extraction and have a swelling or plug 97 for perfectly closing the opening of the form portion 88 through which they have passed.

Cores 94, 94', 94" also carry at their inside further cores 98, 98', 98" for the formation of transversal cavities 9 (figures from 1 to 3) of floor 1. Said cores 98, 98', 98" are brought into working position retracted on the inside of the respective cores 94, 94', 94" and when these have been placed in the desired position, are caused to exit oleodynamically in the direction of the Z axis, so as to form a continuous core perpendicular to cores 94, 94', 94" for the formation of said transversal cavities 9.

It will be understood that cores 94, 94', 94" will form half of the longitudinal cavity 8 of floor 1, as well as one of the transversal cavities 9, the other half of the cavity 8 and the other cavity 9 being formed by the outer form frame group which is on the other side of the machine. It will further be understood that the movement of each core 94, 94', 94" is indipendent from the others.

The outer form frame group further comprises (see figure 16) side heads 99, 99' for the formation of the edges of the component indicated in 17 in figure 3, that is the edges of the side walls 2, 3 which extend in length in the direction of the Z axis and in width in the direction of the X axis. Said side heads 99, 99' are connected to the framework 85 by means of a system of hydraulic pistons and guiding bars 100, as well as by a system of hydraulic pistons (not shown) for the closing in and detachment of the forming metal sheet 101, 101' towards and away from the working position. The heads 99 and 99' are further provided with pins 102, 102' for making them integral with the respective form cases 88, 88', 88". It will be under-

stood that each head 99, 99' is formed actually by three independent heads, each of which is associated with one of the form cases 88, 88', 88", in order to allow a modular manufacture of the component. The forming surfaces 101, 101' are shaped so as to form the seat for the connecting elements 23, as well as the grooves 18, 19 (figure 7), and the branching boxes 13. Preferably the shape for forming of the branching boxes 13 is a part of the forming metal sheet 101, 101', which is controlled independently by means of small oleodynamic pistons according to a pre-established working program, so that the finished component has said outputs or branching boxes 13 formed in the desired positions and in the desired number. Preferably the forming metal sheet 101, 101' of the heads 99, 99' is provided with a hole having the profile of the base of the branching box 13.

The forming element of the cavity for the branching box 13 is moved by means of a selective control, between a position wherein the base of said forming element closes said hole, at the edge of the rest of the forming metal sheet 101, 101' and another position wherein said forming element protrudes through said hole, so as to create in the edges 17 of the component, the cavities 13 for the branching box, after the hardening of the cast of conglomerate material.

It will be understood that similar branching boxes may be created in the edge of the longitudinal walls 4, using the same technique.

The movement of the heads 99, 99' is therefore independent from that of the form cases 88, 88', 88" and in the manufacture of the component the form disassembly of side

walls 2 and 3 takes place by separating the component first from the form backing cases 88, 88', 88" and leaving in their place the heads 99, 99'. Then the inner form frames 55, 56 are moved away in the way previously described and only at the end the heads 99, 99' are removed as well. This allows to form disassemble the internal component without danger of deformations.

The elements of the machine so far described are the elements which always take part in the manufacture of the component, no matter what the position the longitudinal wall 4 must assume therein. It will be understood from the foregoing description that by means of the elements of the machine previously described it is possible to manufacture components of different width (in the direction of the Z axis), by reason of the possibility of variating the position of the supporting deck 58 and of the carriage 66 made integral therewith, with respect to the inner form frame 55, 56 and to the possibility of alternatively using one or more form backing cases 88, 88', 88" of the outer form frames 102, 102'.

Although the machine illustrated offers the possibility of manufacturing components having at the most a width of three modular units, it will be understood that, by simply varying the dimensions of the machine and adding other form backing cases to the outer form frames 102, 102', it is possible to manufacture components having a width over three modular units. At the same time, although the example of embodiment illustrated of the machine shows a floor having a length of seven modular units, as can be seen from figure 17, a machine may be produced of the

same type which is capable of manufacturing components having a larger or smaller number of modular units in length.

It should also be understood that, although in the present description reference is made to a component obtained from reinforced concrete and therefore reference is made to a concrete cast, for the production of the component other materials may be used which are susceptible to being casted in a form in order to take up a particular shape.

The elements of the machine so far described are not sufficient per se for the formation of a component. In order to be complete, the machine must also use other elements which will be described further on. Such elements may be used in alternative or in combination one with the other, depending on the shape of longitudinal wall which it is desired to obtain for the finished component or depending on whether it is desired to have a component without a longitudinal wall.

Such further elements of the machine will now be described.

g) Elevators

Reference is now made to figures 21 and 22.

As previously stated, pillars 40, 41 have, above the base plane 37 a hull 49 having two V shaped corners and pillars 42, 43 are flanked, above base plane 37 by two supplementary pillars 51, 52 also having two V shaped corners.

Said hulls 49, 50 provide a guide for a pair of sliders 103, 103' apt to move between the base plane 37 and the upper plane 38 in a vertical direction by means of their mating with said V shaped corners through grooved wheels 104. Similarly another pair of sliders 105, 105' are capable of sliding in a vertical direction, guided through mating by grooved wheels 106 of pillars 42, 51 and respectively 43, 52. Sliding members 103, 103' and 105, 105' are provided respectively with a pair of main plates 107, 107' and respectively 108, 108'.

The elevators can be moved by means of engagement with worm screws 109, 109' and respectively 110, 110', actuated by mechanical motors, or by equivalent means.

Each main plate is provided, on the side facing towards the machine, with a pair of horizontal guiding tracks, which are indicated schematically in 111, 111' for the sliding members 103 and 103' and in 112, 112' for the sliding members 105 and 105'.

Although only one track for each plate is visible in figure 22, it is intended that actually said tracks are two, placed at a distance and parallel with respect to each other. The plates of the elevators are interconnected by means of horizontal frame beams, as indicated in 113 and 114. Each of said elevators indicated generally in 115, 116 is of use for carrying, at the desired height, a carrier of the upper form frame and a core carrier for the longitudinal wall, which will be described further on.

The elevators 115 and 116 further have hydraulic pistons 117, 117' for horizontally moving said carri ers of the upper inner form frame, as well as hydraulic pistons 118, 118' for horizontally moving said core carriers.

h) Core carrying carriage

Each elevator 115, 116 bears a core carrier 119, 119' supported and guided by one of the pairs of tracks 111, 111' or respectively 112, 112' and moved horizontally back and forth in the direction of the Y axis by means of said hydraulic pistons 118, 118'.

Said core carriers 119, 119' comprise a beam 120, 120' provided at the ends with wheels engaged on said tracks, as well as cores 121, 121' integral respectively with said beam 120, 120'. Said cores 121, 121' serve the purpose of forming the vertical through cavities 6 in a longitudinal wall 4 of the type provided with such cavities (figure 1).

In the manufacturing of the component, when it is desired to form a longitudinal wall 4 provided with cavities on one, or the other side of the floor 1, the corresponding elevator 115, 116 is brought to the appropriate height, above that of the inner form frame 55 or 56 placed also at the appropriate height, and said cores are caused to advance into the working position, so that during the casting a cavity 6 is left corresponding to their shape, on the inside of the longitudinal wall 4.

As can be seen, the position of said cores 121, 121' is established by the position in height which the underlying inner form frame 55 or 56 assumes. The combination, on one or the other side of floor 1 of the relative position of the inner form frames 55 or 56 and the cores 121, 121' makes it possible to obtain components having a longitudinal wall 4 provided with cavities 6 in any modular position.

Said core carrier 119, 119' does not have to be used when the longitudinal wall 4 is not required to be provided with cavities 6, or when said longitudinal wall 4 is absent. In figure 22 the carriage 119 is shown in a backed position, non operative, while the core carrier 119' is shown in an advanced position which is operative.

i) Inner upper form frame carrier

Each elevator 115, 116 carries an upper inner form frame carrier 122 and respectively 122'. Said carriers 122, 122' of upper inner form frame comprise a beam 123, 123' rested and guided by means of grooved wheels on one of said pairs of tracks 111, 111' and 112, 112' carried by the plates 107, 107' and 108, 108' of the elevator 115 and respectively 116. A framework 124, 124' is integral with beams 123, 123' and carries a metal sheet 125, 125' which acts as form portion in order to form the inner upper surface of one longitudinal wall 4 placed on the component in coincidence of an intermodular line. The forming metal sheet 125, 125' comprises a horizontal part, vertical parts 126, 126' and side or flanking parts 127, 127'.

Therefore the upper inner form frame 122, 122' is to be used when it is desired to have on one side or the other of floor 1 a longitudinal wall 4 not placed in coincidence of the edge of the component, but in coincidence of a intermodular line thereof and serves the purpose of forming the surface of the longtudinal 4 facing upwards looking at figure 21. The vertical portions 126, 126' of the forming metal sheet serve the purpose of completing the form for the formation of the floor while the side or flanking parts 127, 127' serve the purpose of completing the form for the formation of the side walls 2, 3.

Obviously the use of the upper inner form frames 122, 122' can take place contemporarily with the use of the cores 121, 121' carried by the core carriers 119, 119', or without the use of the latter. In the first case longitudinal walls 4 will be obtained in the desired position which present through cavities 6, in the second case a longitudinal wall 4 will be obtained of the solid type, which will generally have a thickness below that of the hollow wall.

It should be noted that during the casting of a component of the type represented in figure 21, it is not necessary to use the upper inner form frames 122, 122', since the outer surface of the wall 4 which in figure 21 appears to be in contact with forming metal sheets 125, 125' has no use actually for said forming metal sheets, since it is possible to carry out the casting and level the surface from the outside in a sufficiently accurate way.

j) Upper edge form frame

The upper edge form frame 128 (see figures 15 and 23) serves the purpose of forming the edges of the floor 1 and of the side walls 2, 3, opposed to those indicated in 9 and 10 in figure 3, when a longitudinal wall is not present in coincidence of said edges of the component.

The upper edge form frame 128 is an element of the machine which moves in a horizontal direction, in the direction of the X axis, on the upper plane 38 of the machine, and, as can be seen in figure 15, slides through wheels over horizontal guides 129, 129' which overhang from the upper beams 39. The form frame 128, seen from the top, presents the shape shown in figure 23 and therefore has approximately in plan the same H shape as the carriage 66 and therefore has two wings 130, 130' and a rib 131. The lower surface (not shown) of the form frame 128 is provided with shapes for the forming of grooves equal to those present on the edges 9, 10. The upper part of the form frame 128 is shaped as a hopper (132) both on wings 130, 130', and on the rib 131. Furthermore its bottom is provided with holes and slots 133 in order to allow the passage of the casting of concrete therethrough, into the form cavity.

The form frame 128 is lowered on the cavity formed by the other form portion elements by means of hydraulic pistons 134 and cylindrical guides 135.

Therefore when the upper edge form frame 128 is used, edges are obtained for the component which are completely the same as those formed by the forming surface of carriage 66.

k) Upper box carrier

When it is desired to obtain in the longitudinal wall 4 openings for doors and/or windows, upper box carrier 136 is used (figures 24 and 15). Said carrier 136 which also slides horizontally in the direction of the X axis, on horizontal guides 129, 129' which overhang from the upper beams 39, carries therewith a plurality of boxes 137 hung to devices 138, for example of the hydraulic piston type or the like.

Said boxes 137 also have modular dimensions and by means of said devices 138 are lowered above the horizontal metal sheet of the inner form frames 55 or 56, in the position in which it is desired that the longitudinal wall 4 be provided with an aperture of the same dimension of the box itself. Said boxes 137 are provided with openings wherein the cores 121, 121' may be inserted of the core carriers 119, 119', which cores 121, 121' fix in this way the position of said boxes 137. When such position has been fixed, the devices 138 drop the boxes in their place and the upper carrier 136 is moved on its guides 129, 129'. the core carrier 119, 119' is brought into the desired position by means of the elevators 115, 116 and, if necessary, also the carrier 122, 122' of the upper inner form frame is placed into its working position.

In the concrete casting in the point where box 137 is, an opening will be obtained having the shape of the box itself, and with a very accurate profile.

Obviously in the form disassembly the boxes are picked up

again by devices 138 of the upper carrier 136.

The machine further comprises equipment for the formation of the mixture of concrete of other conglomerate and for the supply thereof into the form cavity.

Furthermore, since, as has been stated previously, all the elements of the machine are made integral with each other by means of pins, it is possible, as is usual in the art of concrete castings, to cause a vibration of the entire form frame structure, in order to obtain a homogeneous distribution of the conglomerate.

The embodiment described by the invention allows furthermore to employ the usual expedients of the art of manufacturing concrete products, such as the heating through steam or hot air of the form backing cases, which carry the form portions, as well as the passage of the finished component, carried by the carriage 66, towards concrete curing ovens, heated through steam or other means.

Furthermore the finished component, or still fresh component, may be equipped with the required finishings and facilities for the construction of the complete building.

It will therefore be understood how through the machine according to the invention it is possible to produce pre-equipped building components which, although they are homogeneous with respect to each other and with respect to the assembly of a building through said components,

allow a great flexibility and architectural variability, so as to allow the design of each building in an individual way.

Furthermore the components so produced display a very high working accuracy and a high homogeneous reliability and quality of the produced pieces.

Although the invention has been described in considerable detail, it is intended that it may be carried out by resorting to equivalent technical solutions, without departing from the scope thereof.

