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 [21] Appl. No. **878,999**
 [22] Filed **Dec. 8, 1969**
 [45] Patented **Aug. 24, 1971**
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 [32] Priority **Nov. 25, 1966**
 [33] **Germany**
 [31] **K 60 792**
Continuation of application Ser. No.
685,772, Nov. 27, 1967, now abandoned.

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[54] **PROCEDURE AND PRECAST BUILDING ELEMENTS MADE OF CONCRETE OR REINFORCED CONCRETE FOR THE CONSTRUCTION OF BUILDINGS OR SKELETONS**
 15 Claims, 18 Drawing Figs.

[52] U.S. CL..... **52/236,**
52/251, 52/259, 52/437
 [51] Int. CL..... **E04b 2/38,**
E04b 2/52, E04b 5/08
 [50] Field of Search..... **52/79, 251,**
252, 236, 241, 258, 259, 272, 280, 281, 284, 415,
437, 262, 741, 743, 137, 136, 270, 234

ABSTRACT: A skeleton for a building comprising precast frame-shaped elements and precast horizontal support beams which rest on the frame-shaped elements. The frame-shaped elements are placed along at least two mutually facing outer sides of the building and in adjacent or superposed relationship to form intermediate spaces therebetween. The precast horizontal beams are placed on the intermediate edges of the adjacent frame elements and cast in situ concrete is placed in the intermediate spaces defined between the frame-shaped elements.

