Oct. 18, 1966 C. E. ENTWISTLE 3,279,142

METHOD OF CONSTRUCTING A TENSILE SYSTEM OF BUILDING CONSTRUCTION

Filed Nov. 16, 1962 4 Sheets-Sheet 1

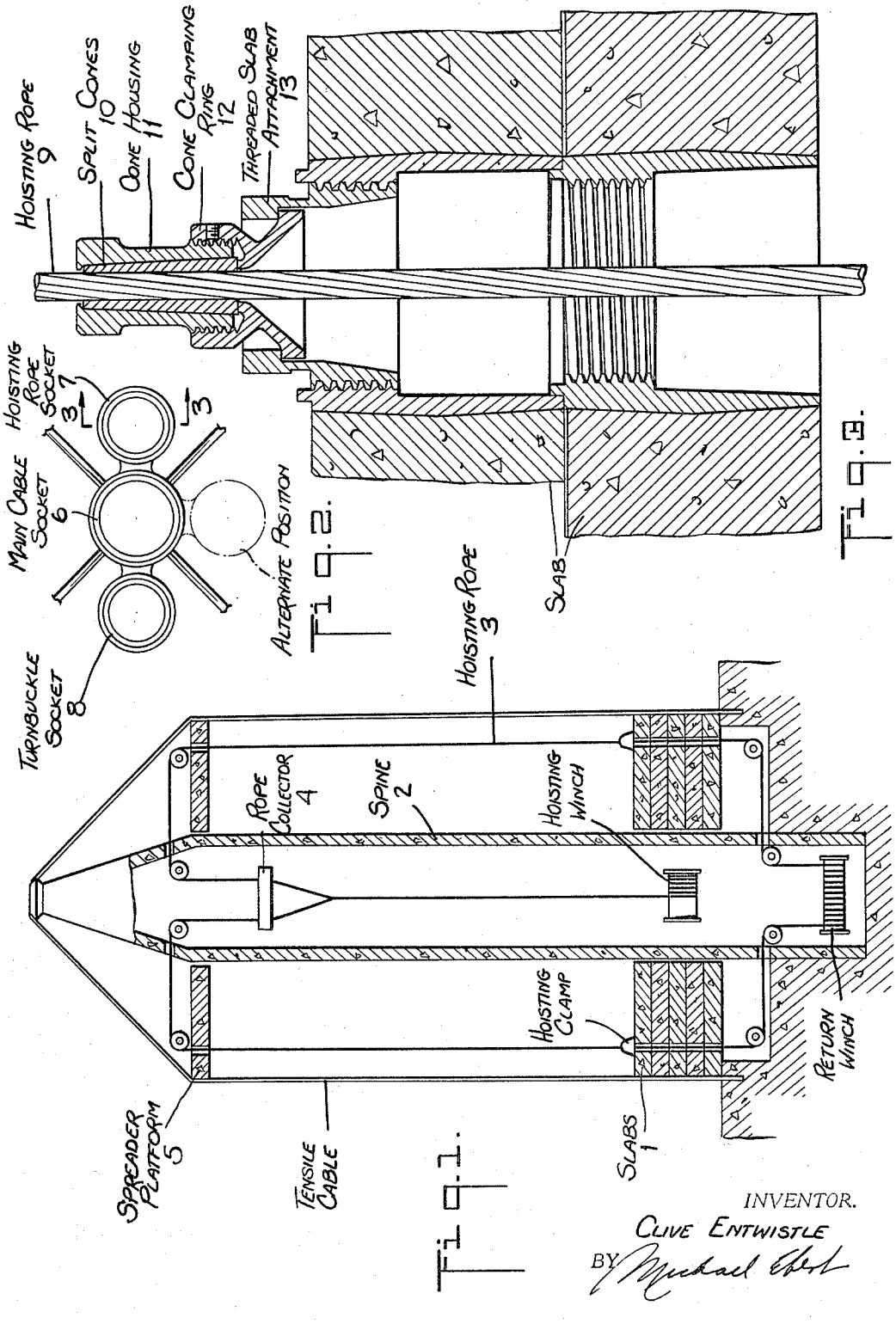


Fig. 3.

Fig. 2.

Fig. 1.

