

"PROCESS FOR THE INSTALLATION OF CURTAIN WALLS AND
APPARATUS FOR CARRYING OUT THE PROCESS"

This invention relates to a process for the
5 installation of curtain walls comprising prefabricated wall
elements, which are transportable in vertical and
horizontal directions on the outside of the curtain wall by
means of hoisting apparatus, and to apparatus for carrying
out such a process.

10 In principle two different processes are known
for the erection of a facade of curtain walls. In one type
of construction the entire curtain wall consists of
individual wall elements which extend the height of one or
more storeys. All these elements are self-supporting and
15 are fastened, for example, to the floor/ceilings of the
building. The mounting of these wall elements is carried
out, for example, by means of a cable winch or a crane.
For this the wall elements are hoisted from ground level
externally of the building. This mode of construction is
20 time-consuming and both the wall elements to be installed
and the wall elements already installed are exposed to
possible damage. The hoisting can be carried out only very
slowly and, because of their relatively large area, the
elements are susceptible to wind forces.

25 Another method of erecting a facade consists of

joining, directly to the exterior of the building, the posts and tie bars for carrying glazing and facade panels. This work is also very time-consuming and requires, furthermore, a suspended car or gondola which must be
5 arranged to move in all directions on the outside of the building.

Underlying the invention is the problem of finding a process, and apparatus for the execution of the process, with which the curtain wall of a building can be
10 erected in the shortest possible time and with which the present dangers resulting from wind forces are excluded.

To this end, according to the invention, in a process for the installation of curtain walls of a building using prefabricated wall elements, each wall element
15 consists of a post and tie bar construction and in each case the posts and tie bars are assembled on a floor of the building on a reusable auxiliary frame into one wall element, the posts are fastened to the auxiliary frame so that the wall element and the auxiliary frame form a
20 transportable unit which guarantees safe handling as the wall element is conveyed from inside the building by a cart or vehicle movable across the floor to the outside of the building, where the wall element is brought into a vertical position and suspended on hoisting apparatus by which it is
25 transported vertically and/or horizontally to the required final position, at which the wall element is installed on fastenings on the building at the exterior thereof.

In the process of the invention the wall elements to be installed on the building are not hoisted from ground level along the outside of the building but the individual wall elements can be stored on different floors, from which
5 they can be brought by the shortest way to the outside of the building. The storing of the facade elements can already be undertaken before the gross basic building operations are concluded. Thus at the commencement of the facade installation proper the time-consuming
10 transportation of materials has by then already been

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carried out.

According to a preferred form of execution the wall element rests on a cart having an approximately horizontal support surface, with the vertical axis of the element running parallel to the longitudinal axis of the cart. The element may project by about one-half beyond the cart, be articulated in the region of its mid-axis on the cart and the cart can be driven to the exterior of the building, after which the element is swung from its horizontal position into a vertical position, so that it can then be suspended on the hoisting apparatus in order, after release from the cart, to be transported while suspended to its place of fastening. There, the articulation of the wall element on the cart can be accomplished by using a rapid lock and the swinging up of the element into its vertical position can be accomplished by using a hydraulic cylinder. With this form of transport of the wall element to in front of the exterior of the building, the element is safeguarded against damage inside the building. Due to the special positioning of the wall element on the cart the forces necessary to swing the element into the vertical position are kept small. As after release of the element from the cart only short distances still have to be covered, the guidance of the element outside the building can be accomplished by hand by construction workers inside the railings of the individual storeys.

A further preferred process is characterized in that the wall element is carried on a boom of a car with the vertical (when installed) axis of the element disposed horizontally, that the element is swung on the car into an approximately horizontal position, that the car is driven towards the exterior of the building, that the element is swung into a vertical position and rotated on the boom until said axis of the element assumes a vertical position, that the element is suspended from the hoisting apparatus, thereupon released from the boom and transported to its place of fastening. In this process a wall element which rests, for example, on the floor/ceiling is picked up on the boom of the car. So that the length of the boom can be kept relatively short, it is swung into an approximately horizontal position, in which it can be brought over the railings provided at the floor edges. As soon as the wall element stands out from the building it is swung round until the surface of the wall element runs parallel to the side of the building. Thereupon the wall element is turned through 90° on the boom arm, so that the longitudinal axis of the wall element occupies a vertical position. After suspension of the wall element on the hoisting apparatus and after release of the wall element from the boom arm, the element can be moved to its final position and there fastened.

