

[54] **METHOD OF ERECTING A MULTI-STORY BUILDING AND APPARATUS THEREFOR**

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Related U.S. Application Data

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[52] U.S. Cl. **254/105, 264/34**

[51] Int. Cl. **B66f 1/00**

[58] Field of Search **254/89 H, 105, 109**

[56] **References Cited**

UNITED STATES PATENTS

3,154,292 10/1964 Rankin et al. 254/10 S
3,201,088 8/1965 Long 254/89 H

Primary Examiner—Othell M. Simpson
Attorney, Agent, or Firm—Cameron, Kerkam, Sutton,
Stowell & Stowell

[57] **ABSTRACT**

A multi-story building with concrete floor slabs and supporting columns is formed in a roof down fashion and erected in a progressive lifting process from the foundation. Auxiliary columns in the form of sectional steel casings hold fresh concrete to form the columns, support the building while the concrete columns harden and provide means for attachment to lifting devices that are supported on bearing platforms at the foundation. The load of the permanent concrete structure is transferred to the auxiliary columns through interlocking surfaces between the casings and the concrete columns. The auxiliary columns are pushed up by the lifting devices, that act in a climbing fashion, until the concrete therein hardens to a strength to support the weight of the upper part of the building. The sections of the casings are then peeled off and rotated to positions below for reuse so that the bottom part of the building is always supported by the auxiliary columns acting as an interim support structure. When the building has reached the planned height, the lowermost concrete columns are cast solid with the foundation and the auxiliary equipment is removed for reuse in other buildings.

14 Claims, 14 Drawing Figures

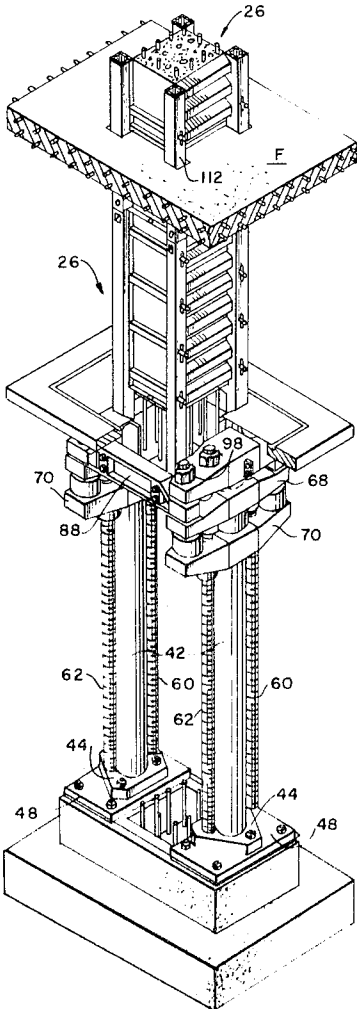


FIG. 1.

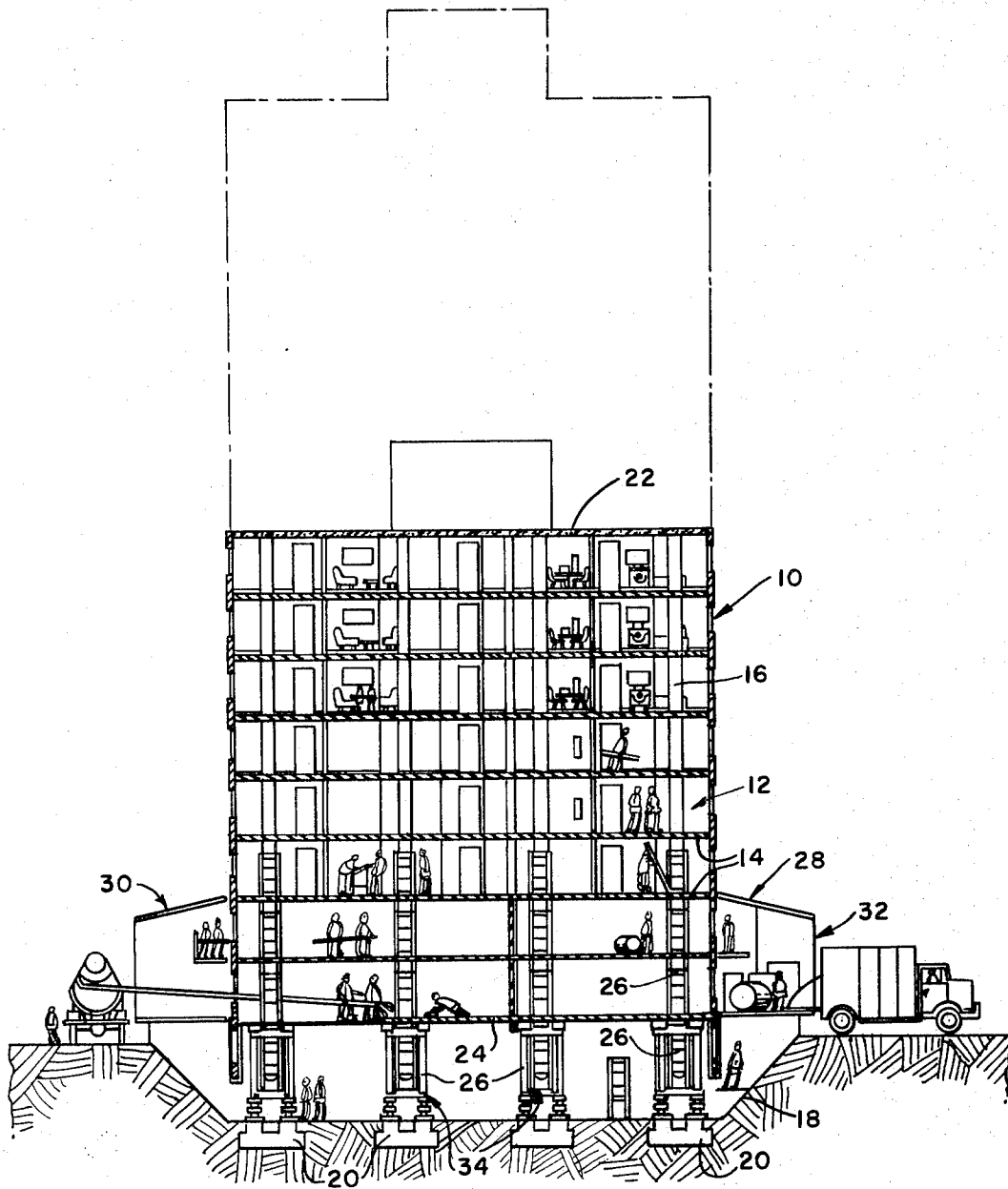


FIG. 2.