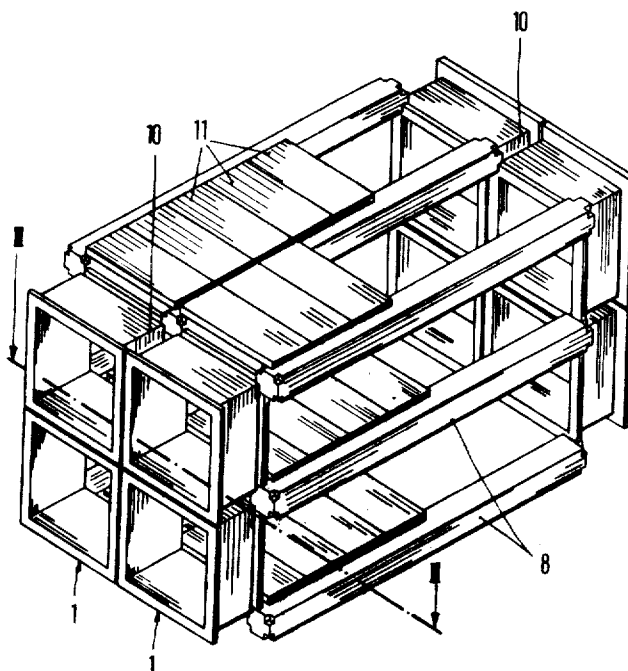


Fig. 1

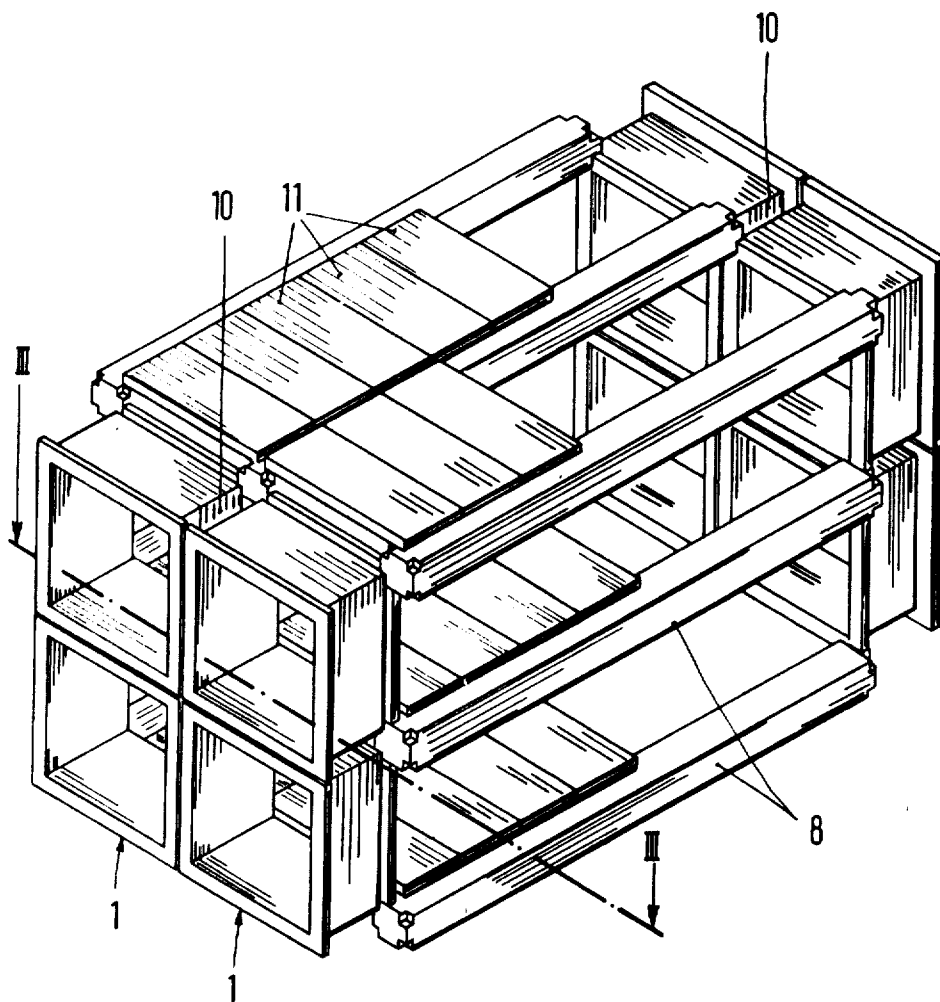


Fig. 2

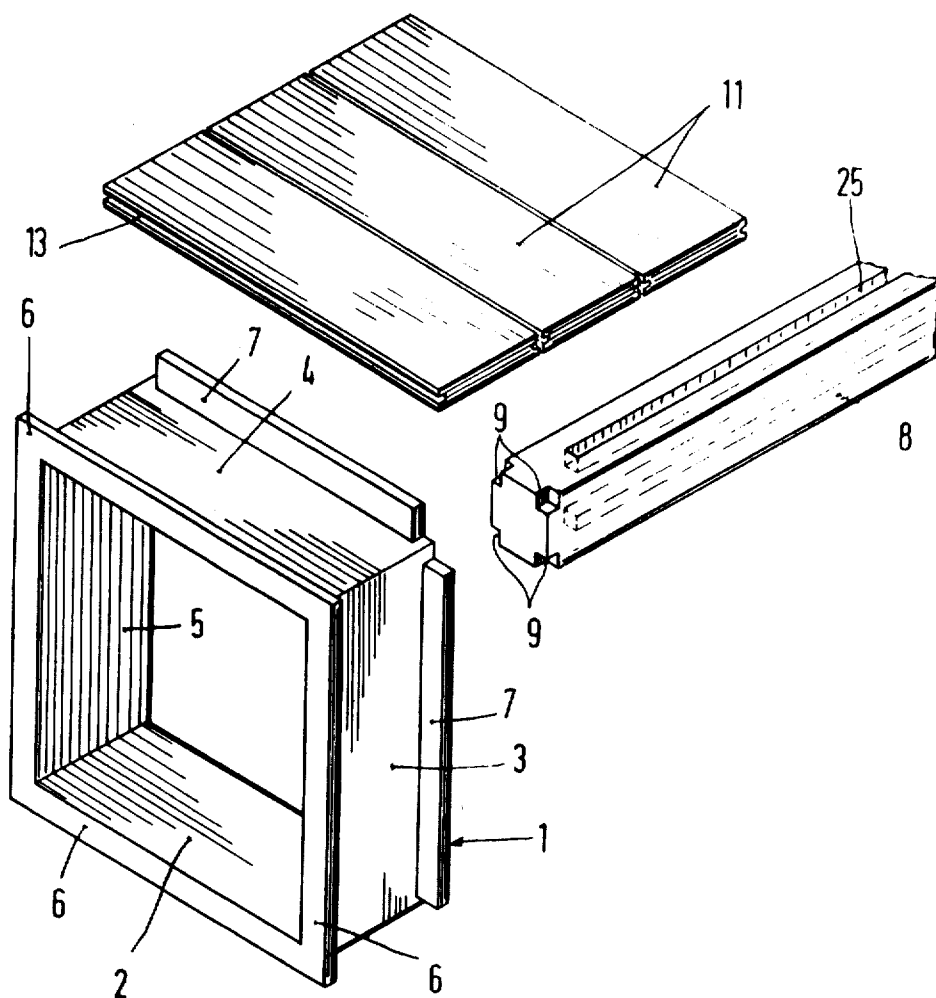


Fig. 3

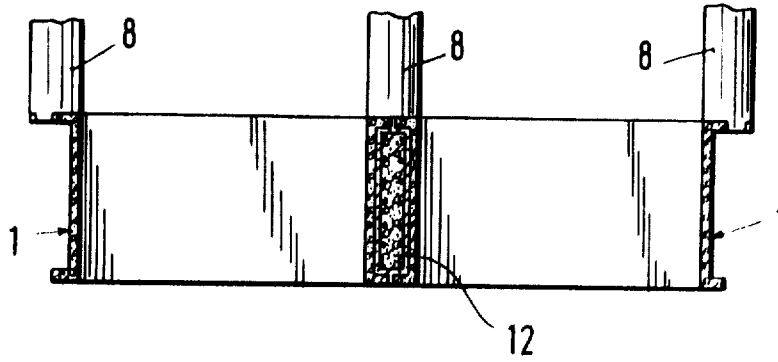


Fig. 4

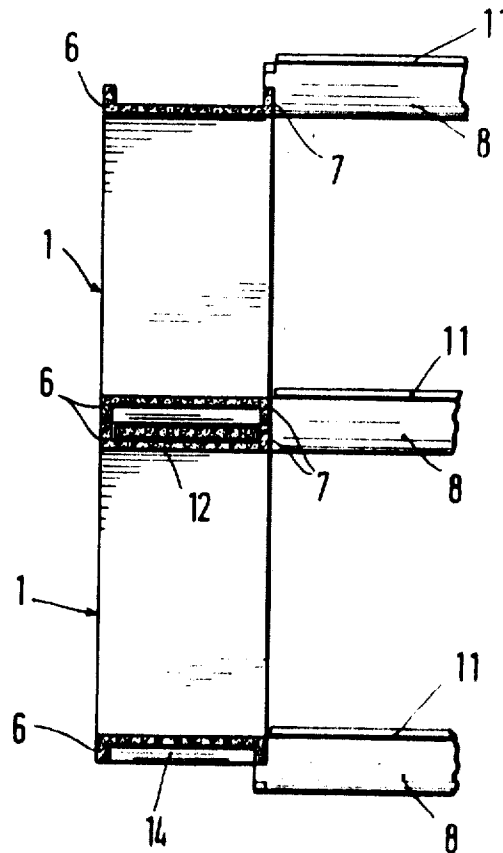


