

- [54] **METHOD FOR CONSTRUCTION AND ERECTION OF FLOOR SLABS**
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- [52] U.S. Cl.52/745, 52/69, 52/126,
52/236
- [51] Int. Cl.E04g 21/14, E04b 1/343
- [58] Field of Search.....52/69, 70, 80, 98, 745, 236,
52/126

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Primary Examiner—Henry C. Sutherland
Attorney—Barlow and Barlow

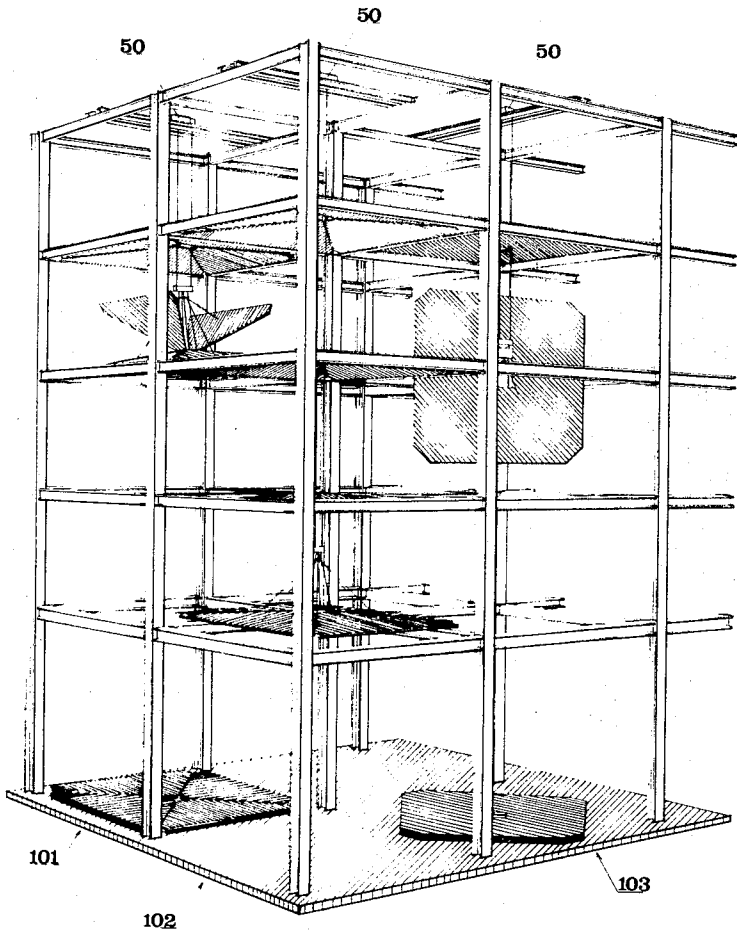
[57] **ABSTRACT**

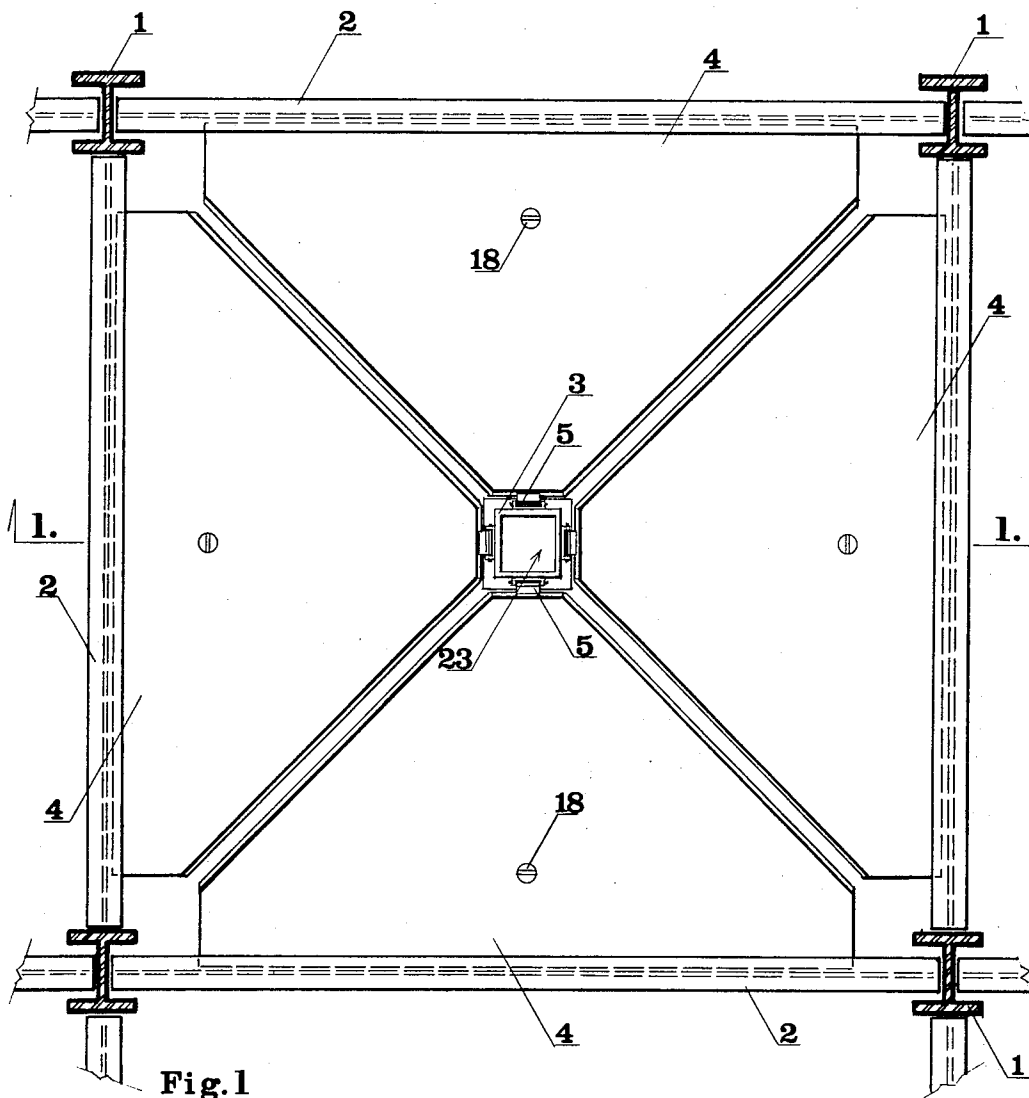
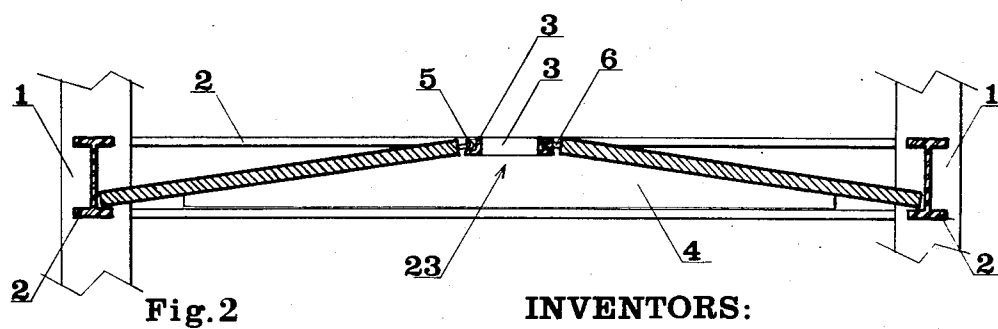
The method of constructing and elevating a building floor slab which comprises the utilization of a frame in the center of the floor slab to which a plurality of sections, such as four sections, are hinged or flexibly connected and then moving the sections about their connection to the frame into a contracted position in plan view of the slab and then elevating the slab to the desired height and then expanding the slab and positioning it on the framework of the building and then subsequently elevating similar slabs by cables passing through the center frame of the slab as a hoistway to position additional slabs below the uppermost slab. In some cases the top slab may be used as a roof.