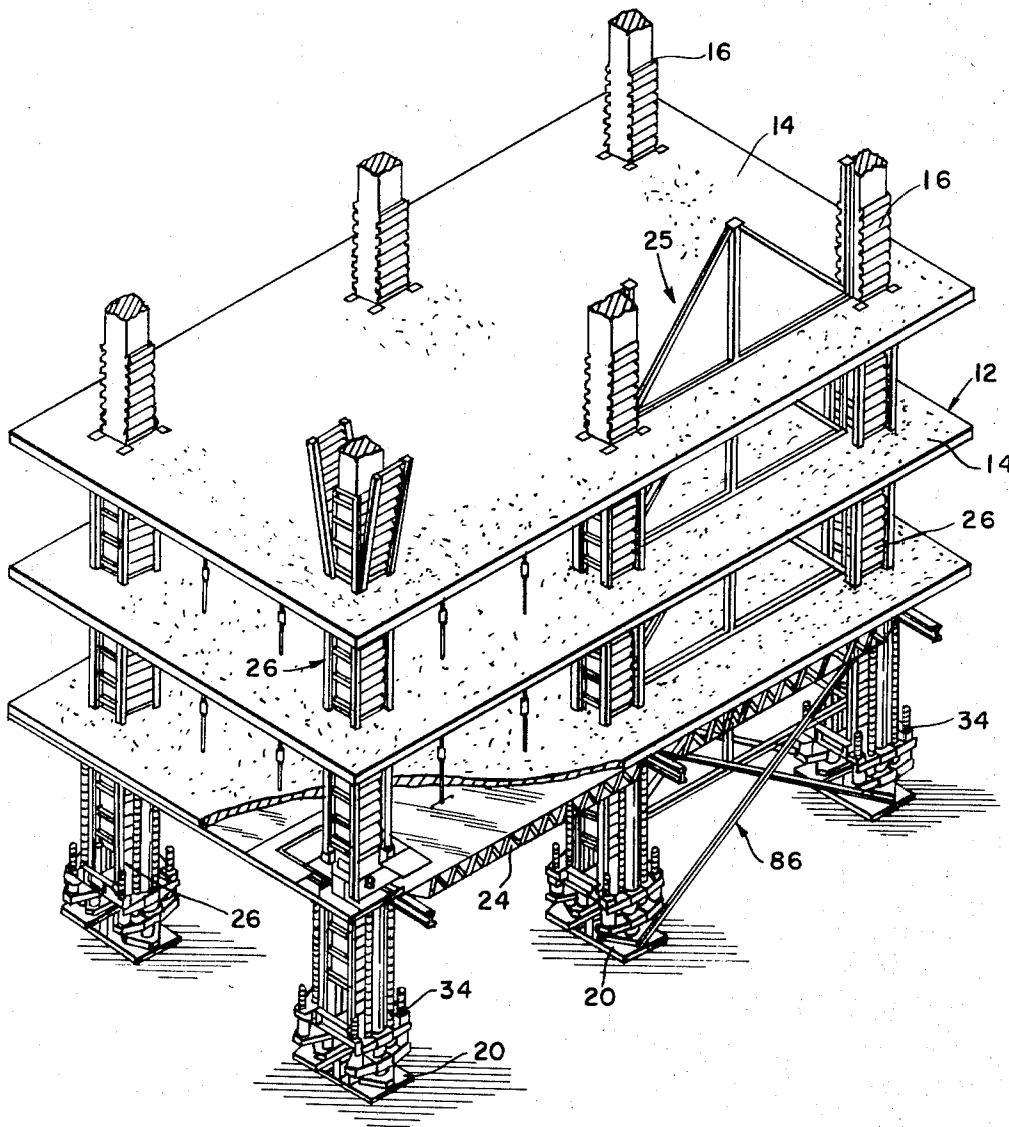


FIG. 5.

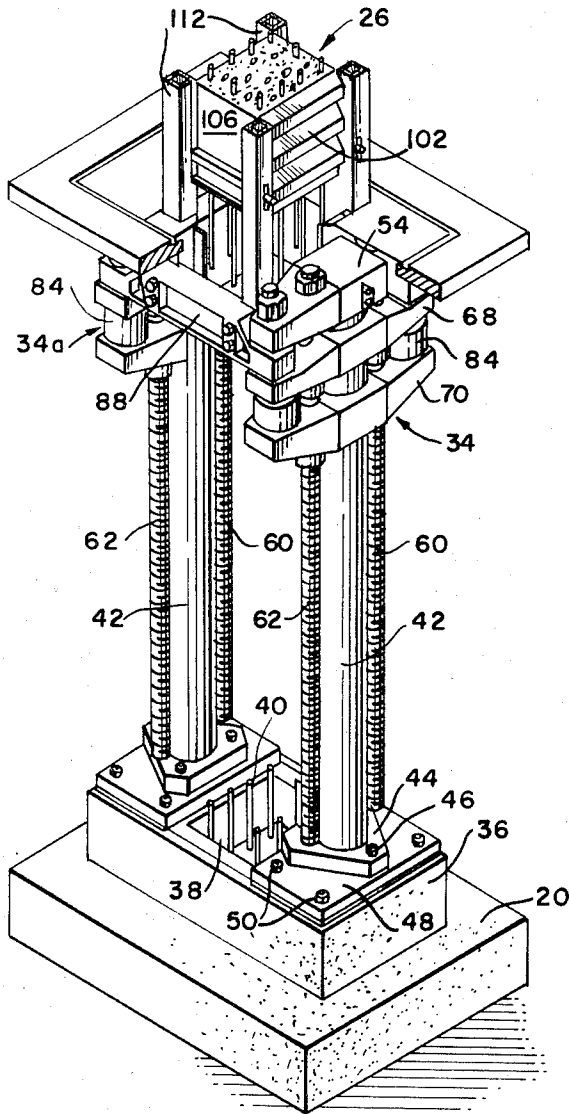


FIG. 6.

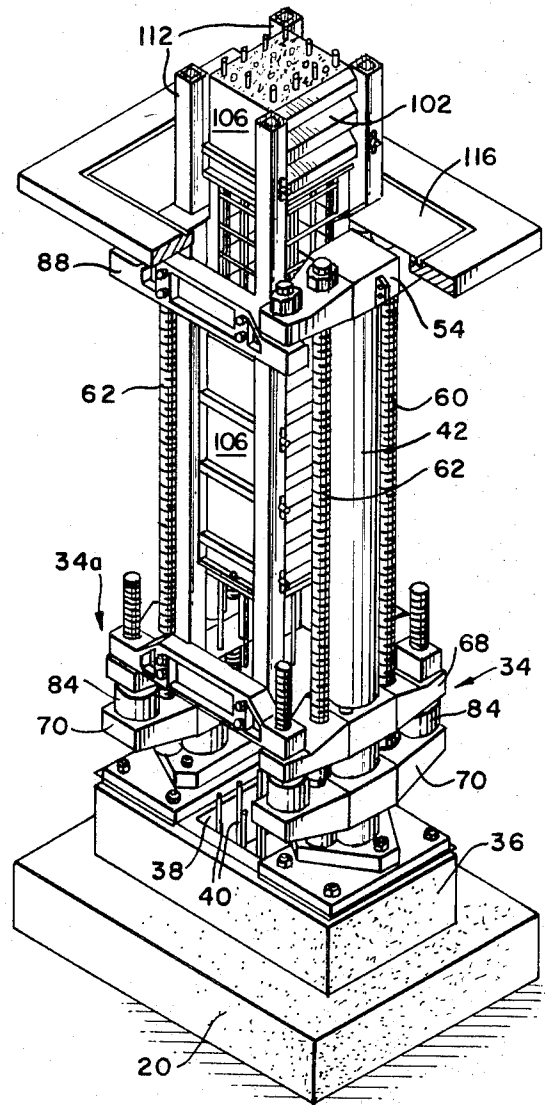


FIG. 7.