Claims

1. Pre-equipped building modular component, tridimensional according to axes X, Y, Z for the construction of buildings, characterized by the fact of comprising, in one single piece:

a floor element having, in the direction of the Z axis a width of one or more standard modular units and, in the direction of the X axis, a length of a multiple of said modular units, said floor being provided with a longitudinal through cavity in the sense of its length, in direction of the X axis, in each of the modular units which form its width, and two through transversal cavities in the direction of its width, in direction of the Z axis, communicating with said longitudinal cavity;

two side walls perpendicular to said floor having, in the direction of the Y axis, a height above said floor, equal to one modular unit and, beneath said floor, equal to two modular units, the inner surfaces of said side walls, facing towards the floor, being smooth and the outer surfaces being provided with a channel in the direction of the Y axis, in each of the modular units which form their width, the edge surfaces on the thickness of said side walls, as well as the edge surfaces on the thickness of said floor, being shaped so as to be provided with continuous grooves therealong, communicating with said inner surfaces of said walls;

a longitudinal wall lying in a plane of direction X, Y integral and perpendicular with said floor and said

two side walls and having the same height thereof, said longitudinal wall being placed on one side and/or the other side of the plane of the floor, and having both its surfaces smooth; and

connecting elements placed on the surfaces of the upper and lower edges of said side walls, in coincidence of the intermodular lines and the ends.

2. The component according to claim 1, wherein said connecting elements are formed by two small steel cups integral with the ends of a rod having the direction of the Y axis, embedded in the side wall, said small cups being embedded one on said upper edge and the other on said lower edge, and having their concavity facing towards the outside and being provided with a welding flange and a recess for the insertion of a connecting body.

3. The component according to claim 1, wherein said longitudinal wall is placed on one single side of the floor, in coincidence with the free end of a modular unit.

4. The component according to claim 1, wherein said longitudinal wall is placed on only one side of the floor, in coincidence with an intermodular line.

5. The component according to claim 1, wherein said longitudinal wall is placed on both sides of the floor in coincidence with the free end of one modular unit.

6. The component according to claim 1,wherein said longitudinal wall, on one side of the floor, is placed in coincidence of the free end of one modular unit, while on the other side of the floor it is placed in coincidence of an intermodular line.

7. The component according to claim 1, wherein said longitudinal wall is placed on one or the other side of the floor in coincidence with one same intermodular line.

8. The component according to claim 1, wherein said longitudinal wall is placed on both sides of the floor in coincidence of two different intermular lines.

9. The component according to any of the preceding claims from 3 to 8, wherein the thickness of said longitudinal wall is internal with respect to the width of the modular unit of the floor and of the side wall adjacent thereto.

10. The component according to any of the preceding claims, wherein said longitudinal wall is on one side and/or on the other side of the floor and is provided with through cavities having the direction along the Y axis, placed at modular intervals.

11. The component according to claim 10, wherein the thickness of said longitudinal wall provided with through cavities is external to or on the same axis with a modular or intermodular line.

12. The component according to any of the preceding claims, wherein said longitudinal wall is provided with spaces for doors and/or windows.

13. The component according to claim 1, modified so as it does not display said longitudinal wall.

14. The combination of components according to any of the preceding claims by laying one over the other and/or placing side by side and connecting by welding said connecting elements one with the other of the respective components in order to achieve the structure of a building.

15. The process for the manufacturing of a modular pre-equipped building component, such as claimed in any of the preceding claims from 1 to 13, wherein said component is produced through casting of a material hardening up to a conglomerate, in form frames which delimit a cavity having the shape of said component, characterized by the operations of:

mounting said form frames in such a way that said floor assumes a position in a vertical plane with the X and Y axes of the component in the horizontal position and the Z axis of the component in the vertical position;

disassembling the form for the inner surfaces of said side walls by means of a translation movement of the respective form frame towards the bottom in an oblique direction with respect to the plane of said side walls, to the plane of said floor and to the horizontal plane; and

successively disassembling the form for the surface of said floor and the inner surface of said longitudinal wall, through a translation movement towards the bottom of the related ;

form frames, in an oblique direction with respect to the plane of said floor and to the horizontal plane.

16. A machine for manufacturing a modular component for the construction of buildings, such as claimed in any of the preceding claims from 1 to 14, placed on three horizontal planes defined respectively as bottom plane, base plane and upper plane and oriented according to a longitudinal X axis, a transversal Y axis and a vertical Z axis comprising:

a) two pairs of vertical supporting pillars having their basis on said bottom plane, placed at the vertexes of a rectangle and carrying upperly at the level of said upper plane, supporting guides having the direction according to the longitudinal X axis;

b) a pair of horizontal beams, parallel to the direction of the longitudinal X axis, guided at their ends respectively along a pair of said pillars for a movement according to the direction of the vertical Z axis, supported on vertically movable supports, moved by a motor and apt to assume, independently one from the other, a lowered position below said base plane and several raised positions at the level of said base plane;

c) a supporting deck formed by a pair of beams parallel to the transversal Y axis, connected rigidly one to the other, resting on vertically movable supports moved by a motor and guided along vertical fixed guides resting on said bottom plane, said supporting deck being movable between a position at the level of said base plane and a position above same;

d) a carriage movable along the transversal Y axis on said base plane, said carriage carrying form surfaces for the formation of the edge surfaces along the Y axis of said side walls and of the edge of said floor along the X axis, and being movable between an external position with respect to the machine and a resting position on said supporting deck;

e) two groups of lower inner form frames, each supported on one of said two horizontal beams, said form frames carrying form surfaces for the formation of the inner surfaces of said side walls, of said longitudinal wall and of the floor;

f) two groups of outer form frames supported on said base plane, each group carrying form portions for the formation of the outer surfaces of said side walls, and of the edge along the Y axis of said longitudinal wall, said form portions being movable through motors in the direction in the longitudinal X axis, said groups further carrying heads for the formation of the edges of thickness having a direction along the Z axis of said sidewalls, movable by means of motors in the direction of the transversal Y axis, as well as cores for the formation of said longitudinal through cavities at the inside of the thickness of the floor, movable by means of motors in the direction of the longitudinal X axis and cores for the formation of said transversal through cavities of the floor, movable through motors in the direction of the vertical Z axis;

g) two elevators movable by means of motors between an

upper plane and said base plane, and being guided each at the ends for a vertical movement, in the direction of the Z axis, on a same pair of pillars on which one of said horizontal beams is guided;

h) a core carrier slidingly supported in the direction of the transversal Y axis on each of said elevators, said core carrier carrying cores for the formation of the through cavities in the direction of the Y axis in said longitudinal wall, as well as a form portion for the formation of the edge of said longitudinal wall;

i) an upper inner form frame supported in a sliding way in the direction of the transversal Y axis on each of said elevators, said form frame carrying a form for the formation of the surface facing towards the top of a longitudinal wall, placed on an intermodular line, as well as the formation of the part of the surface of the floor and of the side walls comprised between their edge facing towards the top and the longitudinal wall;

j) a form frame for said edge facing towards the top, slidable on said supporting guides at the level of said upper plane in the direction of the X axis, said form frame for the edge facing towards the top carrying a form frame movable in the direction of the Z axis, for the formation of edges facing towards the top of the floor and of the side walls, said form frame for the edge facing towards the top being provided with passages for the casting of the conglomerate mixture;

k) an upper box carrier slidable on said supporting guides at the level of said upper plane in the direction of the X axis, said upper carrier carrying boxes movable in the direction of the Z axis, to be used as forms for the formation of openings for doors and windows in said longitudinal wall, said boxes having openings wherein said cores carried by said core carrier penetrate; and

l) means apt to transport and discharge said mixture of conglomerate, whereby preparing a reinforcement on said lower carriage, bringing said lower carriage over said supporting deck, bringing into position the various forms and carrying out the casting, the form disassembly after the hardening leaves the form piece on the lower carriage, which is extracted from the machine translating said lower carriage on said base plane.

17. The machine according to claim 16, wherein said supports movable for the pair of horizontal beams are worm screws actuated by an electric motor and said beams present ends provided with grooved wheels which slide over corners of said pillars.

18. The machine according to claim 16, wherein said movable supports for said supporting deck are formed by a piston of a hydraulic jack and said supporting deck is provided with vertical extensions which slide in contact with the grooves of wheels fixed to said vertical fixed guides.

19. The machine according to claim 16, wherein each of said lower inner form frames comprises: a first supporting frame work integral with one of said two horizontal beams; a second frame work carrying a form portion for the formation of one of the surfaces of the floor, as well as the formation of the inner surface of the longitudinal wall, said second framework and said first framework being connected though means which allow a movement of said second framework with respect to said first framework according to an oblique trajectory with respect to the directions of the Z and Y axes; two form portions the formation of the inner surfaces of the side walls, connected with said second framework through means which allow the movement of said two form portions with respect to said second frame work, according to an oblique direction with respect to the three X, Y, Z axes.

20. The machine according to claim 19, wherein said means are formed by a system of connecting rods shaped as a linked parallelogram and by motors having hydraulic pistons.

21. The machine according to claim 16, wherein each of said two groups of outer form frames is formed by sub-groups carrying each respectively a form portion for the formation of one modular unit of outer surface of said side walls, each sub-group being provided individually with a hydraulic linear motor which carries out the separation of the form portion from the finished piece, while motor means carry out a global movement of the group in the direction of the X axis, each sub-group being

associated with a core for the formation of a longitudinal through cavity of the floor, said core being guided along guides carried by the main framework of the group, each core carrying on its inside two cores for the formation of said transversal through cavities of the floor, said cores for the transversal cavities being brought into the working position on the outside of the longitudinal core, after that the latter has assumed its working position.

22. The machine according to claim 16, wherein said heads for the formation of the edges of thickness having a direction along the Z axis of said side walls, of the outer form frame groups, comprise forming surfaces having shapes for the formation of branching boxes, said shapes being brought selectively into the operating position of casting by means actuated by a selective control.

23. The machine according to claim 16, comprising pin blocking elements on said supporting deck and said inner form frames, to the end of blocking the position related therebetween, as well as pin blocking elements rigidly connecting said outer form frames and said carriage with said supporting deck.

24. The machine according to any of the preceding claims, further comprising means apt to vibrate the forms during the casting of the material for the formation of the conglomerate.

25. The machine according to any of the preceding claims, compri comprising means for carrying out a heating of the forms during the casting of the material for the formation of the conglomerate.