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4 Claims, 15 Drawing Figures



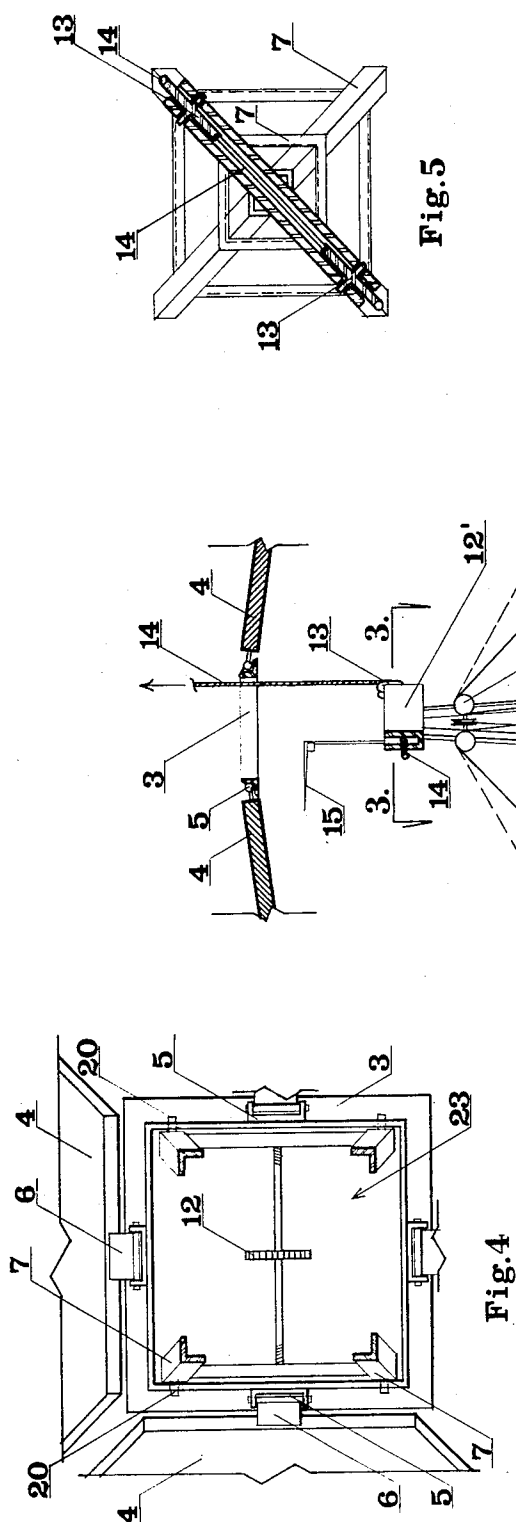
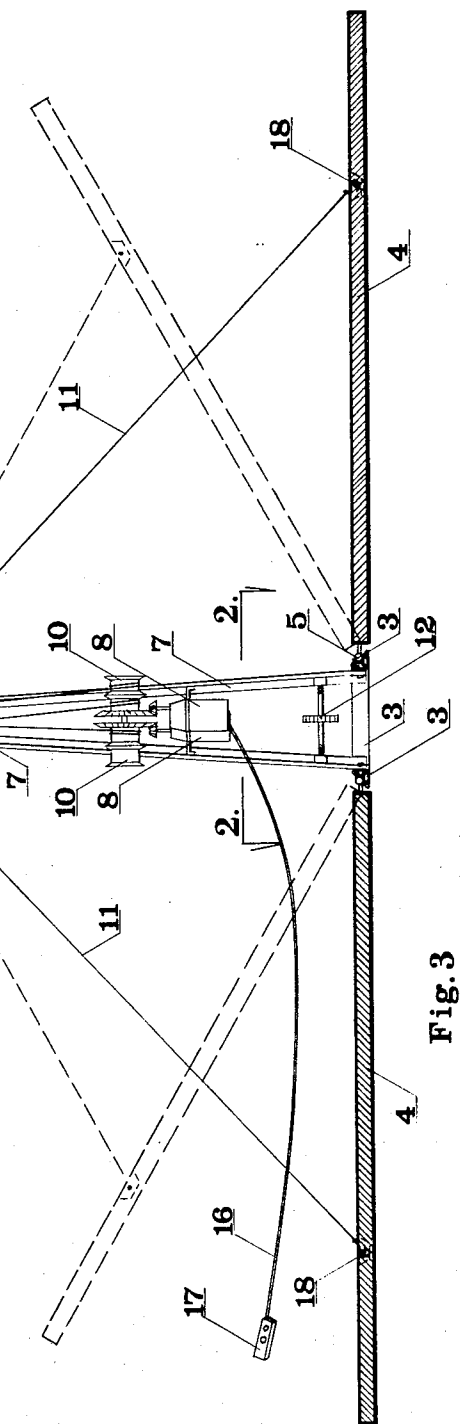


