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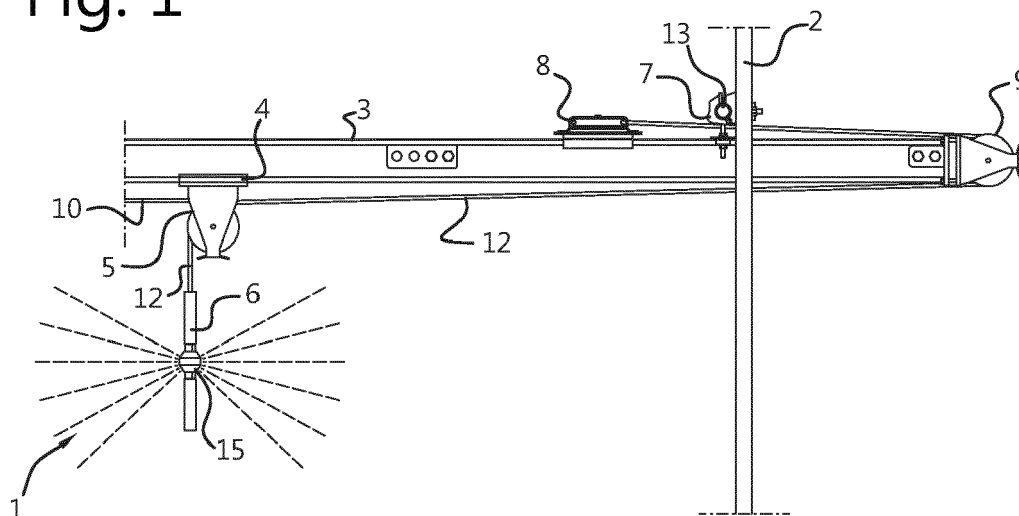
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(54) **METHOD AND SYSTEM FOR CLEANING BOILERS, SPECIFICALLY LIGNITE BOILERS**

(57) System for cleaning boilers, preferably lignite boilers, comprising
at least one cleaning device, for cleaning the boiler internally, comprising a spray head and a water supply connection; a suspension means for each of the cleaning devices, for keeping the cleaning device suspended at the top of the boiler and adjusting the height position of the cleaning device relative to the top of the boiler, wherein the suspension means is suitable for being coupled

with the cleaning agent with one end, and wherein the suspension means is movably coupled with another side to the top of the boiler; and a water supply means adapted to be coupled to the water supply connection of the cleaning devices for supplying high pressure water to the cleaning devices, the system further comprising a controller suitable for controlling the suspension means, the controller monitoring the cleaning of the boiler.

Fig. 1



Description

TECHNICAL FIELD

[0001] The invention relates to a device and method for cleaning boilers, in particular lignite boilers.

PRIOR ART

[0002] Lignite boilers are still often used to heat water to form steam. The water is fed through a network of pipes, which are often stacked and oriented in parallel in a boiler. The pipes are herein supported in height by support pillars, whereby several corridors are formed between the stacked pipes. The water is heated by burning lignite. However, after the burning of lignite, ash is released which ends up around the pipes in the lignite boiler and can even cake on the pipes over time. The ashes on the pipes form a kind of insulating layer, so that less steam can be formed, which has a major impact on the efficiency of the process. To avoid this problem, the pipes should be cleaned regularly.

[0003] DE 101 20 338, DE 10 2004 060884, EP 1 291 598, DE 103 40 790 and DE 20 2008 011514 describe systems and methods for cleaning the internal structures and inner walls of boilers but fail to describe an easily installable and automatable system that can perform the cleaning procedure quickly and without much follow-up (which requires entering the boiler).

[0004] A first problem arises due to the difficult accessibility of these boilers. A maze of water pipes and pillars makes it difficult to enter and clean them manually, as not all positions are easily accessible or cleanable at all. Secondly, manual cleaning requires too much manpower anyway, and the boilers would have to be shut down for too long, compared to the running time between periodic cleanings. For this reason, automation has been opted for, in which a suspension point and/or rail is built over which a spray head is moved. Once the route has been completed, the boiler is reentered and a new suspension point and/or rail is built.

[0005] It is clear that this method results in too long a lead time, and also requires operators to enter the boiler very often, which is undesirable. Moreover, such systems are often insufficiently able to clean all positions, so that the boiler is cleaned both too slowly and insufficiently effectively. For these and other reasons, the applicant provides the present invention.

[0006] The present invention thus aims to solve at least some of the above problems or drawbacks. The aim of the invention is to provide a method which eliminates those disadvantages.

SUMMARY OF THE INVENTION

[0007] In a first aspect, the invention relates to a system for cleaning boilers, and in particular lignite boilers, according to claim 1.

[0008] Preferred embodiments of the device are set out in claims 2-11.

[0009] In a second aspect, the present invention relates to a method for cleaning boilers, and in particular lignite boilers, according to claim 12.

[0010] Preferred embodiments of the method are described in dependent claims 13 and 14.

[0011] In a third aspect, the present invention relates to the use of a system and/or method for cleaning boilers, more particularly lignite boilers, according to claim 15.

DESCRIPTION OF THE FIGURES

[0012]

Figure 1 shows a side view of a system according to an embodiment of the invention.

Figures 2-5 show schematic plan views of a system according to an embodiment of the invention, showing the progression of the system during cleaning of a boiler step by step.

Figure 6 shows a side view of a spray head as part of a cleaning device according to an embodiment of the invention.

Figure 7 shows a side view of a system according to an embodiment of the invention.

DETAILED DESCRIPTION

[0013] Unless otherwise defined, all terms used in the description of the invention, including technical and scientific terms, have the meaning as commonly understood by a person skilled in the art to which the invention pertains. For a better understanding of the description of the invention, the following terms are explained explicitly.

[0014] In this document, "a" and "the" refer to both the singular and the plural, unless the context presupposes otherwise. For example, "a segment" means one or more segments.

[0015] When the term "around" or "about" is used in this document with a measurable quantity, a parameter, a duration or moment, and the like, then variations are meant of approx. 20% or less, preferably approx. 10% or less, more preferably approx. 5% or less, even more preferably approx. 1% or less, and even more preferably approx. 0.1% or less than and of the quoted value, insofar as such variations are applicable in the described invention. However, it must be understood that the value of a quantity used where the term "about" or "around" is used, is itself specifically disclosed.

