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(54) **A handling device for liquor guns of a recovery boiler plant, a recovery boiler plant, and a method in a recovery boiler**

(57) A handling device for liquor guns (2) of a recovery boiler plant, which device comprises transfer means (11) for transferring a nozzle (7) of a liquor gun to the

furnace (1) of a boiler and out from the furnace. In addition, the invention relates to a recovery boiler plant as well as a method in a recovery boiler plant.

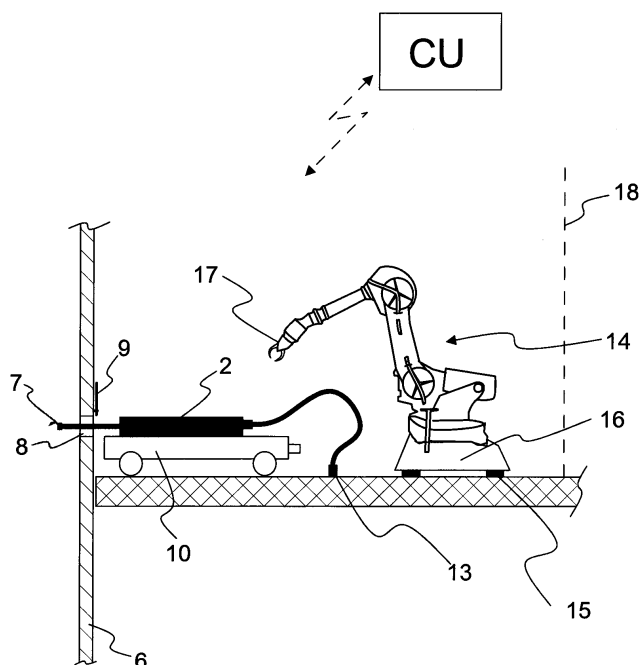


Fig. 3

Description

Field of the invention

[0001] The invention relates to a handling device for liquor guns of a recovery boiler plant. In addition, the invention relates to a recovery boiler plant as well as a method in a recovery boiler.

Background of the invention

[0002] The spent lye, i.e. the so-called black liquor created in pulp manufacture is burnt in a recovery boiler, on one hand, in order to recover the energy it includes, and on the other hand, in order to recover the chemicals in it and to recycle them back to circulation.

[0003] Black liquor is fed to a boiler on a so-called liquor gun area, which comprises several liquor guns, with which the pressurized black liquor is brought inside the boiler. For using and maintaining liquor guns, a typical plant comprises an access platform (a so-called main service platform). Moving on the main service platform becomes risky if the boiler for some reason changes to positive pressure. For example, if the boiler is becoming plugged, a person walking on the main service platform or working at the gun area may become exposed to a spray of sparks. A similar situation may occur, for example, when the induced draft fans are stopped unintentionally or as a result of locking. Changes in the boiler load are made manually, in which case it is necessary to operate in the vicinity of guns. Perhaps one great disadvantage is that the operators are exposed to dangerous situations when changing liquor guns. When handling liquor nozzles (for example, a change situation, opening of a nozzle attachment, opening a plugged nozzle) the operator comes in direct contact with hot (125-150 °C) black liquor.

[0004] The liquor gun area is one of the most accident-prone areas of a recovery boiler from the point of view of work safety. Safety has conventionally been aimed to be improved by different ergonomic and mechanical solutions, which take into account the actions of a human being on the area in question.

Brief summary of the invention

[0005] Now a solution has been invented, which enables decreasing the amount of work required of the operators at the liquor gun area.

[0006] To achieve this aim, the handling device according to the invention is primarily characterized in what will be presented in the independent claim 1. The recovery boiler plant according to the invention, in turn, is primarily characterized in what will be presented in the independent claim 6. The method according to the invention is primarily characterized in what will be presented in the independent claim 11. The other, dependent claims will present some preferred embodiments of the inven-

tion.

[0007] The basic idea of the invention is to create the handling device of liquor guns in a recovery boiler plant in such a manner that the handling device comprises transfer means for transferring the head of a liquor gun and the nozzle in it to the furnace of the boiler and out of the furnace.