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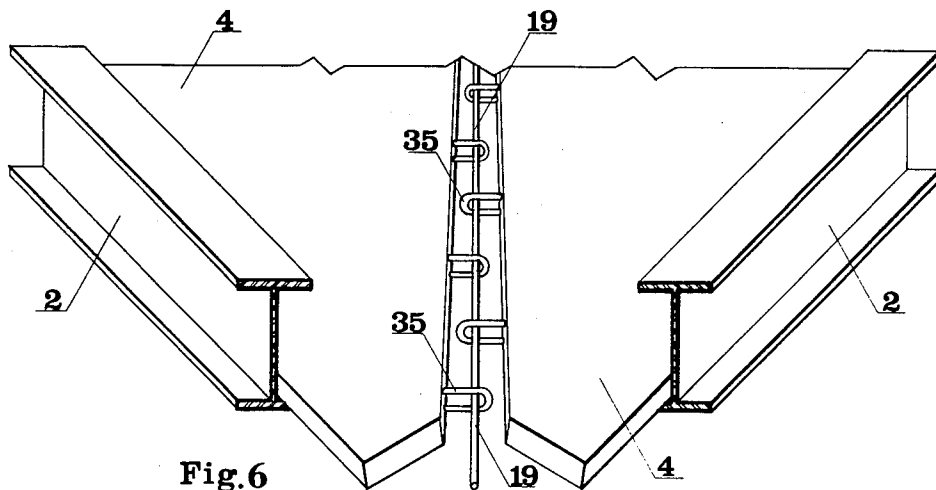
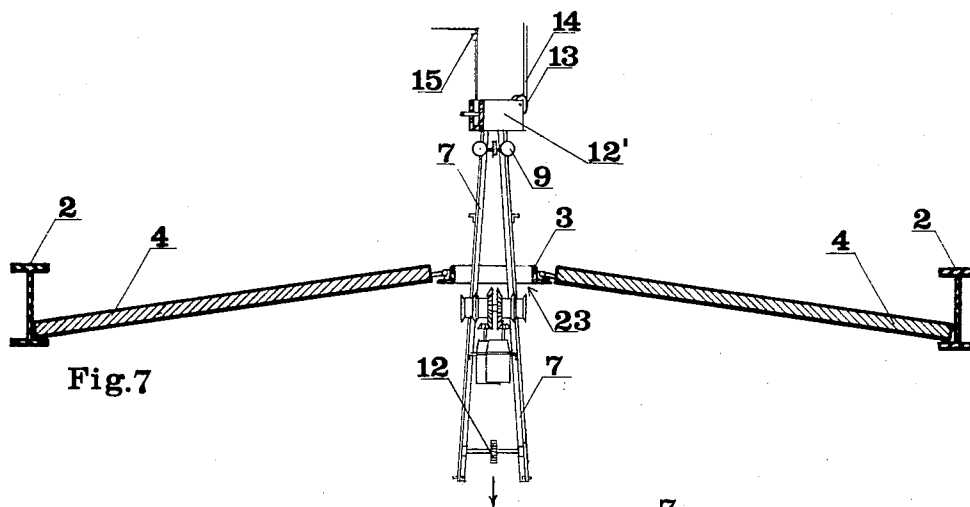
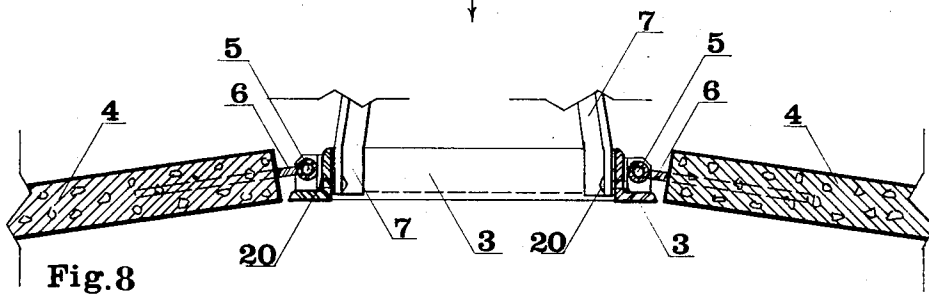
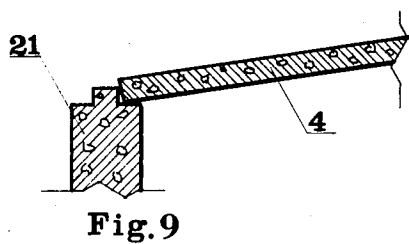


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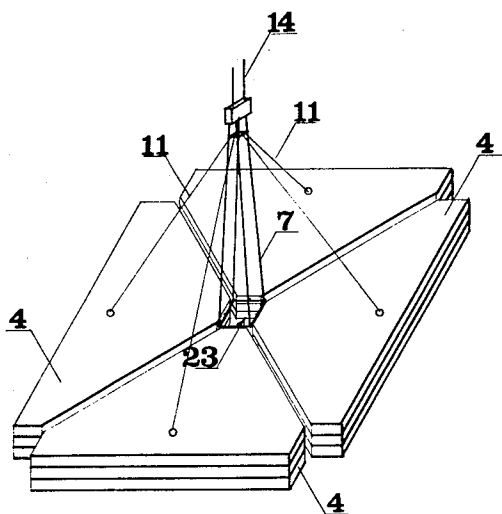