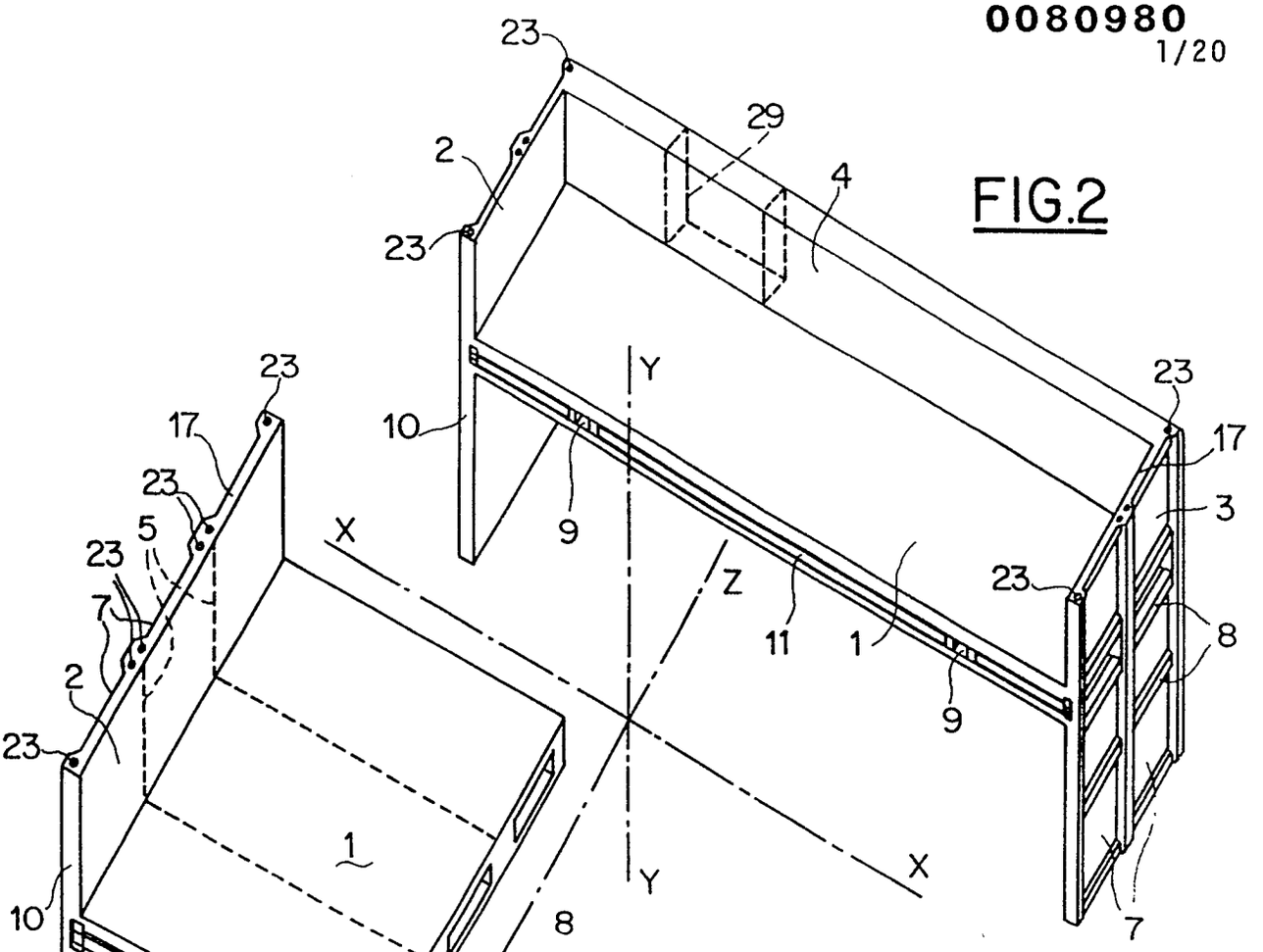


FIG.2

FIG.3

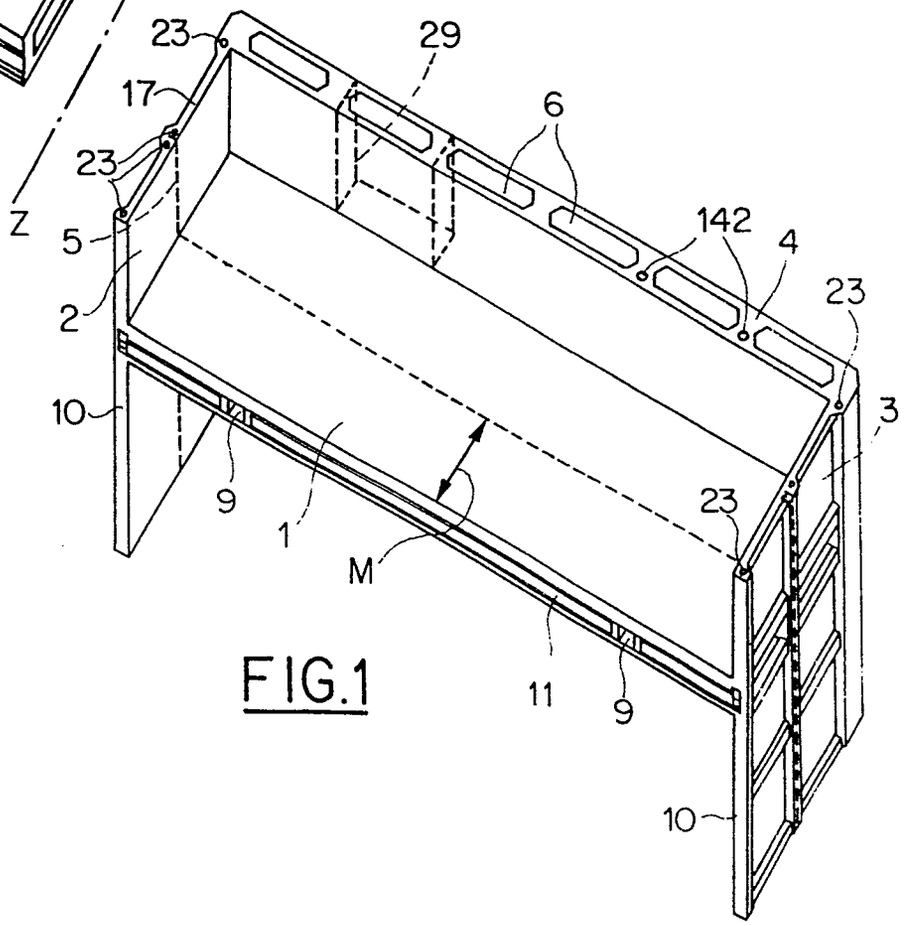


FIG.1

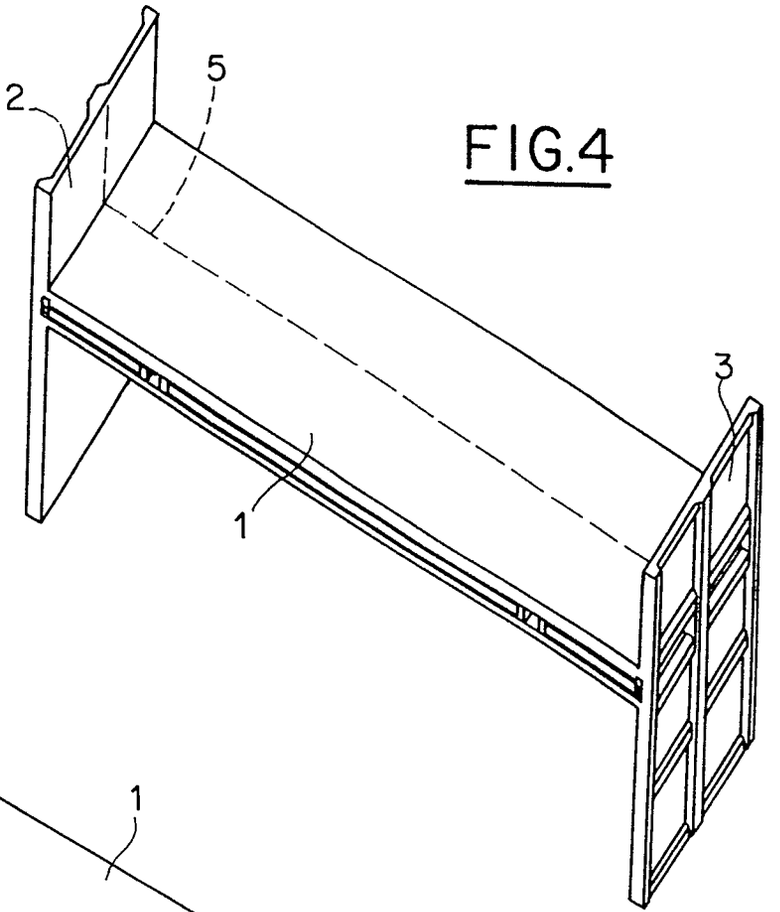


FIG.4

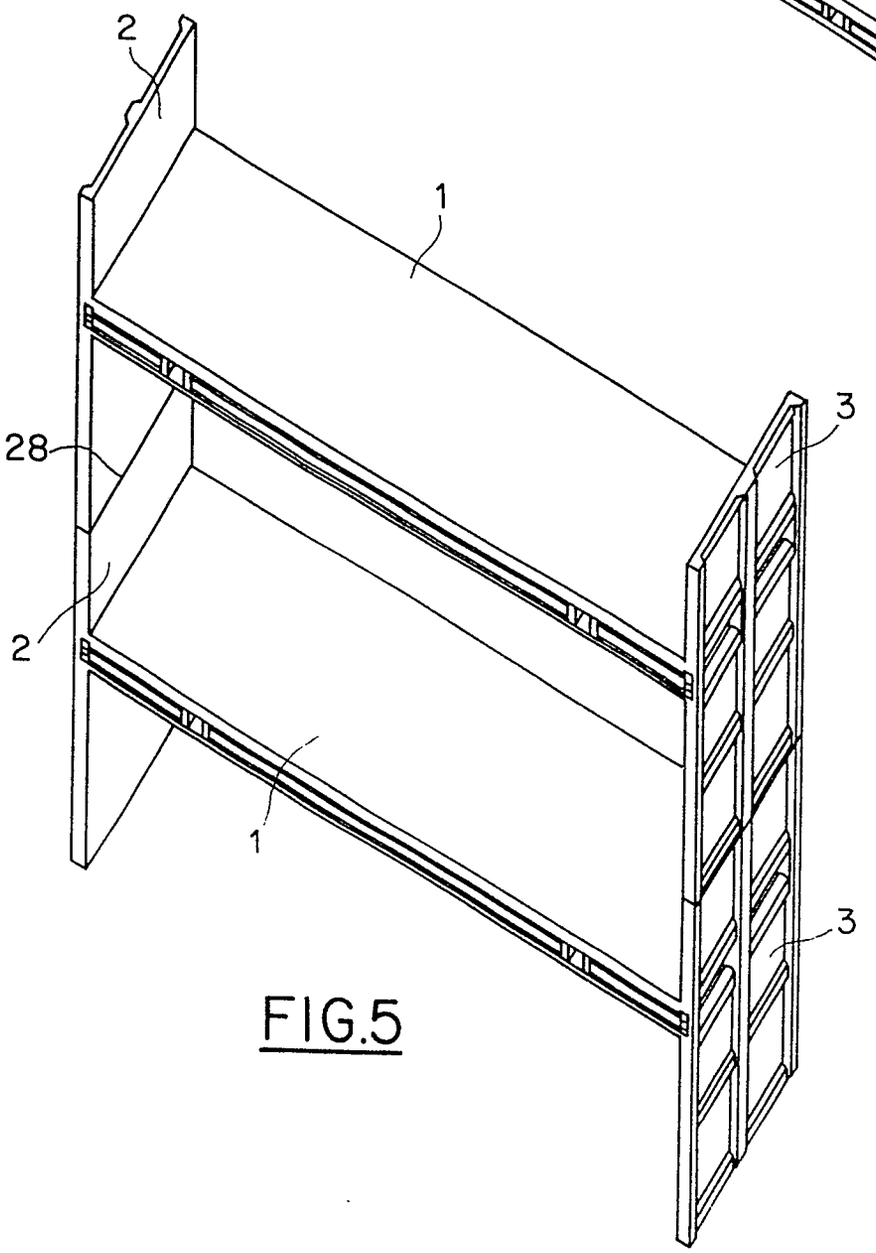
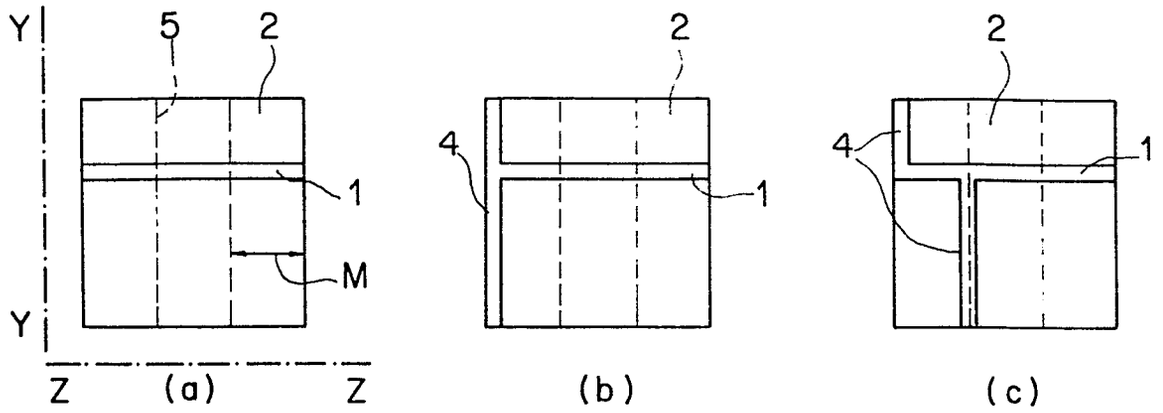
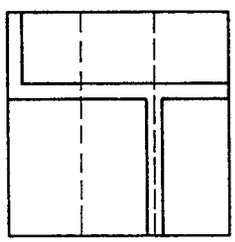


FIG.5

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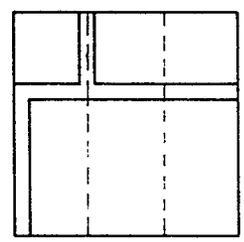
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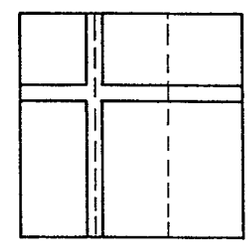
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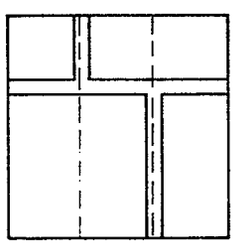
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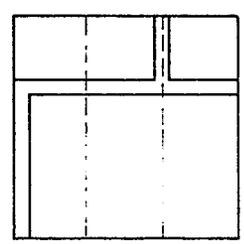
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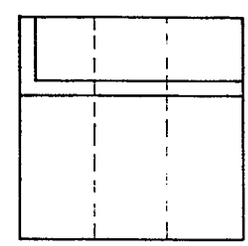
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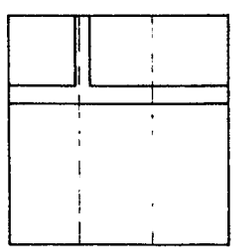
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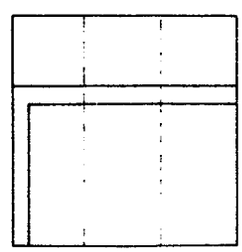
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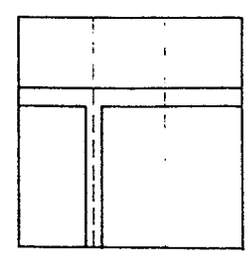
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FIG.6