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Filed Nov. 16, 1962 4 Sheets-Sheet 2

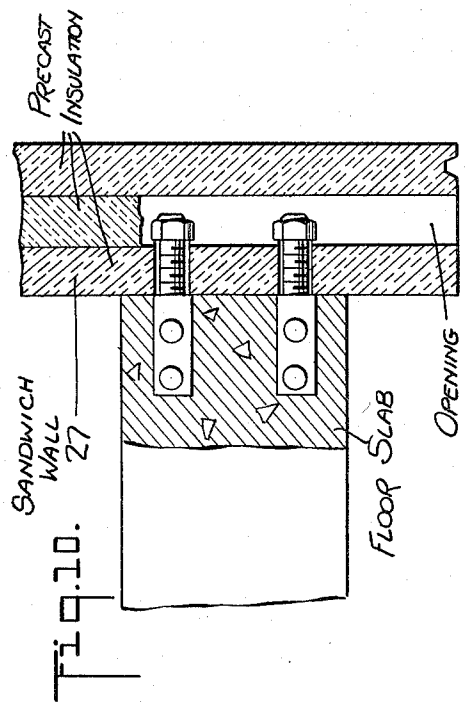


FIG. 10.

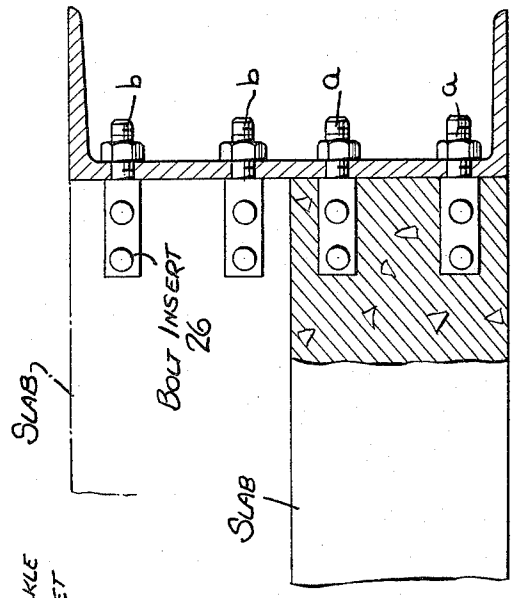


FIG. 9.

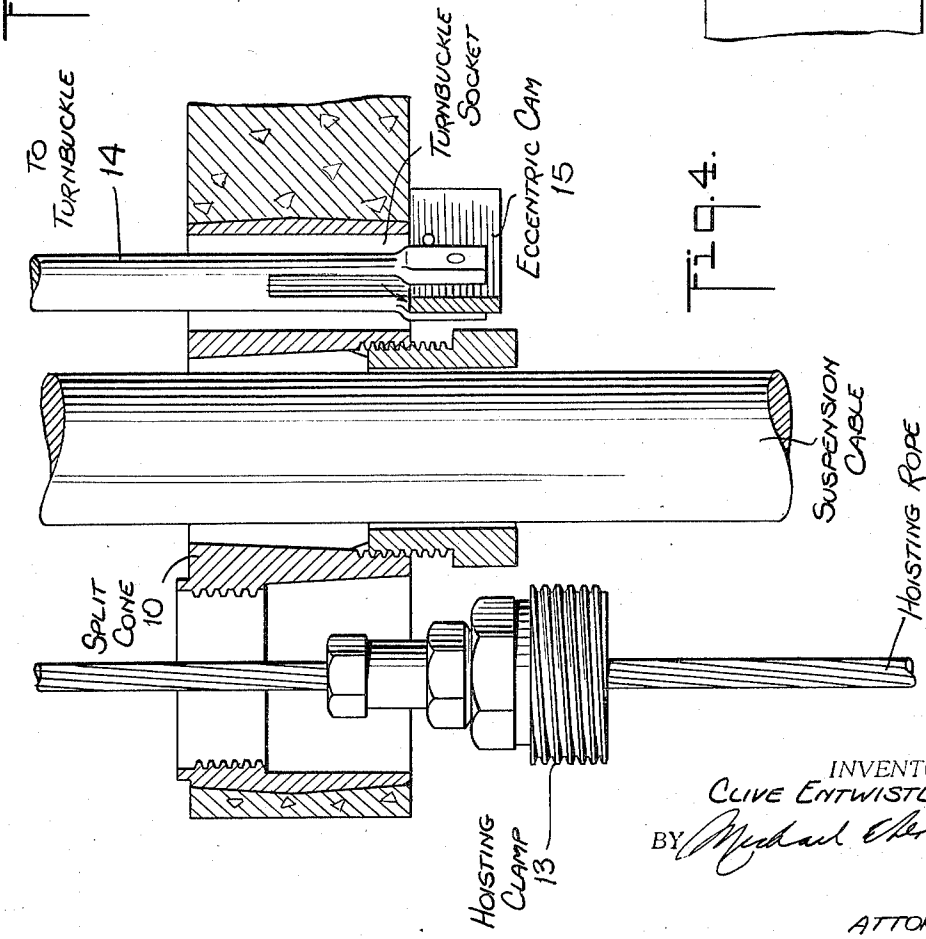


FIG. 4.

