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Ohta

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[45] **Apr. 1, 1975**

[54] **APPARATUS FOR PRODUCING PRECAST CONCRETE MEMBERS**

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[73] Assignee: **The Shimizu Construction Co. Ltd.,** Tokyo, Japan

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[21] Appl. No.: **322,719**

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Jan. 14, 1972	Japan	47-5876
Jan. 21, 1972	Japan	47-7684

[52] **U.S. Cl.** ..... **425/88,** 280/33.99 T

[51] **Int. Cl.** **B28b 15/00**

[58] **Field of Search**.... 425/88, DIG. 117, DIG. 118; 264/DIG. 43, 333, 336, 297, 39; 432/153, 162; 214/16.1 R, 16.4 R; 280/33.99 T, 79.1, 79.2, 79.3; 108/106, 109, 110; 211/128, 133, 134

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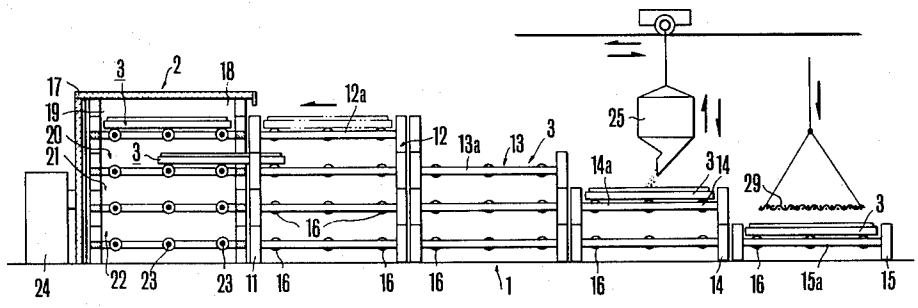
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Assistant Examiner—John S. Brown
Attorney, Agent, or Firm—Ostrolenk, Faber, Gerb & Soffen

[57] **ABSTRACT**

An apparatus for producing precast concrete members which is efficient, mobile and cost saving, and comprises at least: a curing chamber having an opening in the portion which faces substantially a concrete placing section and having a plurality of support members to support form members leaving predetermined distance apart, a high temperature curing apparatus which is installed to said curing chamber, a concrete placing section in which necessary work for concrete placing is carried out, and a predetemined number of precast concrete form members which are disposed horizontally or vertically and moved separately between said support members in said curing chamber and said concrete placing section by horizontal transfer means.

4 Claims, 13 Drawing Figures



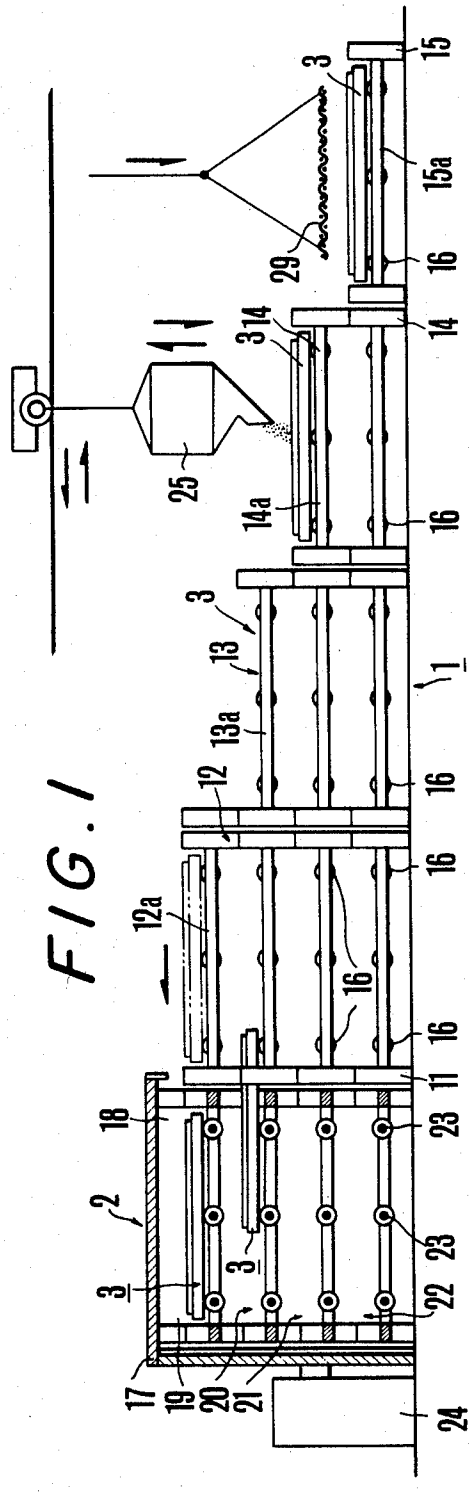

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15
15a
29
16
14
3
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25
14a
16
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13a
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FIG. 1