[0008] In an embodiment the handling device is arranged to handle at least two liquor guns and the handling device comprises moving means for moving the handling device from a first liquor gun to a second liquor gun.

[0009] In an embodiment the handling device is arranged to define the location of the handling device by scanning the surroundings.

[0010] In an embodiment the handling device is arranged to perform at least one of the following:

- operator tasks relating to starting or finishing liquor combustion (such as, for example, taking the liquor gun in and out of the furnace)
- rodding the liquor gun opening
- cleaning the nozzle area
- trimming the position of the gun
- detaching the liquor gun
- blowing the liquor gun clean, for example, to a blowing well
- washing the liquor gun
- changing the liquor gun
- changing the nozzle
- sampling the black liquor

[0011] In an embodiment also the following monitoring operations are automated:

- monitoring that the liquor gun is safely at its place and inside the furnace during liquor spraying
- stopping the liquor spraying to the gun in question if the value "gun in furnace of the limit switch of the gun holder is no longer valid
- leakage monitoring of the pipework on the basis of pressure changes

[0012] In an embodiment the handling device comprises computer vision means and by means of the computer vision at least some of the following are determined:

- the form of the spray formed by the liquor gun
- droplet size
- rodding need of the liquor gun
- need to change the liquor gun

[0013] In an embodiment the valves used for connecting liquor guns are automated.

[0014] In an embodiment the recovery boiler plant comprises

- a hatch that can be used to close the liquor gun opening,

- transfer means for moving the hatch.

[0015] In an embodiment the liquor guns are placed in holders in such a manner that they can be pulled out. The valves connected to spraying black liquor are automated in such a manner that liquor spraying can be started sequentially controlled via a distributed control system (DCS), for example, one liquor gun at a time.

[0016] In an embodiment the construction is composed of one or more robots, which perform different actions on the main service platform, mainly in the black liquor gun area. The robot is connected to the rest of the control system of the plant, such as, for example, a distributed control system. Preferably the robot circulates in the furnace along a guide rail or the like. In an embodiment the handling device comprising an actuator is a moving 6-axis robot unit.

[0017] In an embodiment the work area of liquor guns is separated from the rest of the area by a curtain or a light screen.

[0018] The different embodiments of the above-described arrangement, taken separately and in various combinations, provide several advantages. A single application may comprise one or more of the following advantages depending on its implementation.

- Safety of use is improved
- Operations to be performed by humans are minimized
- Work time in the vicinity of guns is decreased significantly. The remaining compulsory visits take place more safely than at the moment
- The risk of personal injuries is decreased
- With the black liquor guns the operations take place in a controlled manner and always in the same way
- The possibility of misuse is decreased
- Usability is improved

Description of the drawings

[0019] In the following, the invention will be described in more detail with reference to the appended principle drawings, in which

Fig. 1 shows a recovery boiler plant in principle

Fig. 2 shows a detail of the liquor gun area

Fig. 3 shows another embodiment of the handling unit.

[0020] For the sake of clarity, the drawings only show the details necessary for understanding the invention. The structures and details that are not necessary for understanding the invention but are obvious for anyone skilled in the art have been omitted in the figures in order to emphasize the characteristics of the invention.

Detailed description of the invention

[0021] Figure 1 shows in principle a recovery boiler plant. The plant comprises a furnace 1, where the black liquor to be combusted is fed by liquor guns 2. The figure shows that the liquor gun area 3 is in the lower part of the plant. The liquor gun area 3 typically comprises a so-called main service platform for using and maintaining the liquor guns 2. Below the liquor gun area 3 is the smelt spout area 4. In the example, above the liquor gun area 3 are, in turn, air supply platforms 5. The number and location of air supply platforms 5 may vary depending on the application. The different parts of the figure are not dimensioned correctly in relation to each other, because the purpose of the figure is to show the location of the liquor gun area 3 of the invention.