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METHOD OF CONSTRUCTING A TENSILE SYSTEM OF BUILDING CONSTRUCTION

Filed Nov. 16, 1962 4 Sheets-Sheet 3

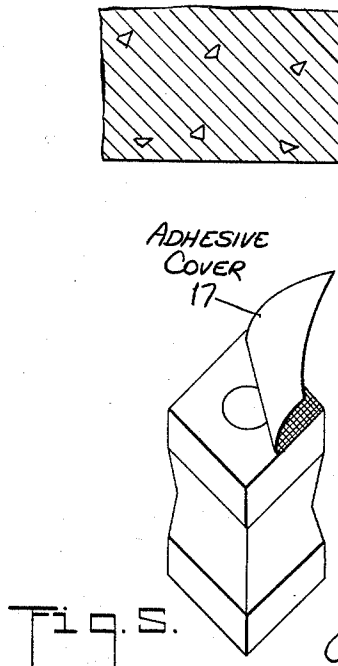


Fig. 5.

Fig. 6.

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METHOD OF CONSTRUCTING A TENSILE SYSTEM OF BUILDING CONSTRUCTION

Filed Nov. 16, 1962 4 Sheets-Sheet 4

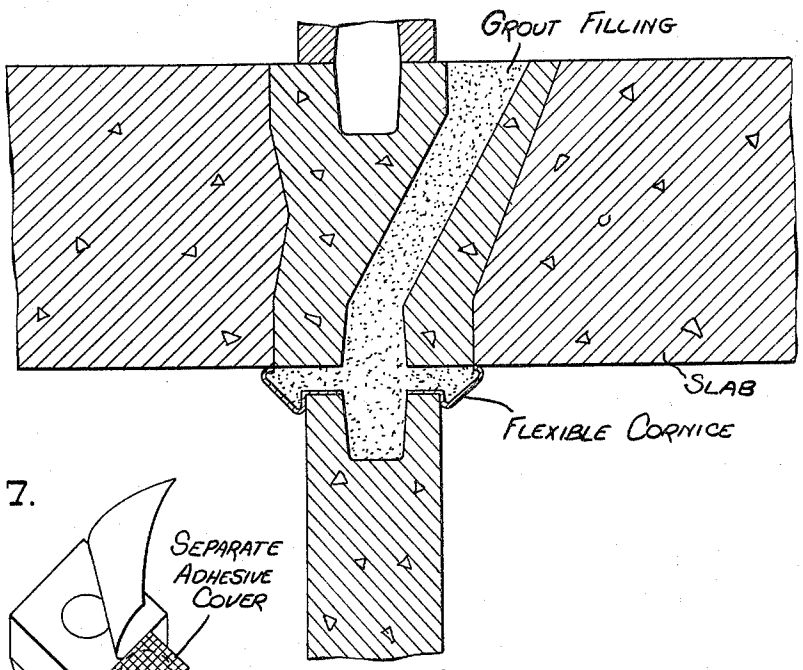


Fig. 7.

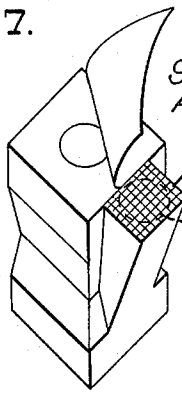


Fig. 8.

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United States Patent Office

3,279,142

Patented Oct. 18, 1966

3,279,142

METHOD OF CONSTRUCTING A TENSILE SYSTEM OF BUILDING CONSTRUCTION

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Filed Nov. 16, 1962, Ser. No. 238,242
2 Claims. (Cl. 52—745)

The subject of the present invention supplements the copending application Serial No. 210,487, filed July 17, 1962, entitled "Tensile System of Building Construction," and is particularly though not exclusively applicable to buildings constructed according to the system therein described, that is to say, by vertical cables disposed around a central spine. This invention concerns preferred methods of raising floors in such a structure, and of forming, locating and fixing partitioning and walls on such floors.