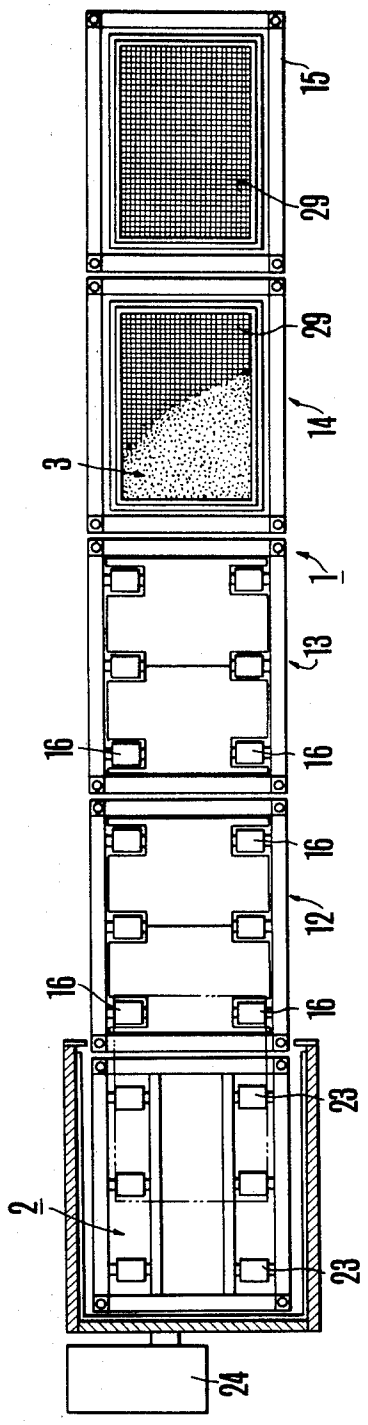

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FIG. 2

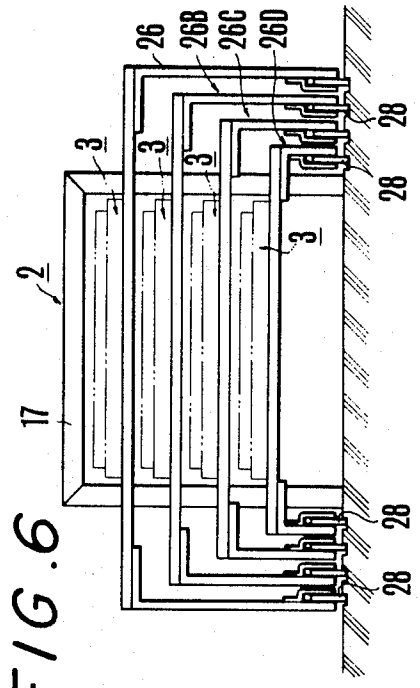


FIG. 6

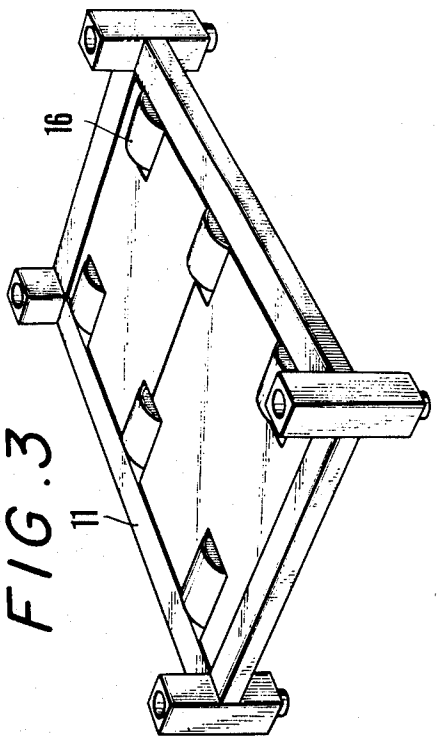


FIG. 3

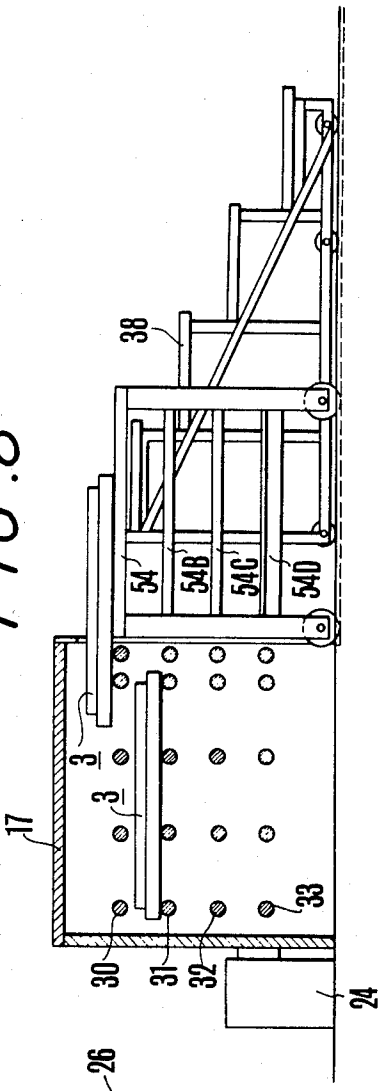


FIG. 8

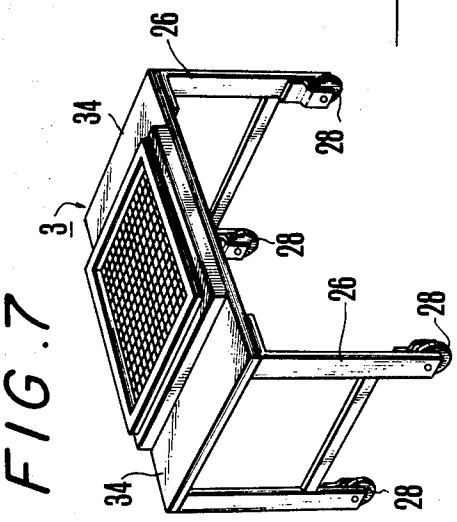


FIG. 7

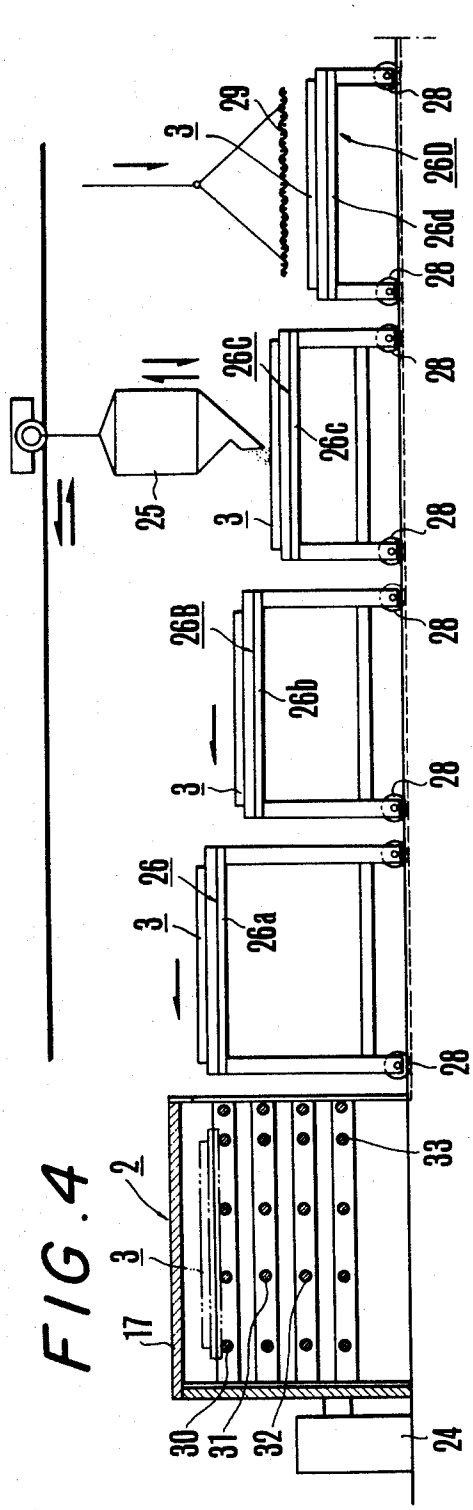

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3
28
26D
26d
26C
26c
25
26B
26b
26
26a
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2
