Sept. 24, 1968 M. P. RAINAUT 3,402,515

FOLDING MULTI-STOREYED BUILDINGS

Filed Oct. 4, 1966 4 Sheets-Sheet 1

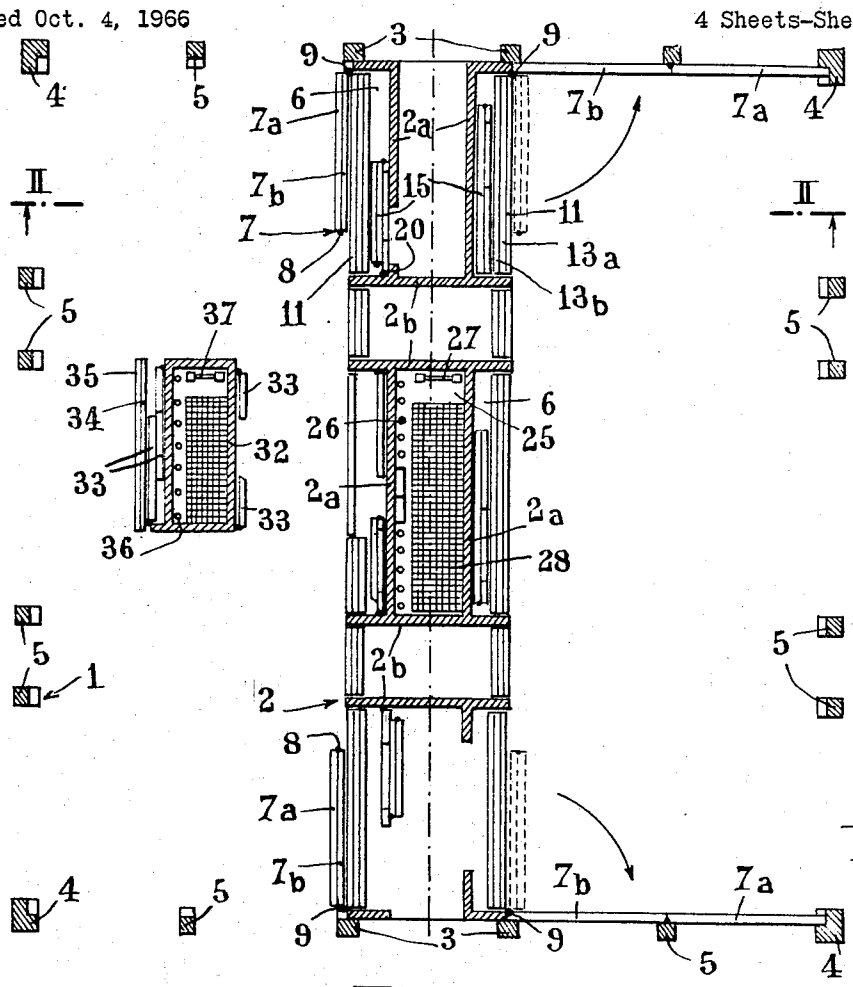


Fig.1.

Fig.2.

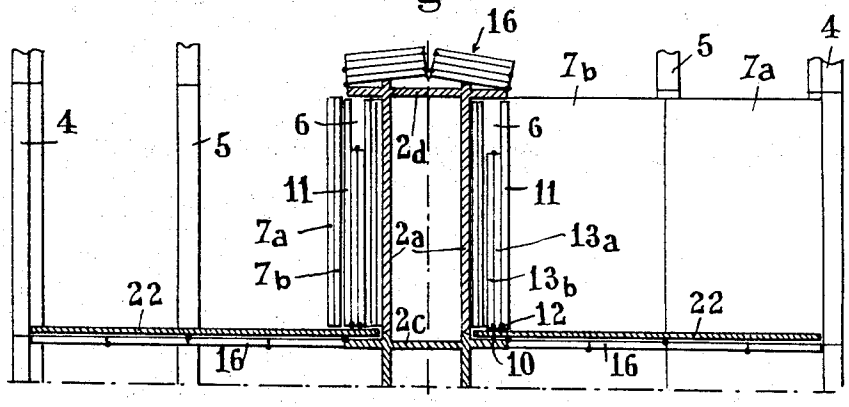

Fig. 3.