[0022] Figure 2 shows a detail of the liquor gun area 3. The figure shows the placement of a liquor gun 2 in the vicinity of the wall 6 of the boiler. The output end of the liquor gun 2 comprises a nozzle 7, from where the black liquor is fed out of the liquor gun. In the figure the head of the liquor gun 2 and the nozzle 7 attached to it are in the inside position and placed inside the furnace 1, i.e. the liquor gun is in the use position. A liquor gun opening 8 is formed in the wall 6 of the boiler for placing the liquor gun 2 inside the furnace 1. The liquor gun opening 8 can advantageously be closed by a hatch 9 when the head of the liquor gun 2 and the nozzle 7 attached to it are in the outside position (maintenance position), i.e. out of the furnace 1.

[0023] In the embodiment according to figure 2 the liquor guns 2 are placed in the holders 10 in such a manner that the liquor guns can be moved by means of movable holders. Thus, the heads of the liquor guns 2, as well as the nozzles 7 of the liquor guns can be pulled out. The holder 10 is moved by an actuator 11, such as, for example, a motor, a cylinder or a robot (a robot is shown in figure 3). In the example the holder 10 and the actuator 11 form the handling device of a liquor gun 2 and the actuator 11 operates as a transfer means. The hatch 9 of the liquor gun opening 8 is also moved by an actuator 12, such as, for example, a motor, a cylinder or a robot (a robot is shown in figure 3).

[0024] The valves 13 relating to the black liquor spraying are automated. Advantageously the valves 13 are automated in such a manner the liquor spraying can be started via a Distributed Control System (DCS) in a sequentially controlled manner, for example, one liquor gun 2 at a time.

[0025] Moving the liquor guns 2 by the actuator 11 and the automated control of the valves 13 enable different functions. For example, when removing a liquor gun 2 from the furnace 1, either for maintenance, load decrease or other reasons, the following actions take place: in a sequentially controlled manner the black liquor feeding is closed and the nozzle 7 is blown clean with steam, non-pressure is confirmed, the nozzle is pulled with the actuator to the outside position and the hatch 9 of the

gun opening 8 is closed by the actuator 12. After this the liquor gun 2 is in a relatively safely operatable position.

[0026] In the application according to figure 2, the following operations are advantageously automated:

- taking the liquor gun in and out of the furnace
- starting and stopping spraying with the required preparations
- monitoring the position of the liquor gun in order to ensure that the gun is safely at its place and inside the furnace during liquor spraying
- stopping the liquor spraying if the value "gun in furnace" of the limit switch of the gun holder is no longer valid
- leakage monitoring of the pipework on the basis of pressure changes
- trimming the positions of guns from the monitor room
- rodding the liquor gun openings
- washing the tubes and liquor guns

[0027] It is possible to use different mechanical, electrical and/or optical switches and controllers (such as, for example, different limit switches) for identifying the position of the gun holder 10.

[0028] Fig. 3 shows another embodiment of a handling device for liquor guns 2 of a boiler. In this embodiment the handling device comprises a moving handling unit 14, which can move on the path 15 and the operation of the handling device is controlled by a control unit (not shown). In the figure the path 15 is formed by the guide rails on the floor of the service platform. The handling unit, in turn, is formed by a carriage 16 and a handling member 17, which are described more in detail later in the description. The handling unit may travel along the path 15 horizontally parallel to the wall 6 of the boiler.

[0029] The path 15, which here refers to the structure guiding the carriage 16 of the handling unit 14, can also be implemented in several ways. The path 15 can be, for example, a guide bar or a rail, which directs and supports the handling unit 14. It is also possible to implement a moving handling unit 14 without the actual structural path 15, in which case the handling unit can travel, for example, on the travel area on the service platform.