[0016] The terms "comprise," "comprising," "consist of," "consisting of," "provided with," "include," "including," "contain," "containing," are synonyms and are inclusive or open terms that indicate the presence of what follows, and which do not exclude or prevent the presence of

other components, characteristics, elements, members, steps, as known from or disclosed in the prior art.

[0017] Quoting numerical ranges by endpoints includes all integers, fractions and/or real numbers between the endpoints, these endpoints included.

[0018] In a first aspect, the invention relates to a system for cleaning boilers, in particular lignite boilers. This system comprises:

- at least one cleaning device, for cleaning the boiler internally, comprising a spray head and a water supply connection;
- a suspension means for each of the cleaning devices, for keeping the cleaning device suspended at the top of the boiler and adjusting the height position of the cleaning device relative to the top of the boiler, wherein the suspension means is suitable for being coupled with the cleaning agent with one end, and wherein the suspension means is coupled with another side to the top of the boiler;
- a lifting device for each of the suspension means, for raising and lowering the suspension means, in particular raising and lowering the cleaning device; and
- a water supply means adapted to be coupled to the water supply connection of the cleaning devices for supplying high pressure water to the cleaning devices;

The system further comprises a controller suitable for controlling the lifting devices, wherein the height position of the suspension means is controlled, and wherein the controller monitors the cleaning of the boiler.

[0019] The lifting devices can be movably coupled to the top of the boiler. In this regard, the boilers can already be provided with attachment points on which one or more lifting devices can be placed. In this regard, a suspension means is operated by means of a lifting device. The lifting device can adjust the suspension means in height, and thus controls the height of the cleaning device between the pipes of the boiler. The pipes in the relevant boiler are mainly placed parallel to each other, so that corridors are formed between the pipes. In addition to controlling the cleaning device in height through the corridors, the lifting device can be moved to a second position above the corridors.

[0020] Because the cleaning devices can be coupled movably at the top of the boiler and because the cleaning devices can be adjusted in height by the coupled suspension means, the cleaning devices can reach the full surface of one or more corridors between the pipes. By providing one or more cleaning devices between each corridor, all pipes, in particular the walls of the corridors, can be cleaned at the same time. This saves a lot of time while cleaning the boiler.

[0021] The cleaning device is hereby supplied with water under high pressure. The use of a water supply means for each cleaning device is very advantageous, as it en-

sures that a single defect does not impact the entire cleaning process, and also allows variation in pressure across the different cleaning devices (e.g. certain zones where more or less pressure is required for cleaning).

5 The water supply means ensures that the water supplied to each cleaning device is provided with sufficient pressure. Preferably, the pipes are cleaned with the same pressure, and therefore the same quality, over the entire corridor.

10 **[0022]** Controlling the lifting device by means of a controller has the great advantage that such means can be controlled from a distance. This allows the cleaning process to take place safely, controlled from the outside of the boiler, whereby the boiler does not have to be entered during cleaning, so that the operators are in as little danger as possible. In addition, the additional effect is that the cleaning process is largely automatic. As a result, fewer people need to be present during the cleaning process, in addition, by regulating the cleaning agent in height 15 between the corridors, deeper and better cleaning is ensured. Monitoring the cleaning process has the advantage that adjustments can be made if necessary.

[0023] The controller is capable of adjusting the speed of the lifting instrument. Parts of the boiler that require additional cleaning can be cleaned longer or more specifically by remote adjustment of the system. In addition, problems and defects can be found and resolved more quickly. Due to the controller and monitoring, all parts and pipes of the boiler are sprayed for the same amount of time in the cleaning process by the high pressure water 20 by the cleaning device and thus ensures an equal cleaning quality over the entire boiler, more specifically between the corridors between the pipes.

[0024] Preferably, the spray head comprises a plurality of openings, the openings comprising a channel extending from a cavity of the spray head to the surface of the spray head. The cleaning device comprises a longitudinal axis, wherein at least one of the openings, and preferably at least two, is an offset opening, which extends substantially perpendicular to the longitudinal axis of the cleaning device with a deviation of at most 20°, preferably at most 15°, more preferably at most 10°, wherein the perpendicular projections of the channels of the offset opening on a plane perpendicular to the longitudinal direction 25 have an offset with respect to said longitudinal axis. This means that the channel of the offset opening does not intersect but crosses the longitudinal axis of the spray head.

[0025] The offset openings are thus used as drive mechanisms for rotating the spray head during operation about the longitudinal axis. Due to the great pressure with which water is ejected, and the offset, the spray head undergoes not only a radial (reaction) force, but also a tangential (reaction) force that causes the rotation.

30 **[0026]** It should be noted that only the channels generating substantially "horizontal" jets (i.e., in a plane approximately perpendicular to the longitudinal axis) have the offset. In this way it is avoided that in addition to a

rotation around the longitudinal axis, the rotation also has other components around other axes, which can adversely affect the operation of the spray head.

[0027] Other channels, which deviate more from the "horizontal" direction, have no offset and intersect approximately with the longitudinal axis so as not to create an unwanted torque, the direction of which would deviate greatly from the longitudinal axis.

[0028] In a preferred embodiment, the offset openings are located in a central portion of the spray head along the longitudinal axis. Again, this ensures that torques caused by the offset have the desired results, namely a controllable rotation about the longitudinal axis, without too many side effects (angular momentum about another axis that can lead to the spray head wobbling).

[0029] This central portion preferably occupies the middle third of the spray head along the longitudinal axis. Preferably, the offset openings are positioned even more centrally, namely in the middle quarter or even middle fifth. In this way it is avoided that too great a torque is present around an axis other than the longitudinal axis.

[0030] As indicated, the openings that are not offset openings most preferably have channels intersecting the longitudinal axis of the spray head, so as to generate (virtually) no torque thereabout.

[0031] Channels preferably intersect or cross the longitudinal axis at a maximum distance from the center plane of the spray head perpendicular to the longitudinal axis, said maximum distance being maximally 10.0 cm, preferably maximally 5.0 cm, even more preferably maximally 2.5 cm or even 1.0 cm or 0.5 cm (can this be shown in a smaller amount?). Even more preferably, this distance is at most 0.25 cm, or even 0.1 cm or even lower.