Fig. 5

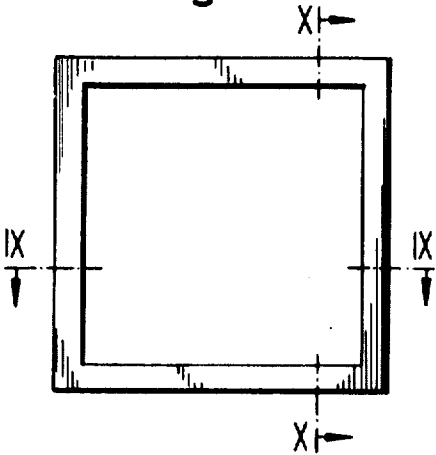


Fig. 8

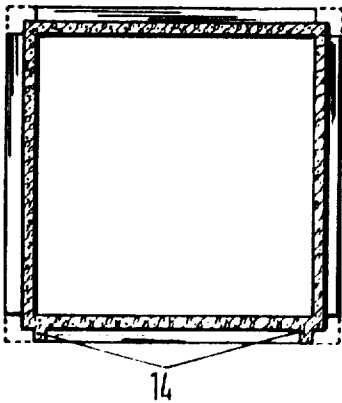


Fig. 6



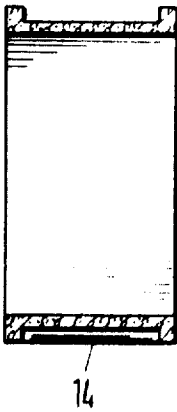
Fig. 9



Fig. 7



Fig. 10



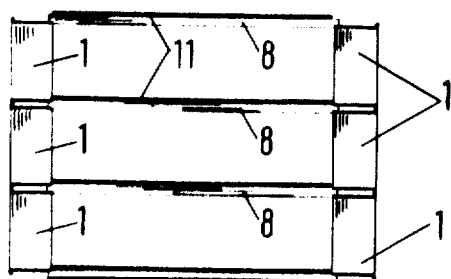


Fig. 11

