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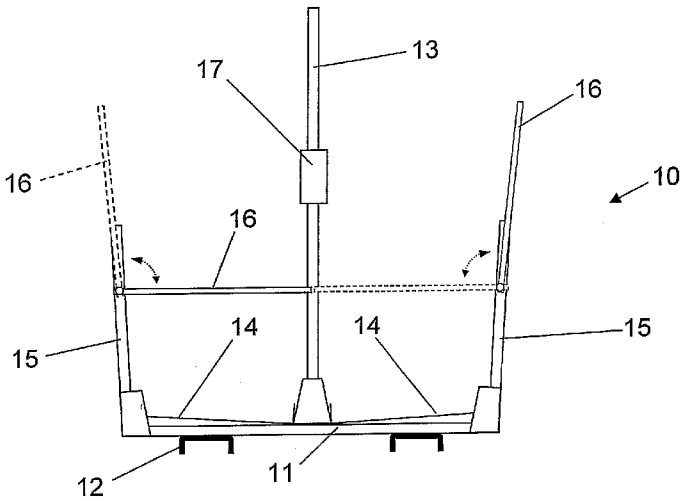
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(54) Title: MATERIALS HANDLING SYSTEM



(57) Abstract: A materials handling system for transporting and positioning wall frames of a prefabricated building structure from a factory location to the final end position as part of a building under construction comprises three principal elements. A stillage sled (10) supports a stack of wall frames, each panel being in substantially upright orientation. The complete stack, on the stillage sled, can be lifted onto a lorry for transport by road to the building site, and can be lifted from that lorry by crane to an appropriate floor level of the building under construction. A gantry (20) at that floor level permits offloading the wall frames singly from the stillage sled. A masted lifting truck (30) receives the individual wall frames from the gantry and carries them to their precise end positions on the floor of the building under construction.

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Materials Handling System

DESCRIPTION

Field of the Invention

The invention relates to a materials handling system for the controlled movement of pre-formed wall frames of a pre-fabricated building structure from the factory location to a final end position as part of building under construction.

Background Art

In modular building construction it is known to assemble a building from factory-formed modular building panels each fabricated from steel rails bolted, welded or brazed together to create a dimensionally precise and structurally sound wall frame. One very cost-effective construction system utilizes cold-formed structural steel to create the wall frames. The steel is cold-formed into various profiles to create the necessary rigidity, and each wall frame comprises a framework which includes some vertical members, some horizontal members and optionally one or more diagonal cross-brace members. Z-section cold-formed structural steel members are secured to the frameworks in the final building to provide off-set support shoulders for supporting plasterboard panels on the inside walls of the building, or for supporting cladding on the outside. Recent advances have made it possible to construct buildings twelve or more storeys high using such wall frames joined at their opposite end uprights to one another or to vertical support pillars of the building structure.

One advantage of the use of such wall frames to erect a pre-fabricated building is that the building can be constructed floor by floor. As each storey is finished by positioning a pre-fabricated floor unit supported around its periphery by the top rails of the wall frames of the floor below, those floor

panels themselves create a smooth working platform for the erection of the next storey.

Traditionally the individual wall frames have been manufactured to precise sizes in a factory, carefully numbered or coded for identification purposes (because not all of the floor panels will be identical, some being different sizes or shapes and some including window or door openings) and then lifted individually onto a lorry, generally as a stack of wall frames laid horizontally. The stack of panels is then transported to the building site where the panels are lifted from the lorry individually by an overhead crane, and swung by the crane into the approximate final position where they are needed in the building under construction. This final lifting into position is quite labour intensive. The crane operator is a skilled operative, and a team of workmen is required to guide the individual panels to the end location, to supervise the offloading from the crane whilst supporting the panel manually, and finally to manoeuvre each panel manually to its desired end position. During this operation there is considerable scope for error in the actual sequencing of the wall frames. The crane operator cannot read the code marked on each panel he is handling, and therefore good communication must be established between a supervisor at the lorry that has delivered the wall frames, informing the crane driver and the team of workmen at the relevant floor level of the exact panel being lifted and its desired location in the finished building. If the panels are laid flat on the lorry and if the sequence of panels in the stack has been mixed up at the factory end when loading the lorry, then the panels may be lifted from the lorry by the crane in a sequence that is incompatible with the final building sequence, which means that the crane operator may have to offload one or more panels and place them in an intermediate storage location prior to retrieving the desired next panel in the building sequence.