Fig. 10

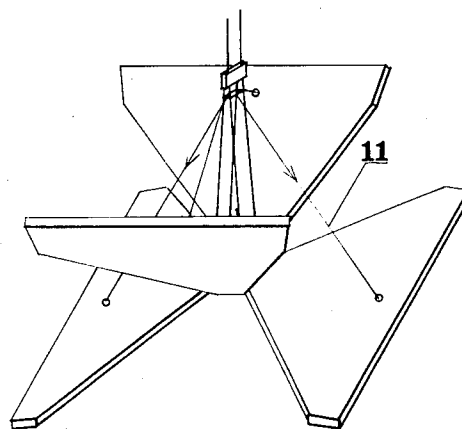


Fig. 13

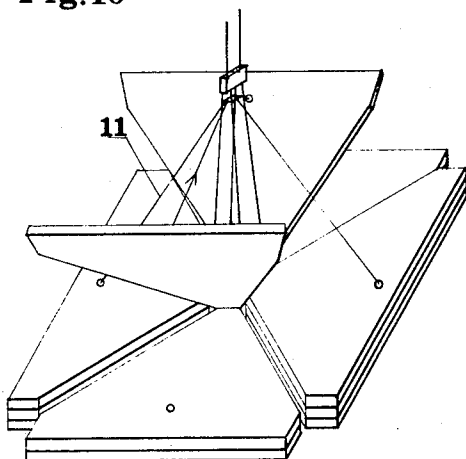


Fig. 11

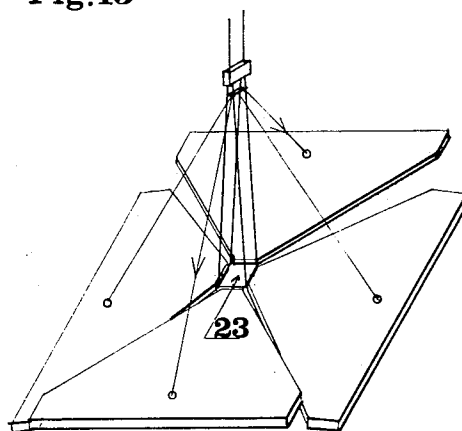


Fig. 14

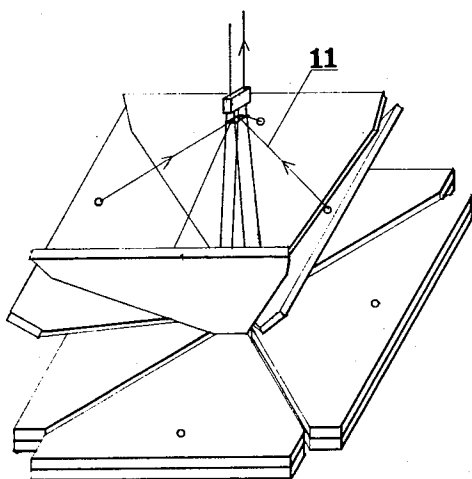


Fig. 12

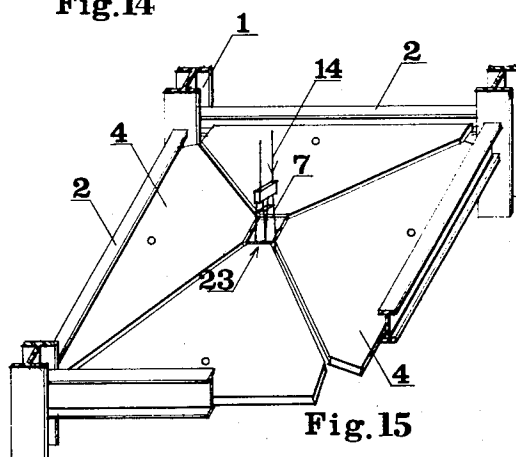


Fig. 15

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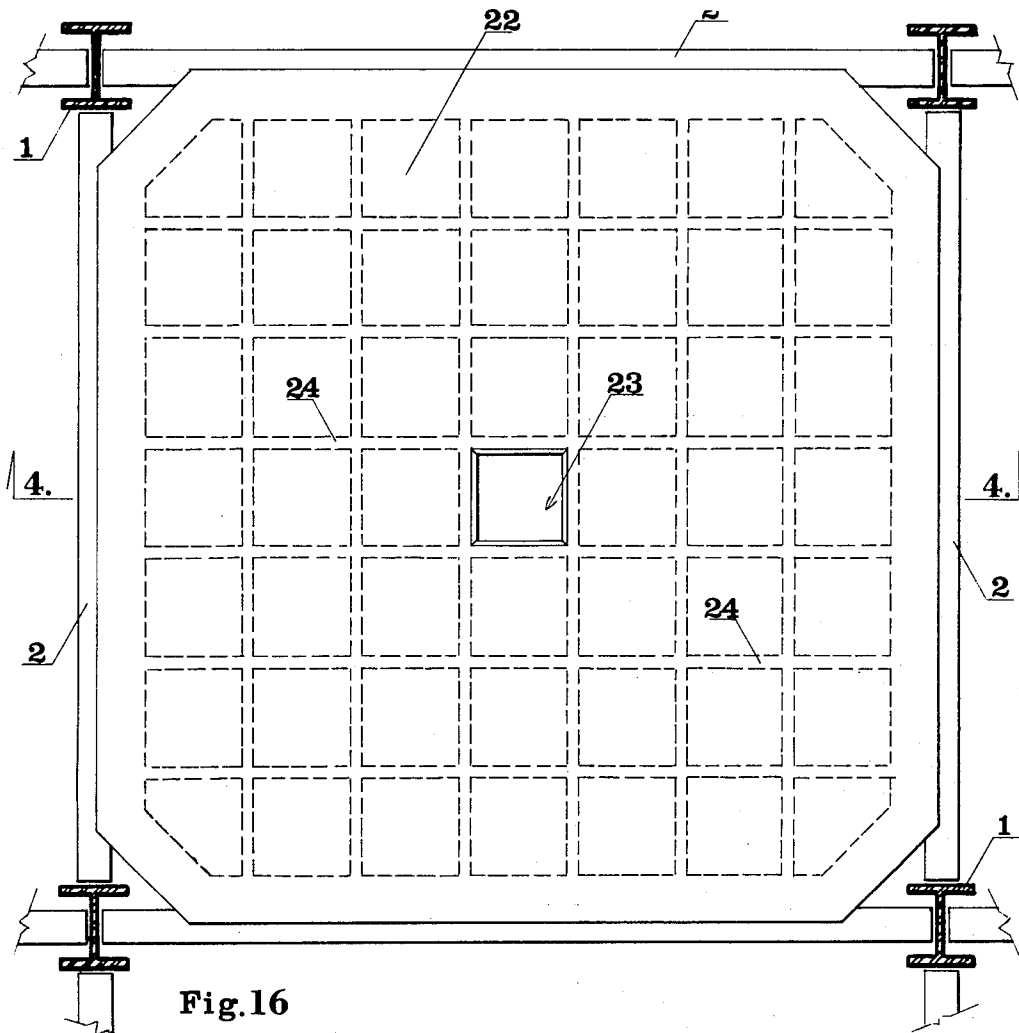


Fig. 16

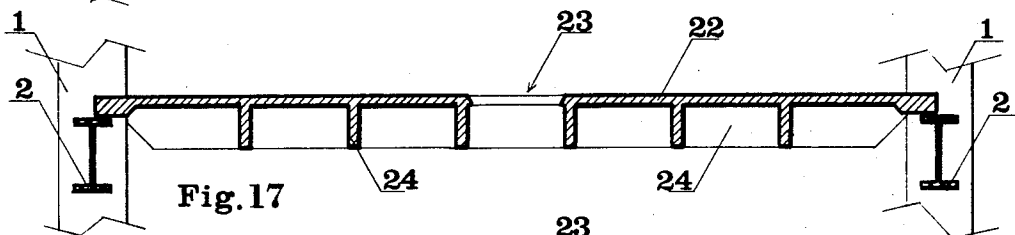


Fig. 17

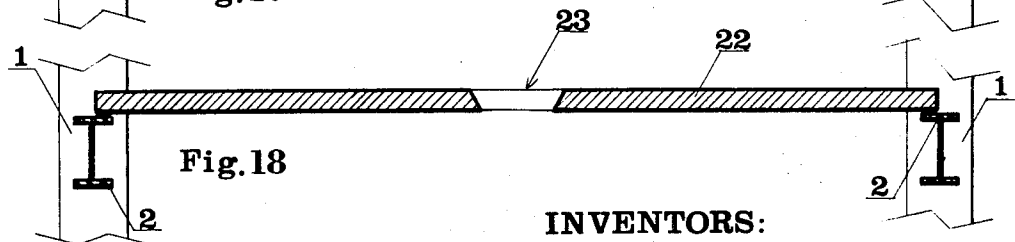


Fig. 18

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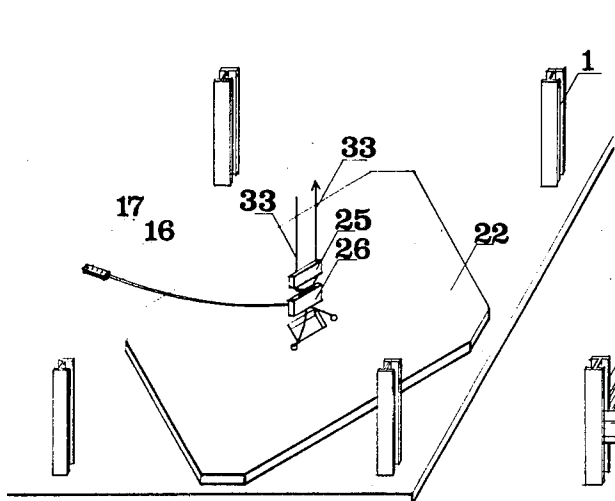


