

Description

Cleaning System for a Facade of a Building

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Technical Area

The invention relates to a cleaning system for a facade
10 of a building, and a building having the cleaning system
according to the invention.

Background Information

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Publication US 5,465,446 makes known a cleaning machine
for a tall building. The cleaning machine comprises an
elevator cage equipped with two rollers. The two rotating
cleaning rollers are used to clean the facade of a tall
20 building. The elevator cage itself hangs from two steel
cables connected to a carrier disposed on the roof of the
tall building. To clean the facade of the tall building,
the elevator cage is moved up and down on the tall
building, cleaning the facade along a vertical path. The
25 carrier is then moved further on the roof of the tall
building, and the elevator cage is moved up and down on
the tall building once more to clean the facade along
another vertical path. However, this solution is usable
only for tall buildings that do not curve vertically.
30 Overhanging regions in particular cannot be cleaned using
this cleaning machine. The further the freely hanging
elevator cage moves downward in the region of the

overhang, the further away it is situated from the surface to be cleaned.

Publication CH 670 248 A5 makes known an arrangement
5 comprising a vertically displaceable cabin for working on structures having a vertically curved surface. The arrangement is used in particular for working on large surfaces, such as cooling towers, masonry dams, sides of ships, and the like. The arrangement comprises a cabin
10 for this purpose, which is equipped with a crawler drive having suction cups. The crawler drive is used to move the cabin along the facade of the building. The suction cups adhere to the facade of the building and ensure that the distance between the cabin and the facade remains the
15 same. A live ring comprising a carrier, to which the cabin is connected by way of a cable, is located on top of the building.

The two solutions described above have the disadvantage,
20 however, that they require a flat surface on the roof or top of the building for installation of the carrier and the live ring. If such a surface is not present, neither of the two solutions can be implemented.

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Advantages of the Invention

A problem addressed by the invention is that of providing a cleaning system for a facade of a building, which can
30 also be used to clean facades having an overhang and which operate without a carrier or a live ring in the roof region of the building.

The problem is solved by a cleaning system for a facade of a building having the features of claim 1, and by a cleaning system for a facade of a building having the features of claim 7.

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The cleaning system according to the invention for a facade of a building comprises an annular supporting structure which is designed such that it can enclose the building. The cleaning system also comprises a transport
10 device which is attached to the supporting structure and is provided to move the supporting structure. In addition, a cleaning device is present, which is connected to the supporting structure and is provided to clean the facade of the building.

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In an alternative embodiment, the cleaning system according to the invention for a facade of a building comprises an airship and a cleaning device provided to clean the facade of the building. In addition, a supply
20 device is present, which is connected to the airship and the cleaning device, and is provided to supply the cleaning device with energy and cleaning agent.

Advantageous developments of the invention will be
25 apparent from the features indicated in the dependent claims.

In the case of an embodiment of the cleaning system according to the invention, a supply device is present
30 which is connected to the supporting structure and is provided to supply the cleaning device and the transport device with energy and cleaning agent. A central supply station is therefore made available. This has the

advantage that a separate energy source does not need to be provided for every cleaning device and every transport device. The overall weight of the cleaning system is thereby reduced.

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According to a further embodiment of the cleaning system according to the invention, the supporting structure is made of lightweight construction material. The supporting structure is made lighter as a result, thereby enabling
10 the transport device, which transports the cleaning system and holds the entire cleaning system securely against the facade, to be designed smaller in size.

In addition, the supporting structure of the cleaning
15 system according to the invention can have a lattice structure. The stiffness of the supporting structure can be increased as a result.

Moreover, the transport device in the cleaning system
20 according to the invention can comprise suction cups. They are advantageous in particular when the cleaning system is intended for use on a building having a smooth facade, such as a glass facade.

25 As an alternative or in addition thereto, the transport device in the cleaning system according to the invention can comprise a crawler drive or walking legs.

According to a development of the cleaning system
30 according to the invention, the supply device comprises a supply container that can be used for the cleaning agent.