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32
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FIG. 4

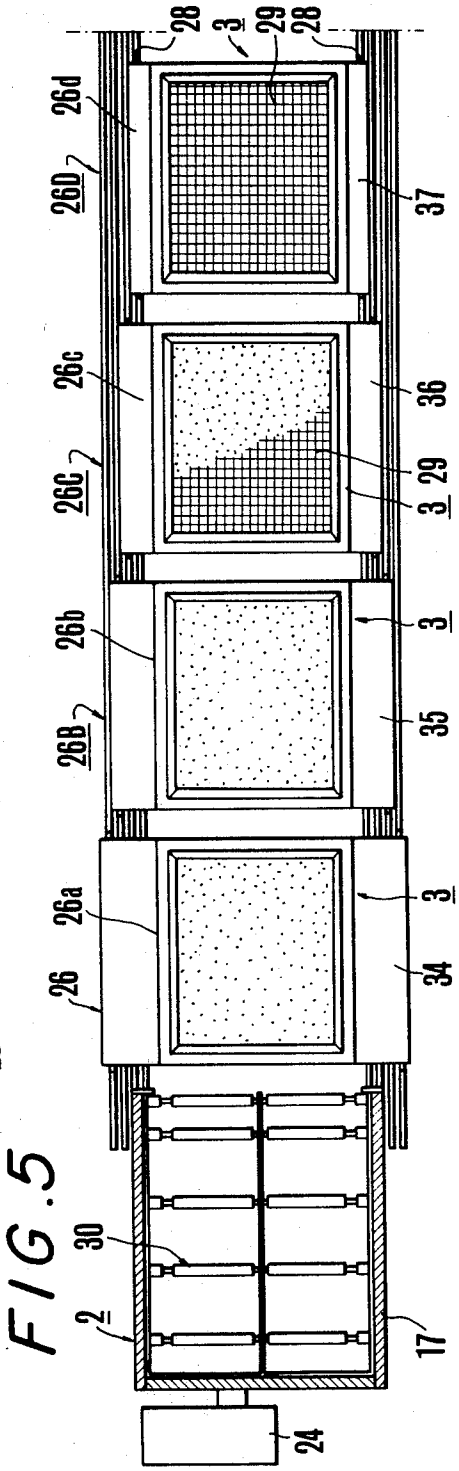

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26d
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26c
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26C
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26b
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26a
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FIG. 5