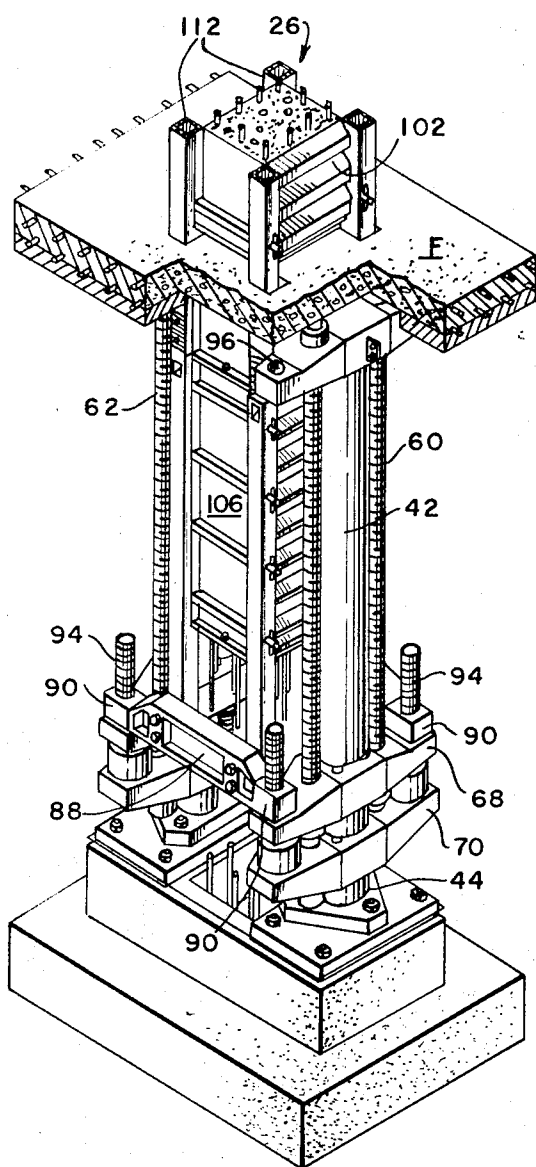


FIG. 8.

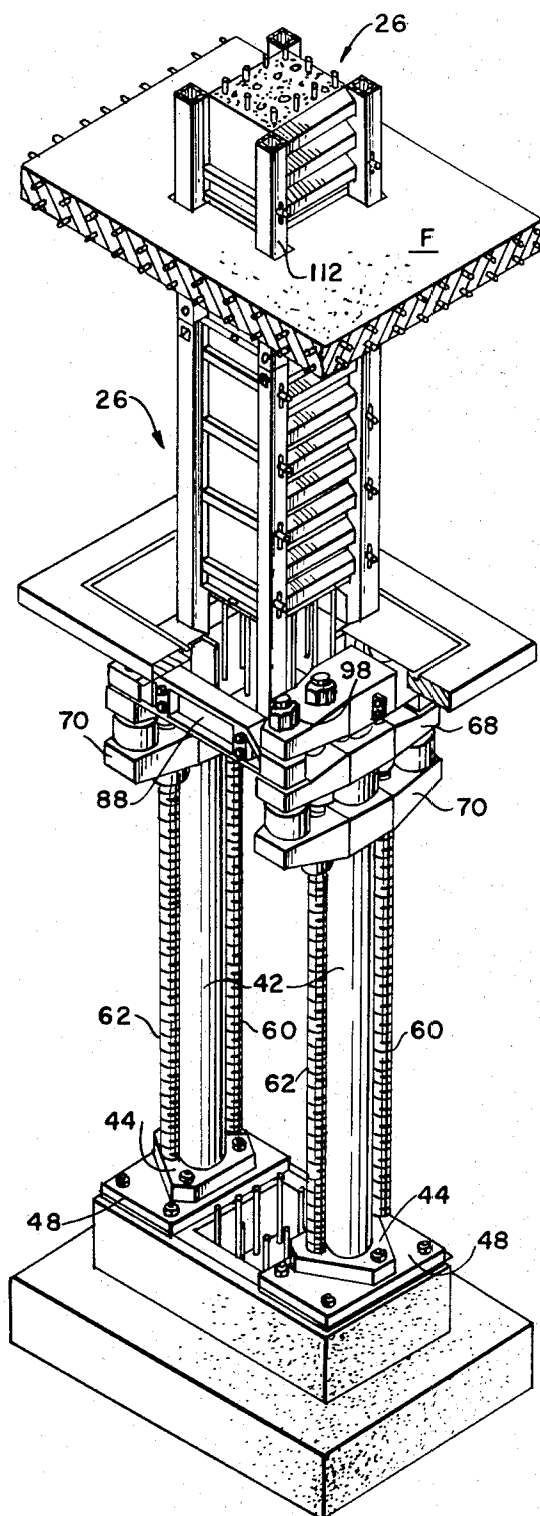


FIG. 9.

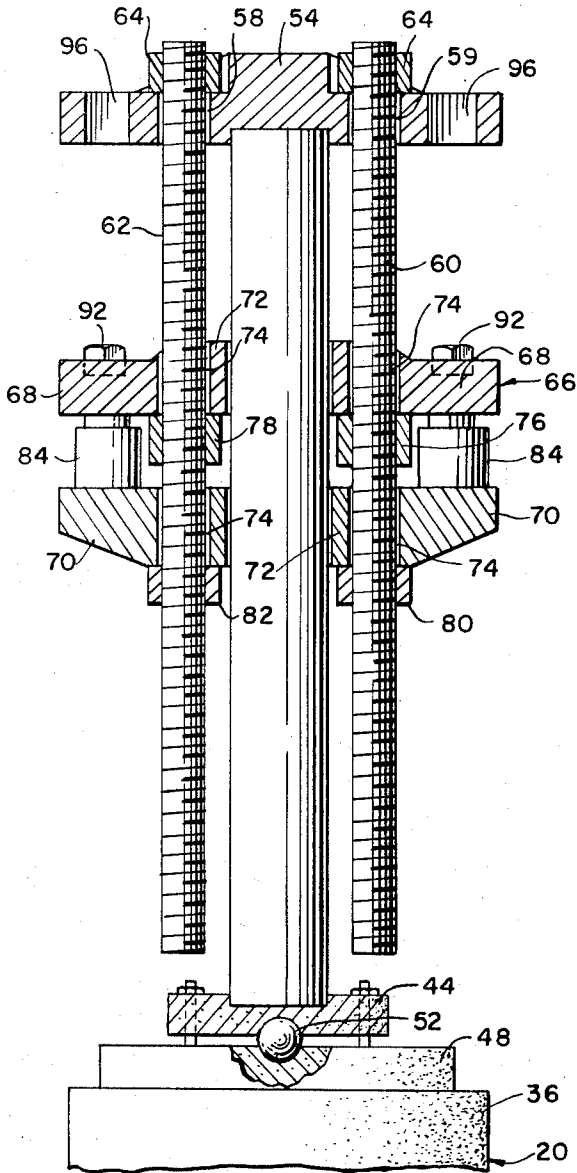


FIG. 10.