[0032] Most preferably, the channels of the openings that are not offset openings are oriented to intersect the longitudinal axis at the center (along the longitudinal axis) of the spray head, again to reduce or completely avoid torque.

[0033] It should be noted that for the offset openings, the channels are oriented so that they cross the plane perpendicular to the longitudinal axis (closest approach) at the center of the spray head (along its longitudinal axis). This avoids/reduces a torque about other axes.

[0034] The rotational speed of the spray head about the longitudinal axis is controlled by a lubricant as control element between a stationary element and the spray head, the stationary element being provided fixed to the suspension means at the end, and the spray head being rotatable about the stationary element. The choice of lubricant (more or less viscous, etc.) allows to limit the speed of rotation. By using a lubricant that gives more resistance, the maximum speed is reduced, since the force with which the water is ejected can also be controlled.

[0035] The control element, in particular the lubricant, therefore, does not so much determine a maximum speed, but rather ensures a (known, predetermined) reduction in rotational speed through friction. The maxi-

mum speed is still dependent on the torque of the water ejected (in particular through the offset openings).

[0036] Preferably, the lubricant has a (kinematic) viscosity between 2000 and 12500 centistokes (cSt), depending on the requirements for the braking of motion by the lubricant. A possible lubricant is high viscosity silicone damping fluid.

[0037] According to an embodiment, the suspension means comprises a pulley wheel, preferably one for each suspension means, movably couplable to the top of the boiler. The suspension means can herein be placed over the pulley wheel, suitable for changing the pulling direction of the suspension means, the pulley wheel changing the pulling direction of the suspension means with an angle of 90°, directed away from the transport means.

[0038] The pulley wheel is advantageous in that it allows the control element for regulating the height of the suspension means, for instance a motor winch, to be placed at a position at an end of the sections. As a result, the relevant motor can be better protected against dirt and moisture splashing up during cleaning of the boiler. For example, the motor winches can be fitted with a housing with only an opening for the suspension means.

[0039] According to an embodiment, the spray head comprises a central cavity and a plurality of openings, the openings comprising a channel extending from the cavity to the surface of the spray head. The cavity typically extends along the longitudinal direction of the cleaning device.

[0040] In a preferred embodiment, the cleaning device comprises a longitudinal direction, wherein two openings have an angle between 60° and 80°, preferably between 65° and 75°, even more preferably between 70° and 75°, one opening has an angle between 70° and 90°, preferably between 75° and 85°, even more preferably between 75° and 80°, one opening has an angle between 90° and 110°, preferably between 95° and 105°, even more preferably between 100° and 105°, and two openings have an angle between 100° and 120°, preferably between 105° and 115°, even more preferably between 105° and 110° with respect to the longitudinal direction.

[0041] In an alternative embodiment, the cleaning device comprises a longitudinal direction, wherein two openings have an angle between 35° and 55°, preferably between 40° and 50°, one opening has an angle between 70° and 90°, preferably between 75° and 85°, one opening has an angle between 90° and 110°, preferably between 95° and 105° and two openings have an angle between 125° and 145°, preferably between 130° and 140° with respect to the longitudinal direction.

[0042] In a preferred embodiment, a first offset opening has an angle between 70° and 90°, preferably between 75° and 85°, with respect to the longitudinal direction, and a second offset opening has an angle between 90° and 110°, preferably between 95° and 105° with respect to the longitudinal direction. In certain embodiments, there are multiple first and/or multiple second offset openings.

[0043] In addition, one or two (or more) openings may have an angle between 60° and 80°, preferably between 65° and 75°, with respect to the longitudinal direction, and/or one or two (or more) openings may have an angle between 100° and 120°, preferably between 105° and 115° with respect to the longitudinal direction.

[0044] The above angles are preferably coupled as pairs of supplementary angles, with the openings with supplementary angles preferably on an opposite side of the spray head, as shown in the figures. In this way, especially for the angles between 70° and 110°, it is ensured that they do not interfere with each other, which would be detrimental to the power of the ejected water jet.

[0045] According to an embodiment, the channels have a projection on a plane perpendicular to the longitudinal direction of the cleaning device. Each projection of the channels makes an angle of at least 40° in a first sense, preferably at least 55° in the first sense, more preferably at least 85° in the first sense, with at least one other projection of the channels, and preferably wherein each projection of the channels makes an angle of at least 40° in a second sense, preferably at least 55° in the first sense, more preferably at least 85° in the first sense, with at least one other projection of the channels. The above ensures a good distribution of the openings of the channels over the circumference of the spray head, which, in particular in combination with the following embodiments, provides unique advantages in terms of automatic propulsion of the spray head.

[0046] According to an embodiment, the cleaning device comprises a longitudinal axis and at least two offset openings, wherein the perpendicular projections of the channels of the offset openings on a plane perpendicular to the longitudinal direction all have an offset, preferably substantially the same, with respect to said longitudinal axis, wherein the direction of the offset with respect to the longitudinal axis and the direction from the channel to the surface have a vector product with the same sign for each channel.

[0047] The above amounts to a deviation of the projections of the channels from a radial direction, and thus the extension of the channels does not intersect the central axis of the cleaning device. This deviation, which is in the same direction for all channels, ensures automatic rotation of the spray head. By providing the same offset, the reaction forces that the spray head undergoes are controlled to even partially compensate for unwanted components thereof.

[0048] In most embodiments, the openings and channels are oriented so that they do not completely lie in a plane perpendicular to the longitudinal axis of the spray head/cleaning device. In this way it is avoided that the jet partially rebounds from a sprayed wall or object, in the direction of the jet. On the one hand, this can lead to unwanted impulses and movements of the spray head, but it also weakens the jet and can lead to incomplete cleaning. The deviation from this perpendicular plane is preferably at least 5°, more preferably at least 7.5°, and

no more than 20°, preferably at most 15° and most preferably at most 10° or less. This ensures a maximum torque around the longitudinal axis for the spray head (due to the offset, among other things), and above all a sufficiently reduced torque around other axes, and also ensures that the rebounded jet does not or only slightly disturbs the original jet.