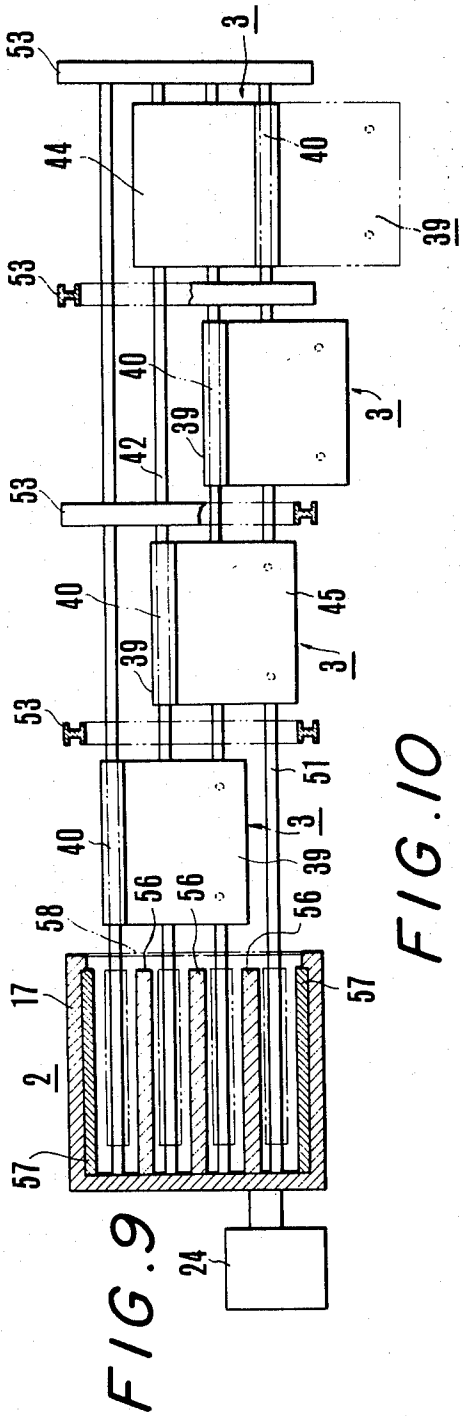


FIG. 9

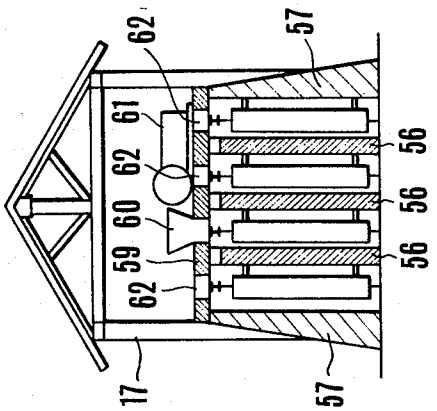


FIG. 10

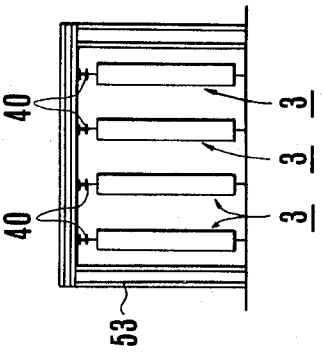


FIG. 11

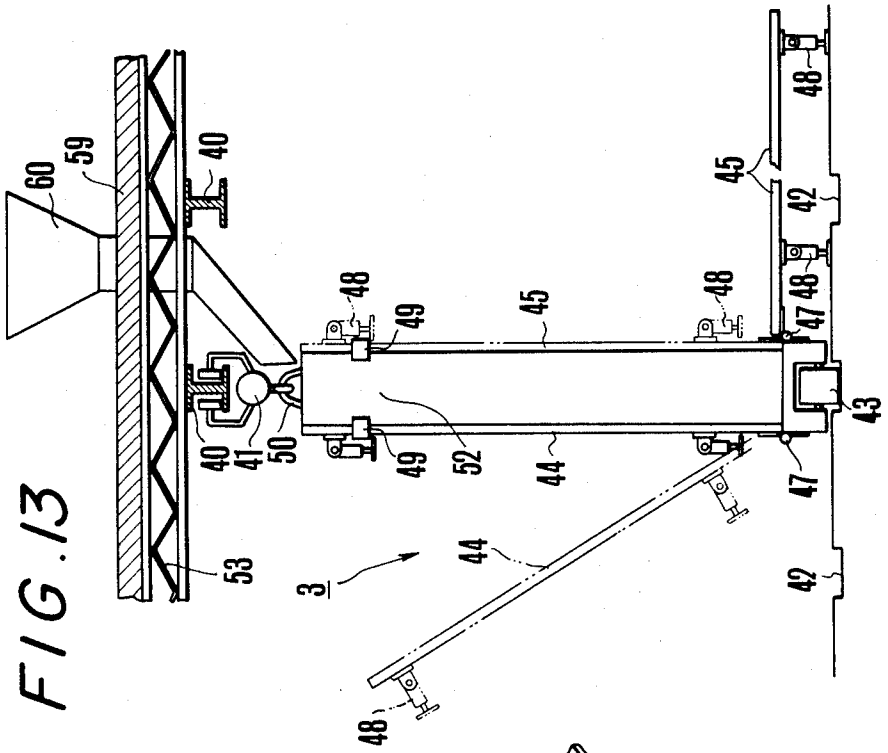

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FIG. 13

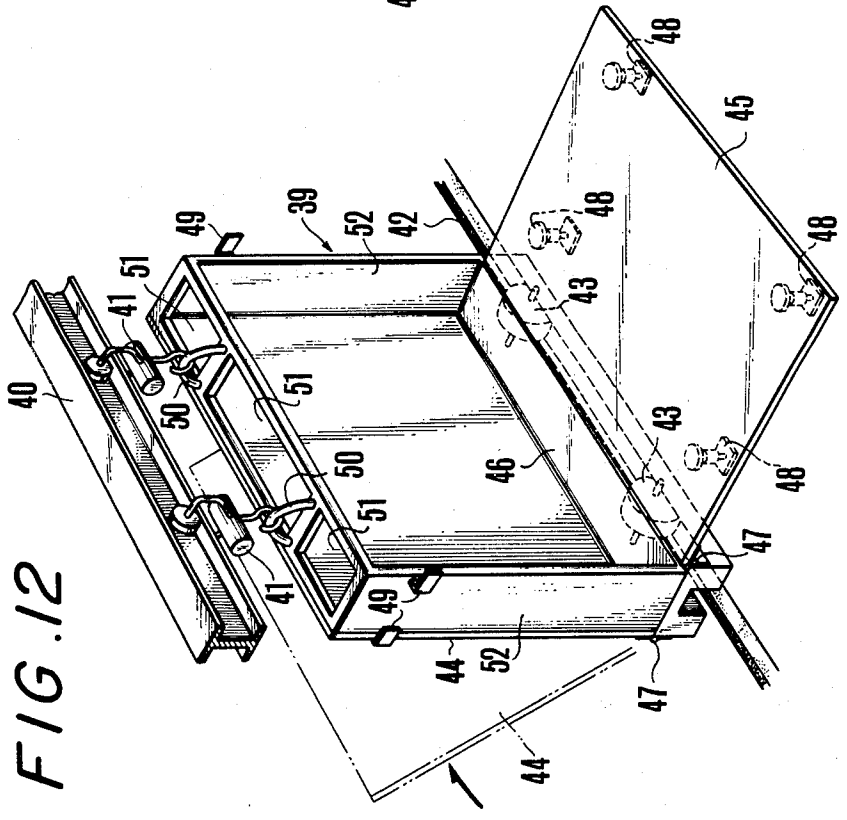

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FIG. 12

APPARATUS FOR PRODUCING PRECAST CONCRETE MEMBERS

The present invention relates to an apparatus for producing precast concrete members. Further, the invention relates to an improved apparatus for producing the precast concrete members (hereinafter referred to as "PC member"), in which the concrete placing and curing are performed in multilayered relation with continuous manner, and the apparatus of the present invention is suitable for the production of the PC members in the construction site, as it is compact and mobile one.

The present invention provides a novel apparatus for producing the PC members which is characterized in several advantages of the readiness of concrete placing, the savings of equipments and floor space in the arrangement and the workability of the conveyer system. Further, the apparatus of the invention comprises several unit parts which can be assembled and disassembled without any trouble and difficulty. Therefore, the apparatus is very convenient for the production of the PC members in the construction site, and the construciton work can be rationalized.

In the apparatus of the invention, the concrete placing sections being provided with form members, are positioned near the curing chamber, and the preliminary work and placing of concrete can be carried out separately or concurrently in said sections to improve the workability.

Several steps in the production of the PC members by the apparatus of the invention can be carried out independently with regard to respective production processes, the control of curing chamber is easy, the supply of the raw material is convenient by the fixed place production, the inspection of the process is easy to facilitate the check of defects, and there is no fear of delay caused by the preceding and following steps.

Further, in the apparatus of the invention, the main portions comprise multi-layered unit bodies which are suitable as the mobile plant, in addition to that each form member can be introduced into or taken out from the curing chamber separately, thus the workability can be increased very much.

Still further, with regard to the apparatus of the invention, the working space is small as the apparatus is multi-layered arrangement to save the cost for land, the preliminary work for the form member is carried out on each multi-layered support truck, each support truck is moved independently with regard to other support trucks, the order of the work can be determined at will, and the work can be started from any support truck, thus the work hours can be used most efficiently. Furthermore, the complete cycle of production can be designed by providing each production line with each time schedule, and the taking out of the form members from the curing chamber can be performed at any time.

Lastly, in one embodiment of the apparatus of the invention, the form member comprises a flat box which is vertically held, and moved in the horizontal direction from the working section to the curing section without causing any disturbance to other form members, and the form member can be held vertically in the curing chamber, thereby improving the workability, saving the space for the curing chamber and facilitating the control of the curing chamber.

In order that the invention may be more fully understood, preferred embodiments and various supplementary features will be described with reference to the accompanying drawings, in which:

FIG. **1** is an elevational view partly in section of an embodiment of the apparatus of the invention in which the supporting tables and the curing chamber are made of layered unit bodies;

FIG. **2** is a plan view partly in section of the embodiment as shown in FIG. **1.**

FIG. **3** is a perspective view of a unit body;

FIG. **4** is an elevational view partly in section of the second embodiment of the apparatus of the invention in which support trucks are employed as the support members for the form members;

FIG. **5** is a plan view partly in section of the second embodiment;

FIG. **6** is an elevational view of the support trucks which are combined into one;

FIG. **7** is a perspective view of the support truck;

FIG. **8** is an elevational view partly in section in which a plurality of the support trucks are combined and are positioned in front of the curing chamber;

FIG. **9** is a plan view partly in section of the third embodiment of the apparatus of the invention in which the form members comprise boxes and are suspended by the horizontal transfer means provided in parallel to the concrete placing section;

FIG. **10** is a vertical sectional view of the curing chamber of the third embodiment;

FIG. **11** is a vertical sectional view of the concrete placing section;

FIG. **12** is a perspective view of the form member; and

FIG. **13** is a side view of the form member which is hung by the hanger rail.

In the following, the embodiments of the present invention will be explained according to the accompanying drawings.

The first embodiment of the invention is shown in FIGS. **1** to **3.** The apparatus of the invention consists of a plurality of layered unit members to form the supporting members in the working or concrete placing section. The unit support tables which carry the form members **3** are piled up in different layers with each other, so that the placing work can be carried out in each different stage. Said unit member **11** comprises, as being shown in FIG. **3,** square pillars at the four corners and a floor plate which is supported by said pillars. This unit member **11** can be laid on another member **11** by said square pillars, therefore a combination of multi-layered unit members **11** can be formed and this combination can be separated with ease to the respective unit members **11.**

The number of layers of the support table **12** is the same as that of the curing chamber **2,** and the numbers of layers of the adjacent support tables **13, 14** and **15** are reduced one by one. The surface of the floor plate of said support table is provided with rollers **16** and fixing means for said rollers, thereby the form member **3** can be moved on said floor plate horizontally. The uppermost stage **12***a* of said support table **12** is positioned on the same horizontal level of the corresponding uppermost stage **19** of the curing chamber **2** and the form member **3** is moved through them. The uppermost stage **13***a* of the support table **13** is positioned on the level of the second stage of the support table **12,**

through which the form member 3 is moved to and from the second stage 20 of the curing chamber 2. In like manner as the above, the support tables 14 and 15 are arranged so as to move the form members 3 from the uppermost stages 14*a* and 15*a* to the third stage and the fourth stage of the curing chamber 2, respectively. Further, the pillars of each support table can be provided with moving means such as wheels in order to facilitate the movement of the support table in the working section. Then the arrangement of each apparatus or transfer of the apparatus can be carried out easily.