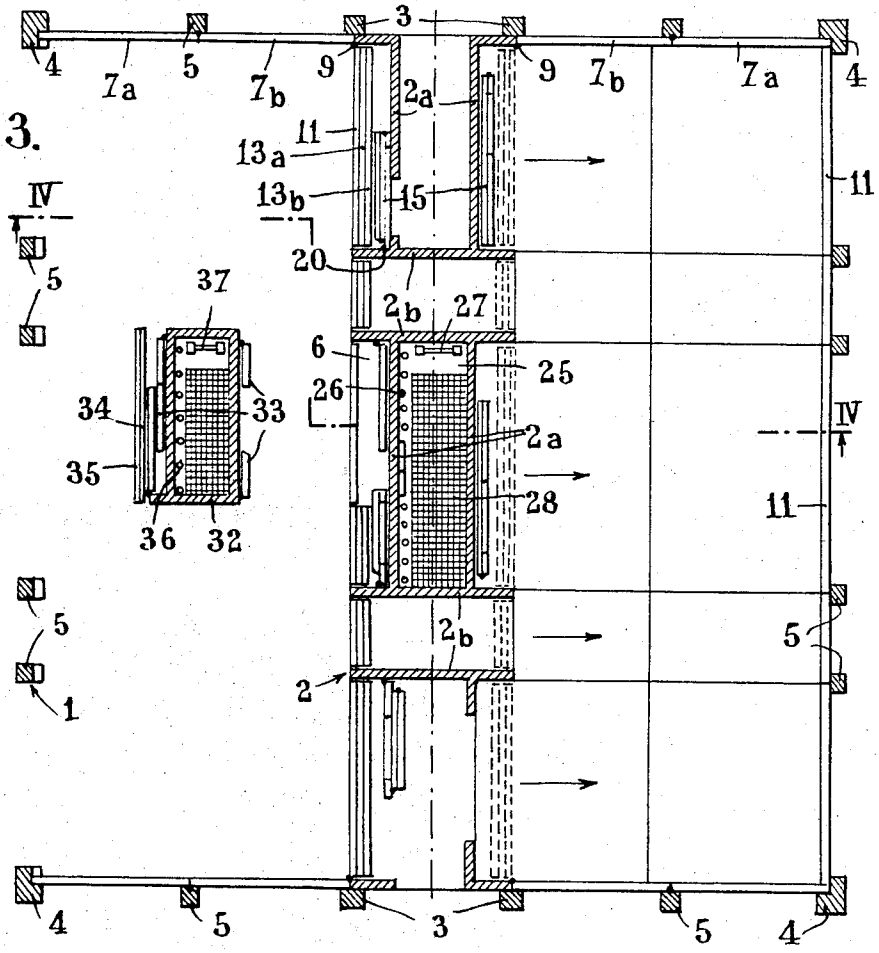
3
4
7a
5
7b
9
2a
11
13a
13b
15
20
2b
27
6
25
26
IV
34
33
35
36
32
37
28
1
2
16
2d
10
22
12
2c

Fig. 4.

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Fig. 5.