Preferably the swinging of the wall elements on the boom of the car is accomplished by hydraulic cylinder



means. The hoisting apparatus, by which the wall elements are transported along the side of the building, preferably comprises a monorail hoist trolley which is mounted one or more storeys above the floor on which the wall elements are stored.

In order to simplify the process for installation of a curtain wall and also to cheapen it, each wall element is of post and tie bar construction, with the posts and tie bars pre-assembled on a floor of the building into units transportable on an auxiliary frame. On assembly preferably only the posts are fastened to the auxiliary frame. In this process, therefore, the advantages of the post and tie bar construction can be combined with the advantages of the element construction mode. At the building site the posts and tie bars are delivered pre-cut to length. While work is still in progress on the basic building structure, the posts and tie bars can already be stored on suitable floors. The posts and tie bars are not then assembled on the outside of the building, but are assembled in a place convenient for the assembler inside a storey of the building. So that this assembled unit does not fall apart during transport to the place of installation, the posts are fixed by screws to an auxiliary frame. The wall element thus prefabricated, together with the auxiliary frame, is then transported to its final position. Conveying to the outside of the building can be carried out by means of the cart with a

horizontal swingable support surface, or by means of the hydraulic car with a boom. When the prefabricated wall element is on the outside of the building, the auxiliary frame is suspended on the hook of the trolley. After the transport of the wall element to its destination and fastening of the posts, for example to the storey ceiling, the auxiliary frame is released from the posts and by means of the trolley drawn away from the wall element and moved back to the floor on which the pre-assembly is carried out.

10 If the pre-assembled wall element is carried to the outside on the cart equipped with a swingable support surface, the assembly of the wall element can be executed on a table. The table (or stand) on which the assembling is done and the upper side of the cart may be provided with support rollers on which the prefabricated wall element can easily be conveyed and brought into its swinging position. Before the swinging-up of the wall element the auxiliary frame is hingedly attached to the table. After the suspension of the wall element on the trolley the table attachment is released and the element can be moved. After the fastening of the wall element to the floor/ceiling the auxiliary frame is again hinged to the table, swung into its horizontal position, driven back to the assembling table and conveyed on the rollers from the cart on to the assembling table.

25 If a prefabricated wall element is to be moved by the car with a boom, a ball turntable may be mounted on the

auxiliary frame, the midpoint of which corresponds approximately to the centre of gravity of the prefabricated wall element. To this ball turntable is fastened a plate, and to this plate the end of the boom; the wall element can be hoisted and swung into a horizontal position in order thereupon to be transported to and in front of the exterior of the building. In that position the plate on the boom is swung until the wall element occupies a position about parallel to the facade surface of the building. However, in this position the longitudinal axis of the element is still disposed horizontally and thus the wall element must be turned through 90° into its vertical position. It is then suspended from the trolley, the boom is released from the turntable of the frame and the wall element can be transported to its destination and there fastened. The auxiliary frame is then released from the posts, brought back by the trolley until it can again be fastened to the boom or can be pulled in by hand by the assembler on to the floor. Another wall element can then be pre-assembled on the auxiliary frame and transported by the car to the exterior of the building. Since the centre of gravity of the pre-assembled wall element approximately corresponds with the centre of the turntable, the 90° rotation of the wall element in front of the exterior of the building can be accomplished, for example, by hand as no great force has to be expended for the purpose.

Preferably the apparatus for execution of the

process comprises an assembling table on which a wall element can be assembled, a cart for conveying the wall element from the table to the exterior of the building and a monorail hoist trolley mounted on a floor above. For
5 easy sliding of the prefabricated element on the table or on the cart, their upper sides may be provided with support rollers. The swinging movement of the element on the cart can be accomplished by means of a hydraulic cylinder, the piston of which is articulated on a frame holding the
10 auxiliary frame with the wall element.