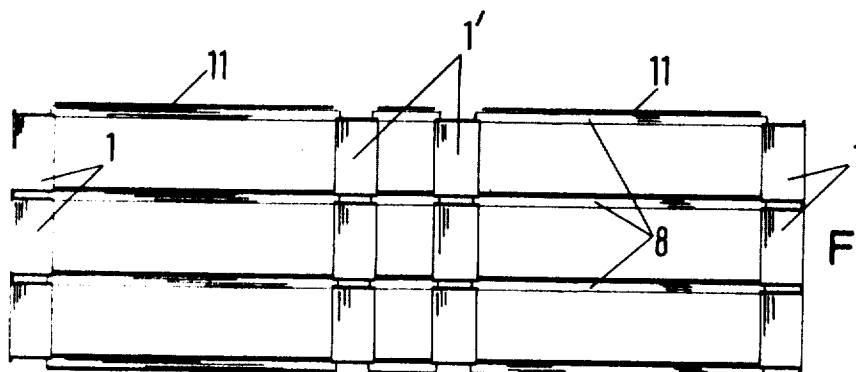


Fig. 12

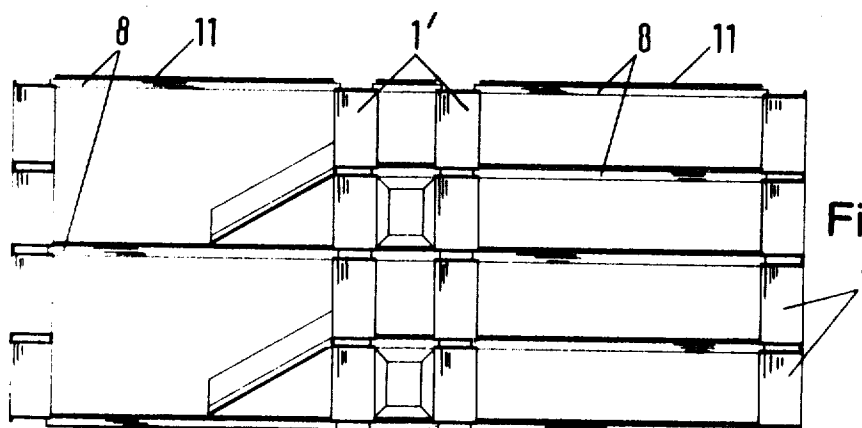


Fig. 13

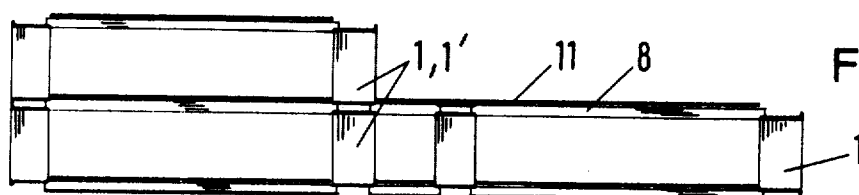


Fig. 14

Fig. 15

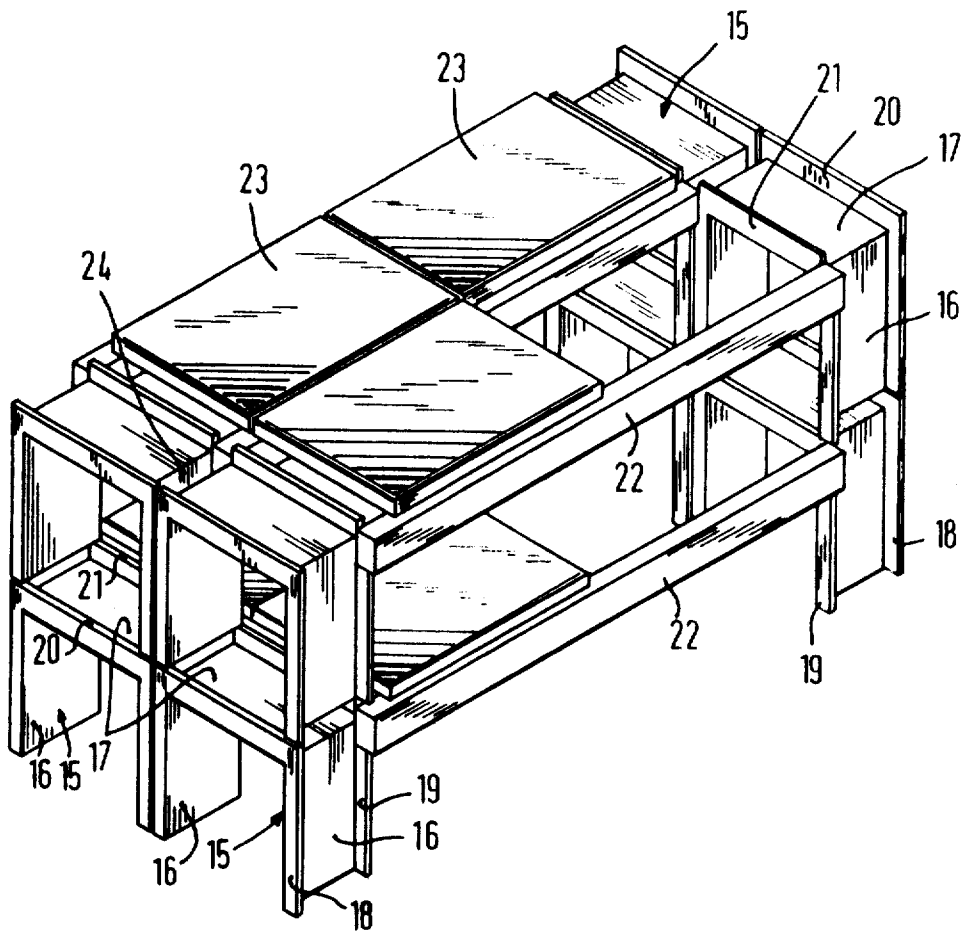
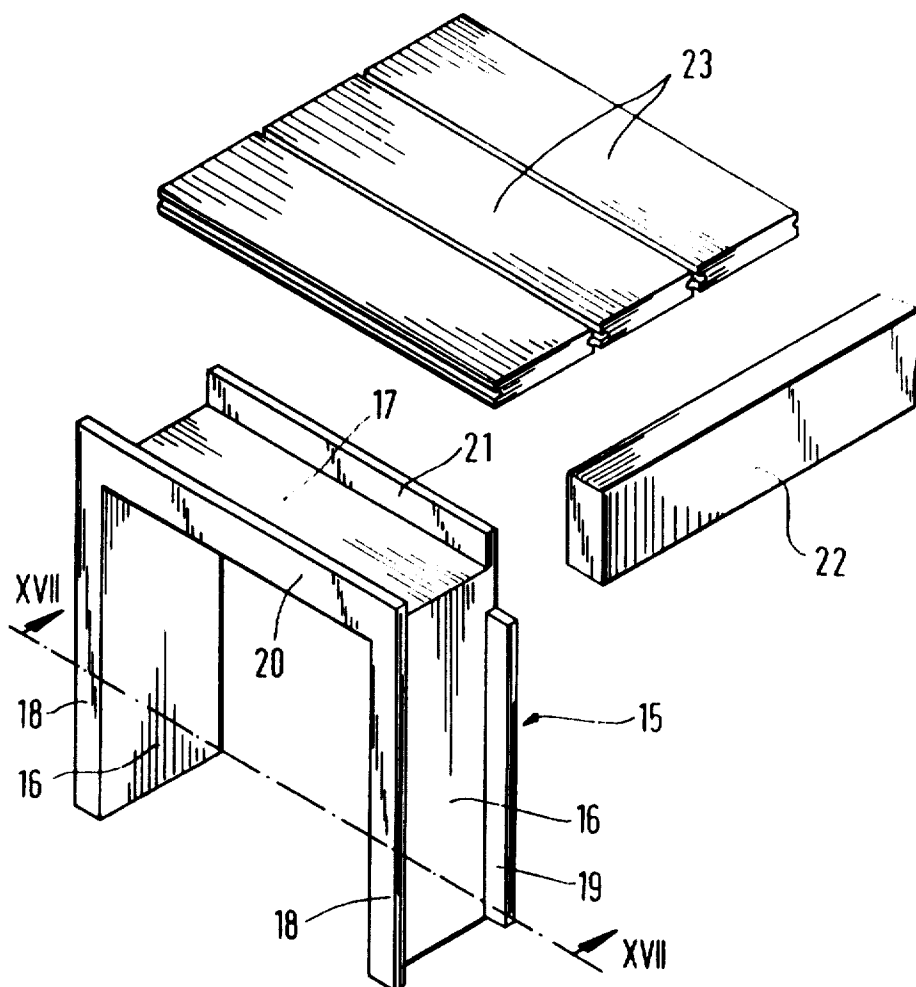