[0049] According to an embodiment, the spray head can rotate at least 360° around the longitudinal direction of the cleaning agent. More preferably, the spray head can rotate unrestrictedly about this axis.

[0050] The respective configuration of the angles mentioned above has the advantage that the water, which is forced under high pressure from the cavity through the channels of the cavities, automatically rotates the spray head, because the force with which the water leaves the spray head has a tangential component, in addition to the typical radial component, which causes a rotation on the spray head due to conservation of angular momentum. This provides the advantage that the water jets from the spray head can reach a larger cleaning area, namely the full 360° around the longitudinal direction of the cleaning device. As a result, fewer openings can be provided in the spray head for spraying the same surface to be cleaned. As a result, the pressure of the water with which the boiler is sprayed is greater, so that the pipes are cleaned better, and a better end result is obtained during a single cycle.

[0051] Furthermore, the choice of the openings is very advantageous because the water jets hereby move through a substantially two-dimensional plane. As a result, the water jets are more focused on the walls of the corridors and no water is sprayed upwards. As a result, more surface area of the boiler is sprayed with water for a longer period of time, which also ensures better cleaning.

[0052] According to an embodiment, the spray head further comprises a control element, coupled in the cavity of the spray head, for presetting the maximum rotational speed of the spray head.

[0053] However, the water, which causes the spray head to rotate under pressure, can cause the spray head to move so quickly that the water leaving the spray head has very little impact. This is because the force of the water is converted into the rotational speed of the spray head. However, this is not desirable and the control element in the spray head is very advantageous for this purpose. Depending on the pressure, the control element will give more or less resistance to the spray head, so that the rotational speed of the spray head is adjusted when the water pressure is high. Thus, the water leaving the spray head ends up with a sufficiently high pressure on the surface to be sprayed and cleaned, so that the surface is still cleaned, and the water jets are sprayed 360° around the longitudinal axis of the cleaning device.

[0054] According to an embodiment, the controller comprises a sensor suitable for measuring the position of the transport means and the height of the cleaning

device.

[0055] The advantage of this (first) sensor is that the controller makes it clear where the cleaning device is located in the boiler. This also makes it possible to move the cleaning device with the controller to a specific location in the boilers that may need to be sprayed more with water, for example due to limited accessibility due to obstructions and/or a known tendency to greater accumulation of dirt or more difficult to clean dirt.

[0056] Optionally, the controller further comprises a (second) pressure sensor suitable for measuring the pressure of the water supply. The controller is configured for this purpose to stop the progress of the cleaning if the pressure of the water supply to one or more of the spray heads is insufficient.

[0057] Furthermore, this also allows pressure losses to be detected. When pressure losses are prevented, the spray head, which experiences the pressure losses, is automatically stopped so that it can be repaired in a targeted manner. The spray head can hereby continue the cleaning process, whereby the cleaning device can still clean the entire corridor between the pipes.

[0058] According to an embodiment, the lifting devices each comprise a housing, the housing further comprising a brush, suitable for keeping the suspension means clean during adjustment of the height of the cleaning device.

[0059] According to an embodiment, the system further comprises a storage space, preferably for each of the suspension means, the storage space further comprising a housing. The storage means is suitable for storing the excess suspension means. The suspension means can be a motor with a cable, where there is a surplus of cable so that the system can be used for different boilers with different heights. The storage space herein comprises a reel so that the excess suspension means can be wound onto the reel, the reel occupying as small an area as possible. This has the great advantage that the suspension means is always placed in an organized manner and is not randomly spread throughout the boiler. As a result, the aforementioned suspension means is not capable of tangling with itself, or nearby suspension means. In addition, the housing ensures that the wound up part of the suspension means remains clean and dry.

[0060] In a preferred embodiment, the lifting devices are placed on fixed suspension points. These lifting points can be elements already present in the boiler but can also be "external" elements that are placed on which to place the lifting devices. For example, these can be scaffold tubes. The suspension points provide a guaranteed safe anchorage for the lifting devices. In this case, the lifting devices are then gradually moved (manually) after each cleaning cycle in the horizontal plane (vertical movement cycle of the spray head).

[0061] According to an embodiment, the system further comprises a plurality of rails, suitable for being coupled to the top of the boiler. In the case of rails, the suspension means is suspended from transport units mov-

able along the rails, the controller being suitable for controlling the transport units.

[0062] According to an embodiment, the suspension points and/or rails are attached at the top of the boiler to the support pillars of the pipes, preferably the suspension points and/or rails are always oriented parallel and centered above a corridor between the pipes. However, this gives the advantage that the lifting devices can be moved across the section, centered over and/or between the corridors.

[0063] The transport means can be driven by means of an external drive mechanism, such as a winch, which moves the transport means along the sections. The cleaning device can herein be brought to a next position after completing a height cycle between the corridors.

[0064] In an alternative embodiment, the transport means is provided with a drive mechanism suitable for moving the transport means over the sections. By providing the drive mechanism on the transport means itself, the movement is more efficient and also easier to actuate. This has the further advantage that the movement of the suspension means over the corridors can be automated, which in turn saves time during cleaning of a boiler.

[0065] In a second aspect, the invention relates to a method for cleaning boilers, preferably lignite boilers.

[0066] A method according to the second aspect comprising:

- installing high-pressure pipes and compressed air pipes;
- opening the boiler, preferably opening the lignite boiler;
- cleaning places in the boiler where the system is placed with compressed air;
- installing a system according to claims 1-10, wherein the system is coupled to the high-pressure pipes for supplying high-pressure water to the system;
- cleaning the boiler by using the system, whereby the boiler is cleaned internally by means of water under high pressure;

wherein a plurality of cleaning devices are operated and controlled simultaneously and synchronously during cleaning, wherein each cleaning device is automatically adjusted in height by means of a lifting device, wherein the speed of the height adjustment can be adjusted.

[0067] The boilers are mainly entered from above through relatively small openings. The access to the boilers must be set up so that the system can be safely connected to the upper part of the boilers. This can be both in the upper part of the boiler and on the boiler.