Fig. 19

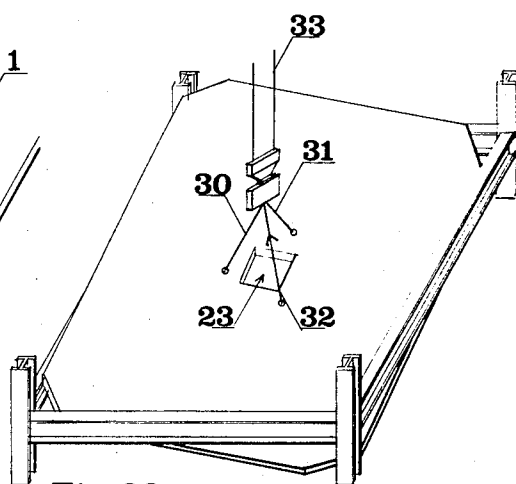


Fig. 22

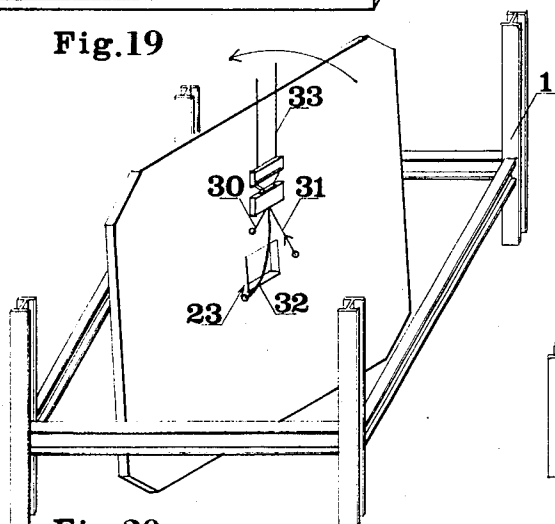


Fig. 20

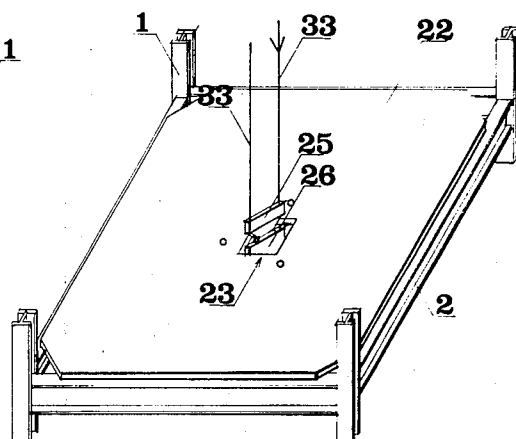


Fig. 23

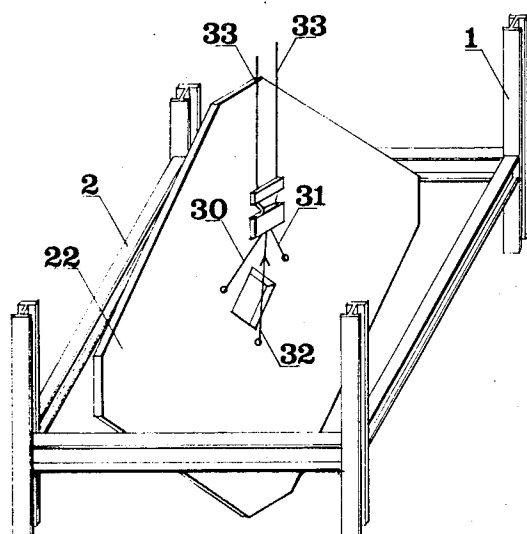


Fig. 21

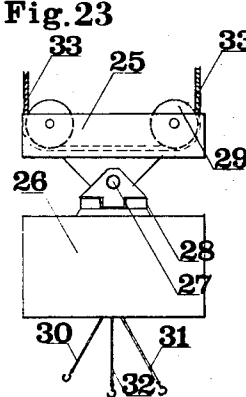


Fig. 24

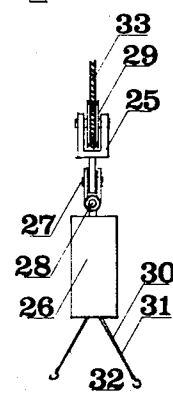


Fig. 25

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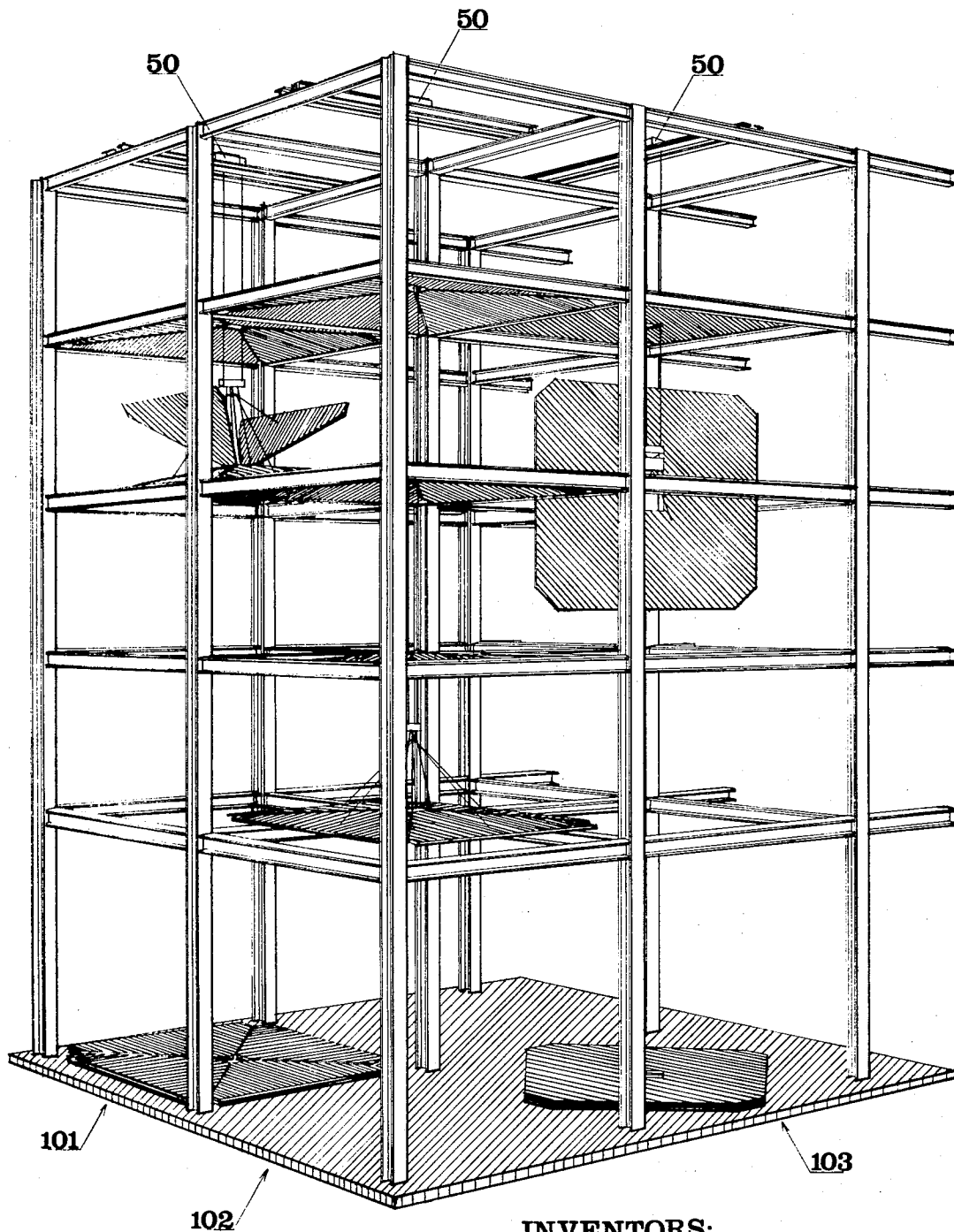