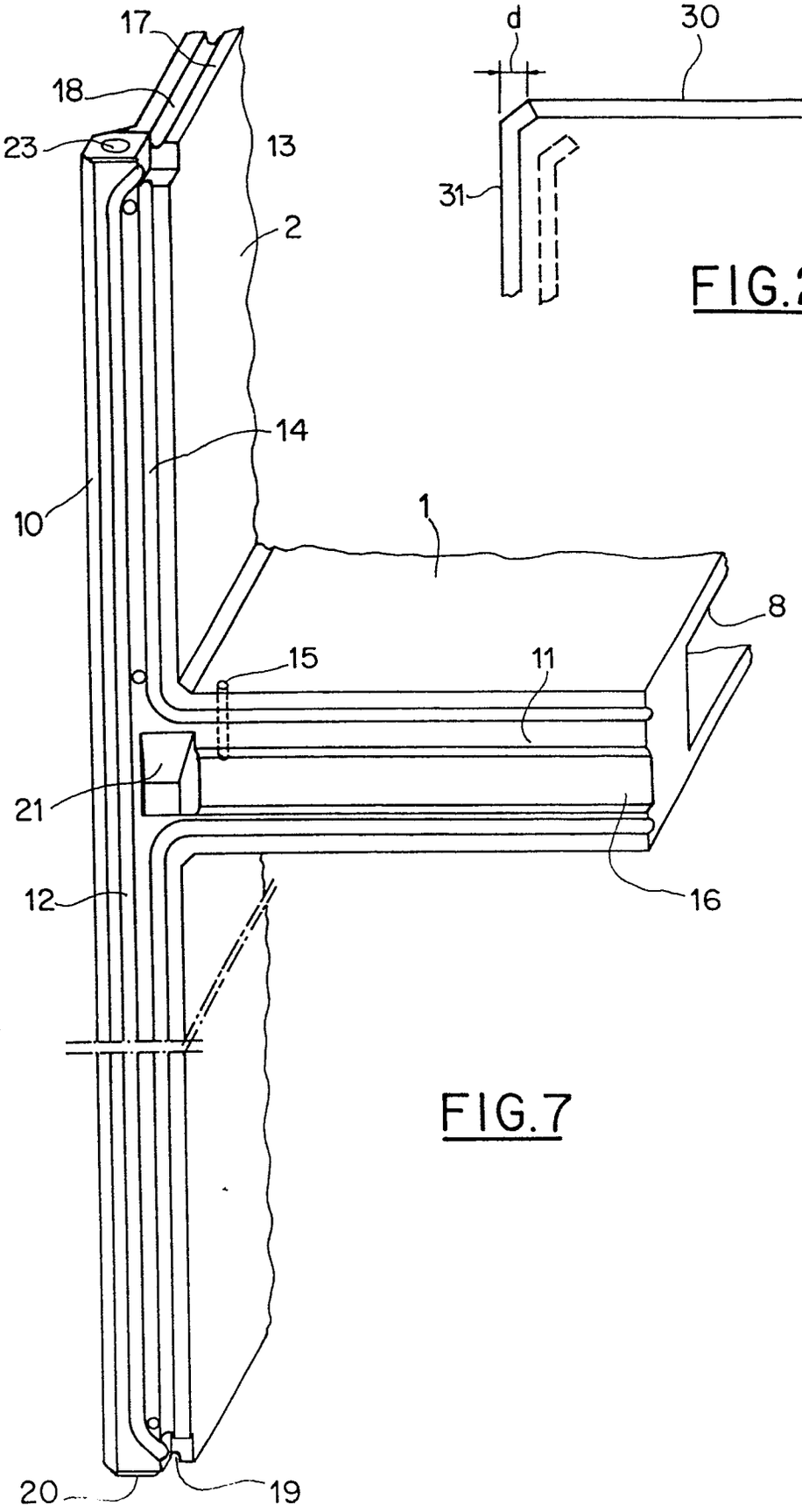
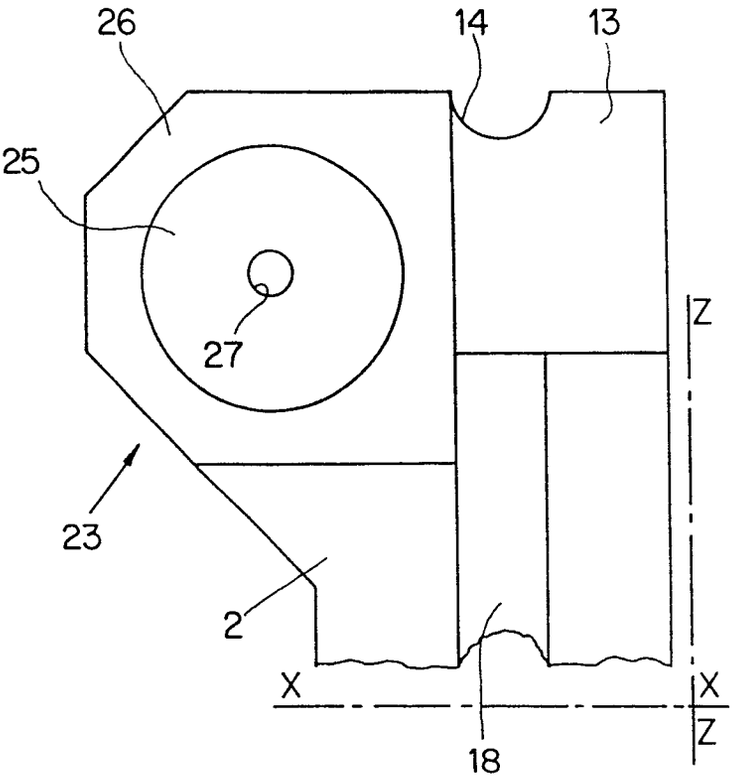


FIG.7

FIG.28

FIG.9



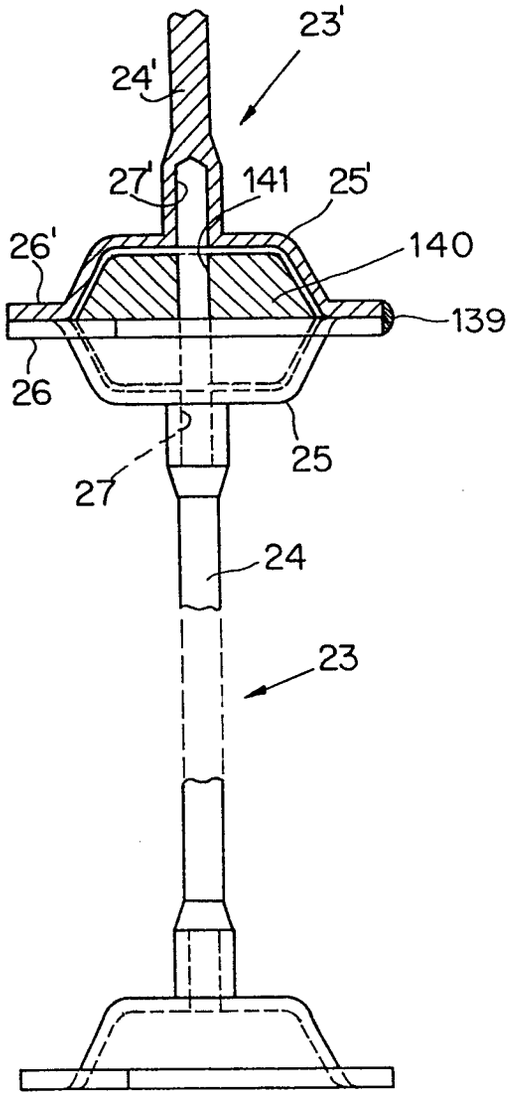
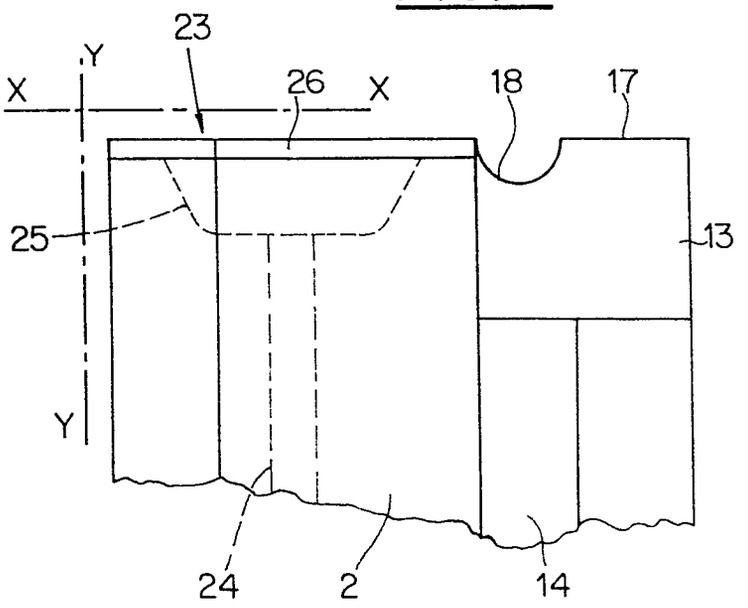