[0068] As mentioned earlier, the boilers, in particular lignite boilers, comprise several pipes between which parallel corridors are formed. A system is coupled above each corridor as described for the invention according to the first aspect, wherein a cleaning device can be moved through the height of the corridors by means of a controller.

[0069] After placing a system above each corridor, the cleaning process is initiated in which the cleaning device is moved in height by the suspension means and in a longitudinal direction through a corridor. In addition, water is supplied to the cleaning device under high pressure by a water supply means, whereby the cleaning device cleans the pipes arranged in the walls and the inner walls of the boiler.

[0070] According to an embodiment, during cleaning, the lifting device with the suspension means is moved to a next position after a height cycle has been completed.

[0071] The cleaning device is hereby placed in a first position, preferably at an end of a corridor. In a subsequent step, the cleaning device is moved through the height of a corridor at a certain speed so that the pipes can be sufficiently sprayed. After moving the cleaning device through the height, the cleaning means is brought to a second position, by moving the lifting devices with the suspension means, where the cleaning device is moved again through the height of the corridors. This cleaning process continues in successive steps until the complete corridors have been completed and everything has been cleaned.

[0072] The automatic adjustment of the height of the cleaning device during cleaning of the boilers has the advantage of reducing the need to enter the boilers during cleaning to move the cleaning device or to set it up again, which increases safety. This also leads to a substantial acceleration of the cleaning process.

[0073] An additional advantage is that fewer people have to be provided during the cleaning process.

[0074] Subsequently, during cleaning of the boiler, the boiler is entered if the system is hindered by an obstacle. In normal circumstances, the boiler only needs to be entered to set up the system, and then to dismantle it, while in existing methods and systems, this is easily tens to hundreds of times, depending on the size of the boiler.

[0075] In order to provide the corridors with more stability in a direction perpendicular to the longitudinal direction of the pipe, the relevant boilers, in particular lignite boilers, are provided with beams coupled to the support posts perpendicular to the longitudinal direction of the pipes. As a result, the corridors are interrupted in some places and the boiler is entered to disconnect the cleaning device and reconnect it after the obstacle.

[0076] Thus, there is a very limited need to enter the boilers, which lowers the risk of operators having to enter the boilers.

[0077] According to an embodiment according to the second aspect further comprising:

- placing one or more suspension points and/or rails from the top of the boiler;
- providing lifting devices suspended from transport units which are movable between the suspension points and/or along rails, the lifting devices adjusting a cleaning agent in height by means of a suspension means;

- controlling the transport means for movement along the suspension points/rails.

[0078] In some cases the systems cannot be suspended from the top of the boiler. A solution to this is to place suspension points parallel above the corridors formed by the pipes in the boiler. The suspension points and rails can also be fitted with a transport unit that makes it possible to move over the suspension points. The transport units can herewith move along the corridors.

[0079] The transport units here have the option of being controlled by means of a controller that allows the transport unit to move automatically over the corridors. It is also clear that the transport units can also be moved manually.

[0080] Preferably, however, the lifting devices are not moved with the aid of a transport unit but are positioned manually on other suspension points after a cleaning cycle (vertical movement cycle of the spray head).

[0081] A lifting device is further coupled to each transport means, which can adjust the height of the cleaning device by operating and guiding the suspension means.

[0082] In particular, the invention relates to the use of the device according to the first aspect and/or the method according to the second aspect for cleaning boilers, preferably lignite boilers.

[0083] By using a system according to the first aspect in a method according to the second aspect, fewer people are required to set up the system and during the performance of the cleaning process. For further advantages, reference is made to previous sections in the description.

[0084] In what follows, the invention is described by way of non-limiting examples or figures illustrating the invention, and which are not intended to and should not be interpreted as limiting the scope of the invention.

DESCRIPTION OF THE FIGURES

[0085] Figure 1 shows a side view of the system installed in a boiler.

[0086] Figure 1 shows a system (1) with a support pillars (2) to which pipes in a lower part of a boiler are connected (not shown in Figure 1). The system (1) furthermore has a cross-beam (13) attached to the support pillars (2). A section (3) is coupled to the cross-beam (13) by means of a bracket connection (7). The section is further provided with two pulley wheels (8, 9). A first pulley wheel is coupled to one end of the profile, with a second pulley wheel (8) coupled to the section rotated approximately 90° relative to the first pulley wheel (9).

[0087] Over a flange of the section (2) a transport means (4), more specifically a carriage (4), is placed, which can run over the flange of the section (2). The transport means (4) has a pulley wheel (5) coupled to a side opposite to the section (2). A suspension means (12) is tensioned via the second pulley wheel (8) over the first pulley wheel (9), the suspension means (12) being tensioned over the pulley wheel (5) of the transport

means. At the end of the suspension means (12) tensioned over the pulley wheel (5), a cleaning device (6) is coupled. A control element (14) is coupled to the other end of the suspension means (12), for example a motor winch, whereby the control element can cause the cleaning device to vary in height relative to the section (3) via the suspension means (12).

[0088] The use of the first and second pulley wheel (8, 9) has the advantage that the control element can be placed in a different position, away from the transport means. This not only reduces the weight of the transport means (4), but also keeps the control element clean and protects against water splashing up from the cleaning device. Because the control element is placed in a different position, the control element can be provided with a watertight or splash-proof housing, in which an opening is provided with a brush for the suspension means (12). Thus, the suspension means contained in the housing is always kept clean of impurities, such as ash from the lignite.

[0089] The transport means (4) is further provided with a second control element which couples the transport means (4) via for instance a cable (10) to the controller. The relevant cable (10) is coupled to the transport means on the same side as that where the suspension means connects to the pulley wheel (5) of the transport means (4).

[0090] This way of coupling has the advantage that the weight of the cleaning device (6) causes the pulley wheel to move in the direction of pulley wheel (9) and thereby tensions the cable (10). This allows the second control element to move the transport means (4) over the section in a controlled manner via cable (10).

[0091] The control elements for controlling the position of the cleaning device (6) are further controlled by means of a controller that monitors the position of the cleaning device just as the cleaning process is monitored.