There is a great need for a reliable materials handling system for facilitating the transportation of the factory-made wall frames from the initial factory site to their end positions in the building under construction, in the reliably correct

sequence. There is also a great need for such a system which reduces as far as possible the number of personnel required to oversee the handling of the panels, and to manoeuvre individual panels to their precise end positions in the building under construction.

The invention

The invention provides a materials handling system as defined in claim 1. There are three principal elements to the materials handling system: the stillage sled, the gantry and the masted lifting truck. The stillage sled permits the stacking and transportation of a number of wall frames in a generally vertical orientation, as opposed to being laid flat. That has two advantages. In the first place there is an energy saving, because energy and fuel have to be expended in lowering individual panels from a vertical orientation to a horizontal stack (as was common in the prior art) simply to have to raise them once again to a vertical orientation for presentation up in the final building. The use of a vertical or substantially vertical stack also makes it much easier to extract a wall frame from other than the end of the stack if for any reason the sequence of wall frames stacked onto the stillage sled at the factory is not the correct sequence for incorporation into the building under construction. A complete stack can be assembled in the factory and moved around by fork lift truck to await the arrival of the lorry on which the wall frames are to be transported to the final building site. The lorry loading time is therefore much reduced, because the entire stack can be loaded by crane or by fork lift truck in one loading operation. Similarly the unloading time at the building site is very much reduced. The overhead crane can lift the entire loaded stillage sled from the lorry in one operation, and deposit that stillage sled and the complete stack of wall frames to a suitable location at the top floor level of the building under construction. That location should be adjacent a gantry, which is the second principal element of the materials handling system of the invention.

The gantry comprises an overhead track supported by wheeled end frames. The wheels are preferably castor wheels, and preferably the overhead track of the gantry is at least twice the length of the longest wall frame. In use the gantry is moved manually on its castor wheels to a position straddling the loaded stillage sled, and there anchored in a fixed position. The track preferably carries a pair of trolleys each supporting lifting tackle having hook means for engaging end uprights of individual wall frames in the stack. The lifting tackle can then be used to lift individual floor panels from the stillage sled, and to slide them longitudinally along the track to a position immediately to one side of the stillage sled. There the individual wall frames can be picked up by the masted lifting truck which is the third principal component of the materials handling system of the invention. It will be appreciated that the lifting of the wall frames from the stacked stillage sled and their movement along the track of the gantry requires only one or two building workers, because at no time does the wall frame have to be lifted manually without mechanical assistance. The lifting tackle can be geared such that it is suitable for one man operation, and if the trolleys running on the overhead track of the gantry are sufficiently low friction, it is quite feasible for one or at most two persons to move the individual wall frames from the stack and out to a position to one side of the stillage sled for collection by the masted lifting truck.

The masted lifting truck preferably comprises a motorised lifting mast having means for engaging beneath the top span of the wall frame that has been swung outwardly on the gantry, alongside the stillage sled. Preferably the truck includes a visible location marker such as an arrow for alignment with a centre of gravity mark on each wall frame being handled, to assure stable lifting of the wall frames by the lifting truck. That is important because the wall frames may not have a symmetrical weight distribution. If there is a window or door opening in a wall frame, then the centre of gravity of the panel may be significantly to one side or another of the centre line. It is however very easy in the factory, where the wall frames are preferably manufactured under

computer control, to calculate where the centre of gravity will lie, and to mark that centre of gravity on the wall frame.

The only motor needed on the lifting truck is that for raising and lowering the lifting mast. It may be a mechanical or hydraulic motor, such as a hydraulic ram. Once the truck picks up the weight of the panel, that panel can be freely moved by pushing the trolley, which is preferably on castor wheels, to bring the panel to the precise end position on the floor of the building under construction where it is to be connected to previously positioned wall frames. It is quite easy for one man or at most two men to position the panel in this way, and no physical lifting of the panel is necessary because all the lifting effort is provided by the motorised lifting mast of the truck.