It is a principle of the copending application that the continuous vertical supports formed by the concrete spine and the tensile cables permit the construction of floors, either in bays or complete floor units, at or near ground level, and their subsequent raising to their predetermined level. The present invention refers particularly to the formation and raising of reinforced and pre-stressed concrete floors, although metal and other types of floors may be similarly raised.

It has been established in practice with the lift-slab technique of building, that important economies in reinforced concrete floor construction can be effected by pouring one slab on top of another, thus dispensing with the need for horizontal formwork. The raising of large floors so constructed requires special dispositions to assure a uniform rate of lift at all points on the floor simultaneously, since the relatively friable nature of such a floor does not tolerate significant distortions from the plane. The raising is accordingly effected generally by a number of hydraulic jacks, usually one to each column position. The process is slow and relatively expensive, neutralizing a significant part of the economies effected by the saving of formwork. At the same time, economies of reinforcement due to the continuity factor, particularly if pre-stressing is employed, makes the raising of whole floors or multiple bay units desirable.

In view of the foregoing, it is one object of the present invention to permit the raising of such large floors by means of wire ropes, without significant distortion, and to overcome all the specific problems posed by the raising with ropes of multiple superimposed floors in an economized and rapid manner.

A further object of this invention is to take advantage of the raising of the floors within the vertical cable framework in order to assemble at or near ground level, partitions and other fixed elements normally located on the finished floor. It is evident that considerable economies in handling can be effected by the assembly of the relatively heavy elements on ground level, instead of loading their constituent parts (concrete blocks, bricks, etc.) onto hoists or cranes, delivering them to the floors, and redistributing them to the work areas. Thus assembly of the partitions and walls at ground level, that is, with unrestricted headroom, permits these elements to be manufactured and installed in large floor-height units, which would prove too cumbersome to handle between installed floors.

More specifically, the objects of the invention are as follows:

(1) To afford economic and rapid means for the hoisting of large floors by wire ropes, without significant distortion, and for the easy return of the hoisting tackle through the installed floors down to ground level.

(2) To permit the assembly of interior partitioning and outside walls and fixed equipment at or near ground level, and the subsequent fixing of such partitions and walling to the floor above after raising to position.

(3) To eliminate the manual setting-out of walls and partitions on each floor, as is the universal custom, this being a relatively expensive, lengthy and often inaccurately performed process.

An important corollary of said copending application is that, due to the continuous nature of the vertical supports, the floors may be positioned far more exactly in a vertical sense than would be possible with framed structures, a fact which permits of novel arrangements for the location and fixing of the upper parts of pre-fabricated partitioning, walling and fenestration elements.

For a better understanding of the invention, as well as other objects and features thereof, reference is made to the following detailed description, to be read in conjunction with the annexed drawings, wherein:

FIG. 1 is a diagrammatic vertical section through such a tensile tower building in accordance with the invention;

FIG. 2 is a plan view of a typical cable clamp;

FIG. 3 is a vertical section through two superimposed cable clamps before floor-raising;

FIG. 4 shows a section through a cable clamp after the floor has been raised;

FIG. 5 is a typical floor location block;

FIG. 6 shows the manner of fixing a partition between two floors containing such location blocks;

FIG. 7 shows an alternative type of location block;

FIG. 8 shows an alternative method of fixing partitions;

FIG. 9 shows the method used to fix and raise edge-forms on the floor-pile; and

FIG. 10 shows how the bolt inserts remaining after floor-pouring serve to secure the external walling of the structure.

In FIG. 1, the pile of floor slabs **1** is shown as cast around the base of the concrete spine **2**. The hoisting ropes **3** are shown passing from the rope collector **4** across the spreader platform **5** and down through the pile of floors to join the return winch situated in the base of the spine.

In FIG. 2 it will be seen that a typical cable clamp comprises three openings or sleeves, one position **6** for the main support cable, one position **7** for the floor hoisting ropes, and a third position **8** for a turnbuckle.

In FIG. 3, there is shown a vertical cross-section through the socket of the cable clamp reserved for the floor-hoisting rope **9**. A pair of split cones **10** surround the hoisting rope, which may be tightened by means of a tapered cone bearing **11** fitted on its upper extremity with a hexagonal collar, and being threaded on its lower end to receive the cone clamping ring **12**. The lower end of the cone clamping ring is flared to carry the threaded slab attachment **13** which in turn is screwed into the main cable clamp.

The procedure for floor-hoisting is then as follows:

(1) Before hoisting the top slab of the floor pile, the threaded slab attachment is engaged and screwed down to a level in the main cable clamps, the main cable being already in position and stressed, as described in my aforesaid copending application.