[0030] In an embodiment the path 15 is attached to the wall 6 of the boiler. By attaching the guide rail to the boiler wall 6, the mutual position of the guide rail and the liquor guns 2 remains substantially constant irrespective of the temperature of the wall. The dimensions of the boiler wall 6 typically change when the temperature changes due to the thermal expansion of the material. The handling unit 14 is preferably arranged primarily below the guide rail 15, i.e. the handling unit is in a way suspended from the guide rail. Advantageously the guide rail 15 enables as unobstructed movement as possible to the area below the rail. The guide rail 15 can in some embodiments be located below the handling unit 14 or on its side as well. It is possible to place the guide rail 15 in other ways as well, but then the variation in the locations of different

parts caused by thermal expansion must be taken into account with some other solutions.

[0031] A handling unit 14 moving on the path 15 comprises the above-mentioned carriage 16 and a handling member 17. The handling unit 14 in this embodiment operates also as a transfer means. The handling unit 14 is connected to the path 15 via the carriage 16 of the handling unit and the handling unit may travel horizontally in parallel with the boiler wall 6 by means of an actuator, such as, for example, an electric motor. In the embodiment according to the example the carriage 16 is arranged to travel along the path 15. The carriage 16 and/or the path 15 comprise suitable transfer structures and glide structures, by means of which the carriage 16 can move from one position to another. The handling member 17 is connected to the carriage 16 in such a manner that the handling member can move at least towards the boiler and away from the boiler and advantageously vertically as well. In the example the carriage 16 and the handling member 17 are connected to each other via a first pivot (hinging structure), such as, for example a gear system. The first pivot enables the turning of the handling member 17 in relation to the axis line of the pivot (gear system), in which case the head of the handling member 17 can move in the height direction. In an embodiment the handling member 17 can also turn horizontally in relation to the carriage. In an advantageous embodiment the handling device comprises a 6-axis robot unit, in which case it is possible to perform versatile movements. Preferably the robot unit is placed in a movable carriage 16, by means of which the robot unit can be moved to a suitable position. The robot unit can be used as a transfer means, with which the liquor guns 2 and hatches 9 can be moved.

[0032] As the actuators creating the dynamics of the handling device it is possible to use devices suitable for the purpose, such as, for example, different electric motors, hydraulic and pneumatic actuators, and their direction of movement can be, for example, linear or rotating. The actuators can be placed in various ways. For example, they can be located centralized in connection with the carriage 16, from where the power is transferred with suitable structures to the arm parts and other necessary targets. The actuators can also be placed in different locations of the handling device and/or handling unit 14, in which case, for example, the actuator creating the movement of the arm part can be in the arm part or in the connection of the arm part.

[0033] In order to determine the location of the handling unit 14, it is possible to use various solutions. The path 15 can comprise identification structures, by means of which the location and/or positioning of the handling unit 14 can be made. In an embodiment the positioning takes place by means of computer vision and in an application measuring members are used, and the position is determined on the basis of the measuring information received from them. It is also possible to use different mechanical, electrical and/or optical switches and controls (such as, for example, different limit switches).

[0034] As computer vision it is possible to use, for example, a camera that records the target substantially on the wavelength of visible light. It is also possible to use a sensor, which forms an image on some other wavelength area, such as, for example, the IR-area. An embodiment uses a computer vision, which utilizes information received from several different wavelength areas.

[0035] In an embodiment the handling unit 14 defines its own position in relation to the target by scanning the target with the handling member 17. On the basis of the detected characteristics, the location is defined and coordinates are formed. After this the paths required by the operations are fitted to the coordinates. In an advantageous embodiment computer vision and scanning are used for determining the location. Thus, on the basis of the characteristics detected by computer vision and/or scanning, the location is defined and the coordinates are formed, if necessary.

[0036] The operation of the handling device is controlled by a control unit. The control unit can be implemented in a variety of ways. For example, the functions of the control unit can be implemented by programming and the program can be either in its own data handling unit or in a data handling unit together with some other program. In an application the commands of the control unit are a part of the other command set of the boiler usage control program. Program-based control makes it possible to take into account the individual properties of different targets and their possible effects on the handling.

[0037] Programming the program-based control can be implemented in various ways, such as, for example, by inputting the commands separately to a control unit or by guiding or teaching the desired function to the control unit. In the programming, *inter alia* the paths of movement of the handling member 17 and information connected to the carriage 16 movement are determined.

