United States Patent

Abe et al.

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[54] METHOD OF ERECTING SUPER-HIGH-RISED TOWER STRUCTURE

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[51] **Int. Cl.**.....**E04h 12/00**, E04g 1/20

[58] **Field of Search**.....52/40, 123, 126, 745, 741; 182/187, 178; 214/14, 2.5; 212/46, 57

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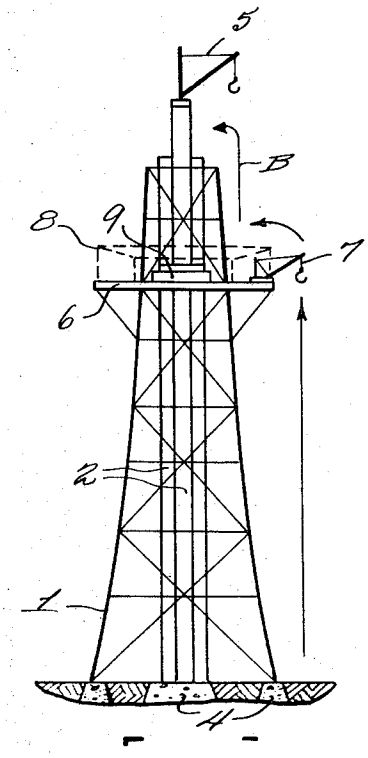
[57] **ABSTRACT**

A method of erecting a super-high-rised towery structure, which comprises assembling the lowermost segment of the towery structure on a foundation in fixed relation thereto, assembling the uppermost segment of a cylindrical body within the thus assembled lowermost segment of the towery structure in such a manner that it is supported upright by the horizontal members of said lowermost segment, said uppermost segment of the cylindrical body having a crane mounted at the top end thereof, lifting said uppermost segment of the cylindrical body by push-up means or hoisting means, connecting the next lower segment of said cylindrical body to the lower end of said uppermost segment of the same, assembling the next higher segment of the towery structure on top of said lowermost segment of the same while hoisting the structural members thereof by said crane, again lifting the assembly of the uppermost and the next lower segments of said cylindrical body and connecting the next lower segment of the cylindrical body to the lower end of said assembly, repeating the above-described steps to construct the segments of the towery structure to a predetermined height, constructing a platform of a sufficient width on top of the thus assembled portion of the towery structure in fixed relation thereto, carrying up the construction materials required for the construction of the remaining segments of the towery structure from the ground onto said platform by means of another crane mounted on said platform, and assembling the remaining segments of the towery structure while hoisting the structural members thereof from said platform by the crane at the top end of said uppermost segment of the cylindrical body.

2 Claims, 7 Drawing Figures



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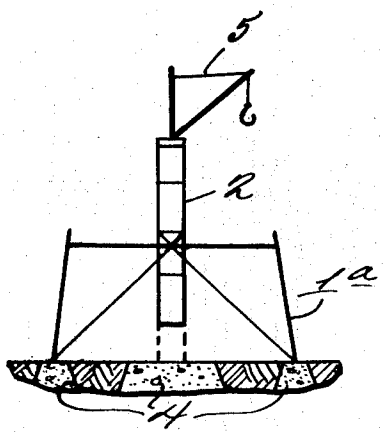