FIG.8

FIG.10



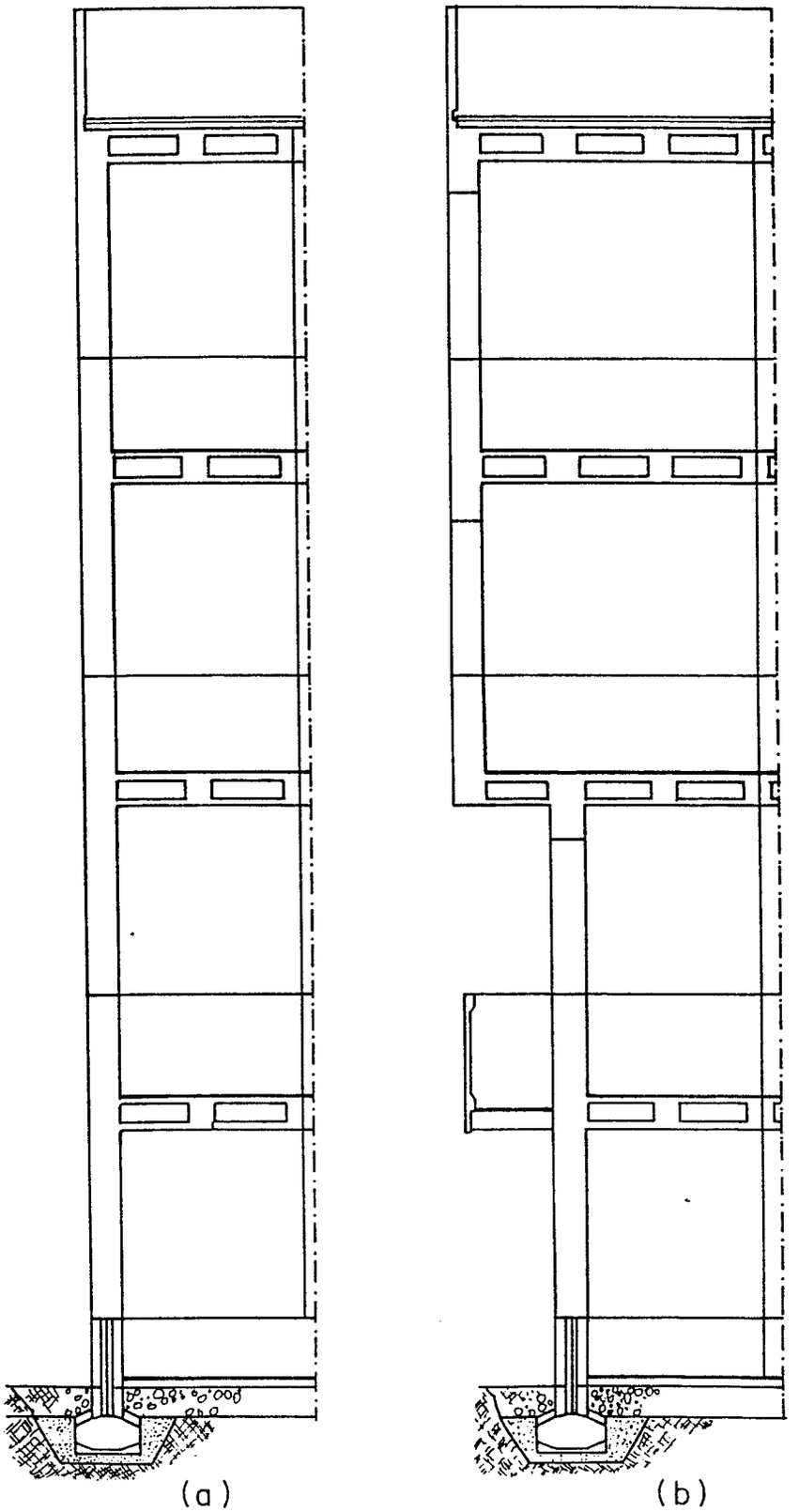


FIG.11

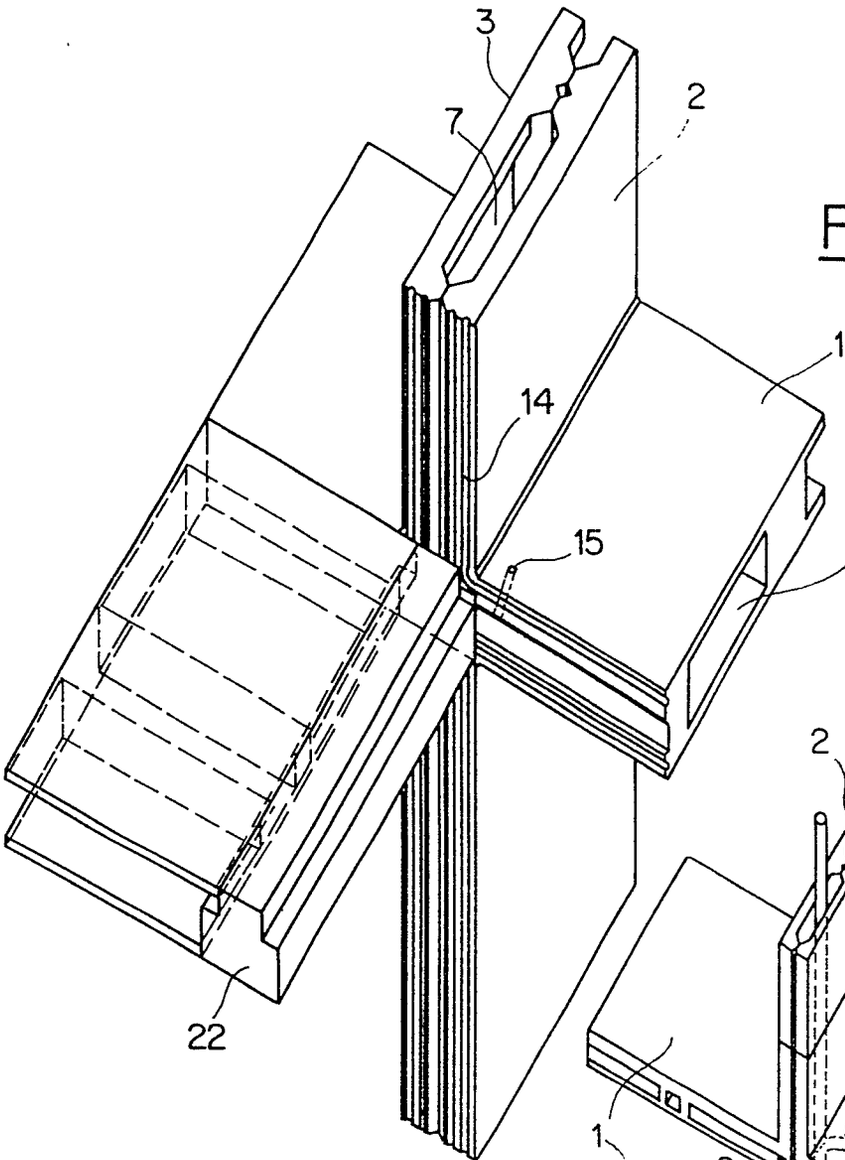


FIG.12

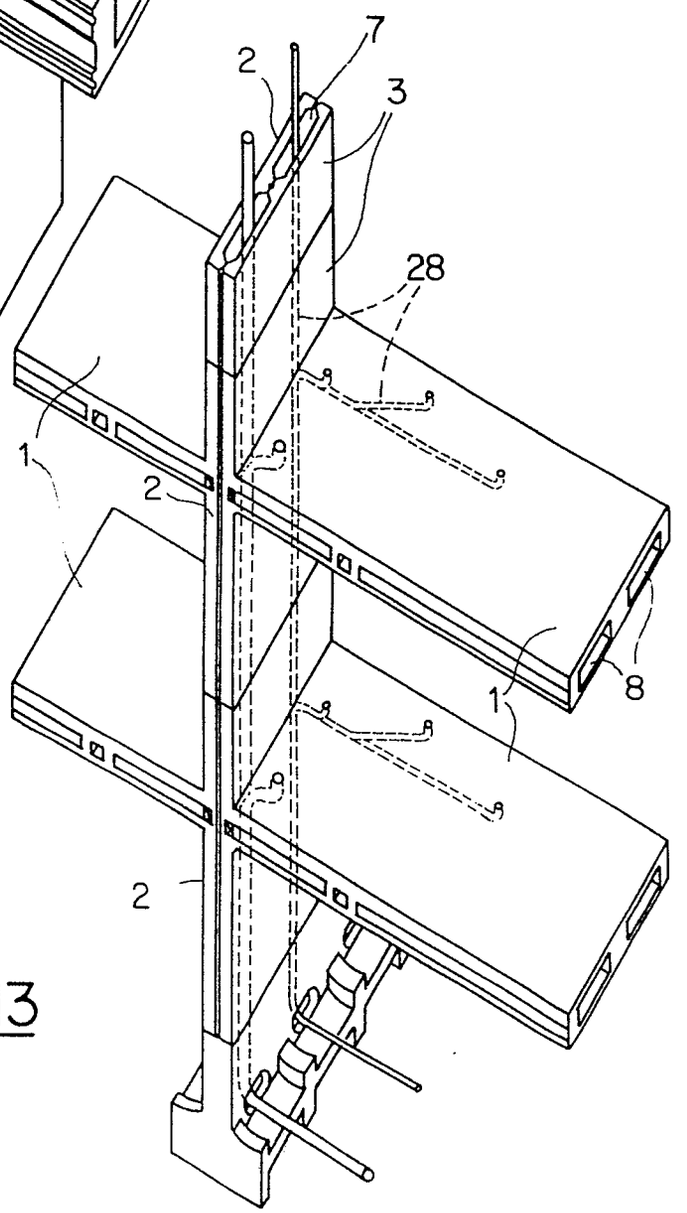
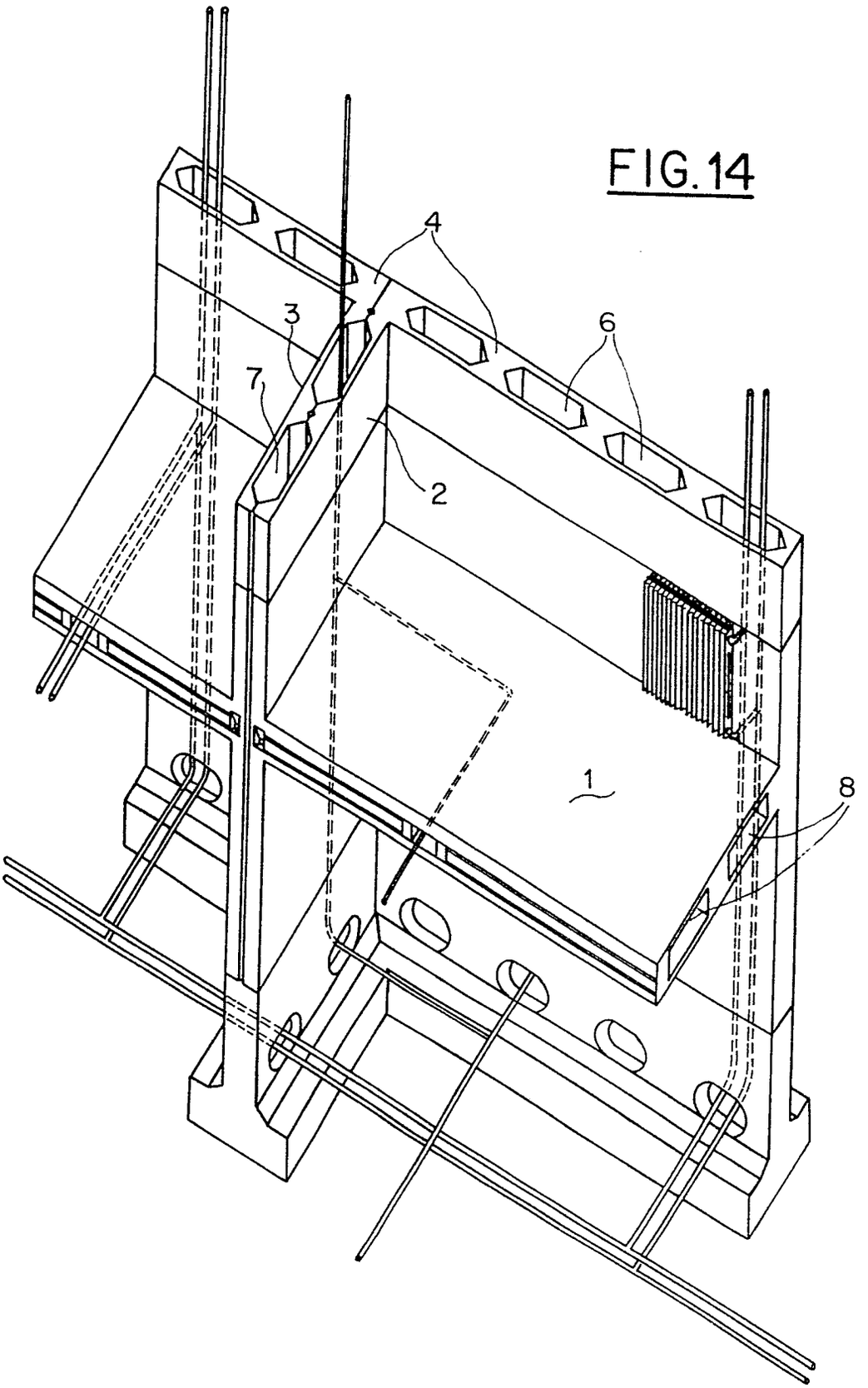