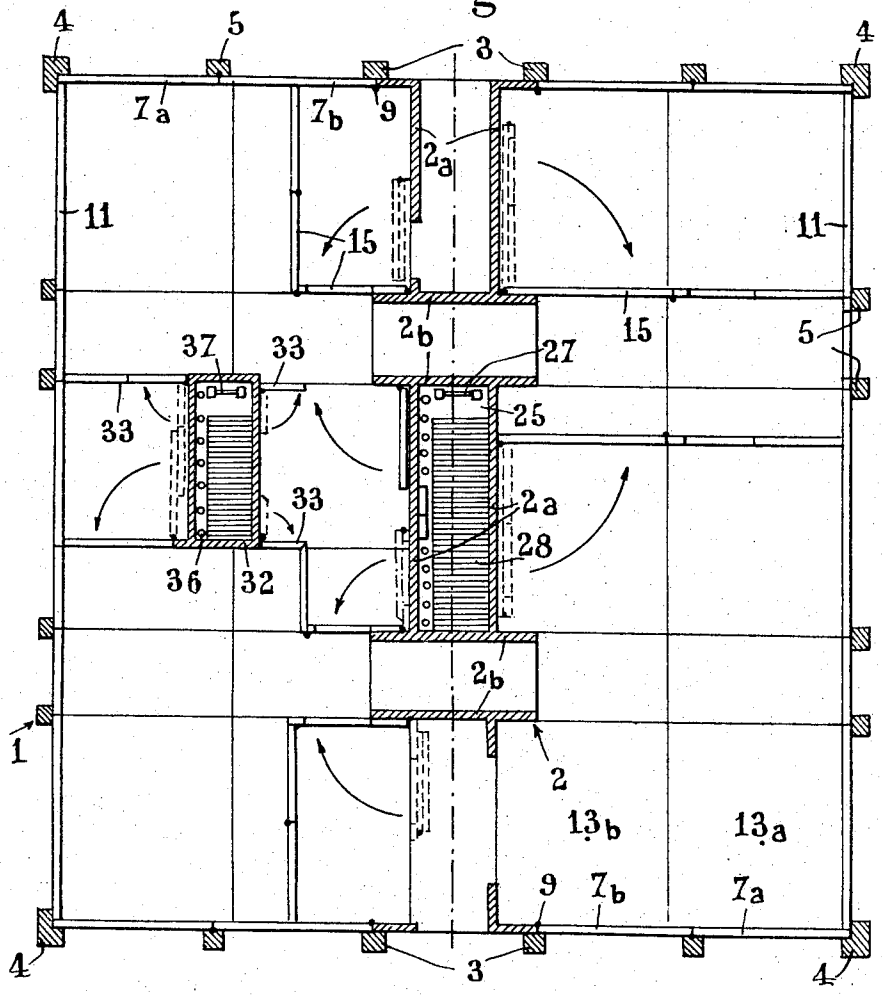


Fig.7.

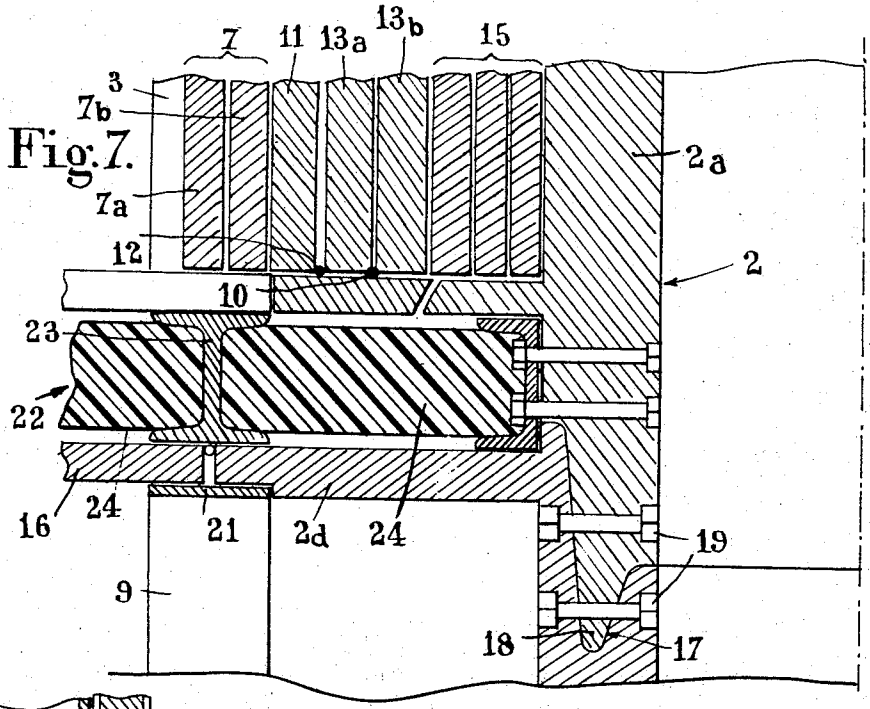
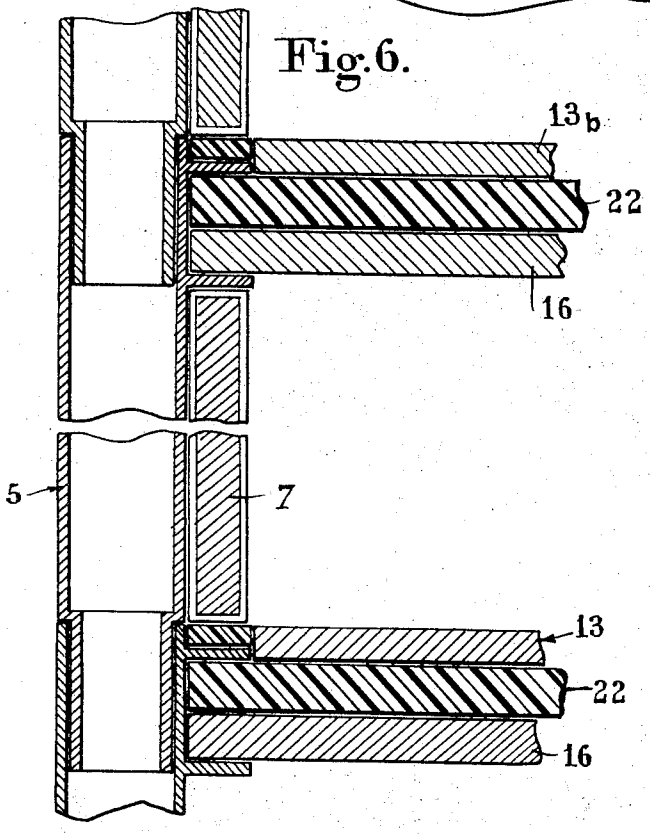