The curing chamber 2 of this embodiment comprises a structure 17 which holds the form members 3 in layers, and the opening 18 thereof faces the working section 1. In said structure 17 support stages 19, 20, 21 and 22 are provided, which are positioned to correspond respective stages of said support tables. A plurality of rollers 23 are fitted to said support stages and they are rotatable and facilitate the movement of said form member 3. Further, this curing chamber 2 may be made of heat insulating material and it is provided with a high temperature steam generator 24 such as a boiler.

Further, the above-mentioned structure itself can be formed with using the unit members 11 which are common with the above support tables. Above the working section 1, a hopper chute 25 for the fresh concrete placing is provided, and the chute 25 is hung by a suspending device (not shown) such as a crane and is moved vertically and longitudinally.

In the operation of the above-mentioned apparatus, the support tables 12 – 15 are put side by side in front of the opening of the curing chamber 2, and each form member 3 is placed upon each uppermost support table. Then the reinforcing steel is disposed on the form member 3 and the fresh concrete is placed into said form member 3 from the hopper chute 25. Of course, in the above procedure, the usual steps such as cleaning of the form, applying of the release oil, fitting of joint members, pipings and wirings may be carried out before the placement of the concrete.

After the placing of the fresh concrete, each form member 3 is shifted horizontally into each stage of the curing chamber 2, and is subjected to the preheating. Then the form member is taken out from the curing chamber 2 to receive the surface finishing and thereafter the form member 3 is transferred again into the curing chamber 3 to be cured completely. After the curing, the form member 3 is taken out from the curing chamber 2 and the precast concrete slab is released from the form member 3 which is hung by a crane and transferred to the depository. The above-mentioned process will be then repeated to produce other concrete slabs. These processes can be carried out independently in each level of the support table, while said rollers 16 are to be fixed to or lowered from the stage of the table sduring the placing work.

Next embodiment is shown in FIGS. 4 to 8, in which the support table comprises a truck 26. The lowermost ends of this support truck 26 are provided with wheels 28, thereby the support truck 26 can be moved freely in the working section 1. The support trucks 26 are disposed side by side in order to of their height, then the form members 3 are laid on the support trucks 26, the form members 3 are subjected to cleaning, arrangement of the reinforcing steel 29 and other necessary preparations, and the fresh concrete is placed into said form members 3 from the hopper chute 25. Then the form members 3 are shifted into the curing chamber 2 where the racks 30, 31, 32 and 33 are formed by a plurality of roller shafts. Accordingly, each height of the support truck 26 corresponds to each stage of the racks in the curing chamber 2. That is, the support truck 26 having the table 26*a*, the height of which corresponds to the uppermost rack 30 of the curing chamber 2, is larger than the next support truck 26B having the table 26*b*, the height of which corresponds to the second rack 31 of the curing chamber 2, and said support truck 26 receives therein the support truck 26B. The similar relations may be applied to the other support trucks 26C and 26D, so that the support trucks 26, 26B, 26C and 26D can be combined in the state as shown in FIGS. 6 and 8, while they can be disposed side by side as shown in FIG. 4 with ease. The differences of the height of the support trucks may be such that, when the trucks are combined into one, the distances between the adjacent tables 26*a*, 26*b*, 26*c* and 26*d* are sufficient to receive the form members 3. Accordingly, when the height of the lowest support truck 26D is determined, the heights of the upper support trucks can be set in turn. The extending portions 34, 35, 36 and 27 beside those occupied by the form members may be used as the operators' platforms during the concrete placing.

In practice, the support trucks 26 to 26D are drawn one by one on a straight line in front of the opening of the curing chamber 2 in the working section 1, and the hopper chute 25 is movably provided on the support trucks to place the fresh concrete into the form members 3 on each support truck. After several preliminary work operations such as cleaning of the form members and arrangement of the reinforcing steel, the fresh concrete is placed by moving the hopper chute 25, in which in order to facilitate the above work, a step device 38 is provided as shown in FIG. 8. Said step device 38 may be of the type as the entrance steps of a passenger aircraft which has stairs each corresponding to the height of each table or the surface of the form member, and can be moved along the support trucks 26 to 26D by the provision of the wheels, thereby the workman can get on the support trucks.

The curing chamber 2 comprises a structure 17 and a boiler room 24 to generate high temperature steam, and is provided with multi-layered racks 30, 31, 32 and 33 to hold the form members thereon. Each rack 30, 31, 32 or 33 is positioned on the same horizontal level of each support table 26, 26B, 26C or 26D, so that each form member 3 can be placed on each rack in the curing chamber 2 by moving the form member to the horizontal direction.

Further, the structure 17 is made of heat insulating material, and is prefabricated so as to be assembled and disassembled with ease. At least one opening of the curing chamber is of course necessary, while the curing chamber 2 can be provided with two openings on both sides when the chamber 2 is positioned at the center of the working section 1, then both sides of the openings are provided with the support trucks 26 – 26D, separately. Further the curing chamber 2 is naturally provided with the closing means at the opening when it receives the form members placed with the fresh concrete.