According to another preferred form, the apparatus of the invention comprises a vehicle with a boom for taking up and moving the wall elements, and a monorail hoist trolley mounted at a storey above. The swinging
15 movements of the facade elements on the boom are accomplished, preferably, by means of hydraulic units.

The auxiliary frame is preferably of rectangular construction and consists, for example, of welded metal sections. Since the cross ties are slipped on to the
20 posts, it suffices to fasten only the posts to the auxiliary frame. The cross ties and the other curtain elements (glazing, panels) are held by the posts.

Preferably a transport eye is provided on the upper transverse spar of the auxiliary frame, which may be
25 offset at an angle to the element posts, so that the pre-assembled wall element hangs substantially vertically when suspended from the hoisting apparatus.

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The invention will now be further described with reference to the accompanying drawings which illustrate, by way of example, installation processes for curtain walls and apparatus therefor in accordance with the invention.

5 In the drawings:

Figure 1 shows, in front view, a portion of a curtain wall of a building;

Figure 2 is a section through several storeys of the building while under construction, showing apparatus in
10 accordance with the invention and its function in carrying out a process of the invention;

Figure 3 shows, in front view, a partially assembled curtain wall and a further wall element in process of being installed;

15 Figures 4 to 8 show schematic representations of various process steps;

Figure 9 shows, in front view, an assembling stand with a pre-assembled wall element thereon;

Figure 10 is a section through several storeys of a
20 building similar to that illustrated in Figure 2 and showing other apparatus for carrying out a process of the invention; and

Figure 11 shows, in front view, a wall element presented in an intermediate position while in course of
25 installation.

Figure 1 shows, in front view, a portion of a facade of a building, comprising a curtain wall composed of

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wall elements 10. Each of the wall elements 10 consists of a post and tie bar construction, and they comprise middle posts 12, outer left posts 14, outer right posts 16, middle tie bars 18, upper tie bars 20 and lower tie bars 22. In the example illustrated each wall element has three middle posts 12 and one middle tie bar 18, providing overall dimensions of about 3.0 metres in width and 3.5 metres in height. The wall elements are assembled on an auxiliary frame inside the building, from the posts and tie bars, and thereupon brought to the outside of the building and there fastened in position.

Figure 2 shows a partial cross-section through the building under construction and which is to be provided with a curtain wall, and also shown associated with a floor 24 of such building are the devices or apparatus necessary to bring the pre-assembled or prefabricated wall elements to their place of installation. An assembling stand 28 is movably arranged on rails 26 on the floor 24, and has a height which permits a convenient assembling procedure.

On its upper side the stand 28 presents longitudinally extending spars 30 transverse to which are support rollers 32. On these rollers 32 there rests an auxiliary frame 34 on which a wall element is to be pre-assembled, immediately prior to its installation. What may be considered as the upper end 36 of the the auxiliary frame 34 is shown to be bent at an angle and provided with a transport eye 38. When a wall element is assembled on

the frame 34, the bent end portion 36 is adjacent and projects beyond that end portion of the wall element which is uppermost when installed. At the same time a substantial portion of the longitudinal extent of the wall element, approaching one-half thereof, projects beyond the opposite end portion of the frame.

The assembling stand 28 is positioned relatively close to the side of the building where the wall elements will be installed. Mounted on the floor 24 for movement between the stand 28 and the adjacent side of the building where the curtain wall is to be erected is a cart 40. As shown in Figure 2 there is mounted on the cart 40 a frame 34' corresponding to the frame 34, on the top of which is attached a wall element 10' which has previously been pre-assembled on the stand 28. The height of the cart 40 corresponds to the height of the assembling stand 28.

The upper side of the cart 40 is defined by longitudinally extending transversely spaced spars which are transversely bridged by support rollers 44. The fact that a frame mounted on the stand 28 is supported on rollers 32 and the upper surface of the car presents rollers 44 at the same height, enables a frame once it has a wall element assembled thereon to be easily and quickly slid from the stand on to the cart. An axle 46 of the cart 40 at the end thereof adjacent the stand 28, in the arrangement shown, is steerable making the cart readily manoeuvrable to the exterior of the building. A safety

railing 54 is mounted on the floor 24 adjacent its outermost edge, and a similar railing is provided in connection with and upstanding from each floor of the building adjacent its outermost edge. As will be seen, as the cart 40 is moved from the stand 28 to the outer edge of the floor 24, its wheels 60 on an axle parallel to and spaced outwardly from the axle 46 are located by chocks adjacent the railing 54. At this time the top portion of the cart projects over and beyond the railing 54 which does not have to be removed during the procedure for fastening a wall element.