[0038] The program comprises the necessary commands for implementing the handling method. The method may comprise, for example, working phases with which it is possible to control the handling device in such a manner that it

- defines by means of computer vision the form of the spray formed by the liquor gun
- defines droplet size by means of, for example, an endoscopic camera attached to a robot
- defines by means of computer vision whether the liquor gun requires rodding
- defines by means of computer vision whether the liquor gun needs to be changed
- performs the operator tasks connected to starting and stopping liquor combustion
- rods the liquor gun opening
- cleans the nozzle area
- trims the position of the gun
- detaches the liquor gun after receiving permission
- blows the liquor gun clean to, for example, a blowing well

- washes the liquor gun
- changes the liquor gun
- changes the nozzle
- samples the black liquor

[0039] In an embodiment the handling unit 14 can be manually controlled. Thus, a person can in a suitable manner control the operation and movement of the handling unit 14. For example, taking care of unusual situations is therefore possible. Control can take place, for example, by means of a portable control unit or by remote usage from the control room. Remote usage often requires receiving image information, which is why it is advantageous to fit at least one camera in the handling unit, the information produced by which camera is transferred to the control room.

[0040] In an embodiment there is one handling unit 14 on one wall of the boiler. In another embodiment there are, in turn, two or more handling units 14 on one wall of the boiler. Thus, it is possible to maintain one handling unit 14 and at the same time use another handling unit. Using several handling units 14 also enables equipping the handling units in different ways, in which case in different situations it is possible to use a differently equipped handling unit.

[0041] The work area of liquor guns 2 can be separated from the rest of the area by curtains or a light screen 18, through which it is possible to safely monitor the operation of a handling device, such as, for example, a robot and the combustion of the boiler. Figure 3 shows by a dashed line an advantageous location for a protective wall 18 that can be opened. Preferably the curtain or screen 18 can be partly opened in such a manner that it is easy to target the necessary operations on the desired limited area of the liquor gun area 3.

[0042] It is also possible to combine the above-described applications and embodiments in such a manner that the created solution comprises two or more of the above-described structures and/or modes of operation.

[0043] By combining, in various ways, the modes and structures disclosed in connection with the different embodiments of the invention presented above, it is possible to produce various embodiments of the invention in accordance with the spirit of the invention. Therefore, the above-presented examples must not be interpreted as restrictive to the invention, but the embodiments of the invention may be freely varied within the scope of the inventive features presented in the claims hereinbelow.

Claims

1. A handling device for liquor guns of a recovery boiler plant, **characterized in that** the handling device comprises transfer means for transferring the nozzle of a liquor gun to the furnace of a boiler, and out from the furnace.