The reduction in on-site manpower involved in moving the individual wall frames in the correct sequence to the required precise end locations is very significant, as is the speed at which the panels can be moved into their precise end locations. At all times the sequence of removal of wall frames from the stack is under the control of the workmen alongside the panels who can see the precise coding on the individual panels, so the need for detailed and constant communication between the persons on the ground and the crane operative is reduced to an absolute minimum. On completion of each storey of the building the empty stillage sleds can be lifted down by crane to ground level, possibly directly onto the back of a waiting lorry; and the gantry and masted lifting truck can be lifted by crane to the floor level of the next higher storey that is to be constructed.

Drawings

Figure 1 is an end view of a stillage sled of a materials handling system of the invention;

Figure 2 is a schematic perspective view of the sled of Figure 1;

Figure 3 is a schematic perspective view of a gantry of a materials handling system of the invention;

Figure 4 is a very schematic side view of a lifting trolley of a materials handling system of the invention;

Figure 5 is a schematic perspective view of the lifting trolley of Figure 4.

Figures 1 and 2 illustrate the stillage sled 10 which is the first customised piece of equipment to be used in the system of the invention. It comprises a base 11 raised from the ground on two parallel flanged C-section rails that are spaced apart by the normal separation of the tines of a fork lift truck. The rails 12 ensure that when the stillage sled is picked up by a fork lift truck, the pick-up is central of the sled, so that the risk of the loaded stillage sled over balancing is minimal.

The sled is provided with a central support frame 13 against which wall frames can be leaned in a generally upright position. A metal floor 14 over the base 11 is angled slightly, making it easier to stack the stillage sled with a number of wall frames all resting against the central support frame 13. A pair of side frames 15, one on each side of the central support frame 13 at their base prevent outward lateral movement of the bottom edges of the wall frames of the stack during transportation. Figure 1 illustrates a pair of pivotable end guards 16, one on each end of each side frame 15, which can be lifted to the position shown in solid line to the right of Figure 1 to assist the loading of the stillage sled, and then lowered to a locked position as shown in solid line to the left of Figure 1 so that they overlie the opposite ends of the stack of wall frames supported by the stillage sled, to prevent longitudinal movement of the wall frames of the stack during transportation. Latching means (not illustrated) are provided for securing the end guards in their horizontal position during transportation.

Instead of the solid rail end guards illustrated in Figure 1, there may be provided any other form of end guard devices to prevent longitudinal movement of the wall frames of the stack during transportation. For example, webbing straps may be provided in the stillage sled illustrated in Figure 2, and

tightened preferably using a ratchet mechanism before the stacked stillage sled is transported. The advantage of webbing straps is that they can be interlaced through the wall frames of the stack, effectively tying those wall frames together as well as securing them in the stack to the stillage sled.

Figure 3 illustrates a gantry 20 which is the second bespoke piece of apparatus to be used in a materials handling system according to the invention. The gantry 20 comprises two end frames 21 which support an overhead track 22. The track 22 may be a conventional I-section reinforcing steel joist, or any other structural member which provides a smooth running surface for two trolleys 23. The trolleys 23 each support lifting tackle 24 which as illustrated comprises a looped length of chain terminating in hook means for engaging end uprights of individual wall frames for lifting them individually from the stillage sled 10. An operator would pull on the chain of the lifting tackle 24 in order to lift individual wall frames from the stack, and the gearing of the lifting tackle would be such as to make it possible for a single operator to lift each end in turn of the wall frame being lifted from the stack. Instead of the purely manual mechanical advantage that can be obtained by looping a chain through a block and tackle, it is of course feasible for the lifting tackle to be power assisted, for example by a battery driven electric motor.