(2) The lower extremities of the wire hoisting ropes are now stressed, either within the tower or in another convenient position below the floor pile, to a tension corresponding to the proportion of the total floor load they are destined to carry, due to their number and disposition. This tensioning may conveniently be effected by means of hand-operated jacks equipped with tensionometers.

(3) When an individual rope has been correspondingly tensioned, the clamps are tightened on the ropes by screwing the cone clamping ring against the cone housing,

thus causing the split cones to exert pressure against the hoisting rope.

(4) When all hoisting ropes have been so tensioned and secured to the top slab, the main winch is started, raising the top slab to its intended position on the structure, without perceptible deformation, due to the pre-stressing of the hoisting cables to their design load.

(5) Reference may now be made to FIG. 4, which shows a section through the three apertures of the cable clamp after the floor has been hoisted into position.

(6) The floor having been raised to its approximate correct vertical location, it is now secured by a pair of threaded rods **14** equipped with a central turnbuckle and with an eccentric cam **15** at its two extremities. The cam being passed through the corresponding socket in the cable clamp of the floor (or spreader platform) above, and the floor below that has just been delivered by the hoisting ropes, the cams fall to provide a bearing surface above and below the floors in question.

(7) The turnbuckle is now tightened until the two ends of the threaded rods make contact, thus giving a vertical spacing between two floors, of a very exact order, which may conveniently be held in practice to a few hundredths of an inch.

(8) The hoisting clamp on the hoisting rope is now turned so that it passes down through the corresponding threaded portion of the cable clamp insert. It will be appreciated that the hoisting rope can now conveniently be returned to the floor pile, ready to pick up the next floor.

(9) To raise the next floor on the pile, the threaded slab attachment **13** is again engaged in the corresponding socket of the cable clamp insert. No further tensioning of the cable is necessary, so long as each floor in the pile is substantially identical to that above it.

(10) The cone clamping ring or other tightening means is now employed to engage the split cones on the main cable clamps, on the floor last delivered by the hoisting ropes.

(11) The turnbuckles can now be disengaged from the upper floor, by rotating the upper cam, and lowered till the upper cam rests on the clamp insert of the just secured floor, ready to receive and hold the next floor on its arrival.

(12) The above cycle is repeated until all floors are clamped in their designed vertical intervals on the main cables and spine.

The building structure to which the present invention is applicable is disclosed more fully in the above-identified copending patent application, and includes a vertical spine supporting a horizontal platform, the spine being surrounded by a grid formed by an array of tensile cables extending from the edge of the platform to anchor points on the ground. As noted in said copending application, these tensile cables are stressed by means of helical jacks to their ultimate design load so as to eliminate movement during subsequent floor erection. The tension on the suspension cables is thereafter reduced by slacking the jacks in the measure that the dead floor load is applied, so that upon completion, the jack imposes no load. In FIG. 4 herein, one of the suspension cables and one of the hoisting ropes for raising the floors are shown, whereas in FIG. 1, for reasons of clarity, the suspension cables connected to the spreader platform **5** are omitted, and only the pre-stressed hoisting ropes **3** are shown. Thus each time a floor is raised to its location on the cables, the cable tension is reduced accordingly.

There will now be described the procedure whereby the floors may be equipped with partitioning and other fixed elements, as for apartment buildings, at the lower level, that is, while still on the floor pile, and subsequently raised to position as substantially complete floors.

(13) The key to this procedure is the provision of pre-cast concrete (or other preformed material) location blocks. Such a block consists essentially of a prism or

cylinder extending throughout the depth of the floor slab, equippped with a hole at each extremity, and a concave or convex deformation permitting it to key into the poured slab. If it is desired that the joint between partitions and the ceiling of the floor above be closed by dry elastic means, such as a framed plastic strip, then the block will be substantially of the form indicated in FIG. 5.

(14) The procedure is then as follows (FIG. 6). The location blocks, which will eventually serve to locate and fix the partitions, are set out on the ground floor slab at standard intervals, of the order of two feet or so. The first setting out may be more accurately performed wth the aid of a set of preformed steel templates **16**, of which a twin set may serve to locate the corresponding holes in the top and bottom of partitions, during their casting.

(15) The slab is now poured, levelled and cleaned off. The adhesive covers **17** on top of the location blocks are now peeled off, revealing a level surface, and rubber or other plugs **18** are inserted in the holes in the top of the blocks. The floor is now treated with a non-adhesive coating such as oil.