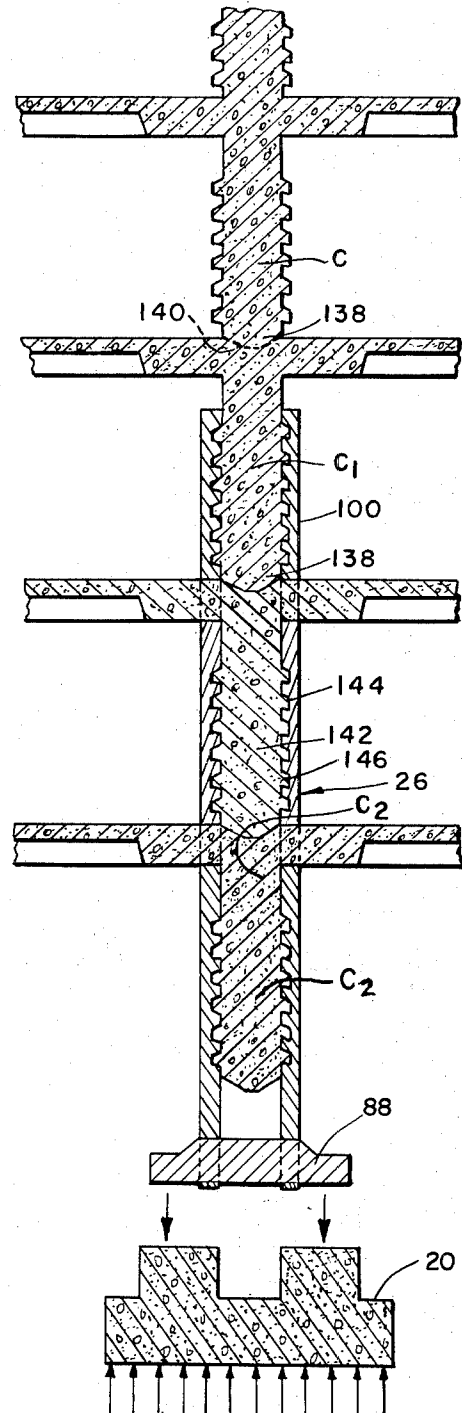


FIG. 11.

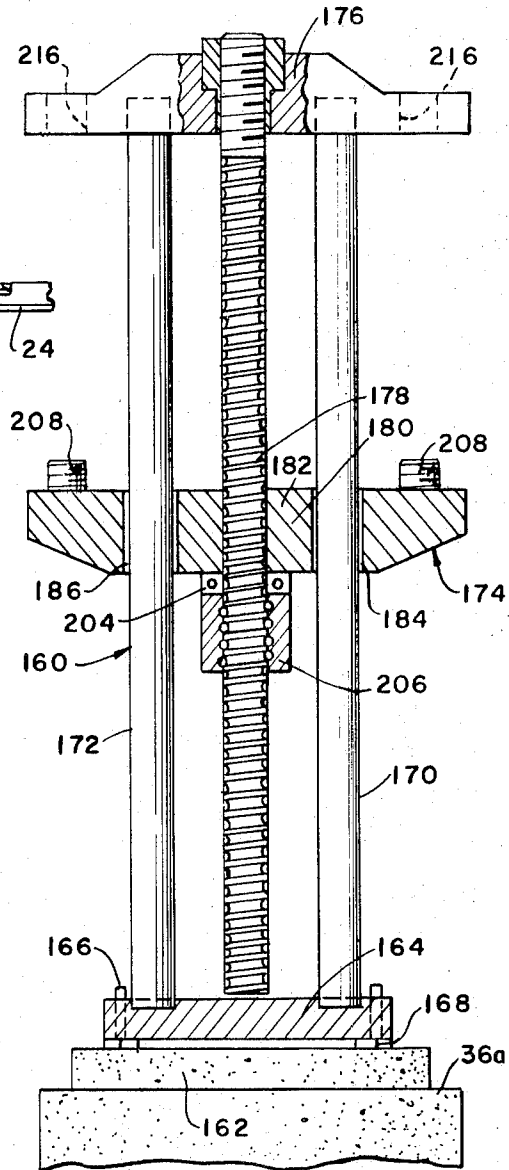


FIG. 12.

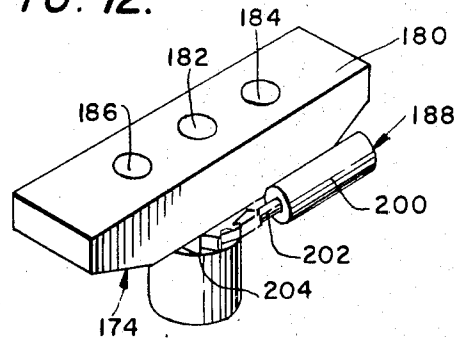


FIG. 13.

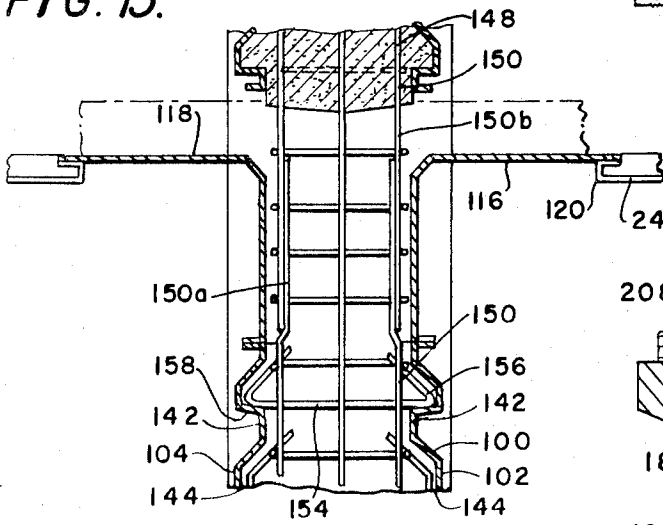
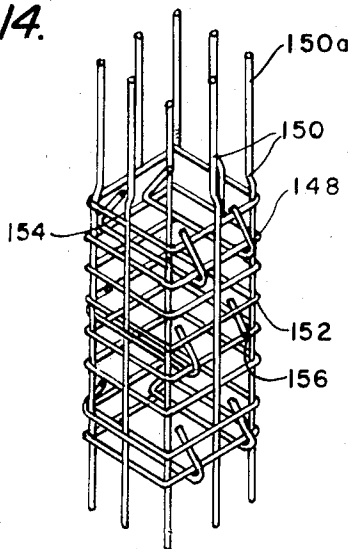


FIG. 14.



METHOD OF ERECTING A MULTI-STORY BUILDING AND APPARATUS THEREFOR

This application is a continuation-in-part of my application Ser. No. 114,455 filed Feb. 11, 1971, now U.S. Pat. No. 3,692,446.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention generally appertains to improvements in the manner of and means for constructing multi-story buildings and other similar structures and more particularly relates to a new and novel method of and apparatus for building high rise structures in a roof down fashion whereby each floor is formed at ground level and pushed up until the building reaches its planned height.

2. Description of the Prior Art

The construction of high-rise or multi-story concrete structures from the roof downward and involving the jacking of the building in floor-by-floor fashion at or below the ground level is well known in the art. Such construction involves a sequence of operations wherein the roof is cast on a fixed platform at ground level, the roof is pushed up and the floor below is cast on the same platform; then the roof and floor are pushed up and the next floor is constructed. The formation and lifting steps are repeated until the building has reached its projected height.

When the building goes up, material for finishing each space between floors is brought in at ground level and processed on the way up. Exterior walls are built and completed at ground level so that the building is enclosed and protected from weather during construction. The installation of partition walls and mechanical, electrical and plumbing facilities is carried out at low elevations with such work being effected on the completed floors as soon as the concrete framework will accommodate such.

There are many salutary and economic advantages attendant with such construction technique. For example, since all of the production is done in a confined factory-like area at a convenient ground level, considerable savings of time is realized, lower construction costs in relation to an increase in building height are achieved and minimization of the danger of accidents occasioned by working at unprotected heights is attained.