Included between and hingedly coupled to the spars 42 by transversely disposed arresting/pivot means 48 is a frame 53, which forms the portion of the top of the cart 40 outermost from that end which positions adjacent the stand 28 to receive thereon a frame bearing a wall element 10 or 10'. When a frame 34 mounting an assembled wall element is slid from the stand 28 on to the top of the cart 40, it will then be moved on to the frame 53 and temporarily secured thereto by releasable clamping means located in the vicinity of the pivot means 48.

A piston-cylinder unit 50,52 is pivotally connected at one end to a portion of the chassis of the cart 40 at a location in underlying spaced relation to its top portion 42,44 with the piston 52 which projects from its opposite end pivotally connected to the frame 53 at a location spaced from the pivot means 48, in the direction

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of the end of the top portion of the cart which first receives thereon a frame bearing an assembled wall element. When the cart 40 is moved outwardly on the floor 24 to the position where its wheels are chocked as previously
5 described, the piston-cylinder unit 50,52 will be energized to pivot the frame 53 to a vertical position spaced immediately outward from the outer edge of the floor 24 and the safety railing 54 and clear thereof. At the same time, as will be obvious, the frame 34' and the wall element 10'
10 will be orientated to be generally perpendicular to the floor 24 and substantially parallel to the adjacent side of the building on which the wall element is to be installed.

On the ceiling 56, i.e. on the floor of the storey above, there is arranged a monorail hoist trolley
15 58. This trolley is movable on a track perpendicularly to the plane of the drawing. When the facade element 10' on the cart 40 has been swung into the vertical position, as described above, a suspension hook 62 of the monorail trolley 68 is engaged in the transport eye 38'. The
20 clamping means at the pivot means 48 is now released and the element 10' with its auxiliary frame 34' is easily pushed outwards and transported laterally to the installation region. At that region the guidance of the wall element 10' can be taken over by the construction
25 workers inside the railing.

In Figure 3 there is shown a partial front view of a building to which wall elements 10 have already been

applied with a wall element 10' which is suspended from the trolley 58 and, for example, is transported to the left and downwards until it occupies its correct position in engagement with the adjacent or underlying wall element 10.

5 In broken lines in this figure there are shown a spar 64 and struts 66 of the auxiliary frame 34'. On the spar 64 and its lower spar (not visible) there are fastened only the posts 12, 14 and 16 of the wall element. The tie bars are not fixed by screws to the auxiliary frame, since they
10 are gripped by the posts and their position is stable.

Figure 4 shows a section through the building which is analogous to Figure 2 and illustrates the wall element 10' which, with the aid of the hoist trolley 58, is transported in both horizontal and vertical directions.
15 The wall element 10' is still fastened to the auxiliary frame 34.

The intermediate position of the wall element 10', which corresponds to that of Figure 4, is shown to a larger scale in Figure 5. Figure 6 shows the wall element
20 10', the posts of which have been fastened to the floor/ceiling 68. The auxiliary frame 34' is still connected with the posts of the wall element 10'.

Figure 7 shows the wall element 10' fastened to the floor/ceiling 58, with the auxiliary frame 34' released
25 from the element 10'. The auxiliary frame can now be hoisted by the trolley 58 up to the storey on which the swing cart 40 is present. There, the auxiliary frame 34'

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suspended from the trolley 58 can again be arrested on the rear end of the cart 40 and by contraction of the piston-cylinder unit 50 can be brought on to the upper side of the swing cart 40 in the horizontal position. After
5 release of the arresting means 48, the auxiliary frame 34' can be slid on the cart 40 and rolled therefrom on to the assembling stand 28. The auxiliary frame 34 can now again be provided with posts, tie bars, glazing and facade panels for assembly of another prefabricated wall element.