7
11
13a
13b
15
3
7b
7a
12
10
23
22
16
24
21
2d
24
2a
2
19
9
18
17

Fig.6.


13b
22
16
5
7
13
22
16

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3,402,515

# FOLDING MULTI-STOREYED BUILDINGS

Marc Pierre Rainaut, 55 Ave. Victor Hugo, Paris 16°, France

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6 Claims. (Cl. 52—64)

## ABSTRACT OF THE DISCLOSURE

This multi-storey building comprises a framework consisting of vertical metal posts having superposed post sections each the height of one storey and prefabricated dwelling units supported by the framework and superposed, with at least one dwelling unit per storey. Each dwelling unit has a rigid central core and elements constituting a frontage, with the floor and ceiling of the unit hingedly mounted on the central core and unfolded and supported by framework posts when the building is erected. The various central cores of superposed dwelling units are assembled in a stacked relationship.

This invention relates to a multi-storeyed building consisting of prefabricated elements and to the method of constructing same.

It is already known to erect houses from elements prefabricated in specialized factories, these houses comprising a rigid central core adapted to constitute the armature or main framework structure of the building both during the transport and after the erection proper, and lateral sections adapted to be folded for transport purposes against said central core, this central core being equipped on the other hand with all the hydraulic and sanitary equipments and all sundry connections and fittings, the lateral sections constituting in their unfolded or spread condition the walls of the various rooms of the house.

It is the essential object of the present invention to generalize this prefabrication principle in the construction of multi-storeyed buildings.

To this end, the present invention provides a multi-storeyed building consisting of prefabricated elements, which is characterized in that it comprises in combination a framework consisting of vertical posts and superposed prefabricated elements, there being at least one prefabricated element per storey and per dwelling unit, each element comprising a central core on which the frontages, floor, ceiling and possibly the inner partitions of each dwelling unit are hingedly mounted in their folded condition and adapted to be subsequently unfolded on the building site after having positioned and locked each central core in the framework.

This framework is adapted to receive said central cores in superposed relationship and consists preferably of metal members, the central cores consisting preferably of adequate plastic material.

This invention is also concerned with a method of constructing a building by means of prefabricated elements, this method comprising the steps of erecting a preferably metallic framework on adequate foundations, fitting at each storey, by using suitable hoisting means, at least one central core on which the ceiling, floor and frontages of each storey are hingedly mounted in their folded condition, together if desired with the inner partitions of each dwelling unit; properly fastening said central core to the support-forming posts of said framework, and eventually unfolding said ceiling, floor, frontages and possibly said inner partitions, whereafter these component elements are assembled and locked to one aother and also to the posts of said metallic framework.



The building construction method according to this invention is also advantageous in that the factory-made central core is delivered to the building site complete with all the component elements of a one-storey dwelling unit or flat. More particularly, all the elements adapted to be unfolded (ceiling, floor, frontages and possibly the inner partitions) are fully equipped with the conventional pipe lines, wirings, and ducts, so that when the unfolding operation is completed it is only necessary to make the usual connections to make the dwelling unit ready for immediate occupation.