Fig. 16



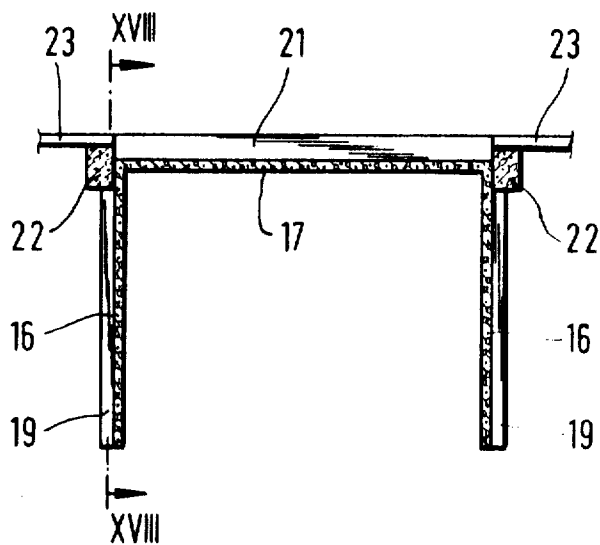


Fig. 17

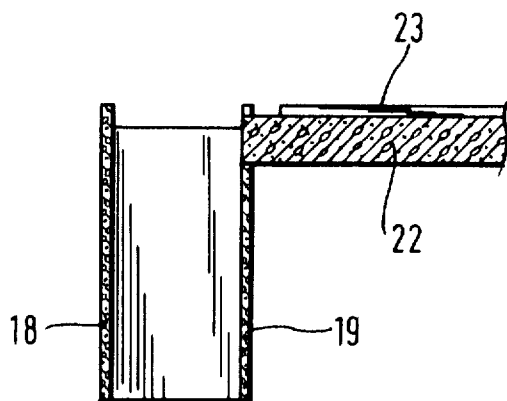


Fig. 18

PROCEDURE AND PRECAST BUILDING ELEMENTS MADE OF CONCRETE OR REINFORCED CONCRETE FOR THE CONSTRUCTION OF BUILDINGS OR SKELETONS

This application is a continuation of U.S. application Ser. No. 685,772, filed Nov. 27, 1967 now abandoned.

The present invention relates to a procedure for the construction of a building or a skeleton by means of precast concrete or reinforced concrete elements. According to conventional methods, buildings or skeletons consisting of reinforced concrete have been erected either by putting up supporting walls and then putting or casting the individual floors on top of these walls, or by erecting supporting columns of reinforced concrete, which are intended to support the floors; another known method is the precast construction procedure, which consists in arranging precast construction elements representing entire room units side by side or on top of each other, the elements including all four sidewalls as well as the floors and the ceilings of the respective room units. All these procedures, however, are complicated, since they necessitate the use of either large molds for casting the supports and/or the floors or expensive heavy-duty transport equipment as well as assembly cranes and, in the case of precast construction, allow only for relatively low stories. The present invention, therefore, aims at providing a method of the mentioned kind above, according to which the supports are cast at the building site. Further, the inventive procedure eliminates the necessity of using any kind of mold for erecting the supports and for casting the floors; moreover, it can be carried out in steps following each other in rapid succession. According to the invention, this aim is achieved by arranging on at least two mutually facing outside walls of the building to be constructed frame-shaped building elements side by side, or, if desired, on top of each other, which elements form intermediate spaces, by placing beams for supporting the floors on top of said frame elements in such a way that they rest with both ends on oppositely disposed frame elements, and by filling up the intermediate spaces between the adjacent frame elements, which spaces may enclose reinforcement bars, with cast in situ concrete in order to form vertical supports. In erecting multistoried buildings, it is suitable to fill up also the spaces between the elements arranged on top of each other—which spaces may or may not include reinforcements—with cast in situ concrete in order to form horizontal or substantially horizontal tension chords. It is further possible to arrange frame element in adjacent and/or superposed relationship also in the interior of the building to be constructed. The spaces between these element, which are in alignment with the outer frame elements, will then also be filled with cast in situ concrete. The inventive procedure has the advantage that it eliminates the necessity of using any kind of mold for the construction of a building or skeleton; moreover, it reduces the size of the areas of thermal conductivity or "cold bridges" as much as possible and guarantees easy accessibility for maintenance and repair work to be done on the facade portions inserted into the frame elements. In addition to the above-mentioned advantages, the present procedure cuts out setting times, which normally slow down the construction of a building or a skeleton, since further frame elements and supporting beams may be added in adjacent and/or superposed relationship practically without any time lags, i.e. as soon as the spaces between the previously erected frame elements have been filled with cast in situ concrete.

The procedure according to the present invention is suited for the construction of high buildings with up to 30 stories and has the advantage that it requires basically only three precast elements—the frame element, the supporting beam and the floor slab to be placed on top of the beams. All conventional construction elements may be used without any difficulty for the construction of further detail. Since the rest of the construction elements are independent of the load-bearing skeleton, it is possible to exploit the respective economic ad-

vantages of various competitive products. An especially advantageous embodiment of the building element for carrying out the inventive procedure has flanges disposed on the front and/or the rear edge of at least one of its sidewalls forming the frame, which flanges are directed outwardly of the respective frame and are designed to enclose, together with the adjacent element, a space formed between the mutually facing sidewalls of the adjacent frame elements, i.e. to close off the space in the front and in the back. At least those flanges disposed on the rear edge of the frame element, i.e. at the rear of its sidewalls, which is intended to face the interior of the building, may be discontinuous, i.e. it may be cut out in the abutting areas of the supporting beams. Thus, the position of the supporting beams is precisely fixed, and the complicated and time-consuming process of leveling those beams has thus been eliminated.