10 Figure 9 shows, in front view, an assembling stand 28 on which rests an auxiliary frame 70. Middle posts 12, as well as an outer left post 14 and an outer
right post 16, are joined with the auxiliary frame 70, for example by screws. The middle posts 12 present a closed
15 profile in cross-section, while the outer posts 14 and 16 have in cross-section an open profile. The posts 14 and 16 are so shaped in cross-section that an outer post part 14 of one element when joined with an outer post part 16 of an
adjoining element yields a composite post structure with a
20 closed profile 72. Between each two adjacent middle posts there are provided tie bars 18, 20 and 22, the lower tie bars 22 being visible in Figure 9.

Figure 10 shows in vertical section a building with floor/ceilings 74, 76, 78 and 80. On the floor/
25 ceiling 76 there are stored posts, tie bars, glazing, facade panels and sealing means of a curtain wall of a building facade, which components are pre-assembled on a

frame into prefabricated wall elements. On the floor/
ceiling 76 there can be seen a transport car 82, with the
aid of which the pre-assembled wall elements are conveyed
in front of the exterior of the building, where they can be
5 suspended from a hoist trolley 84 by which they are
transported to their installation positions.

The intermediately stored individual parts are
assembled on an auxiliary frame 86 into a wall element 88.
There likewise, as in the process already described, only
10 the vertical posts of the wall elements are attached by
screws to the auxiliary frame. On the auxiliary frame 86
there is arranged, in the region of the centre of gravity
of the wall element 88, a ball turntable 90 with an
eccentric suspension capability.

15 The transport car 82 comprises a steerable
chassis 92, wheels 94, a column 96 mounted on the chassis
and a boom arm 98 which can swing on the column 96. The
vertical swinging movement of the boom arm 98 takes place
above a supporting hydraulic piston-cylinder unit 100 by
20 which it is controlled. On the free end of the boom arm 98
is a device to which the auxiliary frame 86 is fastened,
through a plate 102 provided on the ball turntable, to the
transport car 82. Swinging movement of the plate 102 is
produced by a piston-cylinder unit 104 which articulates in
25 the end portion of the boom arm 98.

For pre-assembly of a wall element 88 the
auxiliary frame 86 is used, and on this frame the wall

element is put together with its longitudinal posts attached by screws to transverse spars of the frame 86. The larger dimension of the wall element in this position runs parallel to the outside of the building. After the
 5 pre-assembly of the wall element it is turned by means of a turning device through 180°, so that the auxiliary frame is on top and the ball turntable 90 with the plate 102 can be joined to the boom arm 98 of the transport car 82.

So that the wall element can be guided between
 10 the floor/ceilings 74 and 76 over the safety railing 106 fixed at the outer edge of the floor/ceiling 76, the piston of the piston-cylinder unit 104 is drawn into its cylinder until the wall element 88 lies nearly horizontal. In this position the transport car 82 travels towards the outside
 15 of the building, whereby the wall element 88 is carried outwards over the railing so that it can be swung into the vertical by means of the hydraulic piston-cylinder unit 104. The element is now rotated by hand on the ball turntable 90 through 90°, so that the posts of the wall
 20 element 88 assume a vertical position. In this position the element 88 on the auxiliary frame 86 can be suspended from the overhanging hoist trolley 84. The boom 98 and the swinging piston-cylinder unit 104 are then released from the plate 102 of the turntable 90 and the transport car is
 25 reversed. The wall element 88 now hangs on the auxiliary frame 86 suspended from the monorail trolley 84 and can be guided by hand to its place of installation, for example on

the floor/ceiling 78 above an already fastened wall element 108.

After installation of the wall element 88 on its fastenings, the auxiliary frame 86 is released from the posts of the element 88 and brought back along the track of the trolley 84 to the transport car 82. There, the auxiliary frame 86 is again received by the transport car 82 in order to recommence the assembly cycle.

Figure 11 shows, in front view, a building with wall elements 108 already installed and a wall element 88 which is still connected with the transport vehicle 82 by way of the turntable 90 through its auxiliary frame 86. The wall element 88 is in process of being rotated precisely through 90°, in order to be positioned so that it can be suspended from the trolley 84 and released from the transport car 82, when it can be transported to its place of installation.