The length of the overhead track is slightly longer than twice the length of an individual wall frame, so that by positioning the gantry above and alongside a stillage sled, individual wall frames can easily be lifted from the sled, and then rolled out laterally using the trolleys 23 to a collection position alongside the stillage sled. Clearly this requires accurate positioning of the gantry relative to the stillage sled, and for that reason each end frame 21 of the gantry 20 is mounted on castor wheels 26 to permit the gantry to be manoeuvred into the correct position, aligned with the stillage sled with one end of the overhead track 22 immediately above the stack of wall frames on the stillage sled 10. Once the gantry 20 is in position, it can be anchored by screwing down four

screw jack brake means 27, each of which presses a brake pad against the ground adjacent the corresponding castor wheel 26.

Figures 4 and 5 represent very schematically indeed a masted lifting truck 30 which comprises the third element of the equipment necessary for carrying out the material handlings system of the invention. The truck 30 comprises a body 31 which incorporates a motor for the lifting mechanism. That motor may be a battery powered electric motor or the power source may be an on-board engine. Battery power is very suitable indeed, however, as the weight of the batteries within the body 31 provides exceptional stability for the truck 30. The truck 30 moves freely on castor wheels 32, although a brake mechanism (not shown) is advantageously provided for locking the truck in one position for safety reasons. The truck 31 has a mast 33 which slidably supports a lifting bar 34 for engaging beneath the top span of a single wall frame. To assist the stable weight centring of the wall frame on the bar 34 the mast 33 is preferably provided with a highly visible centring arrow 35 immediately above the lifting bar 34. In the factory when the individual wall frames are made, each is preferably provided with a visible marker identifying the centre of gravity of the wall frame. Such markers can be positioned accurately under computer control during the manufacturing process, and by aligning the centring arrow 35 and the marker on the wall frame, it can be ensured that each panel is stably lifted by the lifting bar 34.

The lifting mechanism illustrated in Figures 4 and 5 is a hydraulic ram 36 under the control of a single operating lever 37 at the rear of the truck 30, although it will be understood that any other suitable mechanism could be used for raising and lowering the lifting bar 34.

In use, the stillage sleds 10 of Figures 1 and 2 are filled by stacking thereon in a generally upright condition the individual wall frames as they are manufactured. It is important that the sequence of wall frames on each stillage sled is comparable with the order in which the wall frames are to be

erected in the building under construction, and to that end each stillage sled 10 includes a metal frame 17 which securely holds and displays a printed inventory of the wall frames loaded onto the stillage sled, optionally together with other essential information such as a floor plan showing exactly where those wall frames are to be utilised in the final building. Each wall frame itself is preferably visibly coded at the end adjacent the metal frame 17, so that a visual audit of the panels stacked onto the stillage sled is greatly facilitated.

Once the wall frames have been stacked onto the stillage sled and locked into position using the guard rails 16 or alternatively using webbing straps, the stillage sleds can be stored in the factory or in a warehouse to await transportation. They can be lifted directly onto the transport lorry using a forklift truck or an overhead crane, which greatly facilitates the loading time at the depot. At the construction site the unloading time is similarly accelerated because the entire loaded stillage sled can be lifted from the lorry by an overhead crane, and deposited in a convenient position on the appropriate floor of the building under construction. The overhead gantry 20 is then wheeled into position as described above, and locked in that position using the screw jacks 27 as releasable brake means for the gantry. As each wall frame is lifted from the stack on the stillage sled 10 and swung out longitudinally along the overhead track 22 of the gantry 20, it can be transferred to the truck 30, unhooked from the lifting gear of the gantry, and wheeled directly to the location within the building where it is to be secured as part of the final building structure. One or at most two men can easily operate the gantry 20, and one man can operate the masted lifting truck 30.

CLAIMS

1. A materials handling system for transporting and positioning wall frames of a prefabricated building structure from a factory location to a final end position as part of a building under construction, comprising:

- a stillage sled for supporting a stack of generally upright wall frames and for maintaining that stack as an integral whole during transportation of the stack by road to a building site and during lifting of the stack by crane to an appropriate floor level of the building under construction;
- a gantry for location at that floor level for offloading the wall frames singly from the stillage sled; and

- a masted lifting truck for receiving the single wall frames from the gantry and wheeling them to their precise end position on the floor of the building under construction.