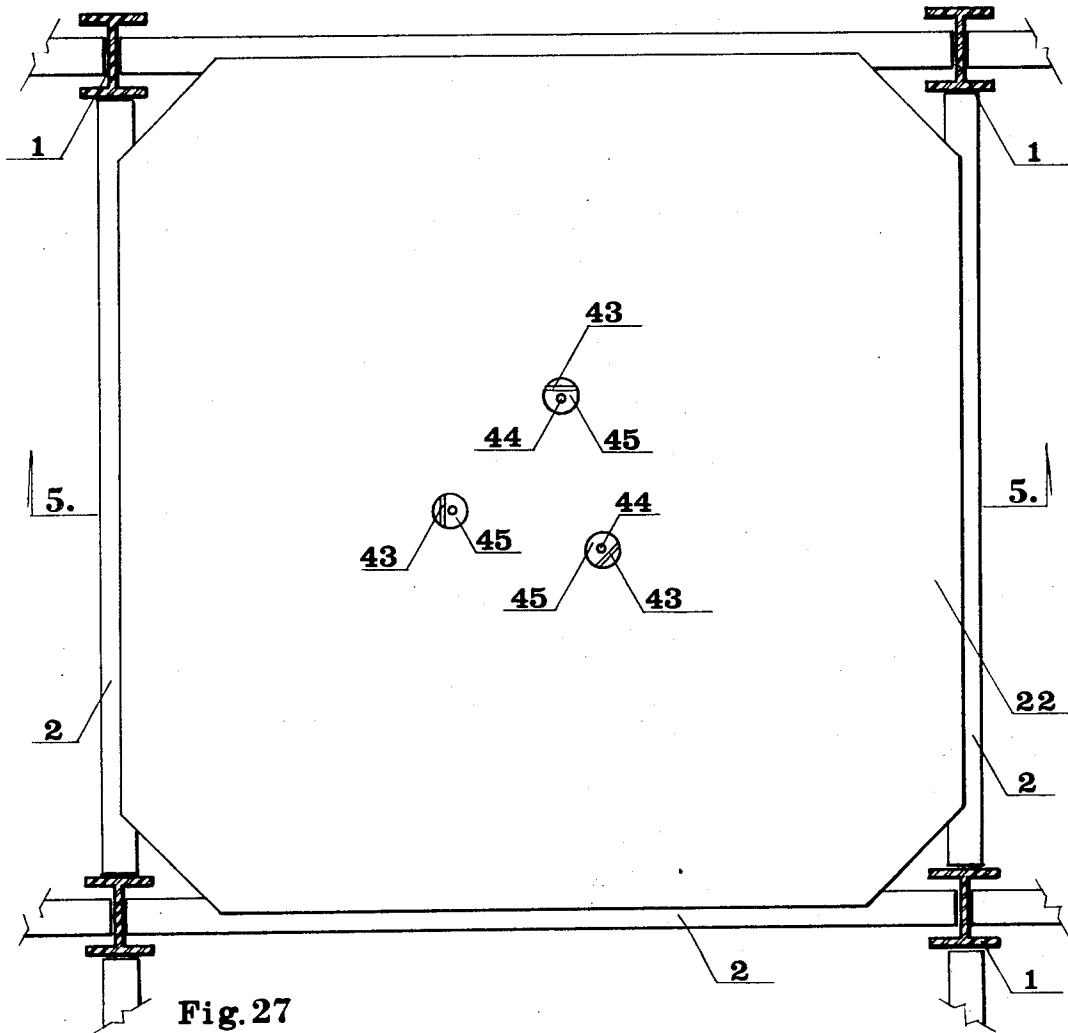
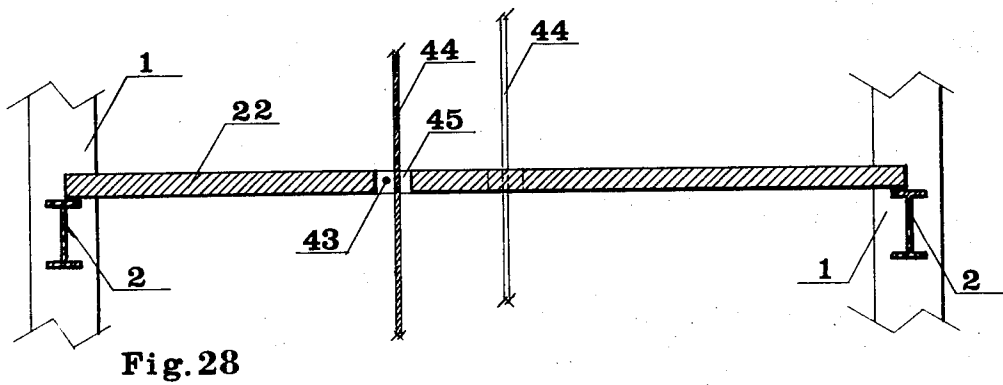
Fig. 26

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METHOD FOR CONSTRUCTION AND ERECTION OF FLOOR SLABS

BACKGROUND OF THE INVENTION

Floor slabs of rectangular shapes and various sizes have been precast and then hoisted by cranes to the desired floor and located in place. Such hoisting has usually been done by a crane from outside the building plan area and then lowered to the desired floor within the building plan. However, in some cases the floor slab has been elevated through a vertical shaft of the building and then positioned in place such as disclosed in U.S. Pat. No. 2,871,544.