According to a further development of the cleaning system according to the invention, the supply device comprises a windlass for lowering the supply container. In addition, a propeller is provided on the supply container. The
5 propeller is used to stabilize the position of the supply container and possibly also the position of the upper part of the supply device. The propeller on the supply container is used to compensate for the wind forces acting on the supply container.

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According to one embodiment of the cleaning system according to the invention, the cleaning device comprises a brush. It enables the facade to be cleaned using cleaning agent and in a mechanical manner.

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According to a further embodiment of the cleaning system according to the invention, the cleaning device comprises a nozzle. This is advantageous in particular when the facade is of the type that is easily scratched by way of
20 mechanical friction.

The cleaning device in the cleaning system according to the invention can also operate using dry ice. This is advantageous in particular when the facade is of the type
25 that is easily scratched by way of mechanical friction. The combination of nozzle and dry ice enables the facade to be cleaned in a particularly gentle manner.

According to one development of the cleaning system
30 according to the invention, a safety cable is provided that connects the airship to the building. In this manner the airship and, therefore, the supply device connected to the airship, and the cleaning device on the building

are secured against falling. Safety is further increased as a result.

5 Furthermore, a building is provided that comprises the cleaning system according to the invention and a hangar for the airship. Locating the hangar in the upper region of the tall building has the advantage that the airship can start from a high position and therefore reach the work site more quickly.

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Finally, the cleaning system according to the invention can be used to clean the facade of a building.

15 **Brief Description of the Drawings**

The invention is explained in greater detail in the following using a plurality of embodiments and with reference to 18 figures.

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Figure 1 shows a first possible embodiment of the cleaning system according to the invention for a facade of a building, together with the building complex, in a side view.

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Figure 2 shows the cleaning device installed on the supporting structure of the cleaning system, in a side view.

30 Figure 3 shows the supply device and transport device installed on the supporting structure of the cleaning system, in a side view.

Figure 4 shows the first embodiment of the cleaning system according to the invention, together with the building complex, in a side view, wherein the supply container of the supply device has just been lowered.

Figure 5 shows the first embodiment of the cleaning system according to the invention, in a top view.

Figure 6 shows the cleaning device installed on the supporting structure of the cleaning system, in a top view.

Figure 7 shows the transport device installed on the supporting structure of the cleaning system, in a top view.

Figure 8 shows the building complex in a side view and at the location where a second possible embodiment of the cleaning system according to the invention is accommodated.

Figure 9 shows an enlarged depiction of the site where the second possible embodiment of the cleaning system according to the invention is accommodated, together with the second embodiment of the cleaning system according to the invention.

Figure 10 shows an enlarged depiction of the telescoping arm used to dock the airship on the building.

Figure 11 shows the building complex together with the airship as it hovers outside of the hangar.

5 Figure 12 shows an enlarged depiction of the airship together with the telescoping arm as it takes off.

10 Figure 13 shows the building complex together with the airship as it hovers in the working position.

15 Figure 14 shows the building complex together with the airship and the cleaning device and the supply device while the building façade is being cleaned.

20 Figure 15 shows the supply station and the cleaning device in an enlarged depiction.

25 Figure 16 shows the building complex together with the airship and the cleaning device, wherein the supply container has been lowered.

30 Figure 17 shows an enlarged depiction of the supply container, which has been lowered.

 Figure 18 shows an enlarged depiction of the upper part of the supply device.

Ways to Implement the Invention

The first embodiment of the cleaning system according to the invention is explained in the following with
5 reference to figures 1 to 7.

Figure 1 shows a building complex together with the first embodiment of cleaning system 4 according to the invention. The building complex comprises a first tall
10 building 1, a second tall building 2, and a connecting building 3 which is short compared to tall buildings 1 and 2 and interconnects tall buildings 1 and 2. In figure 1, cleaning system 4 is located approximately half-way to the top of tall building 1, in order to clean facade 1.1
15 thereof at that point. In the following, first tall building 1 is also referred to as building 1, and second tall building 2 is also referred to as building 2.

The embodiment of cleaning system 4 shown in figure 1
20 comprises an annular supporting structure 5, a cleaning device 6, a supply device 7, and a plurality of transport devices 8.