[0092] Figures 2-5 show via plan views the progression of a system installed in a substantially rectangular space. Figure 2 shows the space to be cleaned containing a number of rows of supporting tubes, shown vertically in the figures. In such spaces there are typically also pipes and other objects to be cleaned (albeit not visible in the figures). The sections extend perpendicular to the rows of supporting tubes, with 15 separate sections in this case. The transport means are provided at a first end of the sections, with winches provided at the other end, which move the transport means along the sections.

[0093] A transport means is provided on each of the sections, which comprises a cleaning device (not visible, suspended under the transport means), and which is supplied with water under high pressure. Each transport means is preferably driven separately, whether or not externally, such as with the aid of a winch. Figure 3 shows the "cleaning zone" of each transport means and cleaning device by means of a circle. It should be noted here that the cleaning devices are adjustable in height and are moved during cleaning in order to clean the boiler over

the entire height.

[0094] As can be seen in Figure 3, the cleaning zones of the individual cleaning devices are contiguous, so that when moving along the sections (from right to left) it is guaranteed that every surface is reached and cleaned.

[0095] Figure 4 shows a further iteration of the system during the cleaning process at a later time, with the cleaning zones of this later time indicated, as well as those of Figure 3. Although it is a substantially continuous process, it is clear that even in these discrete snapshots the entire space is covered along the trajectory.

[0096] Finally, Figure 5 shows the cleaning zones of 11 discrete snapshots, which together cover the entire surface of the space to be cleaned. By adjusting the speed of movement of the transport means, it is easy to guarantee that the space is completely cleaned both horizontally and vertically.

[0097] In the configurations of Figures 2-5, the spray heads are staggered relative to each other to provide optimum coverage of the surfaces to be cleaned. Of course, alternative arrangements are possible, in which all the spray heads, for example, are always placed in one line and moved to a next position in one line.

[0098] In Figure 6 the cleaning device is shown with a spray head. The spray head has a number of openings, more specifically 6 nozzles distributed radially over the spray head. The spray head has a longitudinal axis about which the spray head is rotatably provided. The spray head has a central cavity, to which water is supplied, and from which channels exit to the spray heads. These channels are straight across at least the end thereof, with this straight portion not intersecting the central axis of the spray head, causing all channels to be offset therefrom.

[0099] The nozzles are grouped in pairs, with the nozzles of the pairs being approximately mirrored relative to a central point on the central axis of the spray head. In this respect, the nozzles which form an angle with respect to the longitudinal direction (or at least those whose jets generated by the nozzles form such an angle) lie between 35° and 55° (preferably about 45°) and those between 125° and 145° (preferably about 135°) in the same plane, which moreover substantially comprises the central axis. On one side of said plane relative to the central axis is one nozzle associated with an angle between 35° and 55° and one nozzle associated with an angle between 125° and 145°, these being directed away from each other along the longitudinal axis. On the opposite side of said plane relative to the central axis lies the other nozzle associated with an angle between 35° and 55° and the other spray head associated with an angle between 125° and 145°, these again being directed away from each other along the longitudinal axis. It can also be said that the nozzles associated with the angle between 35° and 55° are rotated relative to each other through 180° about the central axis, with the same statement being true for the nozzles associated with the angle between 125° and 145°.

[0100] The last two openings, with an angle relative to

the longitudinal direction between 70° and 90° on the one hand, and 90° and 110° on the other hand (preferably 80° and 100° respectively), are on opposite sides to the central axis, and in a plane comprising the central axis and substantially perpendicular to the plane in which the other nozzles are located, for an optimal spread of the nozzles and the water jets.

[0101] Figure 7 shows a preferred variant of the system, compared to Figure 1. In Figure 7, fixed suspension points (15) are used in the boiler, between which a beam (16) may be suspended for simplified suspension of the lifting device (20). This is provided with a pulley (5) over which the suspension means (5) is transported, which is provided on one side with a drive device in the form of a lifting and lowering pulley (19), with a housing (18) where the suspension means, for example, can be cleaned before being lifted onto the pulley (19), for example with brushes.

[0102] On the other side, the suspension means (12) flows into the cleaning device (6) with spray head. This is further coupled at the bottom to a water supply connection (17), usually under high pressure, which also holds the cleaning device (6) vertically tensioned together with the suspension means (5).

Claims

1. System for cleaning boilers, preferably lignite boilers comprising:

- at least one cleaning device, for cleaning the boiler internally, comprising a spray head and a water supply connection;
- a suspension means for each of the cleaning devices, for keeping the cleaning device suspended at the top of the boiler and adjusting the height position of the cleaning device relative to the top of the boiler, wherein the suspension means is suitable for being coupled with the cleaning agent with one end, and wherein the suspension means is coupled with another side to the top of the boiler;
- a lifting device for each of the suspension means, for raising and lowering the suspension means, in particular raising and lowering the cleaning device; and
- a water supply means adapted to be coupled to the water supply connection of the cleaning devices for supplying high pressure water to the cleaning devices;

wherein the system further comprises a controller suitable for controlling the lifting devices, wherein the height position of the suspension means is controlled, and wherein the controller monitors the cleaning of the boiler, the spray head comprising a plurality of openings, and the openings comprising

a channel extending from a cavity of the spray head to the surface of the spray head, the cleaning device comprising a longitudinal axis, **characterized in, that** at least one of the openings, and preferably at least two, is an offset opening, which extends substantially perpendicularly with respect to the longitudinal axis of the cleaning device with a deviation of up to 20°, preferably of up to 15°, more preferably of up to 10°, with the perpendicular projections of the channels of the offset opening on a plane perpendicular to the longitudinal direction having an offset with respect to said longitudinal axis.

2. System according to claim 1, **characterized in, that** the spray head comprises a cavity, the water supply means supplying the water to the cavity.

3. System according to claim 2, **characterized in, that** the cleaning device comprises a longitudinal direction, with two openings having an angle between 60° and 80°, preferably between 65° and 75°, a first offset opening has an angle between 70° and 90°, preferably between 75° and 85°, a second offset opening has an angle between 90° and 110°, preferably between 95° and 105°, and two openings have an angle between 100° and 120°, preferably between 105° and 115° in relation to the longitudinal direction.