Fig. 1

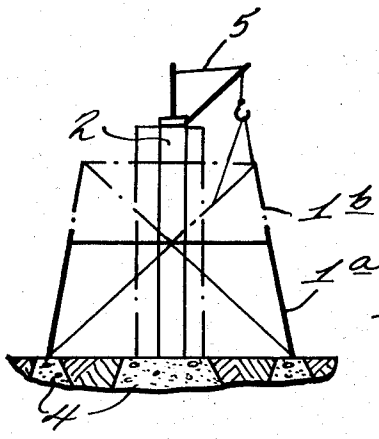

Fig. 2

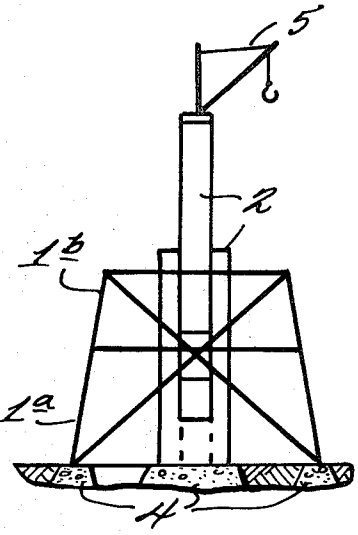

Fig. 3

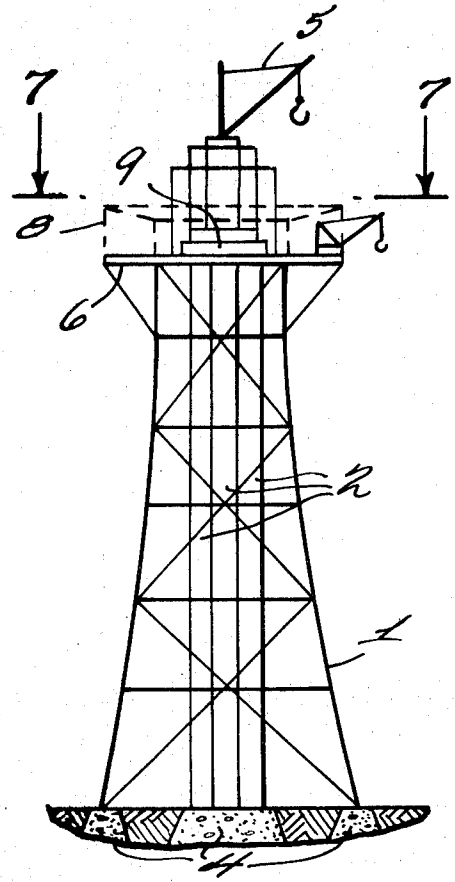

Fig. 4

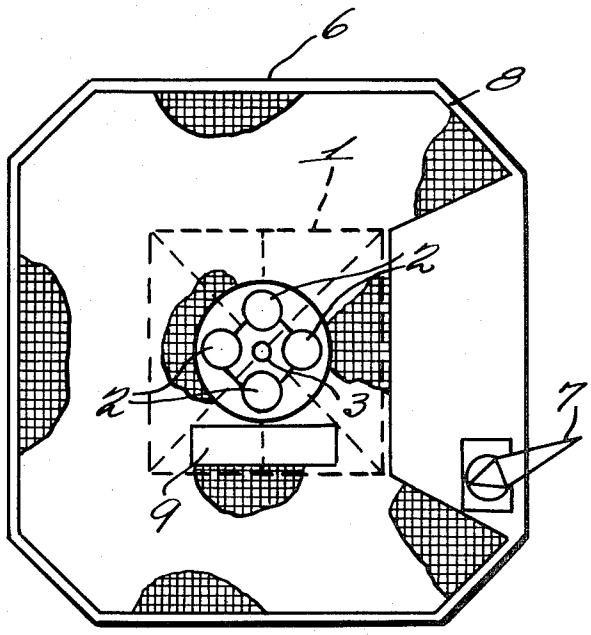

Fig. 7

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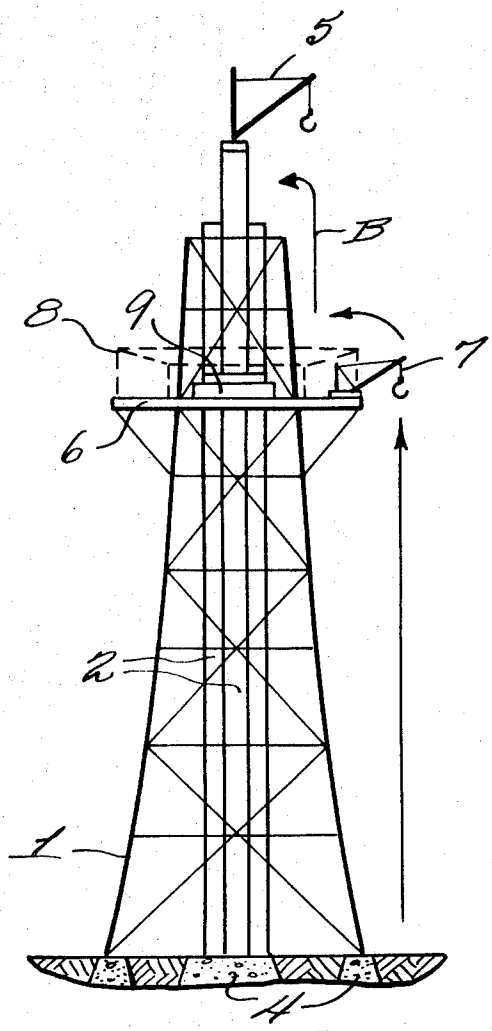