One manner of such jacking method is disclosed in U.S. Pat. No. 3,201,502, issued Aug. 17, 1965. In accordance with such patent, upright support members having a height of at least two floors or stories are fixed on the foundation and circumscribe a columnar area in temporarily retaining form boards for columns to be formed. Beneath the space between the support members and located below the foundation level is a lifting jack which acts directly upon the formed and set columns within the support members to elevate the columns. The formed columns are pushed upwardly by the underlying jacks and slide in the sheath-like support afforded the columns by their support members. Locking wedges cooperate with the columns, including their framework and forms, and cross bars of the upstanding support members to lock the columns in raised positions when the jacks are lowered within the lowermost columnar space afforded by the support members at

the foundation level and which space is created for the formation of a succeeding lower column.

Also, a roof down construction method is disclosed in U.S. Pat. No. 3,239,990, issued Mar. 15, 1966, which method has been commercially practiced in European countries under the tradename "Jackblock". In accordance with such method, a platform is fixed at ground level on which concrete is poured for the penthouse or roof. This concrete, after hardening, is pushed up from the platform by underlying jacks and the next floor is poured on the same platform. After it is hardened, the building is pushed up to make room for the next floor and so forth. The pouring of floors and lifting of the set floors is repeated until the building has reached its planned height. In between the lifts by the jacks, the building is supported by concrete blocks upon which it rests. Thus, after the penthouse or roof is formed and as it is lifted by the jacks, concrete blocks are placed thereunder to support it so that the jacks can be lowered to await the formation of the next floor and the task of lifting the building. After the next floor is lifted by the jacks, it is supported by concrete blocks. The completed floors are raised in a step-by-step fashion in increments equal to the height of a block so as to permit the blocks to be placed one below the other until the height in between floor levels is reached.

The latter patented method has advantages over the former patented method in that it is inherently resistant to lateral forces. The disadvantage is the means of lifting in small increments requiring intermittent manpower.

SUMMARY OF THE INVENTION

In accordance with the present invention, an interim structure is provided for enveloping and supporting a permanent concrete structure. As the building, bridges, silo, tower, etc., rises and the concrete of the permanent structure hardens, the interim structure is dismantled and the function of supporting the structure is taken over by the permanent concrete structure.

While many and varied types of structures may be built using the process and procedures of the invention, the detailed description will be had hereinafter as applied to housing or office structures.

The interim function can be extended either way. For a slow rate of progress the interim structure is low. For a fast rate of progress the said interim structure is high. This makes it possible to build at any speed within reasonable limits, because the rate of progress is naturally also dependent on the curing conditions for the concrete and the type of concrete used. Curing may be accelerated by heating elements in the forms. In any case, interim structure, curing conditions and type of concrete are determinants for the rate of progress and they can be manipulated to accomplish the progress desired. With all conditions being favorable a rate of building erection of one floor per day is achievable.

The interim structure is constituted by auxiliary columns which are in the form of sectional steel casings. They are braced and cross-connected in strategic locations to form a complete secondary structure capable of supporting the entire building during the building process. The casings hold the fresh concrete as the columns are poured, support the building while the concrete columns harden and provide an attachment means for lifting devices that are operatively disposed at the foundation level.

Preferably, the sectional casings are of a length equal to one floor height in their constitution of the auxiliary columns but they may be composed of smaller or larger sections. Such auxiliary columns are lifted by the lifting devices and rise with the building until the concrete contained by them hardens to the point where it is strong enough to support the weight of the building above. At that time, the top sectional casings are stripped or peeled off from the hardened concrete columns. Such removed casings are rotated to positions below at the foundation and fitted with reinforcement and reinstalled.

By this rotating or recycling action the bottom part of the building is continuously supported by a rigid steel frame defined by the interim structure.

The auxiliary columns remain in position until they are anywhere from two to six stories high depending upon curing conditions, type of concrete and rate of progress.

When the building has reached its projected height, the concrete columns are cast solid with the foundation in which cavities are left for such purpose. The auxiliary columns and the lifting devices are then removed to be used at another location in the erection of another building. However, it is envisioned that, at some stage, construction of the building would cease but the building would not be cast solid with the foundation. Rather it would remain supported by the interim structure. After a period of time, involving occupancy of the building, further construction could be carried out with the height of the building being increased.

The load of the permanent concrete structure is transferred to the interim structure through interlocking surfaces on the concrete columns and the casings. The casings are connected to the lifting devices by transfer beams that are supported by the lifting devices which are in the form of climbing units that travel up a supporting vertical structure in a hand-over-hand fashion. The lifting devices are driven by motor means that are controlled in a synchronized fashion from a centrally located console manned by one operator. Interconnections between lifting devices and console ensure that all stations advance one increment before the next is started to guarantee equal lift throughout the building.

In consideration of the foregoing, it can be appreciated that a primary object of the present invention is to provide an alternating cyclic foundation supporting and lifting method and means for erecting a high rise building in a roof down fashion wherein an interim structure supports the entire building and as the building rises and the concrete of the permanent structure hardens, the upper part of the interim structure is dismantled and reused at the foundation until the building reaches its full height and the function of support is taken over by the permanent concrete structure.

Another important object of the present invention is to provide auxiliary columns that are in the form of sectional steel casings and that constitute the interim structure with such auxiliary columns serving three functions, namely, (1) contain the fresh concrete for the columns; (2) support the building while the concrete hardens; and (3) provide attachment for the lifting devices.

A further important object of the present invention is to provide interlocking surface means between the walls of concrete columns and the inner faces of the

casings of the auxiliary columns whereby the load of the formed permanent concrete structure is transferred through such interlocking surfaces to the interim supporting structure and to the foundation.

A further important object of the present invention is to provide lifting devices that are supported at the foundation and driven in such a way that they travel in a hand-over-hand fashion in their elevating attachment to the auxiliary columns.

A still further object of the present invention is to provide novel means for attaching the lifting devices to the auxiliary columns so that the columns can be raised and locked in elevated positions without disturbing the contained poured and setting concrete columns.

A still further important object of the present invention is to provide an improved and efficient concrete structure erection system and arrangement that has definite applicability in the present and future building industry because of the technical, economic and time saving advantages it possesses.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic vertical cross-sectional illustration of a multi-story building under construction in accordance with the method and means of the present invention.

FIG. 2 is a diagrammatic perspective illustration of the various stages of erection of the building and shows the support of the building by the interim structure which has the upper part thereof being removed for re-installation at the foundation level. It also shows a vertical truss being telescopically erected to provide lateral stability; also suspenders for temporary shoring.

FIG. 3 is a vertical sectional view of an auxiliary column in its lowermost foundation level position and shows the same in attachment to the lifting devices which are shown in elevation.

FIG. 4 is an exploded perspective view of one of the auxiliary columns with its load transfer beam that serves to attach it to the lifting devices.

FIG. 5 is a perspective view of one of the auxiliary columns and shows the same in elevated position and locked in place.

FIG. 6 is a perspective view of a successive auxiliary column mounted in its initial position in attachment to the lifting devices.

FIG. 7 is a perspective view of the auxiliary column shown in FIG. 6 with the casting of concrete being complete and the column being ready to be lifted by the lifting devices.

FIG. 8 is a perspective view of the auxiliary column of FIG. 7 and shows the same with the lifting completed and the column in its elevated and locked position such as the column is in FIG. 5.