FIG.13

FIG.14



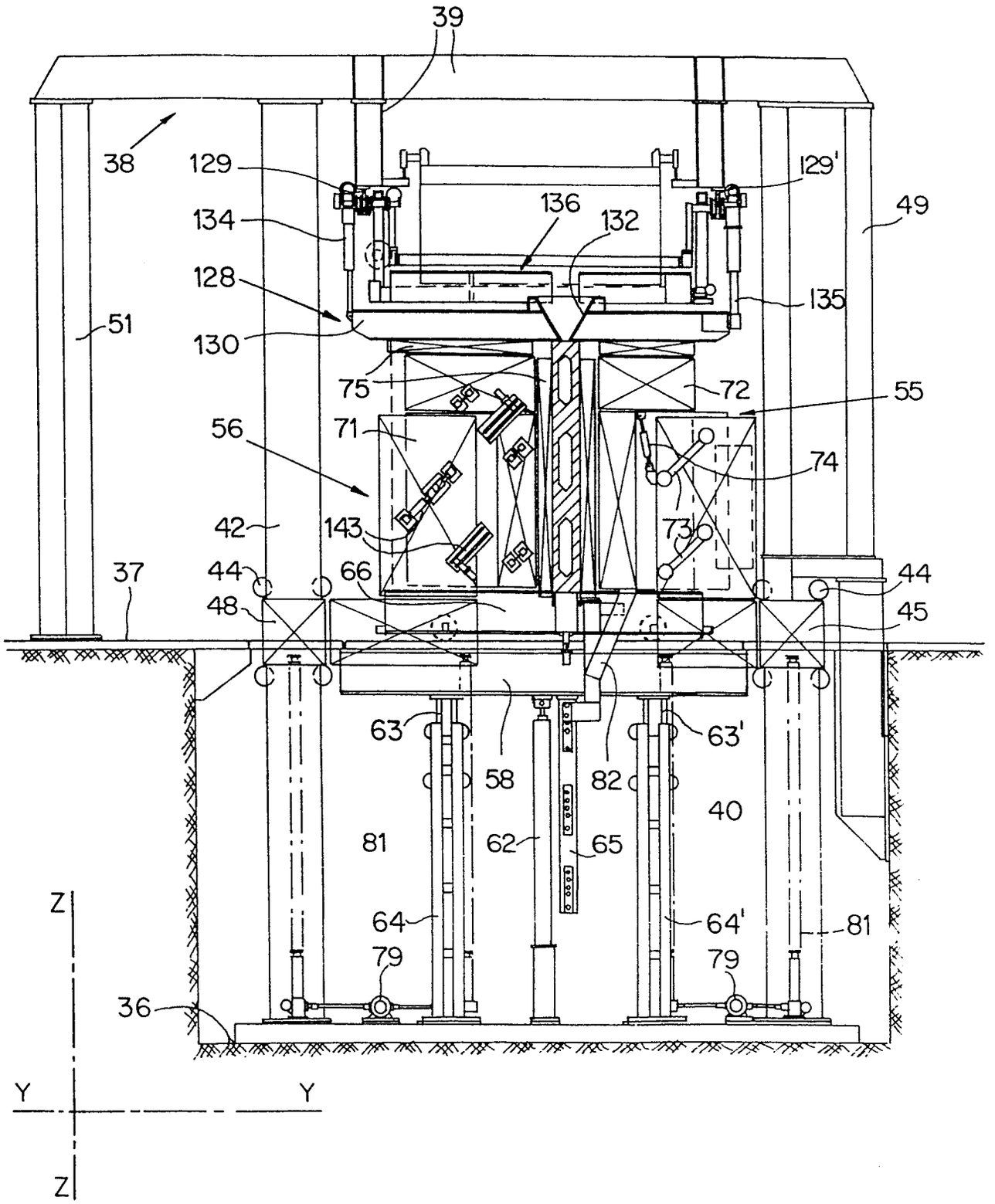

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FIG.15

FIG.16

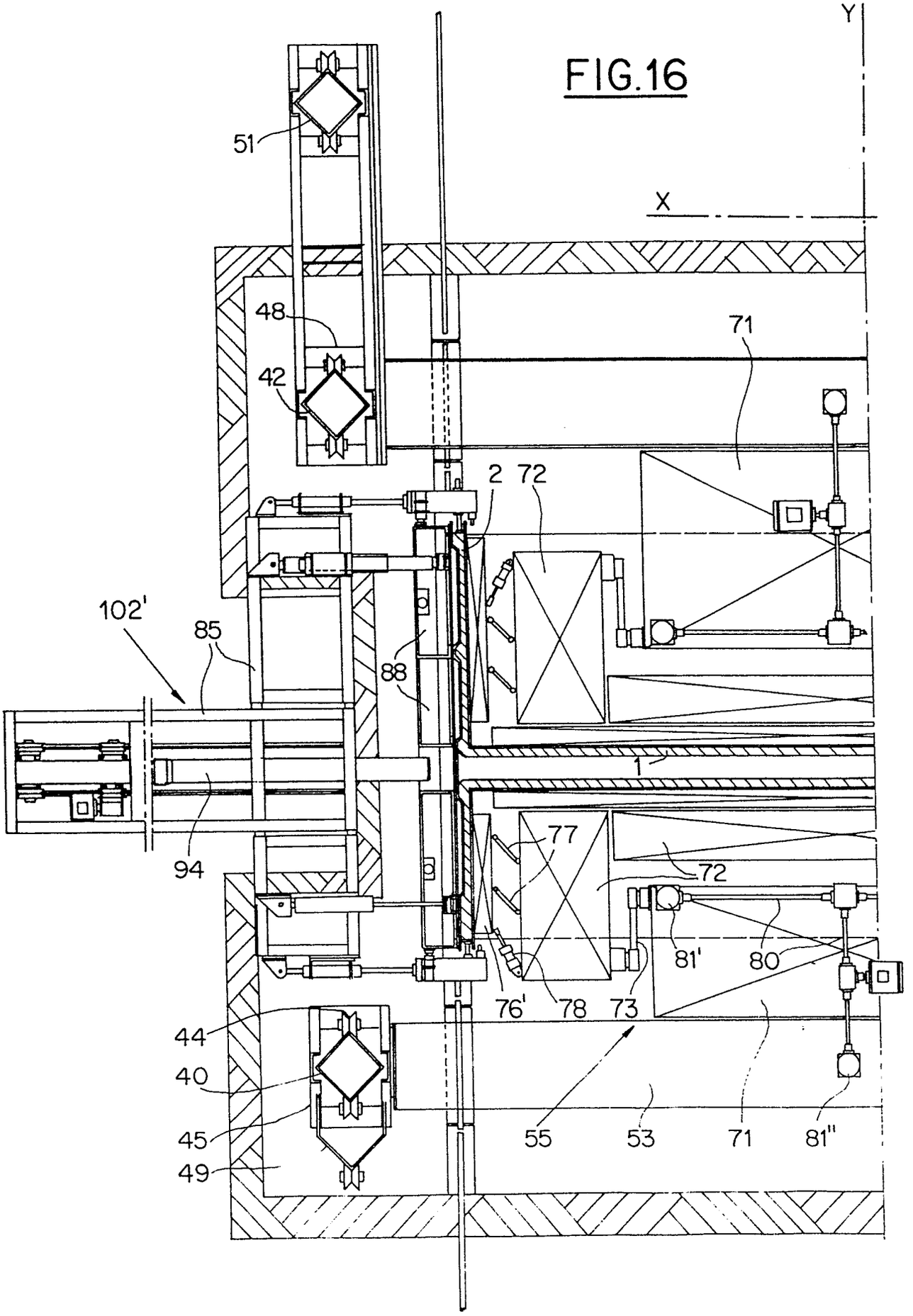
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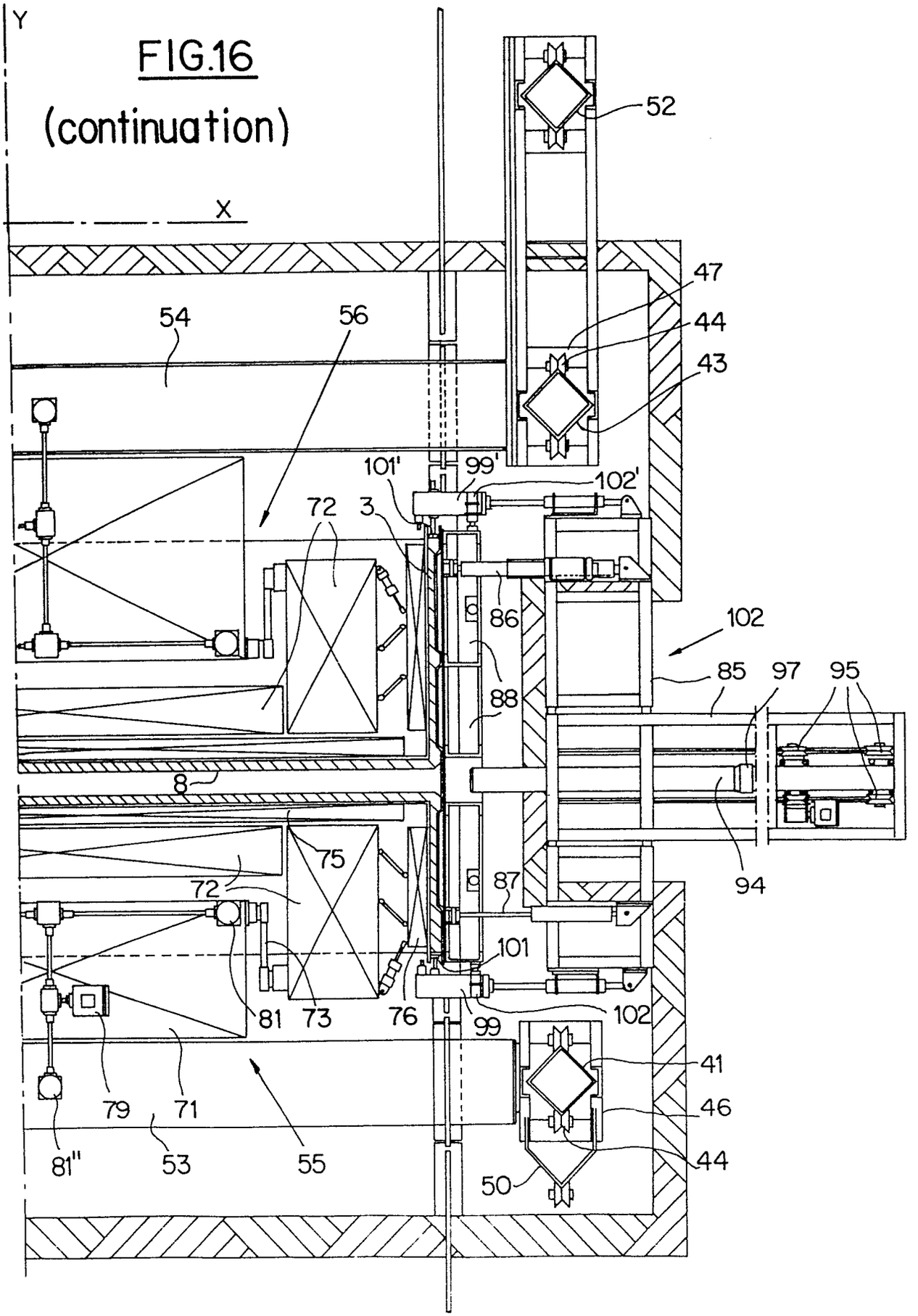
FIG.16
(continuation)