Fig. 5

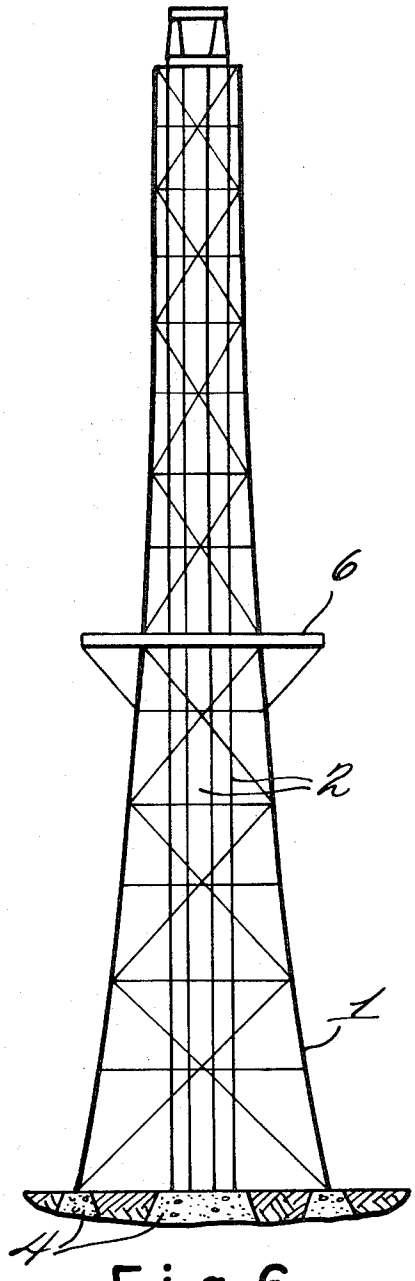

Fig. 6

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METHOD OF ERECTING SUPER-HIGH-RISED TOWER STRUCTURE

This invention relates to an improved method of erecting super-high-rised towery structures.

There is the tendency that the towery structures of the type described become increasingly large in both size and height, with the development of general industries, and accordingly increasingly large apparatus and equipments are required for the construction of such structures.

Particularly, the increasing size of an apparatus which is used at the top end of a structure being constructed and is raised with the progress of the construction work, has added to the difficulty and danger involved in the erection work and inevitably prolonged the construction period.

To describe a conventional manner of construction, reference is made to a steel chimney as an example of the towery structures. Most of the high-rised chimneys are tower-type or multi-leg type chimney assemblies composed of a plurality of smoke stacks. These chimneys are usually constructed by a method wherein one of the chimney stacks is constructed first and then the other chimney stacks or a tower is constructed by stacking the structural members thereof while lifting said structural members by means of a crane mOunted on the top of said first-constructed chimney stack. As the crane used at the top of the chimney stack, one having a hoisting distance of about 200 m has been used.

In the construction of larger and higher towery structures even by the method described above, apparatus and a crane of larger capacity are required according to the size and height of the structures to be erected. In this case, the size of apparatus to be mounted on or in the vicinity of the ground can be increased relatively easily but the use of a large crane will increase the load taken by the top end of the chimney stack of the like on which the crane is mounted and much difficulty and danger will be involved in operating the crane at a higher level.

In addition, the increasing hoisting distance from the ground will bring about the disadvantage that an excessively long time is required for hoisting the construction materials and equipments by the crane.

The present invention is proposed mainly with a view to avoiding an increase in size of the construction equipments used at high levels, to minimizing the danger and difficulty involved in the construction work and to shortening the construction period, in the construction of super-high-rised towery structures.