Still further, guide rails to be engaged with the wheels 28 of the support trucks 26 – 26D can be provided on the floor of the working section 1 which facilitate the shifting of the support trucks, and said wheels of the

support trucks can be driven by any driving means. Further, if the tables of the support trucks are provided with rollers which are similar to those of the curing chamber **2** and the rollers are fixed by some means during the concrete placing work, the movement of the support trucks **26** – **26D** into or out of the curing chamber **2** can be facilitated.

As explained in the above, any of the support trucks **26** – **26D** can be subjected to concrete placing work independently with each other, in which the form member **3** is laid on the table of the support truck, the preparations of the form member **3** such as cleaning of the form and arrangement of the reinforcing steel are carried out, the chute **25,** is shifted on the support truck, and the fresh concrete is fed to the form member **3.** After the concrete placing, the support truck is moved through or over the other support trucks to the curing chamber **2,** and the form member **3** is shifted on the corresponding rack in the curing chamber **2.** Therefore, each work on each support truck can be carried out independently with regard to other trucks. After the curing of the concrete material, the support truck with the corresponding height is moved to the opening of the curing chamber **2,** and the form member **3** is drawn out from the chamber **2,** then the form member **3** is transferred by a crane to an appropriate position and the PC member is released from the form member **3.** It will be convenient to use the step device **38** in these work.

Further, it is possible to omit the racks **30** – **33** in the curing chamber **2,** then the whole of the support truck may be positioned into the curing chamber **2** for curing.

The third embodiment as shown in FIGS. **9** to **13** has flat rectangular boxes as the form member **3** for the molding of PC members, which are quite different from those of the foregoing embodiments. However, this embodiment is provided with several corresponding devices to those of the foregoing embodiments and is used for the same purpose and in the similar manner. The box **39** is hung by a pair of monorail hoists **41** which are slidably fitted to a hanger rail **40,** thus the box **39 81** can be moved in the direction of the flat surface of the box. The bottom of the box **39** is provided with rollers **43** which engage with the channel rail **42** being installed on the floor of the working section **1.** Of course, this box **39** can be self-standing one without using the hanging device, and the rollers and rails may be any of the conventional ones. Said box **39** comprises inside mold surfaces and outer frame members which reinforces said inside mold surfaces, and the end plates **52** are fixed to the bottom. At least one of both side **44** and **45** which are facing each other, for example the side plate **45** is hinged to the bottom plate **46** by a hinge **47** to be opened or closed. As shown in FIGS. **12** and **13,** these side plates **44** and **45** are provided with pairs of stays **48.** Further the end plates **52** are provided with locks **49** in order to fix the side plates **44** and **45** to the end plates **52** to form a box. The upper face of the box **39** is provided with hanger rings **50** and a reinforcing frame and the remainder portion of the upper face is left open as the openings **51.** When the side plate **45** is brought down and laid horizontally on the floor, and when the box is inserted into the curing chamber **2,** said stays **48** are used. On the side plate which is brought down on the floor, several works such as cleaning of the form, arrangement of the reinforcing steel and setting of other insertions are carried out. Accordingly, the positions of the stays **48** are at the outer sides of the upper and lower sides of said side plate **45,** and the stays may be provided with conventional folding mechanism or telescopic mechanism. The above-mentioned hanging rings **50** are held by a pair of the monorail hoists **41.** Therefore, the box **39** can be moved smoothly even when the hanger rail **40** is curved. Said openings **51** is used as the entrance for the fresh concrete and for the work of the top surface finishing.

The above-mentioned form member **3** may be used for producing precast concrete slabs having no openings, however, if the opening must be formed, the corresponding form member can be placed within the box and the side plates **44** and **45** are hollowed out according to the conventional manner.

The working section **1** is installed with a plurality of gate frame **53,** and between the upper beams of the gate frames **53,** a plurality of hanger rails **40** are attached leaving proper distances with each other. Under the beam portion of the gate frame **53,** a proper number of the hanger rails **40** which having I-shaped sections are provided, and one end of each hanger rail **40** is introduced into the curing chamber **2.** The above-mentioned combination of the gate frames **53,** hanger rails **40** and floor rails **42** is one example of the transfer means for moving the form members **3,** while if the form members **3** are of self-standing types, only said floor channel rails **42** will be sufficient as the transfer means. The area of the working section **1** must be at least twice as large as the size of each form member **3,** and each span of the gate frame **53** may be larger than the longitudinal size of said form member **3.** In FIG. **9,** four gate frames **53,** four hanger rails **40** and four form members **3** are provided, thus each form member **3** can be subjected to the work in each span concurrently. These gate frames may be preferably formed so as to be assembled and disassembled.

Further, as shown in FIGS. **9** to **11,** the curing chamber **2** is a conventional housing comprising a structure **17** and a boiler room **24** for the supply of high temperature steam. The structural parts of the aboves are almost the same as those of the above-mentioned frames. The structure **17** is made of the conventional heat insulating wall members and roof members, and in the structure **17,** a plurality of heater plates **56** are disposed, between which the form members **3** are interposed vertically. These heater plates **56** diffuse the steam from the boiler room **24** directly or indirectly to the inside of the structure **17,** and if the steam is not employed for the curing, the heater plates **56** may be electric heaters. Apertures are provided above these heater plates **56** so as to facilitate the circulation of the steam within the curing chamber **2** after the form members **3** are inserted in the chamber **2.** Interposing these heater plates **56,** the side walls of the structure **17** are provided with abutments **57** which hold the form members **3** during the concrete placing and thereafter. The opening **58** of the curing chamber **2** which facing the working section **1** is provided with a closing means to shut up the chamber **2.**

As shown in FIG. **10,** the curing chamber **2** is a two-story structure and is provided with an upper floor **59,** on which the concrete placing machines, for example a hopper **60** and a concrete mixer **61** are installed. Further the floor **59** is provided with a plurality of apertures **62** which communicate to the curing section of

the lower floor. The bottom end of the hopper **60** can be communicated to the transferred form member **3** in the curing chamber **2.** The curing chambers **2** can be placed at the both ends of the working section **1,** thereby the workability will be improved further.