4. System according to claims 2 or 3, **characterized in, that** the channels have a projection on a plane perpendicular to the longitudinal direction of the cleaning device, each projection of the channels making an angle of at least 40° in a first sense, preferably at least 55° in the first sense, more preferably at least 85° in the first sense, with at least one other projection of the channels, and preferably where each projection of the channels forms an angle of at least 40° in a second sense, preferably at least 55° in the first sense, more preferably at least 85° in the first sense, with at least one other projection of the channels.

5. System according to any of the preceding claims 1-4, **characterized in, that** the cleaning device comprises at least two offset openings, the perpendicular projections of the channels of the offset openings on a plane perpendicular to the longitudinal axis all having an offset, preferably substantially the same, with respect to said longitudinal axis, wherein the direction of the offset with respect to the longitudinal axis and the direction from the channel to the surface have a vector product with the same sign for each channel.

6. System according to any of the preceding claims 1-5, **characterized in, that** the offset openings are located in a longitudinal central portion of the spray head, the longitudinal central portion of the spray head ex-

tending over a section of the spray head that is at most 15%, preferably a maximum of 10% or 5%, of the length of the spray head away from the center plane of the spray head, wherein the center plane is perpendicular to the longitudinal axis of the spray head.

7. System according to any of the preceding claims 2-6, **characterized in, that** the spray head further comprises a control element, coupled in the cavity of the spray head, for presetting the maximum rotational speed of the spray head. 5
8. System according to any of the preceding claims 1-7, **characterized in, that** the channels intersect or cross the longitudinal axis at a maximum distance from the center plane of the spray head perpendicular to the longitudinal axis, said maximum distance being at most 10.0 cm, preferably a maximum of 5.0 cm. 20
9. System according to any of the preceding claims 1-8, **characterized in, that** the lifting devices each comprise a housing, each housing further comprising a brush, suitable for keeping the suspension means clean while adjusting the height of the cleaning device. 25
10. System according to any of the preceding claims 1-9, further comprising a storage space, preferably for each of the suspension means, further comprising a housing, the storage means being suitable for storing the excess suspension means. 30
11. System according to any of the preceding claims 1-10, further comprising a plurality of suspension points and optionally rails, suitable for being coupled to the top of the boiler, wherein the suspension means is suspended from transport units movable along suspension points, preferably via the rails, wherein the controller is suitable for controlling the transport units. 35 40
12. Method for cleaning boilers, preferably lignite boilers, comprising: 45
 - installing high-pressure pipes and compressed air pipes;
 - opening the boiler, preferably opening the lignite boiler; 50
 - installing a system according to claims 1-10, wherein the system is coupled to the high-pressure pipes for supplying high-pressure water to the system;
 - cleaning places in the boiler where the system is placed with compressed air; 55
 - cleaning the boiler by using the system, whereby the boiler is cleaned internally by means of

water under high pressure;

wherein a plurality of cleaning devices are operated and controlled simultaneously and synchronously during cleaning, wherein each cleaning device is automatically adjusted in height by means of a lifting device, wherein the speed of the height adjustment can be adjusted.

- 10 13. Method according to claim 12, **characterized in, that** during cleaning the lifting device with the suspension agent is moved to a next position after a height cycle has been completed.
- 15 14. method according to claims 12 or 13, further comprising the following steps:
 - placing one or more suspension points and/or rails from the top of the boiler;
 - providing lifting devices suspended from transport units which are movable along the suspension points and/or rails, the lifting devices adjusting a cleaning agent in height by means of a suspension means;
 - controlling the transport means for movement along the suspension points and/or rails.
- 15 15. Use of the device according to any of claims 1-11 or the method according to any of claims 12-14 for cleaning boilers, preferably lignite boilers.