According to the present invention there is provided a method of constructing a towery structure, which comprises assembling the lowermost segment of the towery structure on a foundation in fixed relation thereto, assembling the uppermost segment of a cylindrical body within the thus assembled lowermost segment of the towery structure in such a manner that it is supported upright by the horizontal members of said lowermost segment, said uppermost segment of the cylindrical body having a crane mounted at the top end thereof, lifting said uppermost segment of the cylindrical body by push-up means or hoisting means, connecting the next lower segment of said cylindrical body to the lower end of said uppermost segment of the same, assembling the next higher segment of the towery structure on top of said lowermost segment of the same (which also happens to be the uppermost segment at this stage of completion), while hoisting the structural members thereof by said crane, again lifting the assembly of the uppermost and the next lower segments of said cylindrical body and connecting the next lower segment of the cylindrical body to the lower end of said assembly, repeating the above-described steps to construct the segments of the towery structure to a predetermined height, (excepting that the next higher segment is installed upon the most recently installed segment, which, following the first such installation, is no longer "lowermost"). constructing a platform of a sufficient width on top of the thus assembled portion of the towery structure in fixed relation thereto, carrying up the construction materials required for the construction of the remaining segments of the towery structure from the ground onto said platform by means of another crane mounted on said platform, and assembling the remaining segments of the towery structure while hoisting the structural members thereof from said platform by the crane at the top end of said uppermost segment of the cylindrical body.

In practicing the method of this invention described above, one or more platforms may be provided at a level or levels which divide the height of the intended towery structure substantially equally, depending upon the scale of said towery structure. The crane provided on the platform may be movable or fixed on said platform. The platform is used as an intermediate storage yard for the structural materials to be hoisted from the ground to a higher level and also as a working field.

Therefore, according to the method of this invention the cranes to be mounted at the top end of the cylindrical body and on the platform can be of relatively small capacities in respect of hoisting distance and drawing distance, and hence can be operated relatively easily. Another advantage of the method of the instant invention is that, since the platform can be used as a storage yard of materials and the structural materials of the towery structure can be carried up thereon beforehand, the transportation of the materials to a higher level can be achieved quickly easily, and the safety and efficiency of the work can be enhanced.

The present invention will be described in detail hereunder by way of example with reference to the accompanYing drawings:

In the drawings,

FIGS. **1** to **6** inclusive are schematic front views illustrating in sequence the steps of constructing a tower-type chimney assembly according to one embodiment of the method of the present invention, respectively and

FIG. **7** is a horizontal cross-sectional view taken along the line VII—VII of FIG. **4**.

Referring to the drawings, reference numeral **1** designates a supporting tower, **2** four smoke-stacks supported upright within said supporting tower **1**, **3** an elevator column similarly supported in the center of the tower **1**, **4** a foundation, **5** a crane which is removably mounted at the top end of one of said smoke-stacks **2** and elevated with said smoke-stack as the latter is constructed by the push-up method, **6** a platform provided at a predetermined level of the supporting tower **1** in fixed relation thereto, **7** a relay crane movably mounted on said platform **6**, **8** a guard screen provided along the periphery of said platform **6**, and **9** a living quarters for laborers on said platform **6**.

The crane **5** and the relay crane **7** may be of any type and capacity, such as a derrick crane or a cantilever crane, which has been used heretofore in the construction of this type of towery structures. It is also to be understood that the relay crane **7** may be simply fixed to the platform at a location shown in FIG. **7**, instead of mounting it movably.

As shown in FIG. **5**, the platform **6** is constructed in any shape but with a sufficient width to provide for hoisting of the construction materials from the ground by the relay crane **7**.

The super-high-rised, tower-type chimney assembly exemplified above will be erected in the following manner:

First of all, the lowermost segment **1***a* of the supporting tower **1** is assembled on the ground and fixed to the foundation **4** and the uppermost segment of one of the smoke-stack **2**, disposed within the thus assembled lowermost segment **1***a* of the supporting tower, is pushed up above the foundation **4** by means of the ordinary hoisting means or push-up means not shown, by being guided by said lowermost segment **1***a* of the supporting tower, following which the next lower segment of the smoke-stack is connected to the lower end of the uppermost segment. In the manner described above, a height of the smoke-stack substantially equal to the height of two segments of the supporting tower is assembled as shown in FIG. **1**. The crane **5** is removably securely mounted on the top end of the smoke-stack **2**.