Further details and advantages of the present invention will be apparent from the following description of the embodiments shown in the appended drawings.

FIG. 1 is a three-quarter view of part of a skeleton erected according to the inventive procedure with partially finished floors;

FIG. 2 is a detailed three-quarter view in a larger scale of the three different precast parts used in constructing the skeleton according to FIG. 1;

FIG. 3 is a horizontal section along line III—III of FIG. 1 through two adjacently disposed frame elements with supporting beams attached thereto;

FIG. 4 is a vertical section through two frame elements disposed on top of each other with supporting beams attached thereto;

FIG. 5 is a front view of one of the frame elements according to FIG. 1;

FIG. 6 is a top view of the frame element according to FIG. 5;

FIG. 7 is a side view of the frame element according to FIGS. 5 and 6;

FIG. 8 is a section along line VIII—VIII of FIGS. 6 and 7;

FIG. 9 is a section along line IX—IX of FIG. 5;

FIG. 10 is a section along line X—X of FIG. 5;

FIGS. 11–14 are vertical sections through four different buildings or skeletons constructed according to the procedure of the present invention;

FIG. 15 is a partial three-quarter view of a further skeleton with a partly finished floor, also constructed according to the inventive procedure;

FIG. 16 is a detailed three-quarter view of the three different precast parts used in the construction of the skeleton according to FIG. 15, however, in a larger scale;

FIG. 17 is a section through the frame element according to FIG. 16 with supporting beams placed on its corners and floor slabs put on the beams, along line XVII—XVII of FIG. 16;

FIG. 18 is a section through the frame element according to FIG. 16 with supporting beams attached thereto and floor slabs lying on the beams, along line XVIII—XVIII of FIG. 17.

FIG. 1 shows part of the building or skeleton constructed according to the method of the present invention and consisting of frame elements arranged only on two opposite sides so as to form the outside walls, but not in the interior of the building, before the pouring of the in situ concrete. This skeleton is constructed as follows:

Two frame elements 1 made of reinforced concrete are arranged directly adjacent to 1 other on the foundation at two oppositely disposed sides of the building. These construction elements consist of precast parts with four walls 2, 3, 4, 5 forming a closed frame having flanges 6, 7 on the front and the rear sides of the frame which are directed away from the latter and abut against the flanges of the respective adjacent elements when the frame elements are placed side by side or on top of each other. Thus, the walls 2 and 4 together with their associated flanges define horizontal members of the frame element, and the walls 3 and 5 together with their associated flanges define vertical members of the frame element. These

abutting flanges from an intermediate space between the sidewalls of the adjacent frame elements 1, which is to be filled out later with cast in situ concrete. Precast transverse horizontal support beams 8 made of reinforced concrete are then placed on the frame elements 1, which have been arranged side by side and exactly opposite the respective frame elements on the opposite side of the building, in such a way that they rest with one end on the corner portions of two frame elements arranged next to each other on the one side of the building, and with the other end on the corner portions of two frame elements arranged next to each other on the other side of the building exactly opposite the first-mentioned frame elements.

In order to insure that the supporting beams 8 resting on the frame elements 1 will not be displaced, a tooth connection is provided between the flanges of the frame elements and the ends of the supporting beams 8. For this purpose, flanges 7, which are disposed on the rear of the frame elements and face the interior of the building, terminate a very short distance from the frame corners to form a kind of cutout at every frame corner, where the flanges 7 surrounding the sides of the frame elements are discontinued. The end of a supporting beam 8, which is provided with corresponding recesses 9 on all four corners, is inserted into this cutout. The depth of the latter, measured in the direction of the beams, corresponds to the thickness of the flanges 7 of the frame element 1, whereas their width and height, also measured in the direction of the beams, correspond to the distance of the flanges 7 from the respective corners of the frame elements. Thus, the supporting beams 8 can be placed accurately with their recesses 9 on the flangeless corners of the frame elements 1, the edges of the adjacent flanges abutting against those sides of the respective beams that are directed toward them. Upon inserting reinforcing bars into the spaces 10, between the frame elements, the latter can be filled with cast in situ concrete 12 (FIG. 3) which connects with the in situ concrete poured between the frame elements below and, together with the portions of the adjacent frame elements enclosing it like a mold, forms a supporting column carrying the load transferred by the supporting beam to the frame elements.

If the building is higher than five stories, it is statically advantageous to form horizontal reinforced concrete tension chords in the stories above the fifth by filling out the space between the upper flanges 6,7 of the frame elements with cast in situ concrete 12 (FIG. 4) after inserting reinforcing bars and before putting the next row of frame elements 1 in place. The filling up of this space between the upper flanges 6,7 of the frame elements, which is open at the top, may be carried out simultaneously with the filling up of the spaces 10 between the adjacent frame elements. It is further possible to interweave the reinforcing elements disposed in said spaces with each other. Further, the reinforcements to be inserted in the concrete may, for instance, be prefabricated reinforcing baskets or steel fabric reinforcements, which may be anchored on reinforcing bars projecting from the frame elements, that is, e.g. from the sidewalls and/or flanges thereof. Upon the filling up of said spaces with cast in situ concrete, precast floor slabs 11 may be laid on the supporting beams 8 placed on the frame elements, and the joints between the slabs and supporting beams may then be filled in with concrete.