(16) A further set of location blocks is now placed on the rubber plugs protruding from the first set, and the floor-pouring operation repeated. This cycle proceeds until all floors are cast. In this way the setting out of partitions, and their fixing means, are "pricked through" automatically from bottom to top of the pile of slabs.

(17) Prior to the raising of the floor, which is the last to be poured, pre-cast or otherwise preformed partitioning, generally of floor to ceiling height, and which may contain electrical conduits and outlets, are conveyed to the top of the floor pile by small mechanical lift trucks, or otherwise, as may be convenient, and tipped or lowered onto the corresponding plugs protruding from the slab. The partitions are held vertical either by clamping or bolting to other partitions or closet walls, or by inclined support posts bolted to prepared positions in the floor. If desired, pressed metal skirting supports **21**, which may carry flexible skirtings **22** and pronged carpet fixing means **23**, may be placed below the partitions.

(18) The floor is now raised to its predetermined height. Due to the precision of the vertical intervals assured by the length of the turnbuckles and the continuity of the vertical supports (spine and cables), the flexible pad **19** and pressed metal cornice **20** may be compressed to a predetermined degree, thus avoiding the manual labor normally associated with the partition-to-ceiling closure.

(19) It will be appreicated that the handling of full-height (floor to ceiling) partitions is practicable and convenient on the floor pile, substantially at ground level, where there is no upper restriction due to the floor above, whereas it would be impracticable in the restricted space between floor and ceiling available in conventional structures.

(20) In an alternative arrangement, the location block (FIG. 7) is equipped with a pouring spout **24**. In this procedure the raising of the floor similarly compresses the flexible steel cornice against the ceiling of the floor above. The interstice between cornice and ceiling is now filled by pouring cement grout through the spouts in the location blocks from the floor above. Flowing down into the sockets in the top of the partition, the cement grout provides a mechanical bond for the top of the partition.

(21) FIG. 9 shows a section through the steel edge forms **25** that are used in pouring the floor pile. The form, which may be of rolled steel channel, is twice as deep as the thickness of the floor, and is provided with holes at regular intervals through which bolts **26** may be passed, of the type providing a key with the concrete slab. The floor is now poured and leveled off to the top of the steel form. After setting, the nuts (*b*—*b*) are removed and the form is moved up one floor thickness,

and re-bolted to the set of bolts cast into the last floor to be poured (*a*—*a*). The process is repeated until the entire floor pile has been cast.

(2) In FIG. 9, it will be seen that the bolted inserts which served to locate and hold the edge-forms are subsequently employed to fix the external walls **27** in spandrel walls of the building, which operation may conveniently be performed after raising the slab a foot or two clear of the floor pile, that is, substantially at ground level, thus permitting further important savings in materials handling, since the external walling or its constituent materials do not have to be raised up the face of the building, and there assembled by means of fixed or movable scaffolds.

While there have been shown preferred embodiments of my tensile system of building construction in accordance with the invention, it will be appreciated that many changes and modifications may be made therein without, however, departing from the essential spirit of the invention as defined in the annexed claims.

What is claimed is:

1. The method of constructing a building structure having a central spine and a spreader platform adjacent the upper end thereof, said method comprising the steps of

(A) connecting a plurality of tensile cables at spaced positions between the edge of the platform and ground anchor points forming a grid array defining a building space,

(B) placing a stack of floor slabs at ground level within said space, each slab including sockets at positions associated with said cables, each socket having at least two openings, through one of which the associated cable extends,

(C) initially stressing said cables to a tension in accordance with their ultimate design load,

(D) passing hoisting ropes for said slabs through the other opening in said sockets of the stack of slabs,

(E) pre-stressing said hoisting ropes to a tension corresponding to the proportion of the total slab load they are destined to carry,

(F) coupling the pre-stressed hoisting ropes to the uppermost slab in said stack and moving said ropes to elevate the coupled slab to its proper vertical floor position on said spine,

(G) attaching the elevated slab to the tensile cables and said spine,

(H) reducing the tension on said cables to the extent of the dead floor load applied by the slab attached thereto, and

(I) decoupling the hoisting ropes from the attached slab and coupling the ropes to the next slab now uppermost in said stack to repeat the operation.

2. In a method as set forth in claim **1**, wherein said sockets include a third opening to accommodate a turnbuckle coupled to vertical spacer rods for adjusting the elevated floor slab to its proper spacing relative to the floor above, before the elevated slab is attached to said cables.

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