Similarly, the doors and windows are mounted beforehand on the frontages and partitions.

The method of constructing buildings according to this invention is advantageous in that it reduces considerably building costs due on the one hand to the highly standardized prefabrication, in suitable factories, of the central core and all the unfolding elements associated therewith, and on the other hand to the rapidity of the building erection operations.

Besides, with this method, the architect can choose at will the internal and external aesthetic appearance of the building thus obtained.

With the method of this invention, a complete industrialization of the building construction is obtained.

In order to afford a clearer understanding of this invention and of the manner in which the same may be carried out in practice, reference will now be made to the accompanying drawings illustrating diagrammatically by way of example a typical form of embodiment of this invention. In the drawings:

FIGURE 1 is a diagrammatic horizontal section showing a factory-made central core fitted in the framework the left-hand portion of the figure showing the central core in its folded condition, as delivered on the site, and the right-hand portion shows the same core with the lateral frontages thereof in their unfolded condition;

FIGURE 2 is a vertical section taken upon the line II—II of FIGURE 1;

FIGURE 3 is a horizontal section similar to FIGURE 1 showing the central core during a subsequent erection step, the lateral frontages along being unfolded in the left-hand portion of the figure, the right-hand portion showing the lateral frontages, the floor and the frontage parallel to the core in their unfolded condition;

FIGURE 4 is a vertical section taken upon the line IV—IV of FIGURE 3, which further illustrates the ceiling unfolding operation;

FIGURE 5 is a diagrammatic horizontal section showing a completed storey to illustrate the manner in which the partitions of each dwelling unit are unfolded;

FIGURE 6 is a vertical section showing on a larger scale the manner in which the framework posts are mounted;

FIGURE 7 is a vertical section showing on a larger scale the assembling of two superposed central cores.

Referring first to FIGURE 1, an external framework designated in general by the reference numeral **1** and a central core **2** are shown. This external framework consists of a number of preferably metallic posts, namely four posts **3** supporting the central core **2**, four corner posts **4** and intermediate posts **5**. These posts are mounted on conventional type foundations of concrete or masonry work, or according to any other suitable method, and rise up to ground-floor level.

At each floor level and between the metal posts **3**, **4**, **5** corresponding in height to one storey, a central core **2** consisting preferably of plastic material is fitted. This central core **2** is prefabricated in a specialized factory and may be constructed either as a unitary structure, as shown in the drawings, or in the form of a plurality of sections assembled with one another on the site. Each

central core 2 is positioned on the supporting posts 3 by means of a suitable hoisting apparatus.

The central core 2 of generally parallelipipedic configuration comprises longitudinal walls 2*a*, transverse walls 2*b*, a lower wall 2*c*, and an upper wall 2*d*, these various walls forming together recesses or housings 6 on the outer surface of the central core 2. These recesses or housings 6 constitute the spaces in which the folded frontages, the floor, and possibly the inner partitions of each storey are stowed, for transport purposes, these elements consisting preferably of suitable plastic material like the walls of the central core 2. In the left portion of FIGURE 1 it will be seen that each one of the end recesses 6 contain a lateral frontage 7 consisting of two elements 7*a* and 7*b* on the one hand, hingedly interconnected by means of a hinge 8 having a vertical axis, and on the other hand pivotally connected to said central core by means of a continuous hinge 9 having a vertical axis, a frontage element 11 parallel to said central core which is pivotally mounted about a hinge 12 having a horizontal axis to the floor 13 consisting in turn of two sections 13*a* and 13*b* folded on each other about a hinge 14 having a horizontal axis, the section 13*b* proper being pivotally mounted in turn on the central core 2 about a hinge 10 having a horizontal axis, and finally a partition 15 consisting of one or several sections folded on one another and pivotally mounted on the central core about a hinge 20.

The core 2 carries at its upper portion the folded ceiling 16 consisting of as many sections as necessary to cover the surface area of the storey.

In the example illustrated by way of example the ceiling 16 consists of four sections hingedly interconnected and pivotally mounted on the central core 2 by means of hinges having a horizontal axis.

All the unfolding elements have embedded or fitted therein the necessary electricity and telephone wirings and the like, together with the windows and doors having the dimensions contemplated by the architect. All these unfolding elements are completed at the works during the prefabrication of the central core 2.