At this point the steps of the above-described procedure are repeated for constructing the next story, i.e. the placing of a further row of frame elements on the one below, the placing of the supporting beams on the corners of the frame elements, the pouring of in situ concrete 10 into the spaces between the adjacent frame elements and between the upper flanges of these frame elements, the placing of the precast floor slabs 11 on the supporting beams 8 and the subsequent filling out of the joints with concrete. In this way, one story after another is constructed. In order to prevent the flowing of concrete into the free upper half of the horizontally extending spaces between the frame elements arranged on top of each other during the process of pouring concrete into the vertically ex-

tending spaces 10 between the frame elements 1, webs 14 are provided on the lower corners of the frame elements. These webs 14 are extensions of the sidewalls 3, 5 and project beyond the bottom walls 2 of the frame elements 1.

The prefabricated ceiling plates 11 are provided with longitudinal grooves 13 extending along their narrow longitudinal sides, which grooves may also be filled with concrete thus insuring a strong tooth connection between the concrete in the joints and the precast floor slabs. The supporting beams 8 are also provided with longitudinal grooves 25 which run along the middle of their upper and lower surfaces. These longitudinal grooves may be used for the installation of cables and pipes as well as for inserting partition walls in the interior of the building. At the same time, however, they insure a reduction in weight of the supporting beams, which are formed basically as double beams with the longitudinal grooves 25 extending along their zero zones. In the area of these grooves vertical bores for accommodating pipes may be provided.

It is further possible to make the supporting beams abut against the middle portions of the frame elements rather than the corner portions thereof, or to insert intermediate beams abutting against the middle portions, if this is necessary for static reasons or in view of the weight of the floor slabs to be placed on the supporting beams. Naturally, building elements other than precast floor slabs 11 used in the illustrated embodiment may be employed in the construction of the individual floors.

FIGS. 11-14 illustrate some of the many ways of constructing a building by means of the building elements according to the present invention. FIG. 11 shows a multistoried building or skeleton, in which the frame elements, as seen in the embodiment of FIG. 1, are arranged only along two opposite outer sides of the building to be constructed, the supporting beams 8 resting on these frame elements bridging the entire interior space between the outside walls of the building. In contrast to this, FIG. 12 shows a building with a substantially larger ground plan. In this case, frame elements 1' are placed also in the middle of the building to provide intermediate supports for the supporting beams 8 and to divide the length of their span.

As can be seen from the illustrated embodiments, the height of the frame-shaped building elements 1, 1', corresponds to the height of the respective stories of the building to be constructed, this height, at the same time, being about equal to the width of said elements. Their clear inner height may, for example, be about 2.50 m., their inside diameter about 2.30 m., and their depth about 150 dm. Other measurements may also be used, they must, however, be adapted to the statical and structural requirements.

The frame elements are especially suited for constructing balconies. For this purpose, they may be fitted with a balcony railing which is disposed on the side facing away from the building and does in no way effect the smooth assembling and putting in place of the frame elements. In this case, facade elements containing windows and/or doors are then placed into or close to the side of the frame elements facing the interior of the building. These first-mentioned elements then form the balcony-facing exterior wall of the building to be constructed.

FIG. 13 shows a building or skeleton containing in one half stories of normal height, whereas, its second half is made up of stories of double height, enclosing halls or the like. This latter part of the building is obtained simply by placing supporting beams 8 intended to carry precast floor slabs 11 only on every other row of the frame elements 1 arranged on top of each other. FIG. 14, e.g., shows the method of constructing a building with parts of different height according to the invention.

For the sake of clarity, the skeleton of FIG. 15 is shown without the cast in situ concrete in between the frame elements and on the upper surfaces thereof. In this embodiment, the frame elements 15 have only three sidewalls 16, 17 and are therefore U shaped.

When constructing a skeleton these U-shaped frame elements 1 are placed directly next to each other in rows with their open sides facing down. The sidewalls 16 are provided

with flanges 18, 19 on the front and rear sides of the frame elements, which flanges extend outwardly of the frames and abut against the flanges of the respective adjoining elements and, together with the latter, enclose the space later to be filled with cast in situ concrete.

Also the sidewall 17 connecting the two above-mentioned sidewalls 16 and forming the top wall of the U-shaped frame element 15, is equipped with flanges 20, 21 which extend from its front and rear sides away from the frame element and jut out somewhat farther in relation to the top wall than flanges 18, 19 in relation to the sidewalls 16. These flanges 18, 19 serve as an enclosure of a space disposed directly above the adjacent frame elements and to be filled with cast in situ concrete in order to form a continuous tension chord connecting the frame elements.

The flanges 19 of the frame sidewalls 16, which are designed to face the interior of the building, terminate at a distance from the frame corners thus forming a cutout, i.e. a place where the flanges 19 are discontinued for the engagement with two sides of the end faces of the supporting beams 22. This cutout or discontinuation is dimensioned in such a way as to place the upper surfaces of the supporting beams 22 resting on the ends of the respective flanges 19 at a distance from the upper edges of flanges 20, 21; this distance corresponds to the thickness of the floor slabs to be put on the beams 22. Since the beams 22 have a cross-sectional width about twice as large as the jutting out portion of flanges 19 of the sidewalls 16 of the frame elements, the supporting beams 22 rest on the flanges 19 of two adjacent frame elements with one-half of their end portions abutting against each one of the flanges.