FIG. 9 is a detailed elevational view, partly in vertical section, of one of the lifting devices to show the hand-over-hand climbing action thereof in elevating the auxiliary columns.

FIG. 10 is a vertical sectional view, partly diagrammatic, through one of the column structures to show the transfer of loads from the concrete column through the auxiliary column through the lifting device (not shown) to the foundation.

FIG. 11 is a detailed elevational view, partly in vertical section, of the lifting device employable with the invention.

FIG. 12 is a perspective view of the drive unit for the lifting device of FIG. 11.

FIG. 13 is a fragmentary vertical sectional view of two auxiliary columns and shows the reinforcement installed in each auxiliary column with the reinforcement of an upper preceding concrete containing column being attached to the similar reinforcement in the lower succeeding empty column into which concrete is to be poured.

FIG. 14 is a perspective showing of the reinforcement for the concrete columns that are poured in the auxiliary columns.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now more particularly to the accompanying drawings and initially to FIGS. 1, 2 and 3 for a general understanding of the system, method and apparatus of the present invention, the reference numeral 10 generally designates a multi-story or high rise building or similar structure which has a basic supporting framework 12 of concrete slabs 14 and columns 16, as shown in FIG. 2. Below the building 10 is a foundation level 18 in the form of a dug-out pit or basement wherein supporting foundations 20 for the columns of the building are initially constructed with one foundation structure being provided for and underlying each column, as shown in FIG. 2.

In the initial stage of construction, the roof unit 22 of the building and its associated underhanging outer walls or other exterior configuration are formed on the fixed platform or slab form 24 which has vertical openings 120, as shown in FIG. 3, to accommodate auxiliary columns 26 which support and lift the building and whereby the permanent concrete columns 16 are formed with the poured concrete on the upper surface of the fixed platform 24 flowing down into the auxiliary columns and over reinforcements housed therein, as will be more particularly described.

As part of the initial erection stage a shed arrangement 28 may be provided over the foundation pit or basement and built to overhang the sides of the building as the erection proceeds so as to provide weather protection for workmen and also provide sheltered areas for concrete delivery, as at 30, and for materials delivery and storage, as at 32, as shown in FIG. 1.

In the sequence of building operations, the roof 22 is cast on the fixed form or platform 24 at ground level. Then, the roof is elevated by lifting devices 34, that are supported on the foundation structures 20, acting on the first set of auxiliary column sections 26. The floor immediately below the roof is then cast on the same form or platform 24; then the roof and floor are pushed up, the next floor cast and the operation continues in sequential operations of lift, support and casting.

While the building goes up, materials for finishing are brought in at ground level into the shelter area 32 and processed on the way up. Exterior walls are built and completed at ground level, for example, by being poured simultaneously with the pouring of the floor slabs and the columns or other method, so that the building is enclosed and protected from the weather during construction.

Instead of building walls in masonry or other materials, they can be made inexpensively as a monolithic part of the total structure 10. Stairways are designed as extensions to the poured floors so they can be lifted

vertically out of fixed forms as the floor is raised. Spandrel beams, balconies and protruding elements are all designed to be a part of the initial system. Windows and doors can be installed at ground level and moved up along with the rest of the floors of the building. Thus, floors, columns, walls with windows and door openings, and stairs can be done in one operation.

The lifting is done by the lifting devices 34 which operate in a cyclic lift fashion, as will be described in greater detail. The lifting devices 34 are synchronized and controlled to ensure equal lift throughout the building. The lifting devices are driven by drive means that are initiated and controlled by a centrally located console (not shown) manned by one operator.

As can be understood from FIGS. 3 and 5-8, there is a pair of cooperating identical lifting devices 34 and 34a for each column structure. The pair of lifting devices is supported on the raised pedestal 36 of the supporting foundations or footings 20 for each column structure. The lifting devices are disposed in laterally spaced apart and confrontingly cooperative relation in their upstanding placement on the foundations and are positioned on opposite sides of the cavity 38 formed in the foundations or footings when they were initially cast.

The cavity 38 is provided with upstanding dowels 40 for use in effecting the final joint between the lowermost end of the last cast column and the associated foundation. Such end of the column is seated in the cavity and cast solid with the foundation when the building has reached its planned height and further erection thereof is to be permanently discontinued.

Each of the lifting devices 34 and 34a has a steel guide post 42 which has its lower end attached to an upper base plate 44 that is movably and adjustably fastened by fasteners 46 to a base plate 48 which is fixed by bolts 50 onto the upper face of the foundation pedestal 36. The guide posts 42 upstand from the adjustable base plates which are movably spaced from the fixed base plates by a ball bearing 52, as shown in FIG. 9.

Each lifting device 34 or 34a further includes a top cross bar or header bar 54 that is fixed on the upper end of the guide post and is arranged transversely thereof. The top cross bar 54 is formed with vertical bores 59 and 58 on opposite sides of the post 42 and threaded rods 60 and 62 depend from the header bar 54 with their upper ends fitted in the bores. The rods are fixedly attached to the bar 54 by nuts 64 so that they depend from the bar 54 on opposite sides of the post and are held in parallel positions with their lower ends spaced away from the base plates.

A climbing unit 66 is slidably mounted on the post and cooperates with the threaded rods 60 and 62 in pulling itself up along the post 42 in a hand-over-hand fashion. The climbing unit 66 is composed of an upper and lower cross-head 68 and 70 that are in overlying relation and have center sleeves 72 slidably fitted on the guide post 42. The cross-heads have pairs of vertically aligned holes 74 through which the threaded rods 60 and 62 freely pass. A pair of take-up nuts 76 and 78 are threaded on the rods 60 and 62 and underlie the upper crosshead 70 while a pair of holding nuts 80 and 82 are threaded on the rods and underlie the lower crosshead 70. The crossheads have their outer ends interconnected by vertically positioned rams 84 which

function to raise the cross-heads in conjunction with the tightening of the nuts.

In operation, the rams 84 are extended to lift the upper crosshead 68 off the take-up nuts 76 and 78. The take-up nuts are then tightened to engage under the crosshead 68. The rams are then retracted to pull the lower crosshead 70 upwardly off of the holding nuts. The holding nuts 80 and 82 are then tightened to engage under the lower crosshead.

Thus, by alternately extending and retracting the rams 84 and tightening the take-up nuts 76 and 78 and then the holding nuts 80 and 82, the climbing unit 66 pulls itself up along the guide post 42, as can be appreciated from a consideration of FIG. 9. The nuts are driven by hydraulic motors (not shown) initiated and controlled by a centrally located console manned by one operator. Interconnections between lifting devices and the console ensure that all column structures advance one increment before the next is started to guarantee equal lift throughout the building.

As shown in FIG. 2, brace means 86 is secured between the lifting devices of adjoining column structures and such brace means also supports the fixed platform 24. In this way, the lifting devices are connected to one another and braced for stability.

The climbing units 66 on each lifting device 34 and 34a are interconnected by a pair of load transfer beams 88 which are attached to the auxiliary columns 26 as will be described. The load transfer beams have opposing ends 90 which are formed on their undersides with sockets (not shown) that receive the rods 92 upstanding from the upper crosshead 68 above the rams whereby the transfer beams are located on the ends of the climbing units in a manner to transversely span the lifting devices 34 and 34a at opposite sides thereof. The outer ends 90 of the load transfer beams 88 also have upstanding threaded lugs 94 which are adapted to fit in vertical holes 96 formed in the outer ends of the header or top cross bars 54 for each lifting device 34 and 34a and to receive locking nuts 98 so as to lock an auxiliary column in an elevated position, as shown in FIG. 5.