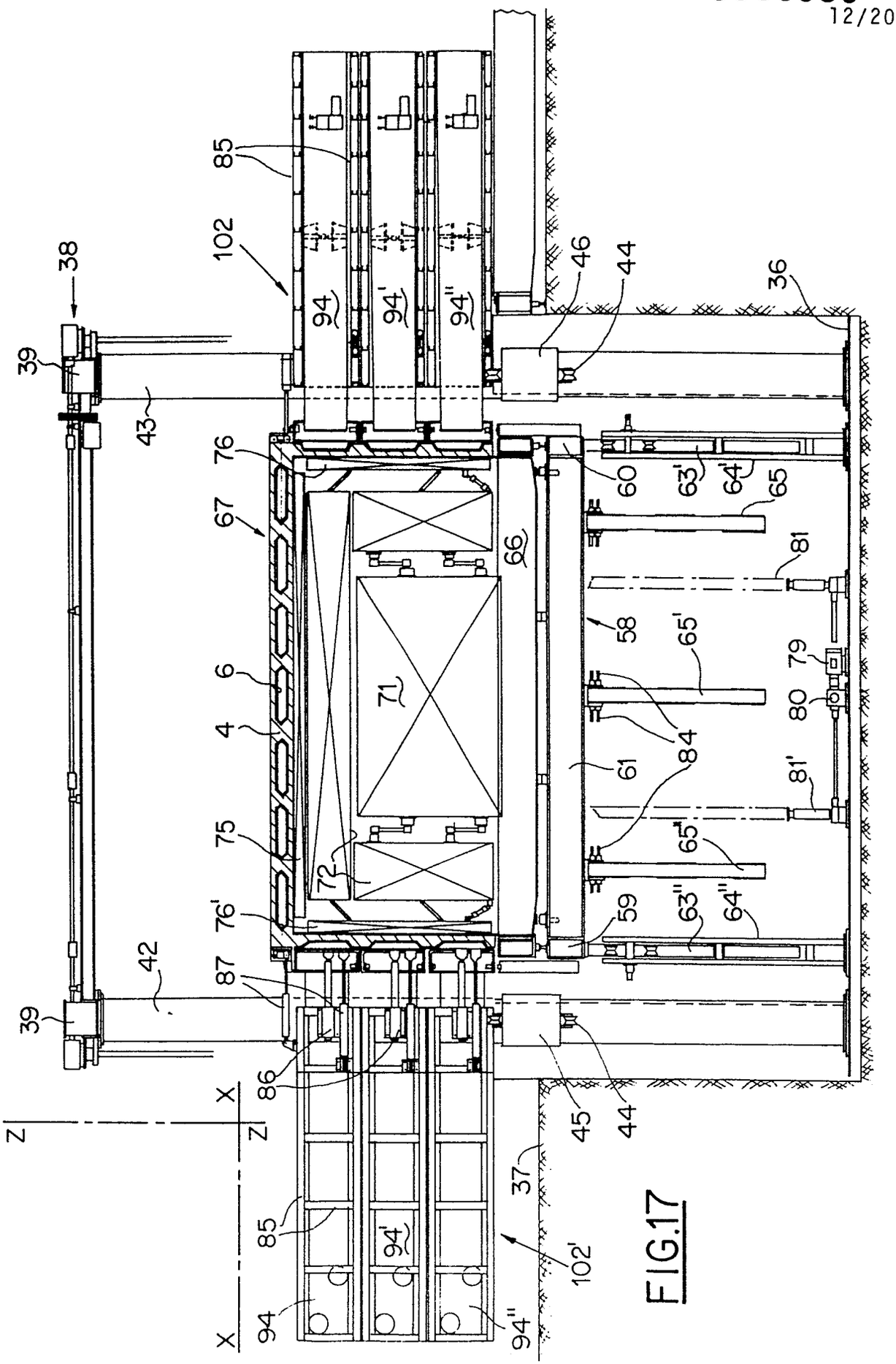

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FIG.17

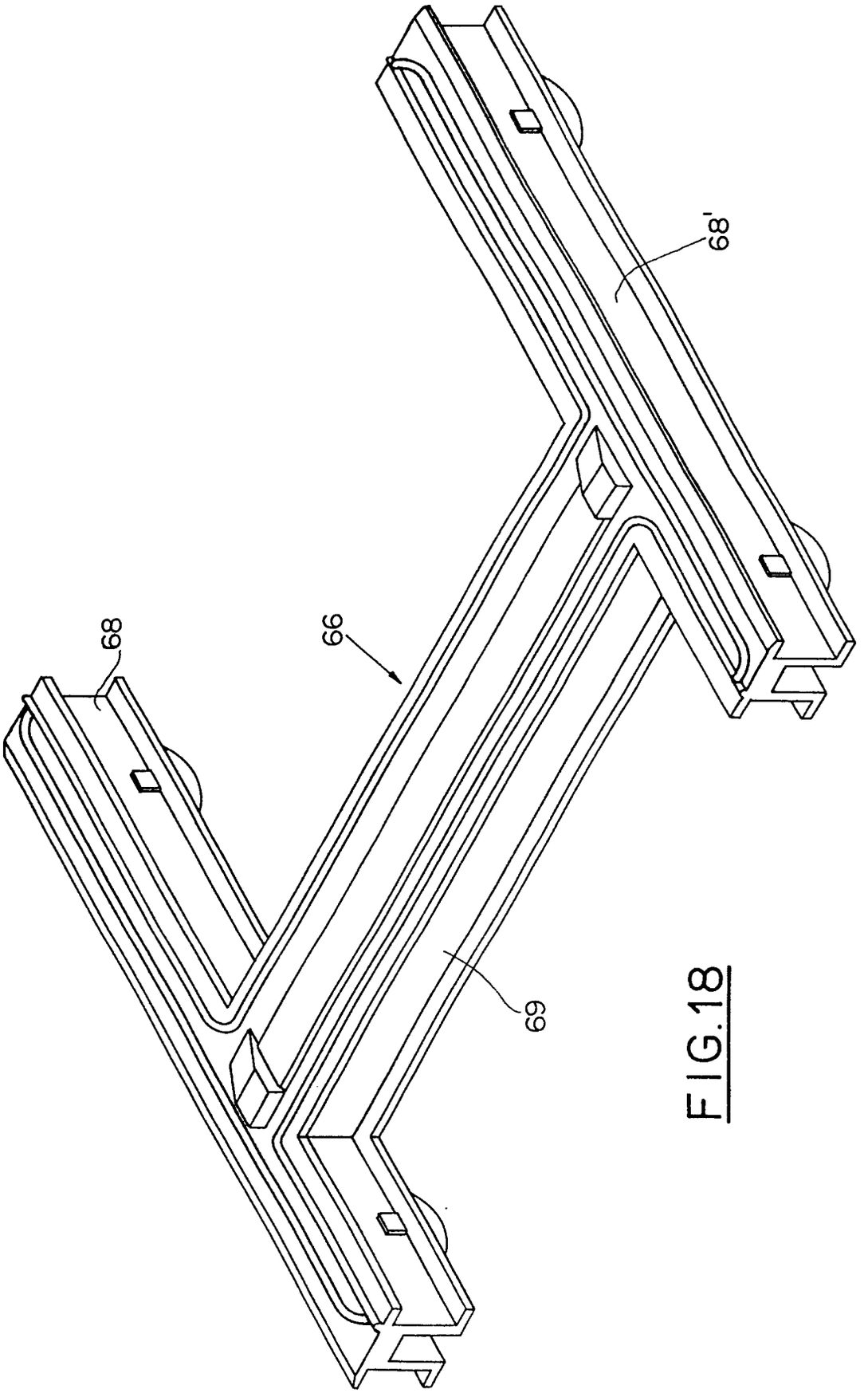

FIG.18

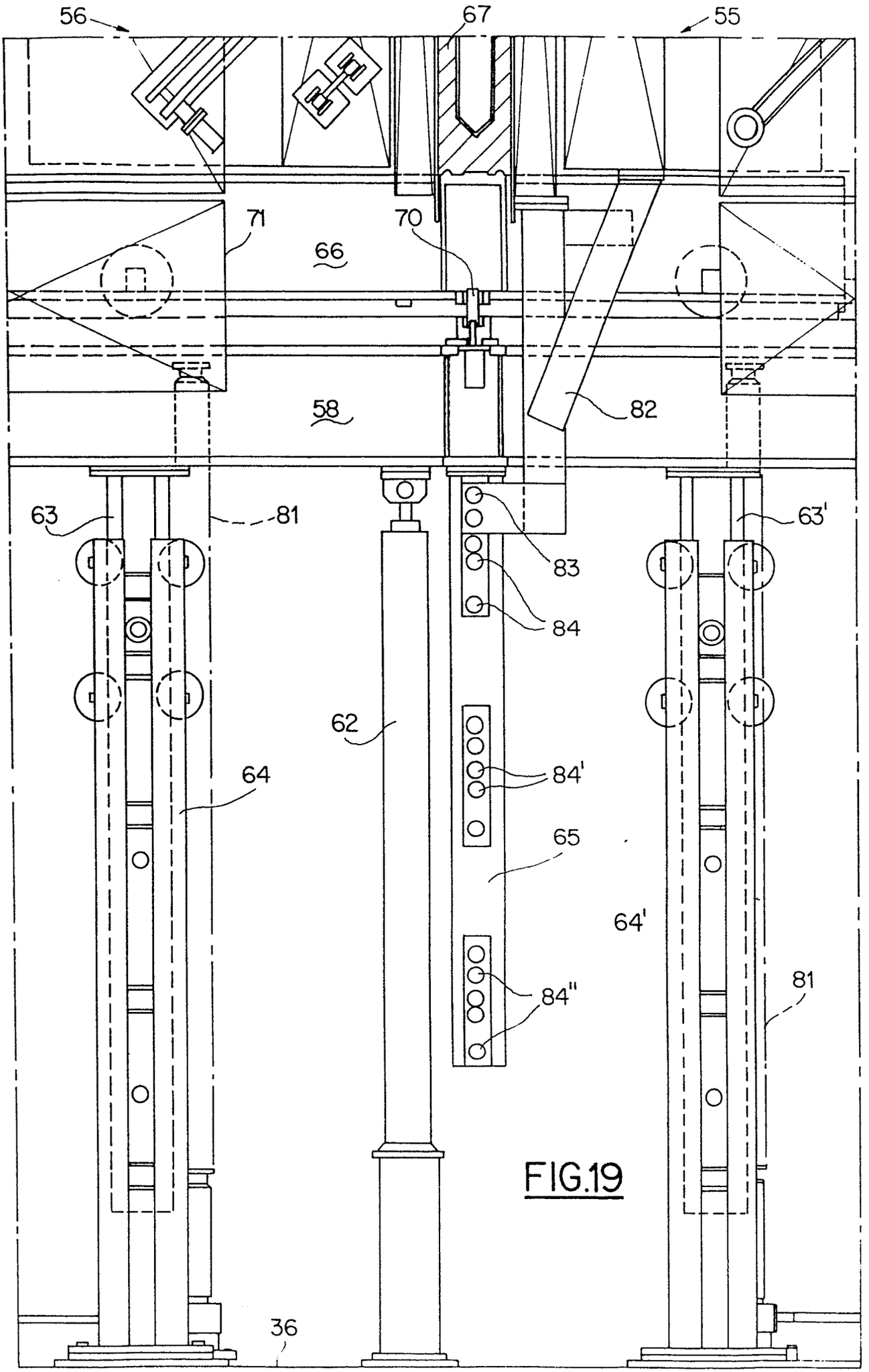

FIG.19

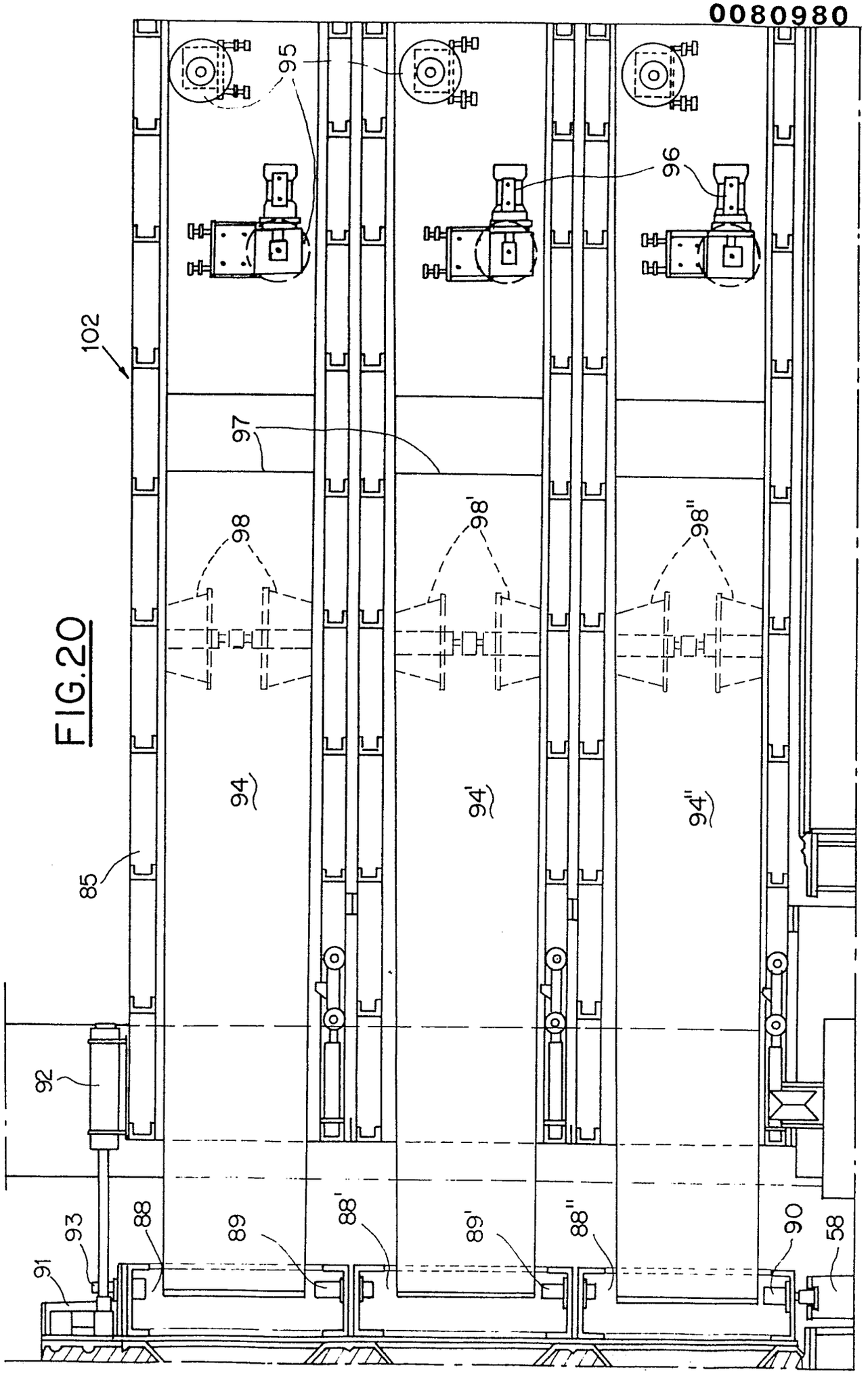

FIG.20

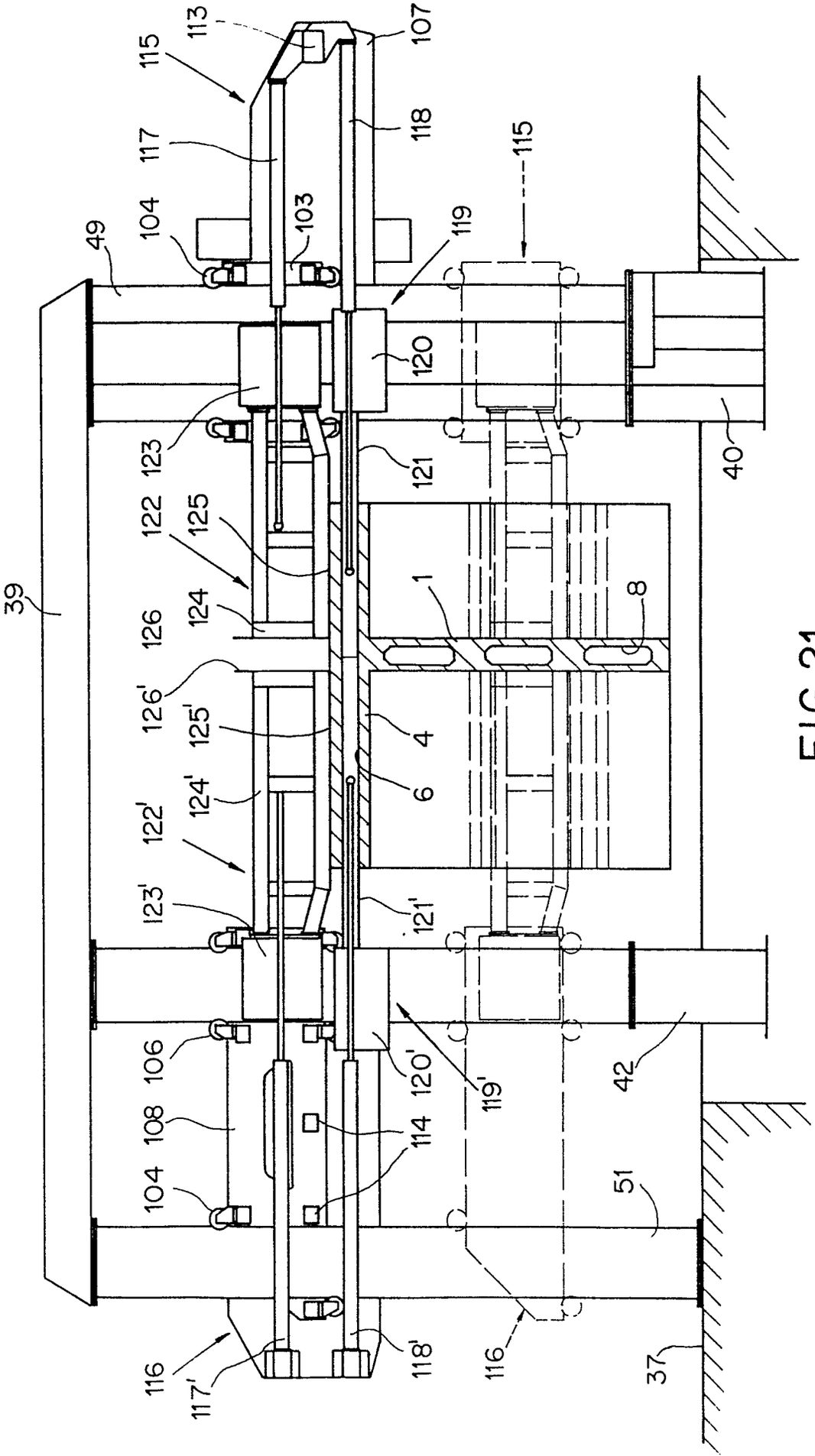
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FIG.21

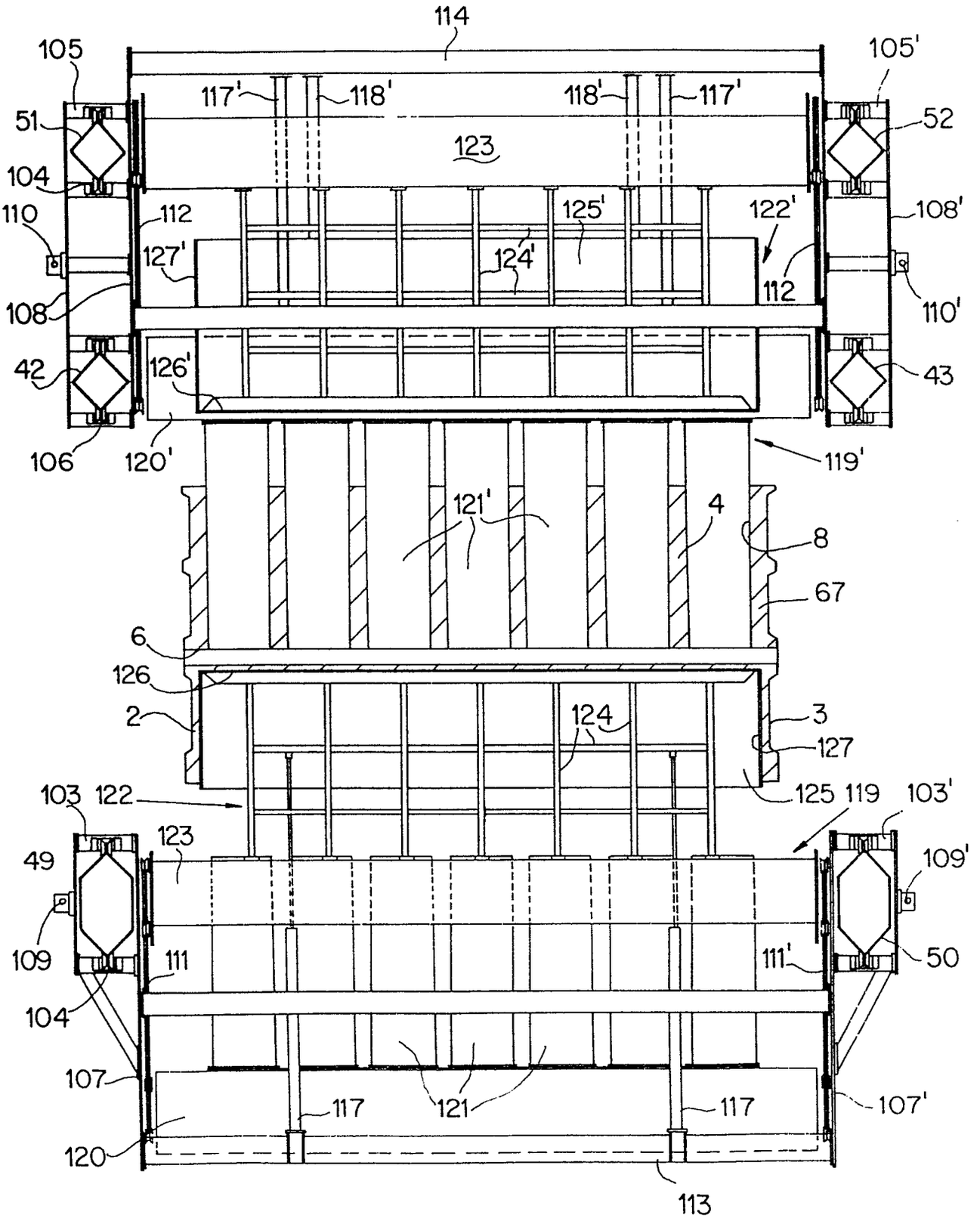
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FIG.22