With regard to the preparation for the concrete placing, as shown in FIG. **9,** each form member **3** is fixed between each span of the gate frames, the side plates **44** and **45** are opened, and the aforementioned preliminary work is carried out, thereafter the form member **3** is closed to form the box **39** and is introduced into the curing chamber **2.** Then, as shown in FIG. **10,** the form member **3** is stood against each of the heater plates **56** using the above-mentioned stays **48,** further the form member **3** is held tightly by the abutment **57** within the curing chamber **2.**

As shown in FIGS. **10** and **13,** the fresh concrete is poured into the form member **3** from the flexible tube which is attached to the bottom end of the movable hopper **60** on the upper floor **59.** As explained in the above, the concrete is fed into the form member through the opening **51** vertically, therefore the advantage of the vertical placing can be expected, that is the surface of the finishing is very small as compared with the horizontal placing method.

As explained in the above with regard to this embodiment of the invention, the preliminary work of the form member **3** such as cleaning and arrangement of the reinforcing steel are carried out independently in each span of the gate frame and the form member **3** are put into the curing chamber **2** separately, thereafter the fresh concrete is poured into the form member **3** and cured properly. If the side plate **45** of the form member **3** cannot be opened by the condition of the working section **1,** or the plate **45** stands in the way of other form member **3,** the other side plate **44** can be opened. If the working section is large enough, the spaces between the rails may be enlarged, or the working section is formed in a fan shape, thereby the preliminary work for the form members **3** can be carried out separately without disturbing others.

The above-mentioned apparatus of the present invention can be assembled and disassembled with ease and portable, therefore they can be used as the mobile plants. The necessary space for the apparatus of the present invention is at least the width of the opened form member and twice of the length of the form member, while in this case single preliminary work for the concrete placing is carried out.

It should be emphasized, however, that the specific embodiments described and shown herein are intended as merely illustrative and in no way restrictive of the invention.

I claim:

1. Apparatus for producing precast concrete members, comprising:

a curing chamber having a side facing a concrete placing section; means in said curing chamber for curing concrete;

a concrete placing section having a side facing said curing chamber side;

concrete form members for receiving concrete while said form members are in said concrete placing section and for forming and shaping the concrete into a predetermined shape and which carry the concrete they receive into said curing chamber;

means for supporting and moving said form members into and between said curing chamber and said concrete placing section;

said supporting means for said form members comprises a first plurality of vertically spaced layers of supports for concrete form members positioned in said curing chamber;

a second plurality of rack means for carrying said members; said rack means being arranged one after the other in a series leading up to said curing chamber side and the last of said rack means being positioned at said curing chamber side; each said rack means being at least the length of a said form member in the dimension along the series thereof;

each said rack means including a respective plurality of vertically spaced layers of supports for concrete form members; said rack means nearest said curing chamber side having said first plurality of layers of supports, and each said rack means next in series further away from said curing chamber side having one fewer of said layers of supports, reducing downwardly from the uppermost said layers of supports; each said rack means layer of supports being aligned with a respective said layer of supports being aligned with a respective said layer of supports of said curing chamber, thereby enabling said form members to be moved along said rack means and into said curing chamber;

means for reciprocally moving said form members between the said rack means at which each said form member is at the top said layer of supports and said curing chamber.

2. An apparatus for producing precast concrete members of claim **1,** wherein each said rack means layer of supports comprises: a single frame and means on said frame for supporting a single said form member; and pillars projecting away from each said frame to support that said frame spaced apart from the neighboring vertically spaced said frames of that said rack means.

3. Apparatus for producing precast concrete members, comprising:

a curing chamber having a side facing a concrete placing section; means in said curing chamber for curing concrete;

a concrete placing section having a side facing said curing chamber side;

concrete form members for receiving concrete while said form members are in said concrete placing section and for forming and shaping the concrete into a predetermined shape and which carry the concrete they receive into said curing chamber;

means for supporting and moving said form members into and between said curing chamber and said concrete placing section;

said suporting means for said form members comprises a first plurality of vertically spaced layers of supports for concrete form members positioned in said curing chamber;

a second plurality of rack means for carrying said form members; said rack means being arranged one after the other in a series leading up to said curing chamber side and the last of said rack means being positioned at said curing chamber side; each said rack means being at least the length of a said form member in the dimension along the series thereof;

each said rack means comprising a separate support for said form members; each said support being independently movable; each said support being at the height of a respective said layer of supports in said curing chamber, and each said support having a different respective height; each said support being of a shape which enables it to be passed under all said supports that are taller than itself and above all said supports that are shorter than itself, thereby enabling each said support to be moved up to said curing chamber side and into said curing chamber;

moving means for moving each said support between said concrete placing section and the inside of said curing chamber.

4. An apparatus for producing precast concrete members of claim **3,** wherein each said support comprises a respective movable truck and said truck being supported on roller means which permits said truck to be rolled toward and away from said curing chamber and into said curing chamber.

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