2. A system according to claim1, wherein the stillage sled comprises a base raised from the ground, a central support frame against which generally upright wall frames of the stack can lean during transportation and a pair of side frames, one on each side of the central support frame, for preventing lateral outward movement of the bottom edges of the wall frames of the stack during transportation.

3. A system according to claim 2, wherein the stillage sled further comprises removable end guards for preventing longitudinal movement of the wall frames of the stack during transportation.

4. A system according to claim 3, wherein the removable end guards comprise pivotable guard rails which can be moved pivotally from a position permitting longitudinal movement of the wall frames of the stack to a guard position preventing such longitudinal movement.

5. A system according to claim 3, wherein the removable end guards comprise webbing straps which can extend between anchor points on the central support frame and the respective side frames to prevent longitudinal movement of the wall frames of the stack during transportation.

6. A system according to any preceding claim, wherein the stillage sled includes a receptacle for a highly visible inventory of the different wall frames of the stack and the sequence of those wall frames in the stack.

7. A system according to any preceding claim, wherein the gantry comprises an overhead track supported by a pair of wheeled end frames, the track carrying a pair of trolleys each supporting lifting tackle having hook

means for engaging end uprights of individual wall frames for lifting them individually from the stillage sled.

8. A system according to claim 7, wherein the hook means on the lifting tackle comprise headed studs for engaging in keyhole shaped apertures in the end uprights of the wall frames.

9. A system according to claim 7 or claim 8, wherein the end frames of the gantry are mounted on castor wheels and are also provided with releasable brake means associated with each castor wheel.

10. A system according to claim 9, wherein each releasable brake means comprises a screw jack for lowering a brake pad against the ground adjacent the corresponding castor wheel.

11. A system according to any preceding claim, wherein the masted lifting truck is freely movable on castor wheels.

12. A system according to claim 11, wherein the masted lifting truck comprises a motorized lifting mast having means for engaging beneath the top span of a single wall frame for lifting that floor panel clear of the ground for manual movement to its precise end position.

13. A system according to claim 12, wherein the masted lifting truck comprises a visible location marker for alignment with a centre of gravity mark on each wall frame being handled, to assure stable lifting of the wall frames.