SUMMARY OF THE INVENTION

A method of construction and erection of a floor slab through a vertical bay of the framework of the building wherein the floor slab is comprised of a plurality of sections which are flexibly or hingedly related to each other so as to move from an open expanded position to a folded contracted position which, in plan, will occupy a smaller area, and then hoisting the contracted slab vertically through the building bay to its desired location and unfolding the sections or opening them to expanded position and supporting the open floor slab in its desired position either as a floor or a roof of the building structure. Desirably there is a framework to which the plurality of sections are flexibly or hingedly related which framework has an opening through which hoisting cables may be located.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional view showing a portion of a building plan enframed by steel beams with four columns located on the corners and a plan of a foldable floor slab consisting of four parts hinged together in the center to a steel frame (collar) and resting on the four steel beams;

FIG. 2 is a sectional view taken on lines 1—1 of FIG. 1, showing a section through a typical structurally framed bay with a foldable floor slab;

FIG. 3 is a sectional view of a foldable floor slab and folding mechanism with two portions of the slab located opposite to each other and hinged to a steel frame (collar) in the center. The slab is shown prior to the erection and folding procedure;

FIG. 4 is a sectional view taken on lines 2—2 of FIG. 3, showing a horizontal section through the folding device and showing the steel frame located in the center of the folded slab with hinges and slab portions in plan;

FIG. 5 is a sectional view taken on lines 3—3 of FIG. 3, showing a section through the upper portion of the folding device, which consists of two pulleys in a steel frame, and showing in view the rest of the folding device;

FIG. 6 is a corner detail of a foldable floor slab located in place and showing the relationship between the slab portions and the steel beams on which the slab is supported and showing one of possible ways of the slab reinforcement connections of two slab portions;

FIG. 7 is a section through a foldable floor slab taken approximately through the center of this slab and showing the slab erected and located in place position while the folding device is being lowered down through the framed opening in the slab center;

FIG. 8 is a section through the central portion of a foldable slab in a larger scale showing the framed opening in the center of the slab and showing the bottom portion of the folding device attached to the steel frame hinged with the folded slab;

FIG. 9 is a modified section showing a part of the foldable slab supported on a concrete beam or a concrete wall top;

FIG. 10 is an isometric view showing three foldable slabs stacked in a pile, with a folding device shown schematically attached to the slab. This figure shows the position of the slab prior to the beginning of the folding procedure and the erection of the slab;

FIG. 11 is an isometric view showing a situation where the beginning of the folding procedure starts; the drawing shows that the two portions of the folded slab located opposite to each other have been brought into a sloped position whereas the two other slab portions are still in horizontal position;

FIG. 12 is an isometric view showing a situation where the remaining two slab portions have been folded, and in this position the floor slab will be elevated to and slightly over the desired floor level. The other two floor slabs shown beneath, will remain in the position shown until the top slab has been erected and the elevating cables with the folding device will be lowered again in order to pick up the next following slab;

FIG. 13 is an isometric view showing the unfolding procedure where two slab portions have been unfolded and are sloping down while the two other portions are still in folded position;

FIG. 14 is an isometric view showing a situation where two floor portions are ready to be placed in position, and the remaining two portions are being folded down and are close to their final position;

FIG. 15 is an isometric view, partly broken away, showing the floor slab located in place in the steel framing horizontal members, the folding device being shown partially lowered down through the opening in the center of the floor slab;

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, there is shown a typical portion of a building floor plan consisting of four columns located on the corners and designated 1, four steel beams 2 framing one structural bay and a floor slab consisting of four parts, each designated 4, which are supported on steel beams 2. A steel collar 3 which frames an opening 23 located in the slab center or several openings could be used. The four floor parts 4 are hinged to the steel collar 3 by a hinge part 5 joined to a flat piece of steel designated 6 which is embedded in each concrete floor portion. As it is shown in section 1—1 in FIG. 2, the floor slab is located within and supported by steel beams so that it creates a pyramid-like shape with cut off top portion. The portions of the floor slab designated 4 are shown in FIGS. 1 and 2 as separated, with empty spaces in between. This space situation will last until these slab portions are connected and the empty spaces filled with concrete. The corners of the slab portions are cut off in order to provide more space during the erection procedure. And so, because the four portions of the slab designated 4 are enframed in a sloped position and supported by

each other through a steel collar in the center, they will cause horizontal forces which will act from inside of the slab plan externally to all four steel beams on the circumference. Naturally these horizontal forces will exist only during the period of time prior to the connection and filling of the spaces between the slab portions. After these spaces are connected and filled with concrete, then the pyramid-like floor slab will create a very strong and rigid structure.

FIG. 3 shows a section taken approximately through the center of the foldable slab while it is in horizontal position on the ground. It shows the folding device designated 7 with electric motors designated 8 and winding spools designated 10 which are connected with the motors through gears. Pulleys 9 support steel cables 11, and the top portion of the folding device 12' consists of a frame and two pulleys 13 (see also FIG. 5). This top portion 12' of the folding device is used exclusively for the vertical movement of the device whereas the hoisting means located on the top of the steel structure are pulling or releasing the cable 14 which action causes the folding device with a floor slab anchored to it (or without the slab) to move upwards or downwards. The steel cable 14 is anchored on the top floor to a lifting device (not shown here) and extends down through two pulleys 13, and then again upwards to the hoist where it is wound or rewound by a winding spool in the hoist.

On the top of the folding device there is shown a safety device designated 15, which disconnects the electric current supply to the hoist on the top floor should the horizontal part of the safety device touch the floor slab collar located in the central part of the slab immediately above. The close relationship between the safety device 15 and the central portion of the slab above is shown in FIG. 3 by a portion of another slab, already erected and located in place, with a steel collar 3 hinged to the slab portions, and an opening framed by this collar. Through this opening runs the steel cable 14 up to the hoist 50 located on the top of the structure. The other end of the cable 14 is shown in FIG. 3 in section. It is characteristic that the top portion of the folding device framing two pulleys 13 is located diagonally with the relation to a framed opening above, designated 23. This diagonal location was chosen in order to increase the distance between two pulleys designated 13 which secures the folding device and the erected slab from movement around its vertical axes. If a greater distance, separate openings for each cable may be used. By dotted lines are indicated two portions 4 of the foldable slab while they are being folded; dotted lines also show the steel cables 11, which accomplish the folding procedure and run through two pulleys 9, located opposite, then down to the winding spool 10.

Each winding spool designated 10 consists of two portions used to wind two cables 11 connected with two slab portions 4 located opposite each other. In other words, when one electric motor designated 8 starts working then one winding spool 10 starts to wind or rewind (dependent on the right and left action of the motor 8) two cables 11 attached to two oppositely located slab portions. In the lower portion of the folding device designated 7 is a draw bolt designated 12, which is used for the purpose of bringing together or

extending the two bottom portions of the folding device. The folding device is connected with the slab collar 3 by four pins designated 20 which are welded to the bottom portion of the folding device and located in openings (holes) provided for this purpose in the slab collar 3. To disconnect the folding device from the slab it is necessary to rotate the drawbolt 12 until the pins 20 are out of the holes in collar 3 and then the folding device can be lowered down through opening 23. The steel cables 11 used for the folding procedure are hooked to the slab portions 4 in points designated 18. Each cable 11 is hooked in one point only, but in case of need, to increase the horizontal stability of a floor portion 4, being folded, instead of one hooking point designated 18 there could be used two hooking points located symmetrically on the slab. Referring to the folding device designated 7, it should be mentioned that its upper part with pulleys 13 is used only for the vertical movement, whereas its lower portion with elements designated 20, 12, 8, 10, 11 and 9 is used for the folding procedure of the slab.