2. The handling device according to claim 1, **characterized in that** the handling device is arranged to handle at least two liquor guns and the handling device comprises moving means for moving the handling device from the first liquor gun to the second liquor gun. 5
3. The handling device according to claim 1 or 2, **characterized in that** the handling device comprises computer vision means, and by means of the computer vision, at least some of the following are determined: 10
 - the form of the spray formed by the liquor gun
 - droplet size
 - rodding need of the liquor gun
 - need to change the liquor gun
4. The handling device according to any of the preceding claims 1 to 3, **characterized in that** the handling device is arranged to define the location of the handling device by scanning the environment. 20
5. The handling device according to any of the preceding claims 1 to 4, **characterized in that** the handling device is arranged to perform at least one of the following: 25
 - starting and stopping the operator tasks connected to liquor combustion
 - rodding the liquor gun opening
 - cleaning the nozzle area
 - trimming the position of the gun
 - detaching the liquor gun
 - blowing the liquor gun clean, for example, to a blowing well
 - washing the liquor gun
 - changing the liquor gun
 - changing the nozzle
 - sampling the black liquor
6. A recovery boiler plant, which comprises a liquor gun area, wherein the nozzles of liquor guns are brought to a furnace via liquor gun openings, and which area comprises at least one handling device for liquor guns, **characterized in that** the handling device comprises transfer means for transferring the nozzle of the liquor gun to the furnace of the boiler and out of the furnace. 30 35 40 45
7. The recovery boiler plant according to claim 6, **characterized in that** the handling device is arranged to handle at least two liquor guns and the handling device comprises moving means for moving the handling device from the first liquor gun to the second liquor gun. 50 55
8. The recovery boiler plant according to claim 6 or 7, **characterized in that** the handling device comprises computer vision means, and by means of the computer vision at least some of the following are determined:
 - the form of the spray formed by the liquor gun
 - droplet size
 - rodding need of the liquor gun
 - need to change the liquor gun
9. The recovery boiler plant according to any of the preceding claims 6 to 8, **characterized in that** the valves used for connecting liquor guns are automated.
10. The recovery boiler plant according to any of the preceding claims 6 to 8, **characterized in that** the recovery boiler plant comprises
 - a hatch that can be used to close a liquor gun opening,
 - transfer means for moving the hatch.
11. A method in a recovery boiler plant, wherein black liquor is fed to a furnace with liquor guns via liquor gun openings, **characterized in that** the nozzle of the liquor gun is transferred to the furnace of the boiler and out of the furnace by an actuator.
12. The method according to claim 11, **characterized in that** several liquor guns are transferred individually with the handling device comprising the actuator.
13. The method according to claim 11 or 12, **characterized in that** with the handling device comprising the actuator, at least one of the following tasks is performed:
 - defining the form of the spray formed by the liquor gun
 - defining droplet size
 - defining whether the liquor gun needs rodding
 - defining whether the liquor gun needs to be changed
 - performing the operator tasks connected to starting and stopping liquor combustion
 - rodding the liquor gun opening
 - cleaning the nozzle area
 - trimming the position of the gun
 - detaching the liquor gun
 - blowing the liquor gun clean to, for example, a blowing well
 - washing the liquor gun
 - changing the liquor gun
 - changing the nozzle
 - sampling the black liquor
14. The method according to any of the preceding claims

11 to 13, **characterized in that** the hatch of the liquor gun opening is opened and closed by the same actuator that transfers the nozzle of the liquor gun to the furnace of the boiler and out from the boiler.

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15. The method according to any of the preceding claims 11 to 14, **characterized in that** the handling device comprising the actuator is a moving 6-axis robot unit.

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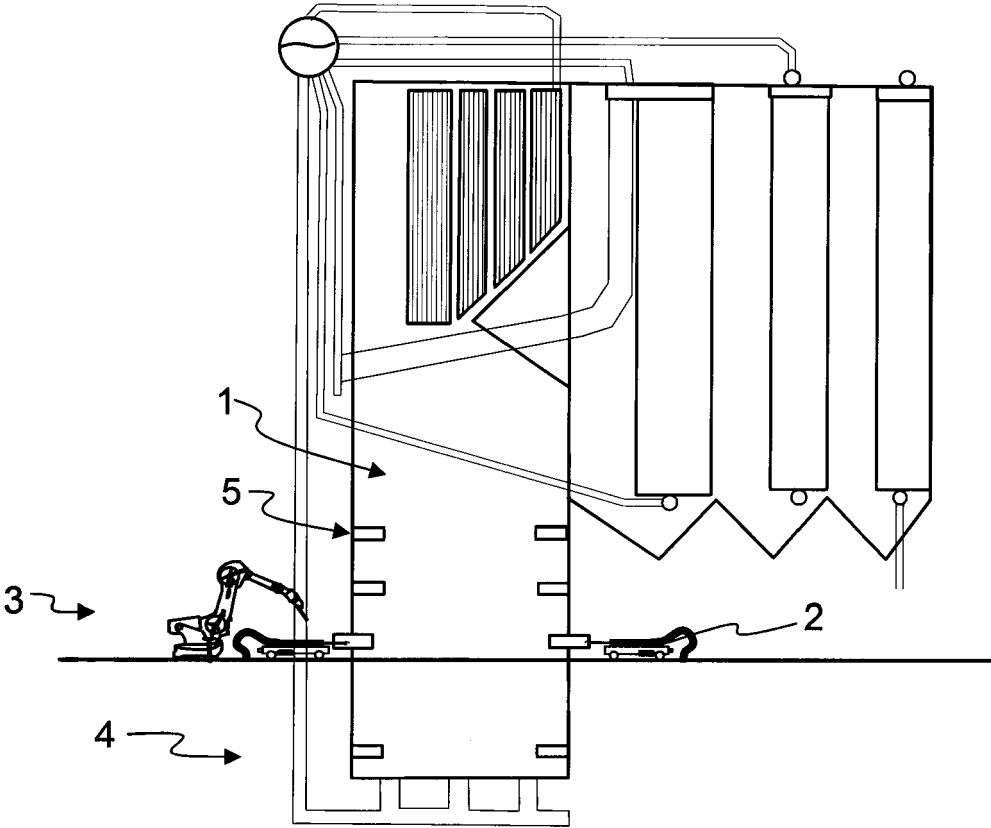