Now the manner in which a building according to this invention is constructed will be described.

The factory-made central core 2 as delivered by a truck to the building site, with all its component elements in their folded condition, is lifted at the level of the storey under construction by means of a suitable hoisting apparatus. This core is laid upon the supporting posts 3 of the framework and also upon the central core 2 of the underlying storey, if any, as shown in FIGURE 7. To this end, each central core 2 has formed in its upper portion a longitudinal groove 17 engageable by a longitudinal rib 18 formed in the lower portion of each central core 2. The groove 17 and rib 18 may be inverted, if desired, and have cross-sectional shapes other than those illustrated in FIGURE 7. Holes are formed in the upper and lower portions of core 2 to permit the passage of assembly bolts 19 therethrough for rigidly assemblying the various superposed central cores 2 with one another.

FIGURE 7 also shows that the upper horizontal wall 2*d* of each central core 2 bears upon an angle member or bracket 21 rigid with the supporting posts 3 for rigidly fastening the central core 2 to the metallic framework.

Having thus positioned and secured the central core 2 to the central core of the underlying storey, the next step of the construction method in the specific form of embodiment contemplated herein by way of example consists in unfolding the lateral frontages 7 equipped with windows and French windows (not shown in the drawings). As clearly shown in the right-hand portion of FIGURE 1, the sections 7*a* and 7*b* of each lateral frontage 7 are adapted to be unfolded by pivoting about the hinge 9 and also with respect to other sections about the hinge 8 so as to snap into locking engagement with the recesses provided to this end in the intermediate posts 5 and corner posts 4. The outer and lower faces of these frontages are completed during the prefabrication of the central core 2, and the windows and doors can be opened and closed, the same also applying to the sliding shutters.

The next step of the construction method of this invention consists in fitting the floor and the frontage parallel to the central core 2. Both floor and sections 13*a* and 13*b* are spread flat on the sub-floor 22 (see FIGURE 4) previously mounted on the ceiling of the preceding or underlying storey, as will be explained presently. This floor 13 is locked in position to constitute a permanent element of the building. On the other hand, the frontage or cross-wall parallel to the central core 2 is straightened and brought into locking engagement with the posts 4 and 5 at locations properly selected to this end. The frontage 11 also carries the necessary windows or French windows. The floor 13 may consist of adequate plastic material, like all the detachable elements of the structure, but wood or any other sufficnently rigid material may also be used to this end.

After the floor 13 and frontage 11 have been unfolded and locked in position, the ceiling 16 is unfolded in turn. This ceiling consisting of four sections in the example illustrated is unfolded in the same manner, the various sections pivoting about very sturdy hinges. The unfolded ceiling 16 is fitted in position and locked with respect to the framework posts 4 and 5. This locking of the ceiling elements 16 is attended by a final locking of the previously positioned frontages 7 and 11.

As a consequence of the first two steps of the construction method, the hingedly mounted partitions 15 stowed in the bottom of the recesses 6 of central core 2 are now free. These partitions 15 are then unfolded and set in the predetermined positions in floor 13 and ceiling 16. The usual openings, doors, cupboard-doors, etc., are formed beforehand in these partitions 15, the same also applying to all wall-cupboards and the like.

The complete storey obtained at the end of these unfolding and locking operations is shown in FIGURE 5.

The prism-shaped duct 25 formed by the walls 2*a* and 2*b* in the central portion of core 2 is open at either ends. It encloses the ducts, wirings and pipe lines 26 necessary for connecting the water, gas and/or electricity mains, as well as the air-conditioning, telephone, TV antenna and like systems, together with an inner ladder 27 permitting a constant access thereto and trellis floors 28 whereby supervision and maintenance staff can check the supply to each storey.

In FIGURE 5 it will be seen that in the left-hand portion of the storey an additional core 32 of parallelipipedic configuration also made preferably of suitable plastic material has been disposed.

All the secondary cores 32 are superposed and assembled to one another in the same manner as the central cores 2.

The secondary core 32 carries sections of unfolding partitions 33 for separating the various rooms from one another as well as a floor element 34 and a frontage element 35 parallel to the core. The secondary core 32 is hollow and may enclose ducts, wirings and/or pipe lines 36 while providing an inner space sufficient to permit the use of a service ladder 37 therein.