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CLAIMS:

1. A process for the installation of curtain walls of a building using prefabricated wall elements, wherein each wall element consists of a post and tie bar construction
5 and in each case the posts and tie bars are assembled on a floor of the building on a reusable auxiliary frame into one wall element, the posts are fastened to the auxiliary frame so that the wall element and the auxiliary frame form a transportable unit which guarantees safe handling as the
10 wall element is conveyed from inside the building by a cart or vehicle movable across the floor to the outside of the building, where the wall element is brought into a vertical position and suspended on hoisting apparatus by which it is transported vertically and/or horizontally to the required
15 final position, at which the wall element is installed on fastenings on the building at the exterior thereof.
2. A process according to claim 1, wherein the auxiliary frame overhangs the pre-assembled wall element at the upper side thereof.
- 20 3. A process according to claim 1 or claim 2, wherein the auxiliary frame is swingably arrestable on the cart.
4. A process according to any one of claims 1 to 3, wherein the pre-assembled wall element on the auxiliary



frame is suspended from the hoisting apparatus, and after the fastening of the wall element to the exterior of the building the auxiliary frame is detached from the posts, then the auxiliary frame is drawn away by the hoisting
5 apparatus and thereupon arrested on the cart, is disengaged from the hoisting apparatus, is swung into the horizontal position and is transferred to a stand on which another wall element is pre-assembled.

5. A process according to claim 4, wherein support
10 rollers are provided on the cart and on the stand on the upper sides thereof, and the auxiliary frame is conveyed on these rollers.

6. A process according to claim 1, wherein the wall
15 element with the outer surface thereof uppermost is assembled on the auxiliary frame which is taken up by the cart, the wall element is turned by a turning device through 180° so that the auxiliary frame lies on top, and the auxiliary frame is provided with a turntable with an eccentric suspension device, with which the auxiliary frame
20 is fastened to a boom of the cart.

7. A process according to claim 6, wherein after the installation of the wall element on the fastenings on the building the auxiliary frame is released, the auxiliary frame with the hoisting apparatus is brought back to the

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cart and taken up by the latter, and then on the auxiliary frame another wall element is assembled.

5 8. Apparatus for carrying out a process according to any one of claims 1 to 5, comprising an assembling table or stand for the assembly of a wall element on an auxiliary frame, a cart for conveying the wall element from the table to the exterior of the building and a monorail hoist trolley mounted on a floor above.

10 9. Apparatus according to claim 8, wherein on the upper side of the table or stand and the upper side of the cart support rollers are provided for the shifting of the auxiliary frame.

15 10. Apparatus according to claim 8 or claim 9, wherein the front end of the cart in a transfer position stands out beyond the exterior of the building, and on the cart there are provided arresting means for arresting the auxiliary frame.

20 11. Apparatus according to claim 10, wherein the arresting means are provided on a frame which is swingable on the cart.

12. Apparatus according to claim 11, wherein there is provided on the cart a hydraulic piston-cylinder unit the



piston of which is articulated on the swingable frame.

13. Apparatus for carrying out a process according to claim 6 or claim 7, comprising a cart for conveying the wall element to the exterior of the building, and a
5 monorail hoist trolley mounted on a floor above, the cart having a boom for taking up an auxiliary frame on which the wall element is to be assembled.

14. Apparatus according to claim 13, wherein there is provided on the vehicle boom a hydraulic piston-cylinder
10 unit for swinging the wall element into the horizontal position, and on the free end of the boom there is provided a fastening arrangement for attachment of an auxiliary frame.

15. Apparatus according to any one of claims 8 to 14,
15 wherein the auxiliary frame is of rectangular form and transverse spars thereof are formed with fastening means for the posts of the wall element.

16. Apparatus according to claim 15, wherein a transport
20 eye is provided on the upper transverse spar of the auxiliary frame.

17. Apparatus according to claim 16, wherein the transport eye is angle-shaped.

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18. Apparatus for the installation of curtain walls of a building, substantially as herein particularly described with reference to Figures 1 to 9, or Figures 10 and 11, of the accompanying drawings.