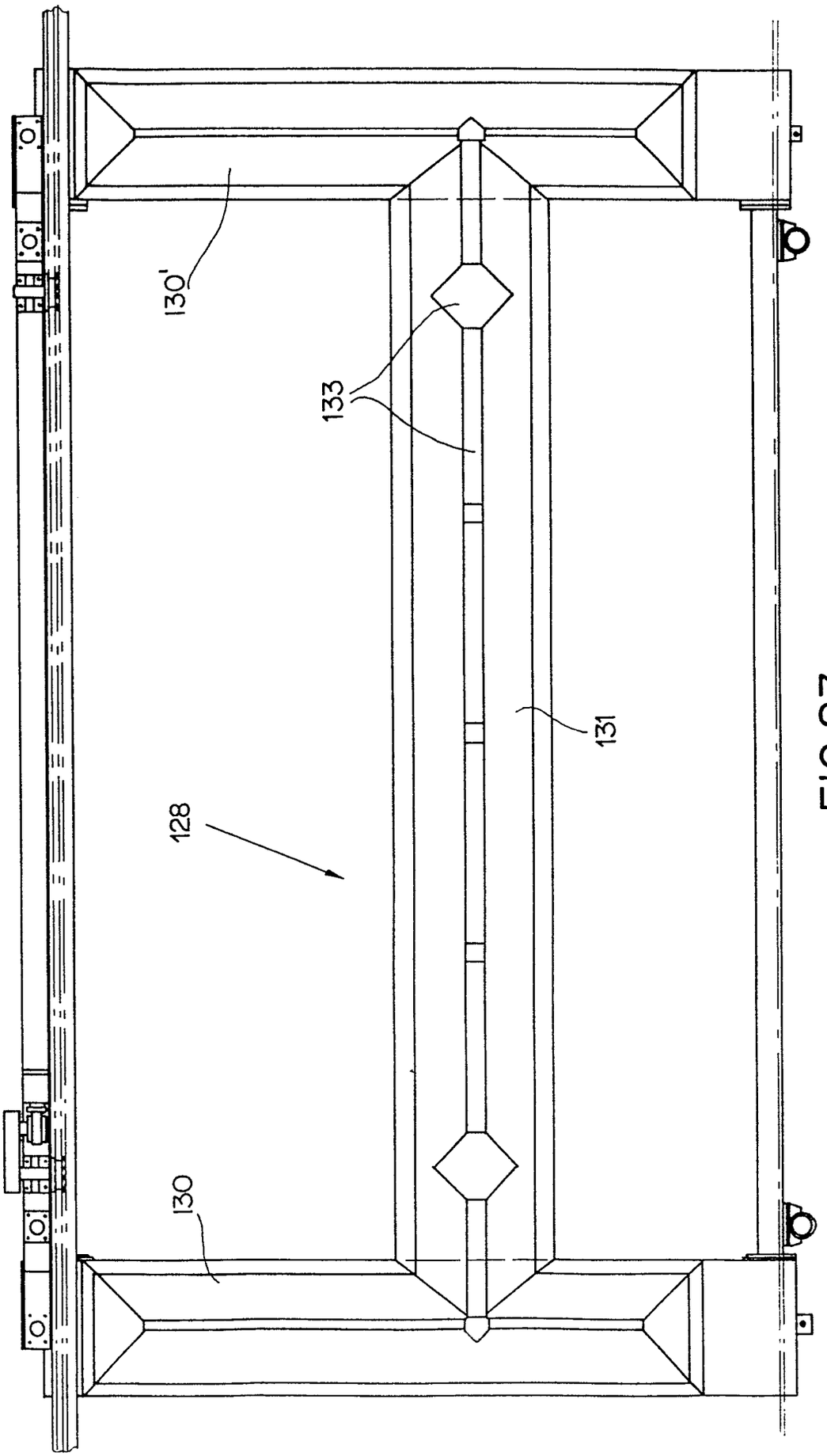

FIG.23

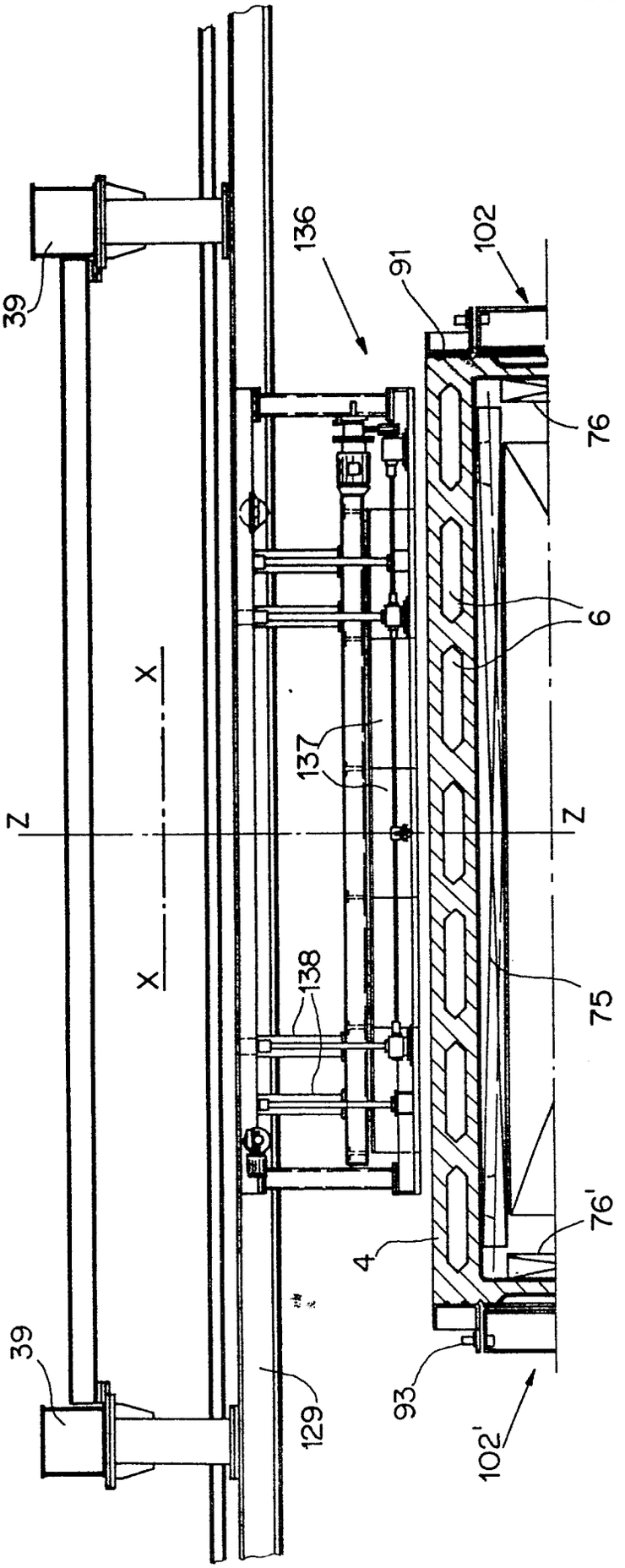

FIG.24

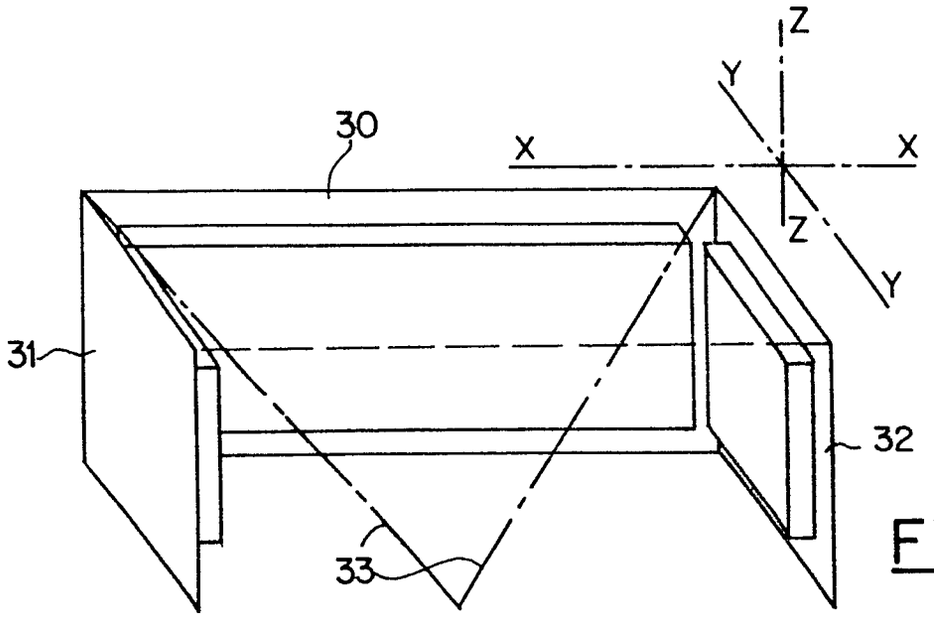

FIG.25

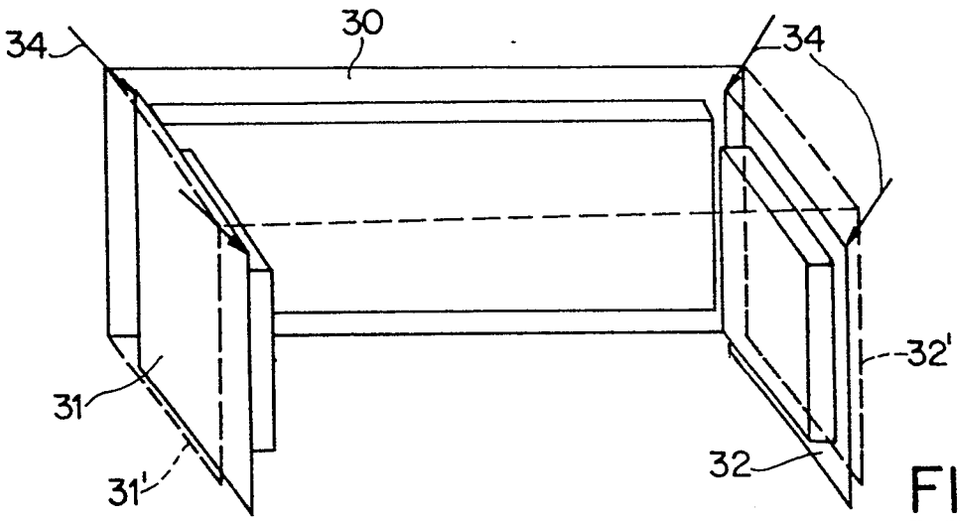

FIG.26

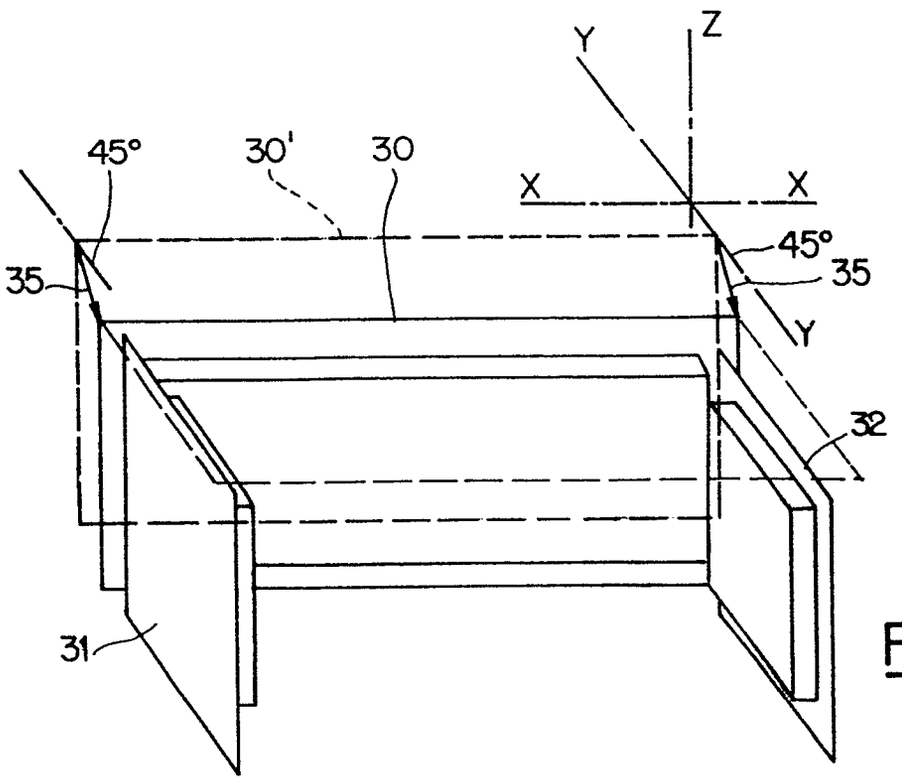

FIG.27

European Patent Office

EUROPEAN SEARCH REPORT

0080980
Application number

EP 82 83 0289

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 ³)
A	CA-A-1 078 640 (Z.A. ZIELINSKI et al.) * Figures 1, 3A, 3B, 3C, 8B; page 12, column 2 *	1-6,8, 10,12, 13	E 04 B 1/348 B 28 B 7/22
A	DE-C- 865 652 (H.J. BÖYNG) * Figures 1,4,5; claim 3; page 2, lines 79-83 *	1,12	
A	DE-A-2 310 312 (H. SCHMID) *Figure 2 *	1,12	
A	DE-C- 867 163 (W. LUDOWICI) * Figures 4,6; page 2, lines 24-32, 38-42 *	1	
A	FR-A-2 214 260 (C. VAN DER LELY N.V.) * Figures 1, 7 *	15,16	
A	DE-C- 842 711 (R. MIELKE) * Figure; page 2, lines 77, 78 *		

TECHNICAL FIELDS SEARCHED (Int. Cl ³)

E 04 B 1/00
B 28 B 7/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	04-02-1983	KRABEL A.W.G.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
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P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
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