Then, the other smoke-stacks 2 and the elevator column 3 are constructed on the foundation 4 by assembling the segments thereof which are hoisted by the crane 5 and the second segment 1*b* of the supporting tower 1 is assembled on top of the first or the lowermost segment 1*a*, with the structural members thereof which are also hoisted by the crane 5, as shown in FIG. 2.

The smoke-stack 2 with the crane 5 mounted on the top end thereof is pushed upward by having the next lower segments connected to the lower end thereof, while being guided by the already assembled segments 1*a*, 1*b* of the supporting tower 1 (FIG. 3), and then the other smoke-stacks, the elevator column and the supporting tower are extended upwardly by stacking the higher segments thereof on top of the already constructed portions respectively by means of the crane 5, to a state similar to FIG. 2. The smoke-stacks are extended further upwardly to a desired level by repeating the above-described steps. This part of the method of this invention is same as the conventional method.

When the supporting tower and the smoke-stacks have been built to a predetermined level, the platform 6 is assembled integrally with the supporting tower 1, with the structural members hoisted by the crane 5, and the relay crane 7 is mounted on said platform (FIG. 4). The platform 6 is formed at a level at which the overall height of the completed smoke-stacks is substantially equally divided, and the width thereof is sufficiently large and substantially equal to the span of the legs of the supporting tower. The laborers' living quarters 9 and the guard screen 8 are also provided on the platform 7 as required.

Then, the structural members required for the construction of the higher segments of the supporting tower and the smoke-stacks are carried up onto the platform 6 from the ground by means of the relay crane 7 as indicated by the arrow A in FIG. 5. The construction of the smoke-stacks above the platform is carried out concurrently, while performing the material hoisting operation described above precedently. In this case, the smoke-stack 2 with the crane 5 mounted thereon is extended upwardly by the push-up method in the manner shown in FIGS. 1 and 3, and the other smoke-stacks, the elevator column 3 and the supporting tower 1 are extended upwardly by stacking the higher segments thereof one on top of another, which are hoisted by the crane 5 from the platform 6 as indicated by the arrow B.

In the method described above, when the lower segments of the smokestack are to be successively connected to the lower end of the uppermost segment with the crane 5 mounted thereon, the entire length of the smoke-stack can be constructed fixedly securing the lower end of the lower segment assembly to the foundation when the platform 7 has been formed at a predetermined level of the supporting tower, disconnecting the lower end of said crane-carrying uppermost segment from the upper end of the lower segment assembly, connecting intermediate segments, carried up onto said platform, to the lower end of said uppermost segment one after another while hanging said uppermost segment upward, and finally connecting the lower end of the intermediate segment assembly with the upper end of the lower segment assembly at the level of said platform. By incorporating the hang-up method in the method of the present invention in the manner described, there can be obtained the advantage that the maximum weight to be hanged up by the hang-up apparatus can be decreased and the hand-up apparatus can be operated efficiently without increasing the capacity thereof, even in the construction of a high-rised chimney.

On the other hand, where the push-up apparatus or jack is used for hoisting the crane-carrying smoke-stack segment, the construction work can also be carried out in the same manner as described above by transferring such apparatus onto the platform during the process of the construction work. However, it is rather advantageous to set a push-up apparatus or jack of large capacity on the foundation at the outset of the construction and hoist the entire weight of the smoke-stack segment assembly solely by said apparatus throughout the construction work.

When the smoke-stacks have been assembled to the intended level in the manner described, the crane 5 is removed and lowered onto the platform 6 and, after being disassembled on said platform, is lowered onto the ground along with the other constructional equipments, such as the relay crane 7, which are also disassembled on the platform. By this step, the erection of the super-high-rised tower-type chimney assembly is accomplished.

It is to be understood that the platform 6 may be provided in two or more stages at levels plurality of leves depending upon the height of a desired high-rised structure, in such a manner as to divide the height substantially equally. Upon completion of the structure, these platforms may be used for the other purposes, such as an observation platform, as they are or may be removed from the structure by taking them to pieces.