Supporting structure 5 carries cleaning device 6.
25 Circular section A in figure 1 encloses supporting structure 5 and cleaning device 6, and is shown in an enlarged view in figure 2.

Supporting structure 5 also carries supply device 7 and
30 transport devices 8. Circular section B in figure 1 encloses supply device 7 and one of the transport devices 8, and is shown in an enlarged view in figure 3. Supply device 7 is installed on the underside of supporting

structure 5 and comprises a windlass 11, a supporting cable 9, and a supply container 10. Windlass 11 can be used to lower supply container 10, which hangs from supporting cable 9, onto the roof of connecting building 3. Cleaning agent such a water or dry ice is stored in supply container 10. Supply container 10 of supply device 7 is connected to cleaning device 6 by way of a hose line to supply it with cleaning agent. It is also possible for a plurality of cleaning devices 6 to be installed on supporting structure 5, which are then supplied with cleaning agent and energy by way of corresponding hose lines from supply device 7. Supply device 7 can also comprise a vacuum generator which is connected to transport devices 8 by way of corresponding lines. The vacuum generator is used to generate the necessary vacuum at the suction cups of transport devices 8 to enable the suction cups to adhere securely to facade 1.1.

Instead of suction cups, or in addition to the suction cups, transport device 8 can also comprise a traveling mechanism as shown in laid-open application DE 102 03 326 A1, in figures 1 to 4, and as described in the description in paragraphs 30 to 37, for example. As an alternative thereto, transport device 8 can also comprise a traveling mechanism which is designed as described in publication EP 1 507 696 B1. Figure 7 shows transport device 8 installed on supporting structure 5 of cleaning system 4, in a top view.

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Figure 5 shows cleaning system 4 together with tall building 1 in a top view (figure 4, view C), wherein tall building 1 is shown in a cross-sectional view. Supporting

structure 5 encloses building 1 and, in fact, typically such that the distance between supporting structure 5 and facade 1.1 of building 1 is approximately constant in the region where the facade is to be cleaned.

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Figure 6 shows cleaning device 6 installed on supporting structure 5 of cleaning system 4, in a top view.

Cleaning system 4 according to the invention can also be removed by dismantling supporting structure 5. Cleaning system 4 can be subsequently reassembled on another building, e.g. on tall building 2, and put into operation there.

Advantageously, supporting structure 5 comprises a plurality of segments 5.1 and is designed such that one or more segments 5.1 can be added thereto, or such that any one segment 5.1 can be replaced.

Building 1 shown in the figures is merely an example which will be used to describe the design and mode of operation of cleaning system 4. The building can also have another type of cross section, of course, such as a square, rectangular, polygonal, or oval cross section.

The segmented design of supporting structure 5 enables it to be adapted easily to different building geometries.

To start the cleaning process, cleaning system 4 is situated on the bottom floor of tall building 1, i.e. on the roof of connecting building 3. During operation, cleaning system 4 is then moved upward along longitudinal axis LA1 with the aid of transport devices

8. Cleaning device 6 or cleaning devices 6 operate during this time and clean facade 1.1 of the tall building.

If cleaning devices 6 are installed on supporting
5 structure 5 in a stationary manner, cleaning system 4 also rotates about longitudinal axis LA1 of tall building 1.

Double arrow H shown in figure 5 is used to illustrate this rotational motion.

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If cleaning devices 6 are situated on supporting structure 5 in a mobile manner, they move back and forth in the horizontal plane, thereby cleaning facade 1.1 section-by-section along horizontal paths. Other patterns
15 of motion are also possible, however.

As soon as one horizontal section of facade 1.1 has been cleaned, cleaning system 4 is transported one step further upward using transport devices 8. This is
20 illustrated using arrow V in figure 1.