Each of the auxiliary columns 26, as shown in detail in FIG. 4, is composed of steel casings 100 made in sections and of a desirable length that is equal to one floor height. Each of the casings 100 has opposing corrugated side plates 102 and 104 which are connected together in fixedly spaced apart parallel relation by plain side plates 106 and 108. The four side plates are releasably fastened together in a substantially square columnar shape by the rods 110. The plates 102 and 104 have side edge bars 112 which have substantially flat upper ends 114 provided with vertical holes 125.

A head form 116 is adapted to be disposed at the upper end of each of the auxiliary columns just prior to pouring of the concrete. The flat plate sections 118 of the head form are adapted to span the openings 120 in the fixed platform 24 and to have their outer edges resting on the platform portions bounding the openings 120 so as to prevent concrete, as it is poured on the platform 24 to form the floor slab and the concrete columns, from seeping down around the outsides of the casings of the auxiliary columns 26 in the space S, FIG. 4, not covered by side plates 102, 104, 106, and 108. Space S is greater than one concrete floor thickness. The depending tubular section 122 (not indicated) of the head form is of an approximate square cross-sectional shape and is adapted to extend into the upper

ends of the casings 100 in a fashion so as to complement the sealing action of the plate sections 118.

The side bars 112 depend from the plates 102 and 104 and define legs 130 for the casing. The legs have outer faces 132 at their lower ends to which the inner surfaces of the outer ends 90 of the transfer beams are fastened by bolts 134. The free lower ends of the legs 130 of an upper auxiliary column section seat on the flat upper ends 114 of a lower succeeding auxiliary column section and have vertical threaded bores (not shown) which align with the vertical apertures 125 in the upper ends for the reception of fastening bolts 126. Shims 128 are fitted between the lower and upper ends of the columns and are held in place by the bolts which are worked by tools placed through side openings 127 in the upper end portions of the edge bars 112. The inner corners of the plate sections 118 are cut out, as at 119, so as to enable the corners to fit tightly around the side edge bars of the auxiliary columns.

The lower end of the casing 100 carries a closure pan 136 of substantially pyramidal shape. The pan 136 serves to close off the lower end of the casing during the pouring of the concrete and the shape thereof results in the formation of the concrete columns with a lower end 138, as shown in FIG. 10, that has upwardly sloped walls 140 serving to ensure good contact with the new concrete during a pouring of a lower succeeding concrete column.

With regard to FIGS. 4 and 10, it can be seen that the corrugated plates 102 and 104 have a vertical series of horizontally disposed, parallel and inwardly directed teeth or ridges 142 which are spaced apart by grooves 144 into which the poured concrete flows. Thus, the inner surfaces of the plates 102 and 104 and the opposing formed walls 146 of the setting concrete columns have an interlocking engagement. It is due to such interlocking engagement that the load of the permanent concrete structure is transferred to the interim structure and to the foundations.

As shown in FIG. 10, the hardened or cured concrete columns C, from which the casing plates have been stripped for recycling use at the foundation, are supported by the setting concrete columns C₁ which are still encased in the casings 100. The columns C₁ are supported through their casings 100 by the auxiliary columns 26 containing the freshly poured concrete columns C₂. The transfer beam 88 through the lifting devices (not shown) passes the load (indicated by the arrows) onto the foundation 20.

As shown in FIGS. 13 and 14, a reinforcement cage 148 formed of vertical rods 150 held in rectangular formation by encircling stirrups 152 is provided for insertion within a casing 100 prior to the pouring of concrete therein so as to provide a reinforcement for the concrete columns. The reinforcement cage is inserted into an auxiliary column section 26 prior to installation. When the column section 26 is installed, the upper ends 150a of the reinforcement cage are attached to the lower hanging ends 150b of a reinforcement cage in an immediately preceding column formation, as shown in FIG. 13. Cross rods 154 are formed with angular outer ends 156 that are adapted to seat on the upper faces or shoulders 158 of the teeth or ridges 142 on the plates 102 and 104 of the casing 100, as shown in FIG. 13.

In operation, the auxiliary column sections 26 are positioned below the platform 24, before the roof is

poured on the platform. The auxiliary columns are attached to the lifting devices 34 by the load transfer beams 88 and would be in a position generally as shown in FIG. 3. The auxiliary columns contain the reinforcement cages 148 and are disposed below the openings 120 with the head forms 118 resting on the platform in place over the auxiliary columns. The lower ends of the auxiliary columns are closed off by the pans 136. concrete poured on the platform flows into the auxiliary columns to form the concrete columns in a monolithic fashion with the roof and walls. However, it will be appreciated that the columns may be pre-filled with concrete on the site or remote therefrom without departing from the scope of the disclosures.

After a certain setting period, the lifting devices are activated and the climbing units 66 operate in synchronism to climb hand-over-hand on their guide posts 42 and raise the roof and the poured concrete columns which are supported by the casings 100 constituting the auxiliary columns 26. The lifting action can be appreciated from a consideration of FIGS. 5-8.

When the lift is completed, the columns are in the fully elevated position of FIG. 5 and the load transfer beams 88 are locked on the stationary top bars 54 of the lifting devices 34 by nuts 98 fastened on the threaded lugs 94 that extend through the openings 96 in the top bars. The climbing units 66 then lower themselves on the guide posts 42 in a reverse action to their climbing action until they reach their lowermost positions. At such point and in such positions, new auxiliary column sections 26 are attached by load transfer beams to the climbing units.

This action is repeated and the erection of the building progresses with the interim structure that is composed of auxiliary columns and bracing where necessary supporting the entire building. As the building rises and the concrete of the permanent structure hardens, the auxiliary columns 26 are removed from the top down, as shown in FIG. 2. Thus, the auxiliary columns 26 rise with the building until the concrete contained by them is strong enough to support the weight of the building above. At that time, the casing plates 102, 104, 106 and 108 are unlocked by removing the tie rods 110 and the plates are peeled or stripped off from the concrete columns, as shown in FIG. 2. The plates 106 and 108 easily pull away from the concrete columns. The plates 102 and 104 of the casing 100 are removed by tilting them away from the permanent concrete columns causing a zipper effect and transferring the load slowly to the bottom and into the next column section. A hydraulic tool or screw device is used to separate the opposing corrugated plates 102 and 104 at an equal rate.

The removed plates 102, 104, 106 and 108 that comprise the casings 100 of the auxiliary columns 26 are rotated to a position at the foundation level where they are reassembled, fitted with a reinforcement cage and reinstalled in attachment to the lifting devices for reuse. By this rotating action, the casings 100 are continuously being recycled. And the bottom part of the building is continuously supported by the rigid steel frame or interim structure. The auxiliary columns may extend upwardly, before they are peeled or stripped off, anywhere from two to six stories depending on curing conditions, type of concrete and rate of progress.

When the building reaches its projected height, the final concrete columns are poured within the casings

100 without the bottom pans 136 so that the concrete columns are cast within the cavities 38 in the foundations or footings 20. If desired, the building can be left in a usable condition wherein it is supported by lowermost auxiliary columns defining a base support structure and without being permanently attached to the foundations. After occupying and attendant use for any given period of time, further construction can be undertaken and the height of the building can be increased.