It is also to be understood that the super-high-rised structure erecting method of the invention described above is not only applicable to the construction of a tower-type chimney assembly but also widely employed in the construction of the other types of chimney assembly, multi-purpose towers and similar towery structures.

In the present invention, as described above, a super-high-rised structure is constructed by employing the conventional push-up methOd and stacking method in combination, while forming a platform with a relay crane thereon at each of predetermined levels in the process of construction. Therefore, according to the present invention there are such advantages that the hoisting distance and drawing distance of the crane used can be shortened, that an increase in size of the crane used can be avoided in spite of the fact that the size and height of towery structures are becoming increasingly large and that, therefore, the danger encountered in operating the crane can be substantially decreased.

There is another advantage that, since the constructional materials can be hoisted and stored on the platform by the relay crane, preparatory to the construction of the higher portion of the intended structure, the material hoisting time can be substantially shortened and hence the construction work can be performed with high efficiency.

Thus, the present invention which provides a method by which super-high-rised towery structures, tending to be larger and larger recently, can be erected safety efficiently, is of great industrial advantage.

What is claimed is:

1. A method of erecting a super-high-rised towery structure, which comprises assembling the lowermost segment of the towery structure on a foundation in fixed relation thereto, assembling the uppermost segment of a cylindrical body within the thus assembled lowermost segment of the towery structure in such a manner that it is supported upright by the horizontal members of said lowermost segment, said uppermost segment of the cylindrical body having a crane mounted at the top end thereof, lifting said uppermost segment of the cylindrical body by push-up means or hoisting means, connecting the next lower segment of said cylindrical body to the lower end of said uppermost segment of the same, assembling the next higher segment of the towery structure on top of said lowermost segment of the same while hoisting the structural members thereof by said crane, again lifting the assembly of the uppermost and the next lower segments of said cylindrical body and connecting the next lower segment of the cylindrical body to the lower end of said assembly, repeating the above-described steps to construct the segments of the towery structure to a predetermined height, constructing a platform of a sufficient width on top of the thus assembled portion of the towery structure in fixed relation thereto, carrying up the construction materials required for the construction of the remaining segments of the towery structure from the ground onto said platform by means of another crane mounted on said platform, and assembling the remaining segments of the towery structure while hoisting the structural members thereof from

said platform by the crane at the top end of said uppermost segment of the cylindrical body.

2. A method of erecting a super-high-rised towery structure, comprising:

a. assembling the lowermost segment of the towery structure on a foundation in fixed relation thereto;

b. placing the uppermost segment of a cylindrical body upright within the lowermost segment of the towery structure so that the latter prevents the former from falling over;

c. mounting a crane on the upper end of the uppermost segment of the cylindrical body;

d. lifting the uppermost segment of the cylindrical body sufficiently high as to make room for the next lower segment of the cylindrical body to be installed therebeneath;

e. disposing the next lower segment of the cylindrical body coaxially beneath the uppermost segment of the cylindrical body and connecting the upper end of the former to the lower end of the latter;

f. assembling the next higher segment of the towery structure on top of the segment of the towery structure most recently previously assembled and fixed on said foundation, including hoisting materials for assembly of said next higher segment using said crane;

g. lifting the so-far assembled segments of the cylindrical body sufficiently to make room for a further next lower segment of the cylindrical body to be installed therebeneath;

h. disposing the further next lower segment of the cylindrical body coaxially beneath the uppermost segment of the cylindrical body and connecting the upper end of the former to the lower end of the latter;

i. repeating steps (f), (g) and (h) at least one more time, until the cylindrical body and towery structure have reached predetermined heights;

j. constructing a work and storage platform on and about the upper end of the so-far completed towery structure;

k. lifting construction materials for constructing remaining upper segments of the towery structure from the ground to the work and storage platform, from the level of the upper end of the so far completed towery structure and the work and storage platform; and

l. assembling the remaining segments of the towery structure from the construction materials lifted to said platform, including lifting said materials into place with the aid of the crane mounted on the upper end of the uppermost segment of the cylindrical body.

* * * * *