Since tall buildings are often a few hundred meters tall, the supply of cleaning agent is typically insufficient to clean entire facade 1.1 of the tall building in one pass.
25 Supply device 7 therefore comprises lowerable supply container 10 which can be lowered, as necessary, to the ground or the roof of connecting building 3. This situation is depicted in figure 4. On the roof of connecting building 3, the supply container is filled
30 with the appropriate cleaning agent, such as water or dry ice, and then drawn back up to cleaning system 4 using windlass 11. The cleaning of facade 1.1 is then continued. Once the cleaning system has reached the top

floor of the tall building and has cleaned the facade there, it is moved downward along longitudinal axis LA1 with the aid of transport devices 8 until it has reached the bottom.

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Cleaning system 4 according to the invention has the advantage that it can also automatically move safely on an overhanging part of tall building 1 (see the top section of the tall building in figure 1). Cleaning
10 system 4 is capable of rotating about its own axis and of advancing vertically, obliquely, or even horizontally.

The second embodiment of the cleaning system according to
15 the invention is explained in the following with reference to figures 8 to 18.

Figure 8 shows the building complex in a side view, and shows the location where a second embodiment of the
20 cleaning system according to the invention is accommodated. Circle F indicates the location where the cleaning system is parked, i.e. when it is not operational.

25 The region inside circle F is shown in an enlarged view in figure 9. An airship 20 is parked in a hangar 2.2 located in the uppermost region of tall building 2. Airship 20 comprises a rotatable drive 20.2 in the front region and a further drive 20.1 in the rear region. A
30 supply device 21 is located on the underside of airship 20, which mainly performs the same tasks as supply device 7 in the first embodiment of cleaning system 4 according to the invention. A telescoping arm 22 is also located in

hangar 2.2, which is used to maneuver airship 20 out of hangar 2.2 and draw it back into the hangar.

Figure 10 shows an enlarged depiction of telescoping arm 22 used to dock the airship on the building. Telescoping arm 22 comprises a docking device 22.1 to enable airship 20 to be docked on telescoping arm 22.

In the following, the term "airship" refers to a steerable aircraft, the lift of which relies on aerostatic forces, and which has its own drive.

To bring the cleaning system into the operating position, airship 20 is pushed out of hangar 2.2 using telescoping arm 22, as shown in figures 11 and 12. Circular section G shown in figure 11 is shown in an enlarged view in figure 12. Once airship 20 has been maneuvered far enough out of hangar 2.2, it floats upward until it reaches its working position, as shown in figure 13. Airship 20 is connected to telescoping arm 22 by way of a safety cable 18. Supply device 21 which contains cleaning device 17 is now moved into the desired working position on two cables 16 which are connected to airship 20. In a further step, cleaning device 17 is transported out of cleaning device 21 and automatically adheres to facade 1.1 of tall building 1 by way of suction cups. Figure 14 shows the building complex, airship 20, supply device 21, and cleaning device 17 during the cleaning of building facade 1.1. Circular section J is shown in an enlarged view in figure 15. Cleaning device 17 is connected by way of a supply line 15 to supply device 21 which is also referred to as a supply station, and is supplied with cleaning agent and energy by way of supply line 15. Supply line 15

also contains a vacuum line so that cleaning device 17 can adhere securely to the facade by way of the suction cups. Moreover, supply line 15 is also designed such that it serves as a safety cable and thereby prevents cleaning
5 device 17 from falling in case of emergency. Cleaning device 17 can move autonomously on facade 1.1 during operation and clean it according to a defined pattern. To enable cleaning device 17 to move, it is provided with a traveling mechanism which can be designed as described in
10 publication EP 1 507 696 B1. The traveling mechanism of cleaning device 17 comprises a plurality of suction devices that circulate in an endless loop in the plane of travel, with their suction sides facing the travel surface. An activated suction device is situated on the
15 plane of travel, while an inactivated suction device circulates at a defined distance from the plane of travel.

As already described in conjunction with the first
20 embodiment of the cleaning system, tall buildings are often a few hundred meters tall, and so the supply of cleaning agent is typically insufficient to clean entire facade 1.1 of the tall building in one pass. Supply device 21 therefore comprises lowerable supply container
25 10 which can be lowered, as necessary, to the ground or the roof of connecting building 3. This situation is depicted in figure 16. Circular section L is shown in an enlarged view in figure 17. Circular section K in figure 16 is shown in an enlarged view in figure 18.