The motors 8 in the folding device are driven electrically and could be fed by an electric flexible cable from the top of the structure or from the ground level. Each of these motors designated 8 will be connected with a steering device 17 by cable 16. This device should be steered manually. The person operating the steering device 17 may be positioned on the ground or anywhere on the steel structure, but it seems that the most convenient place would be on the level and close to where a floor slab is being located. Motors designated 8 and the steering device 17 will be adjusted to cause the movement of the steel cables 11 separately, forward and backwards. FIG. 4 shows in a larger scale the bottom portion of the folding device with the drawbolt located in the center and designated 12 and the four pins designated 20 shown in this drawing as being located in openings in the steel collar 3. On all four sides of the collar 3 there are located four hinges designated 5. These hinges are connected with flat steel elements designated 6 which are embedded in the four concrete slab portions designated 4. FIG. 5 shows in a larger scale a horizontal section through the top portion of the folding device. There are shown two pulleys 13, the steel cable 14 located on these pulleys and the pulley frame. FIG. 5 also shows the frame of the folding device designated 7 as seen from above.

As it was mentioned before, after a folded floor slab consisting of four portions has been erected and located in place in an area enframed by steel beams, these slab portions 4 should be connected with each other. This detail is shown in FIG. 6. It shows one of the possible ways of the reinforcement connection between two slab portions. The reinforcing bars 35 which have been cast into the slab portions stand out from the edge of the portions in the form of a loop, and a bar 19 would be passed thru the loop and the space between two slab portions should be filled with concrete. The opening in the center of the folded slabs and openings in the corners near columns should be also properly reinforced and filled with concrete, but prior to it all slabs in one vertical structurally framed shaft (bay) should be located in place.

FIG. 7 shows a situation where a foldable slab has been erected and located in place. The folding device 7

has been disconnected from the slab collar 3 located in its center. This device is shown in FIG. 7 as being lowered down through the opening 23 in order to be again connected with another foldable slab located next beneath the slab shown in this figure. FIG. 8 shows in a larger scale a section through the center of a folded slab. There is clearly shown the bottom portion of the folding device designated 7 with pins 20 located in openings in the steel collar 3. Also shown are hinges 5 located on collar 3 and connected with the slab portions 4 by a flat steel element 6. This steel element 6 is embedded in the concrete slab. The folded slab is presented in this disclosure as being located on a steel structural framing system, but it is well understood that it could be as well supported on structural elements made of reinforced concrete or any other suitable material. To indicate this possibility FIG. 9 shows a partial section through a foldable slab, which in this example is not supported (located) on steel elements but on a concrete element 21.

FIGS. 10 through 15 show the folding procedure, the erection of a foldable slab and its location in place. FIG. 10 shows three horizontal foldable slabs stacked in a pile, the folding device has been connected with the slab collar 3 located on the slab, the folding cables 11 connected with the corresponding slab portions 4 and cable 14 strained in order to keep the folding device straight up. In this position the slab is prepared for the folding procedure. FIG. 11 shows that the two opposite located slab portions of the slab shown on the top of the pile are folded up. The arrow on the folding cable 11 shows the direction of the pulling force. FIG. 12 shows a situation where the two remaining slab portions designated 4 are also folded up by the action of the two other cables 11. The arrows located on the folding cables 11 show the direction of the folding force. In this position the slab has reached the required folding configuration and as it is shown in this figure it needs more volume in space but it has a much smaller area in plan, and this means that it may be pulled safely to the highest floor without danger that it would touch the steel beams, framing the structural bay on all stories. In the position shown in FIG. 12 the slab will be raised to the top floor. An arrow on pulling cable 14 shows the direction of the erection force.

FIG. 13 shows the folded slab when it has reached the desired floor level and is being unfolded. This figure shows that two slab portions have been already unfolded and are slightly sloping down. This action is indicated by an arrow showing the direction of the unfolding force on the folding cables 11. The remaining two slab portions are still in a folded position. FIG. 14 shows that the remaining two slab portions are being unfolded and are presently in a horizontal position. They will reach their full unfolded position when they will have slopes similar to the two other unfolded slabs. When the unfolding procedure is completely finished the dimensions of this slab in plan will be slightly smaller than the opening framed by structural steel beams 2, and therefore the folded slab will be easily lowered through the opening limited by the four interior edges of the top flanges of the beams 2. As soon as it has passed this level, then all four folding cables

designated 11 will be slightly released and the folded slab portions will slightly increase the exterior slab circumference in plan and be settled on the bottom flanges of the steel beams 2, framing the structural bay. FIG. 15 shows a situation where the folded floor slab was already located in place and where the slab is resting on bottom flanges of steel beams. One column supporting the steel beams was omitted in order to show the location of the slab on the steel beams. This figure also shows that the folding device has been disconnected from the unfolded slab and is being lowered down through the opening 23 in the slab center, in order to be again connected to another folded slab to be located on the next floor below the erected one.

Although we have described this invention as primarily directed to a floor slab it will be apparent that in some cases the uppermost floor slab may be a roof for the vertical shaft of a building section, and in such cases the floor slab may be of such a size that its sections will be inclined to the horizontals when in place such as illuminated in FIG. 2.

For hoisting vertically thru the framework of the building the slab may be folded downwardly as well as upwardly.

We claim:

1. The method of constructing a building comprising erecting a multi-story building framework having vertical elements to define bays providing along said vertical elements a multiplicity of levels, means resisting horizontal and vertical reactions, forming floor slabs from a plurality of sections, flexibly connecting the sections of each floor slab in angularly adjustable relation whereby said sections can move from open expanded position to contracted position, angularly moving the sections to contracted position, elevating the contracted slab upwardly through vertically aligned bays to the desired position, angularly moving the sections to expanded position and supporting the expanded floor slab on its peripheral edges at its desired level on said means along said vertical elements, the horizontal dimension of said floor slabs in a planar relationship being greater than the spacing between said means whereby said slab is under compression in its at rest position.

2. The method of claim 1 wherein the floor slab is formed by hinging a plurality of sections to an open framework.

3. The method of claim 1 wherein the floor slab is formed by hinging a plurality of slab sections to an open frame located generally in the center of the floor slab plan, using the space enframed by said frame as a hoistway for hoisting means and elevating through said hoistway and locating in place beneath it another floor slab.

4. A building floor slab comprising as a part of the slab an open center frame having sides at an angle to each other, a plurality of sections also a part of the slab and of generally trapezoidal shape with one of the parallel sides shorter than the other flexibly connected along its shorter parallel side to said frame for movement relative to the frame from a planar relation to contract the size of the slab in plan.

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