Fig. 1

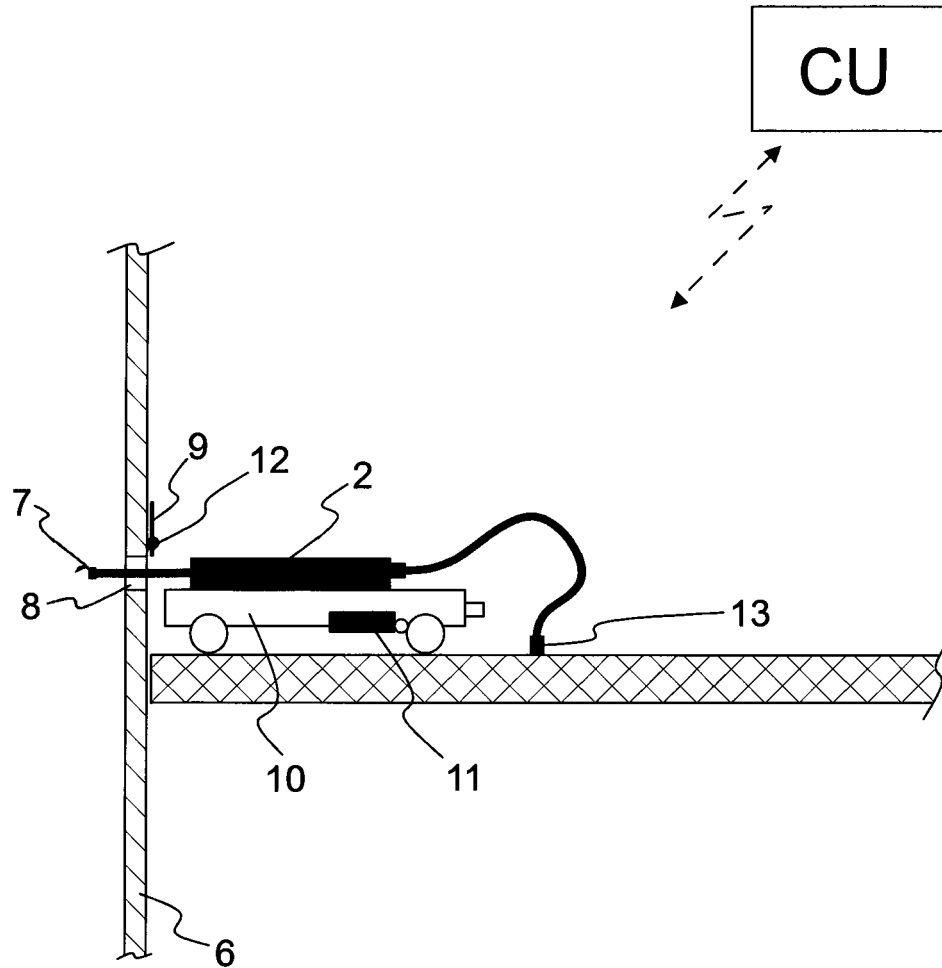


Fig. 2

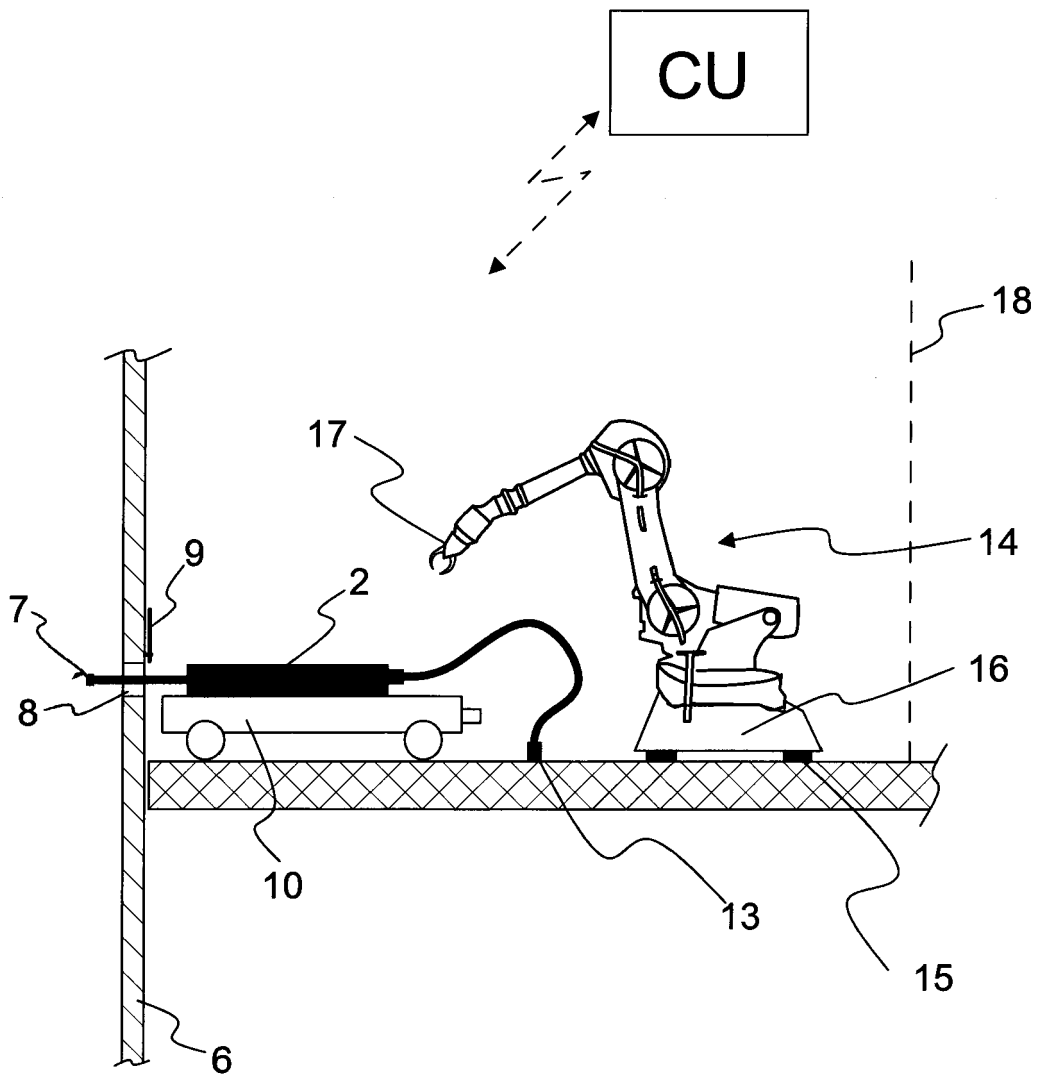


Fig. 3



EUROPEAN SEARCH REPORT

Application Number
EP 09 17 9577

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Place of search Munich		Date of completion of the search 22 April 2010	Examiner Karlsson, Lennart
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 09 17 9577

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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