Now the space 24 between the adjacent frame elements can be filled with cast in situ concrete up to the upper edge of the top walls 17, after reinforcement bars have been inserted into it. Subsequently, the open trough-shaped space formed between flanges 20, 21 on the top walls 17 of the frame elements is also filled out with cast in situ concrete, after reinforcement bars extending over the whole row of adjacent frame elements 15 have been inserted into it; it is done either before or after the floor slabs 23 are placed on the beams 22. Thereby a tension chord is formed that connects all frame elements along their top walls as well as all supports, each of which is formed by two frame elements plus the intermediate concrete. The upper surface of the tension chord is flush with the upper surfaces of the floor slabs 23, the height of the supporting beams 22 plus the thickness of the floor slabs 23 being equal to the distance of the upper end of side flange 19 from the upper edge of the rear top wall flange 21. Thus, the upper surfaces of the tension chords form at the same time the floor surface of the next higher story.

Subsequently, a further row of frame elements 15 is placed on top of each tension chord formed in the above-described manner, the frame elements being placed on the tension chords, i.e. the upper edges of flanges 20, 21 of the frame elements below, in such a way that their sidewall 16 abut directly against said edges. Now, the procedure described above in relation to the storey below is repeated at the level of the next story, i.e. the level of the two rows of frame elements 16 just put in place.

The set of building elements according to the present invention offers the advantage of making possible a complete precast construction procedure requiring only the three different elements of the inventive building set for the erection of almost any desired kind of skeleton. By filling out the spaces between the frame elements used in carrying out this procedure with cast in situ reinforced concrete, the latter, together with the sidewalls and flanges of the frame elements enclosing it, forms supports of such strength that they are suited to carry the load of high superstructures consisting of up to 30 stories. In combination with the cast in situ concrete portions and the precast supporting beams attached to them, the frame elements are thus suited to form a load-bearing structure with a high degree of strength in every direction.

I claim:

1. In a building skeleton comprising vertical and horizontal supports in a common vertical plane and transverse horizontal support beams connected to said horizontal and vertical supports, the improvement wherein the vertical and horizontal supports in the same plane are defined by a plurality of prefabricated reinforced concrete frame-shaped elements disposed in said plane, each of said frame-shaped elements having at least one horizontal member defining both a part of the longitudinal sides and a part of the outer transverse cross-sectional area of one of said horizontal support, and also having two vertical members integral with the opposite longitudinal ends of said horizontal member, and each defining both a part of the longitudinal sides and a part of the transverse cross-sectional area of different ones of said vertical supports, each of said frame-shaped elements abutting adjacent frame-shaped elements and defining intermediate spaces therebetween, whereby at least said vertical supports are formed by abutting vertical members of different ones of said frame-shaped elements; one longitudinal end of each of said transverse horizontal support beams being positioned on an edge of at least one of said frame-shaped elements; and at least the intermediate spaces formed between abutting vertical members being filled with cast in situ concrete, whereby the plurality of prefabricated reinforced concrete frame-shaped elements together with said transverse horizontal support beams and the cast in situ concrete form a spatial system of support carrying substantially the whole load of said building.

2. A building skeleton according to claim 1, characterized in that a layer of cast in situ concrete is placed over the tops of at least several horizontally abutting frame elements to form a horizontal or substantially horizontal tension chord, and in that further frame-shaped elements are placed on said layer of cast in situ concrete and abut the tops of said several frame-shaped elements to form the next floor of the building.

3. A building skeleton according to claim 1 characterized in that the transverse horizontal support beams are placed on the frame-shaped elements so that at least one of the ends of the support beam rests on the corner portions of two vertically abutting frame-shaped elements.

4. A building skeleton according to claim 1 characterized in that the transverse horizontal support beams resting on the frame-shaped elements are at least partially embedded in the cast in situ concrete poured into the spaces between the abutting frame-shaped elements.

5. A building skeleton according to claim 1 characterized in that additional frame-shaped elements are arranged in abutting relationship within the interior of the building to form horizontal and vertical supports therein.

6. A building skeleton according to claim 1 characterized in that each frame-shaped element corresponds to the story height of the building and has a second horizontal member integral with said two vertical members and contributing to the static carrying capacity, said second horizontal member having spaced webs extending along the whole depth of the frame to form additional supporting legs for the frame-shaped element, and an additional form for the cast in situ concrete.

7. A building skeleton according to claim 1 characterized in that the transverse horizontal support beams are placed on alternate horizontal rows of the abutting frame-shaped elements.

8. A building skeleton according to claim 1 characterized in that each of the abutting edges of said frame-shaped elements is defined by spaced-apart flanges which are designed to enclose and define said intermediate spaces formed between abutting frame-shaped elements.

9. A building skeleton according to claim 8 characterized in that one of said spaced-apart flanges is discontinued near the abutting areas of the transverse horizontal support beams.

10. A building skeleton according to claim 8 characterized in that the spaced-apart flanges forming the edges of the horizontal members extend out farther than the spaced flanges forming the edges of the vertical members.

11. A building skeleton according to claim 8 wherein each of said frame-shaped elements is characterized in that it has

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four members, including two horizontal members and two vertical members, forming a closed frame and may be stood up on one of these members.

12. A building skeleton according to claim 8 wherein each of said frame-shaped elements is characterized in that it only has said horizontal and two vertical members which are arranged to form a U-shaped frame which is open on one side.

13. A building skeleton according to claim 8 wherein each of said frame-shaped elements is characterized in that its vertical dimension corresponds substantially to the story height of

the building.

14. A building skeleton according to claim 1 wherein each of said frame-shaped elements is characterized in that its horizontal dimension is substantially equal to its vertical dimension.

15. A building skeleton according to claim 1 wherein each of said frame-shaped elements is characterized in that it is fitted with railings along its front side in order to form a balcony.

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