Upon completion of the above-described unfolding and locking operations, the kitchen equipments and the sanitary equipments stored in the central core 2 during the transport and delivery are fitted in their respective positions. The only operations required to this end consist in connecting these equipments to the various supply and draining pipes of which the outlet and inlet orifices duly prepared during the manufacture required only normal mounting or connecting steps.

Having thus completed all the above-described operations in the central core and possibly in the secondary core or cores, the flat is ready for immediate use.

In its unfolded condition the ceiling 16 may be used as a shuttering and as a means for adjusting the hori-

zontality of the floor. It will be seen in FIGURES 2 and 4, and still better in FIGURE 7, that between the ceiling **16** of a storey and the floor **13** of the overlying storey a metal floor structure **22** is provided; this floor structure **22** consists of metal beams **23** (FIGURE 7) having their relative gaps filled with plastic elements **24** of a type adapted to ensure an adequate sound and heat insulation.

When this metal floor structure is completed a new storey can be constructed.

It may be noted that the floor slabs **22** project somewhat outside the bare frontages. The balconies are then fitted at the last moment and bolted to the metal beams **23** of the floors.

The ceiling and floor joints are scarcely visible along the hinges and may be listed or stopped. The joints between the frontages **7** and **11** on the one hand and the floor **13** on the other hand, and between these frontages and the ceiling **16** are concealed by means of glued skirting-boards or the like.

Of course, the various forms of embodiment described, illustrated or suggested herein are given by way of example only and many modifications and variations may be brought thereto without departing from the spirit and scope of the invention as set forth in the appended claims.

Thus, each storey may comprise a plurality of secondary cores. On the other hand, the unfolding elements (lateral frontage **7**, floor **13**, frontage **11**, partition **15**) may be superposed in a different order (for example by erecting firstly the floor **13** and frontage **11**) and subsequently unfolded in this order (for example firstly the floor, then the ceiling, etc.). The plane of the dwelling unit illustrated in the drawing should not be construed as limiting the invention for any desired types of dwelling units may be constructed by the method of this invention.

The height of each storey may vary in a same building according to the architect's desire and in this case the height of the superposed central and secondary cores varies accordingly.

If the building contemplated has a curved configuration the central and secondary cores have a general trapezoidal shape instead of a parallelipipedic shape.

Finally, the method of this invention is applicable to any desired building shapes, whether orthogonal, cross-shaped, curved, round, etc.

What I claim is:

**1.** A multi-storey building comprising, in combination, a framework consisting of vertical metal posts consisting of superposed post sections each having the height of one storey and prefabricated dwelling units supported by said framework and superposed on one another with at least one dwelling unit per storey, each dwelling unit consisting of a rigid central core and of elements constituting the frontage, floor and ceiling of the unit which are hingedly mounted on said central core and unfolded and supported by said framework posts when the building is erected, the various central cores of said superposed dwelling units being assembled in stacked relationship.

**2.** A multi-storey building as set forth in claim **1**, comprising at least one recess in said hollow central core, a lateral frontage disposed at right angles to said central core in its unfolded position, a frontage parallel to said central core in its unfolded position and a floor, all of which adapted to be stored in their folded condition in said recess, a hinge having a vertical axis which constitutes the pivotal mounting, on said central core, of said lateral frontage to be unfolded at right angles to said central core, a first horizontal hinge constituting the pivotal mounting of said floor to said core, and another horizontal hinge constituting the pivotal mounting of said frontage parallel to said central core on said floor, said lateral frontage comprising at least two hingedly interconnected sections and at least another vertical hinge constituting the pivotal relative mounting of said two frontage sections.

**3.** A multi-storey building as set forth in claim **1**, comprising longitudinal grooves and ribs formed along the upper and lower edges of the superposed central cores and fitting into one another, and assembly means adapted to fasten the cores to one another.

**4.** A multi-storey building as set forth in claim **1**, comprising recesses formed in the posts of said framework and adapted to support said superposed central cores.

**5.** A multi-storey building as set forth in claim **1**, comprising at each storey at least one secondary core, the secondary cores of the various storeys being superposed, and partition elements hingedly mounted on said secondary core.

**6.** A multi-storey building as set forth in claim **5**, wherein each secondary core is hollow.

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FRANK L. ABBOTT, *Primary Examiner.*

C. G. MUELLER, *Assistant Examiner.*