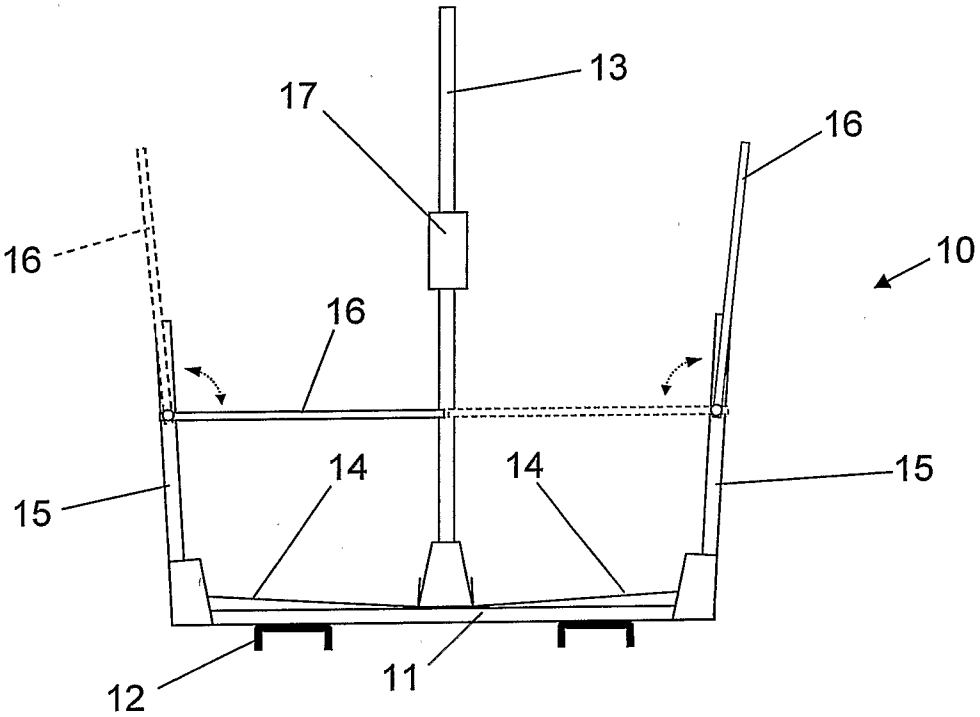


Figure 1

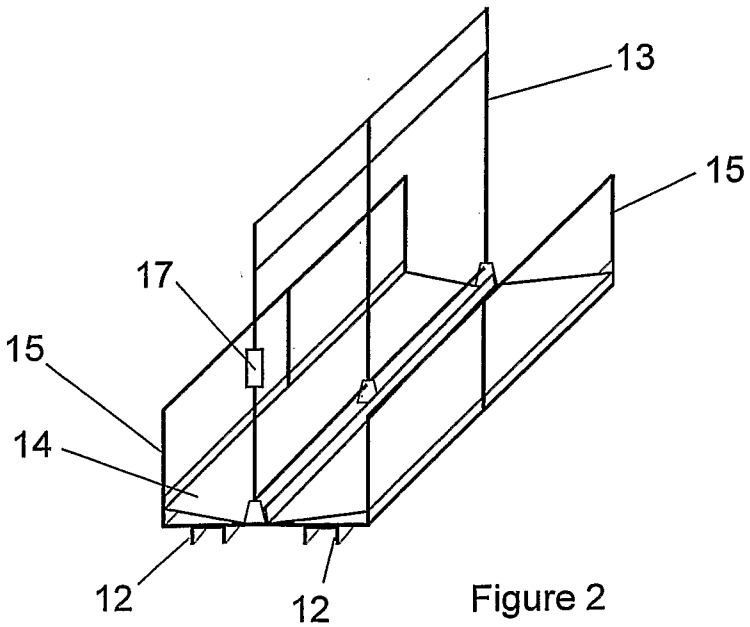


Figure 2

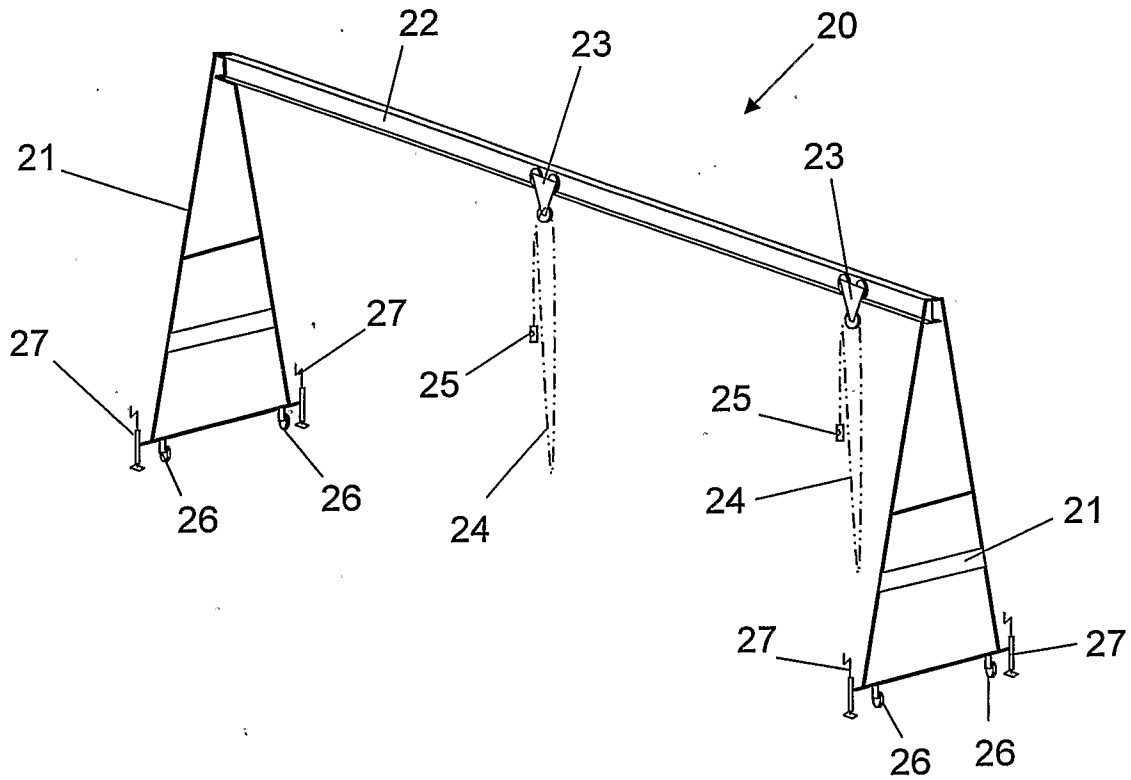


Figure 3

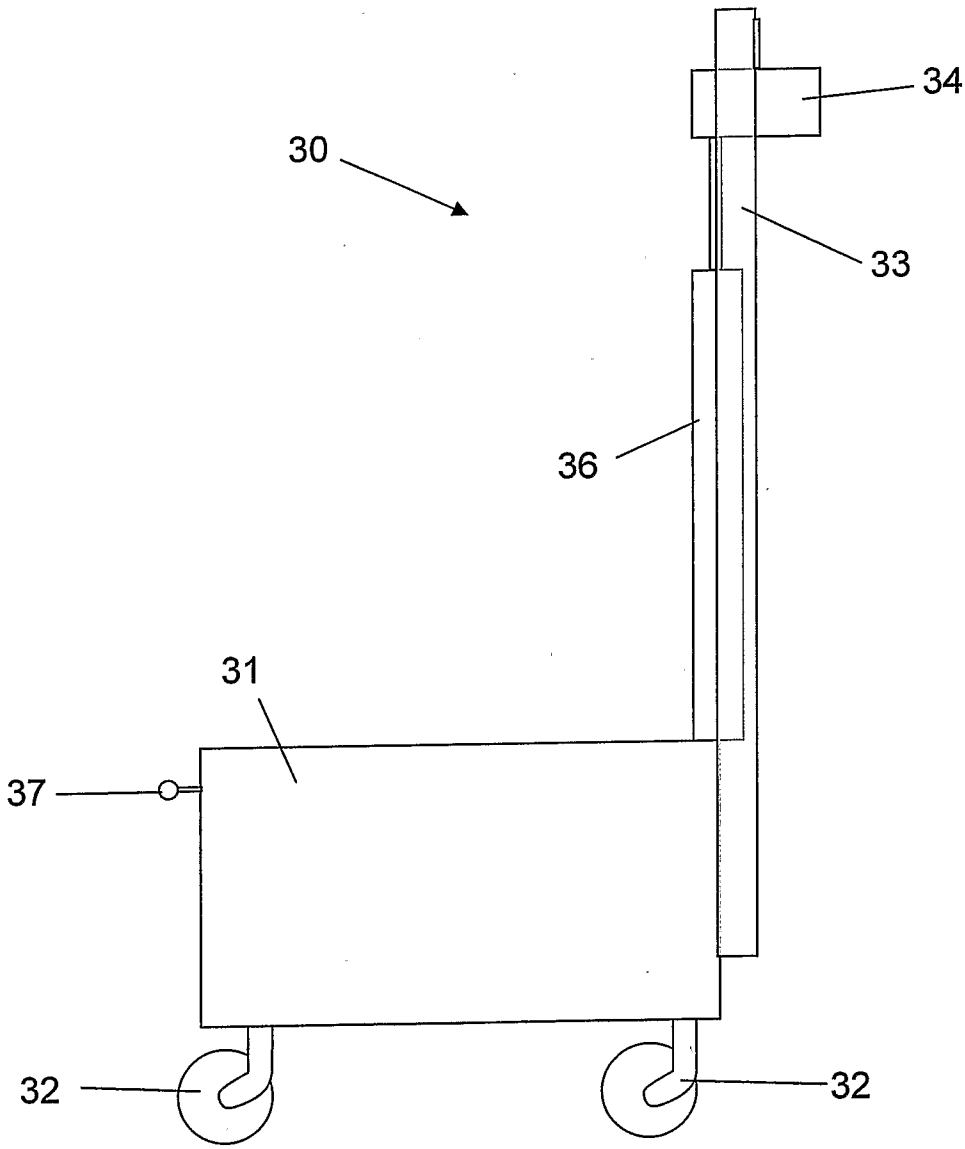


Figure 4

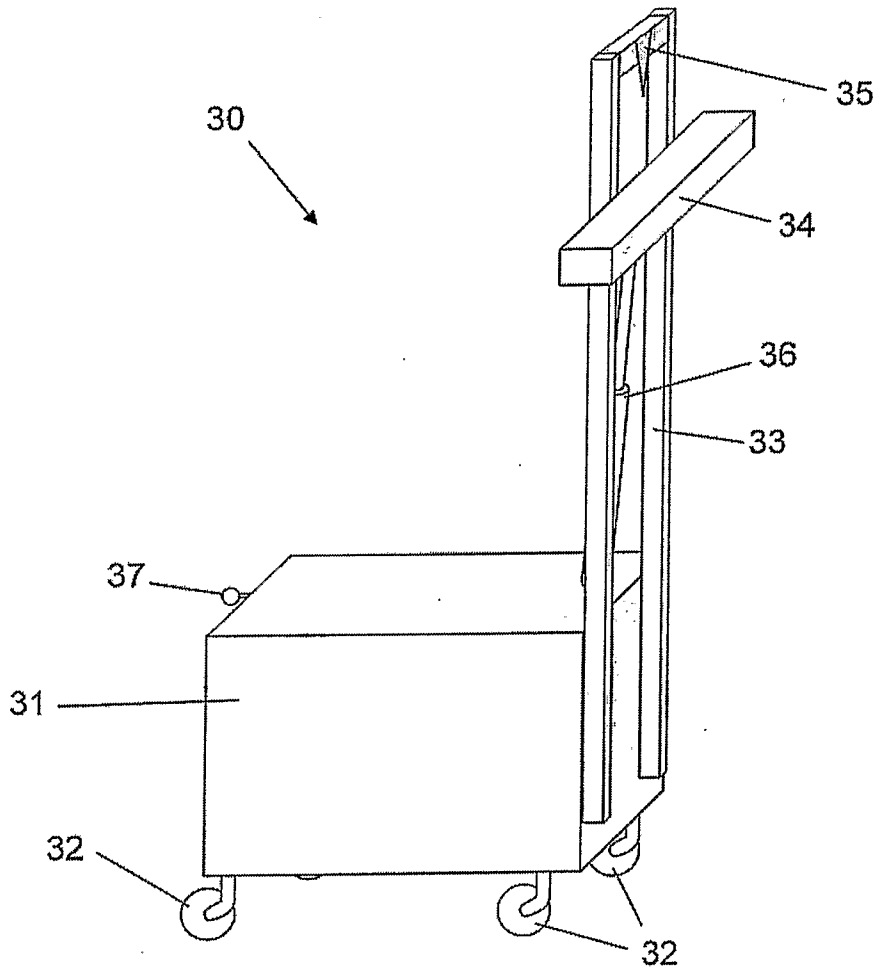


Figure 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2007/004724

A. CLASSIFICATION OF SUBJECT MATTER
INV. E04G21/16

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
E04G B66C B66F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	DE 25 16 203 A1 (GAIL JOSEF) 21 October 1976 (1976-10-21) page 9; figures 4,5	1,2
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A	US 4 334 480 A (WALLACE BERNARD E) 15 June 1982 (1982-06-15) column 4, line 4 - column 6, line 9; figures 1,2	1,7-9

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
16 April 2008	24/04/2008

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Saretta, Guido

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INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2007/004724

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/GB2007/004724

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