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The method for cleaning a facade using dry ice is described in publication DE 102 33 304 B4 which can be

referred to as necessary. Reference is therefore made to that publication at this point.

5 The preceding description of the embodiments according to the present invention is used merely for illustrative purposes and not for the purpose of limiting the invention. Various changes and modifications are possible within the scope of the invention without leaving the scope of the invention and the equivalents thereof. For
10 example, the embodiments explained with reference to figures 1 to 7 and 8 to 18 may therefore be combined with one another and may be used with tall buildings other than those shown in figures 1 to 18. The tall building can also have an oval or angular cross section. In those
15 particular cases, supporting structure 5 is adapted to the particular cross section of the building such that it encloses the building at an approximately constant distance.

List of reference characters

	1	First tall building
	1.1	Facade
5	2	Second tall building
	2.1	Facade
	2.2	Hangar
	3	Connecting building
	4	Cleaning system
10	5	Supporting structure
	5.1	Segments
	6	Cleaning device
	7	Supply device
	8	Transport device
15	9	Cable
	10	Supply container
	11	Windlass
	12	Suction cup
	13	Brush
20	14	Nozzle
	15	Supply line
	16	Supporting cable
	17	Cleaning device
	18	Safety cable
25	20	Airship
	20.1	Drive
	20.2	Drive
	21	Supply device
	22	Telescoping arm
30	A, B	Sections
	C	View
	D - G	Sections
	J, K, L	Sections

H	Horizontal direction of motion
V	Vertical direction of motion
LA1	Longitudinal axis of the first tall building
LA2	Longitudinal axis of the second tall building

Claims

1. A cleaning system for a facade of a building,
 - comprising an annular supporting structure (5)
5 which is designed such that it can enclose the building (1),
 - comprising a transport device (8) which is attached to the supporting structure (5) and is provided to move the supporting structure (5), and
 - 10 - comprising a cleaning device (6) which is connected to the supporting structure (5) and is provided to clean the facade(1.1) of the building (1).
2. The cleaning system according to claim 1,
15 comprising a supply line (7) which is connected to the supporting structure (5) and is provided to supply the cleaning device (6) and the transport device (8) with energy and cleaning agent.
3. The cleaning system according to one of the claims 1
20 or 2,
wherein the supporting structure (5) is made of lightweight construction material.
4. The cleaning system according to one of the claims 1
25 to 3,
wherein the supporting structure (5) has a lattice structure.
5. The cleaning system according to one of the claims 1
to 4,
wherein the supporting structure (8) comprises a suction cups.
- 30 6. The cleaning system according to one of the claims 1 to 5,

wherein the transport device (8) comprises a crawler drive or walking legs.

7. A cleaning system for a facade of a building,
 - comprising an airship (20),
 - 5 - comprising a cleaning device (17) which is provided to clean the facade (1.1) of the building (1), and
 - comprising a supply device (21) which is connected to the airship (20) and the cleaning device (17) and is provided to supply the cleaning device (17) with
 - 10 energy and cleaning agent.
8. The cleaning system according to one of the claims 2 to 7,
wherein the supply device (7; 21) comprises a supply container (10).
- 15 9. The cleaning system according to claim 8,
 - wherein the supply device (7; 21) comprises a windlass (11) for lowering the supply container (10), and
 - wherein the supply container (10) comprises a
 - 20 propeller.
10. The cleaning system according to one of the claims 1 to 9,
wherein the cleaning device (6) comprises a brush (13).
- 25 11. The cleaning system according to one of the claims 1 to 10,
wherein the cleaning device (6) comprises a nozzle (14).
12. The cleaning system according to one of the claims 1
- 30 to 11,

wherein the cleaning device (6) operates using dry ice.

13. The cleaning system according to one of the claims 1 to 12,
5 comprising a safety cable (18) that connects the airship (20) to the building (2).
14. A building comprising a cleaning system according to one of the claims 7 to 13,
comprising a hangar (2.2) for the airship (20).
- 10 15. The use of the cleaning system according to one of the claims 1 to 14,
to clean the facade (1.1) of a building (1).