In the embodiment of FIGS. 11 and 12, lifting means is shown for use with lighter loads. Such lifting means includes a pair of identical lifting devices 160 that are mounted on the pedestal 36a of the foundations or footings of the building. Each of the lifting devices comprises a base plate 162 fixed on the upper face of the pedestal and on which a mounting plate 164 is secured by fasteners 166 with shims 168 being interposed therebetween. Each of the pair of mounting plates 164, only one side of which is illustrated, supports a pair of upstanding guide posts 170 and 172 on which a climbing unit 174 is slidably disposed. The upper ends of the guide posts are joined together by a top cross bar 176.

An elongated screw rod 178, one for each pair, is secured between the supporting base plate 164 and the top cross bar 176 and is located substantially centrally between the guide posts 170 and 172 and is disposed parallel therewith. Each climbing unit 174 comprises a climbing cross bar 180 which has a central vertical bore 182 through which the screw rod 178 freely passes. The climbing cross bar 180 also has vertical openings 184 and 186 that freely receive the guide posts 170 and 172. The guide posts and openings are preferably of a non-circular cross-sectional shape. The climbing cross bar 180 is provided at its center portion with a drive unit 188 that comprises a prime mover 200 that operates a pawl type actuator 202 which is drivingly engaged with a ratchet unit 204 carried by a traveling nut 206 which is threadably engaged on the screw rod 178. The prime mover 200 may be a hydraulic, pneumatic or electric motor.

The climbing bars 180 on each of the lifting devices are provided on the upper faces of their outer end portions with upstanding lugs 208 that fit in sockets (not shown) provided on the underface of the end portions of load transfer beams like beams 88, FIGS. 3 and 4. The load transfer beams are, thusly, located on the climbing units and are attached to the lower ends of the auxiliary columns 26 by bolts. The auxiliary columns are the same in purpose, structure and assembled relation and operation as the auxiliary columns 26, shown in FIG. 4.

While several forms of lifting devices have been shown, other forms could be substituted depending on the lifting requirements of the particular building.

What is claimed is:

1. Apparatus for the formation of a multi-story concrete building having superposed floor slabs spacedly supported by load bearing concrete columns comprising:

- a horizontal platform disposed at ground level and having vertical openings;
- foundation means underlying each of the openings in the platform;
- supporting means mounted on the foundation means;

- d. lifting means operatively mounted on the supporting means;
 - e. auxiliary columns disposed in vertical positions overlying the foundation means and underlying the openings in the platform and into which concrete flows as a floor slab is being formed on the platform so as to form the concrete columns;
 - f. means connecting the lifting means to the auxiliary columns with said lifting means being operative so that after a predetermined setting time the poured floor slab and the auxiliary columns with the contained concrete columns are elevated to a height with the lower ends of the auxiliary columns being adjacent the platform;
 - g. means attaching the lifted auxiliary columns to the supporting means so that they are locked in such elevated positions for the insertion thereunder of further auxiliary columns for the subsequent formation of further concrete columns during the formation of a succeeding lower floor slab on the platform;
 - h. means interconnecting the lower ends of the raised auxiliary columns with the upper ends of the underlying auxiliary columns with a space approximately equal to the thickness of a floor slab being provided therebetween; and
 - i. interlocking facial contact means between the auxiliary columns and the concrete columns formed therein so that lifting pressure applied directly to the auxiliary columns is indirectly applied to the concrete columns and therethrough to the supported floor slab.
2. The apparatus of claim 1 wherein said supporting means includes support posts fixed on the foundation means and upstanding therefrom.
 3. The invention of claim 2 wherein said lifting means includes climbing units slidably mounted on the posts and adapted to move in hand-over-hand fashion thereon.
 4. The invention of claim 2 wherein said lifting means includes screw rods mounted alongside the posts and climbing units moving in hand-over-hand fashion on the screw rods and guidingly traveling on the posts.
 5. The invention of claim 4 wherein said climbing units includes a pair of crossheads slidably disposed in vertically spaced parallel relation on a post and on the screw rods, rams interposed between the bars, take-up nuts threaded on the screw rods and underlying one of the crossheads and holding nuts threaded on the screw rods and underlying the other of the crossheads so that by alternately extending and retracting the rams and tightening the take-up nuts and then the holding nuts the climbing unit pulls itself up along the post.
 6. The invention of claim 1 wherein said supporting means includes a pair of laterally spaced apart guide posts upstanding from the foundation means, and said lifting means includes a vertical screw rod positioned between and parallel with the guide posts and a climbing unit slidably disposed on the posts and having means engaging the screw for advancing it upwardly thereon and actuating means for said advancing means carried by the climbing unit.
 7. The invention of claim 1 wherein said lifting means includes a pair of climbing units disposed on opposite sides of the auxiliary columns, means guidingly mounting the climbing units on the supporting means and said means connecting the lifting means to the auxiliary col-

umns including load transfer beams carried by the climbing units and transversely extending therebetween and fastening means removably securing the load transfer beams to the lower ends of the auxiliary columns.

8. The invention of claim 7 wherein said means attaching the lifted auxiliary columns to the supporting means includes said load transfer beams having connectors, said supporting means having fixed top cross bars provided with means for releasably lockingly receiving said connectors.

9. The invention of claim 1 wherein said auxiliary columns are composed of plates arranged in a columnar arrangement and removable fastening means securing said plates in said arrangement and said plates have upper and lower ends having complemental fastening means constituting means for interconnecting the lower ends of raised auxiliary columns with the upper ends of lower columns.

10. The invention of claim 1 wherein said interlocking facial contact means includes a vertical series of inwardly directed teeth on the auxiliary columns with the poured concrete for the concrete columns flowing in between the teeth and curing therein to form intermeshing teeth when the concrete is set.

11. The invention of claim 1 wherein each of said auxiliary columns is of approximately square cross-sectional shape and is composed of separate side plates, fastening means releasably holding said plates together and, at least, two opposing plates having said interlocking facial contact with the concrete column formed in the auxiliary column.

12. The invention of claim 11 wherein said interlocking contact includes a vertical series of horizontal inwardly directed ridges on the said plates.

13. An apparatus for the formation of multi-story structures of the type wherein each floor is formed at ground level and pushed up until the structure reaches its planned height comprising:

- a. temporary auxiliary re-usable columns within which permanent columns are formed disposed in vertical positions at a plurality of lifting stations;
- b. reversible lifting means at each of said lifting stations;
- c. at least a pair of load transfer beam members;
- d. means releasably connecting said load transfer beam members to said reversible lifting means and to said auxiliary columns;
- e. cross head means at the upper end of the reversible lifting means; and
- f. means releasably connecting said load transfer beam members to the cross head means at the upper end of the reversible lifting means.

14. An apparatus for the formation of multi-story structures of the type wherein each floor is formed at ground level and pushed up until the structure reaches its planned height comprising:

- a. auxiliary columns disposed in vertical positions at a plurality of lifting stations;
- b. reversible lifting means at each of said lifting stations;
- c. at least a pair of load transfer beam members;
- d. means releasably connecting said load transfer beam members to said reversible lifting means and to said auxiliary columns;
- e. cross head means at the upper end of the reversible lifting means;

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f. means releasably connecting said load transfer beam members to the cross head means at the upper end of the reversible lifting means; wherein each reversible lifting means includes at least one fixed vertically positioned load bearing column having secured thereto said cross head means, and a

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lifting arm adapted to be urged in a generally vertical path from the lower end of the fixed column to the cross head means, and wherein the load transfer beam is selectively releasably connectable to the cross head means and to said lifting arm.

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