Fig. 1

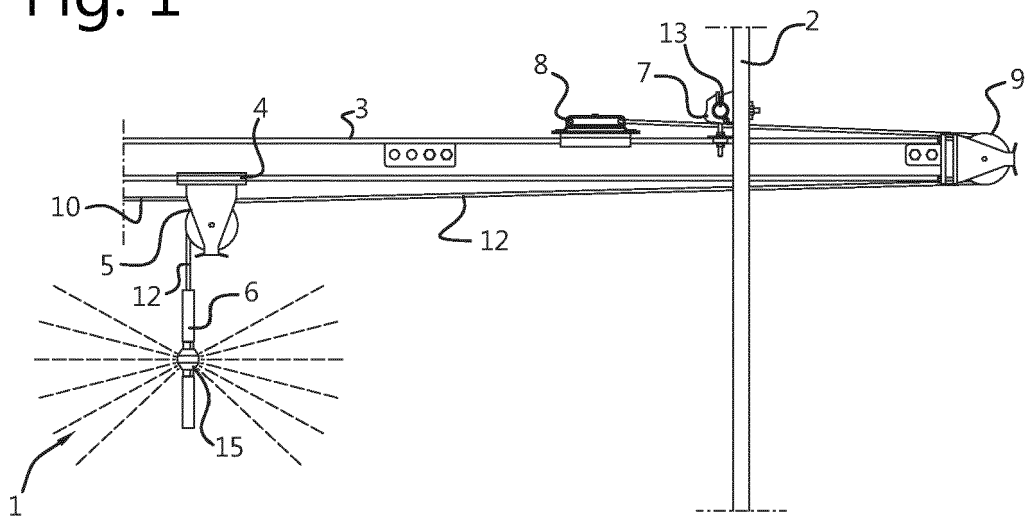


Fig. 2

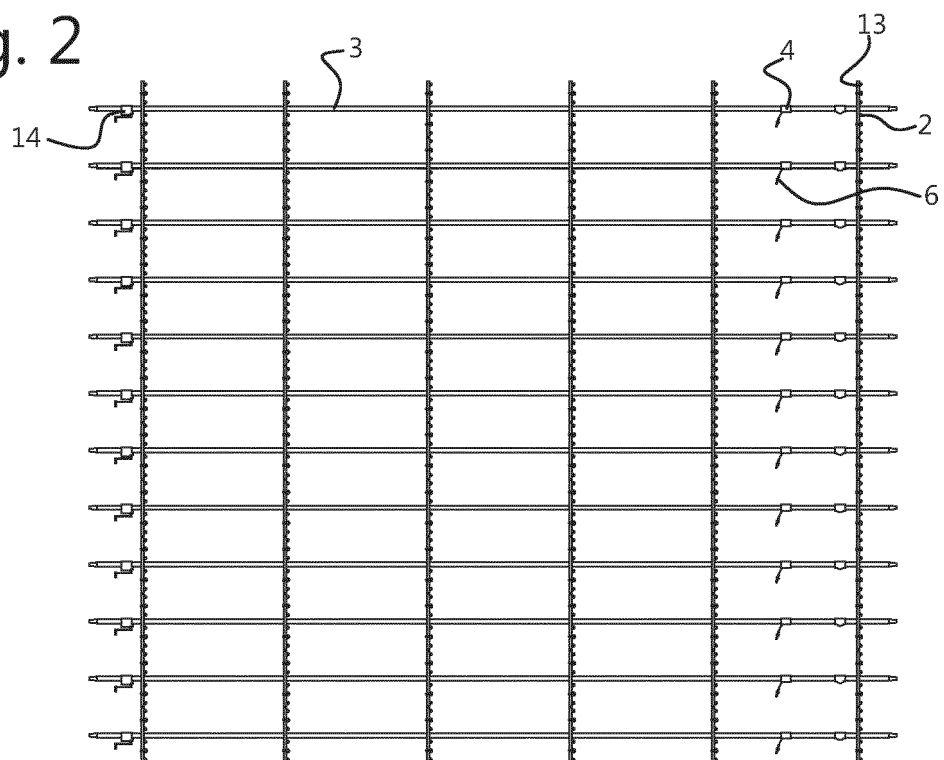


Fig. 3

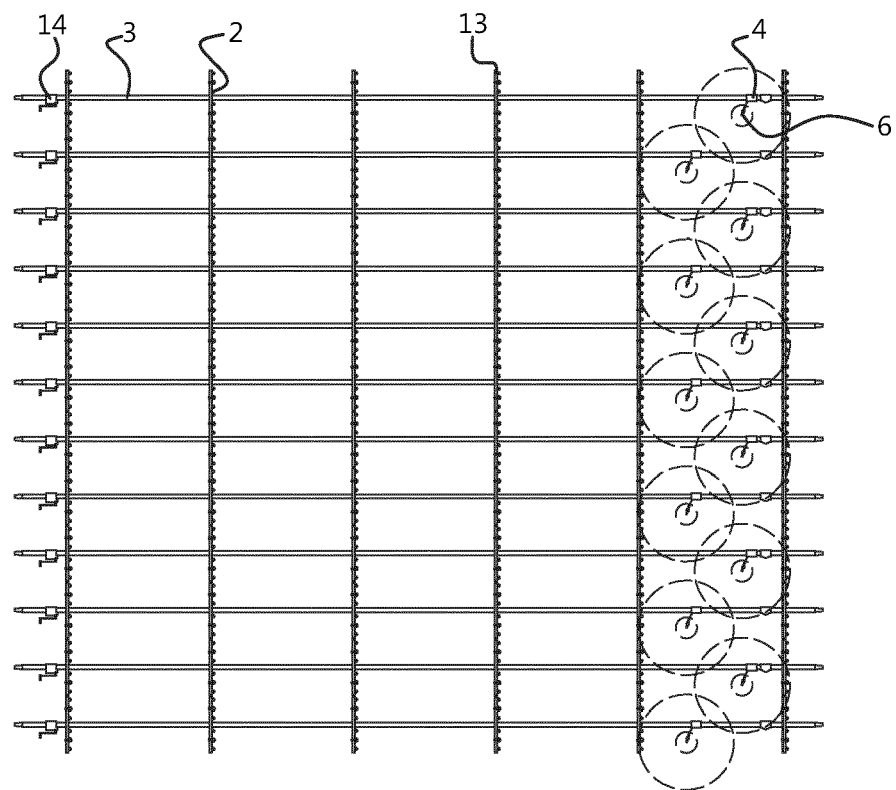


Fig. 4

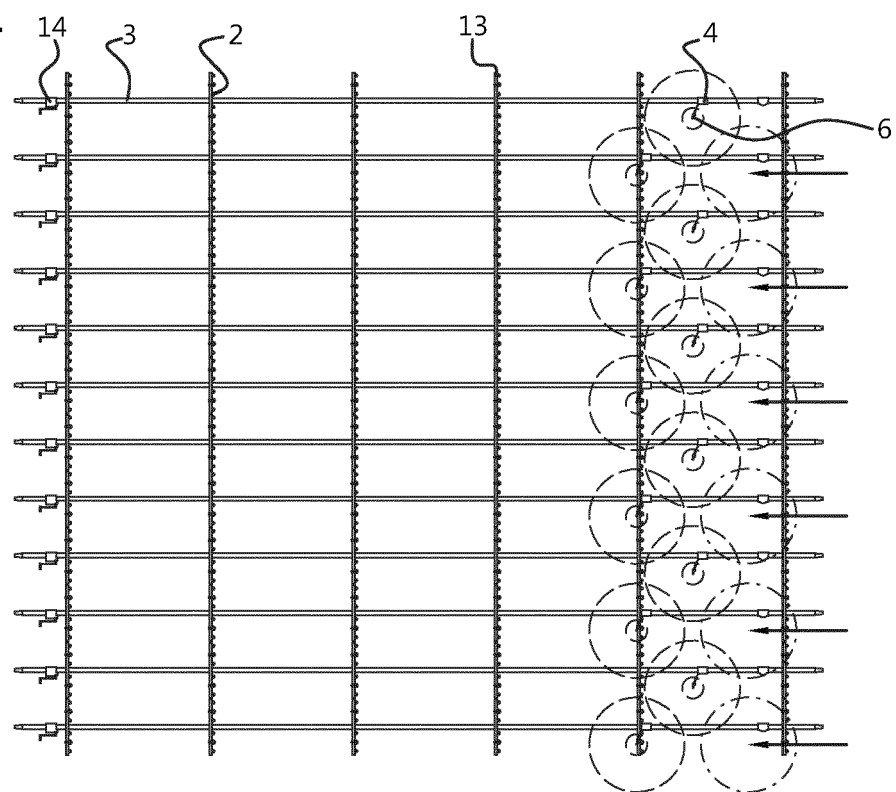


Fig. 5

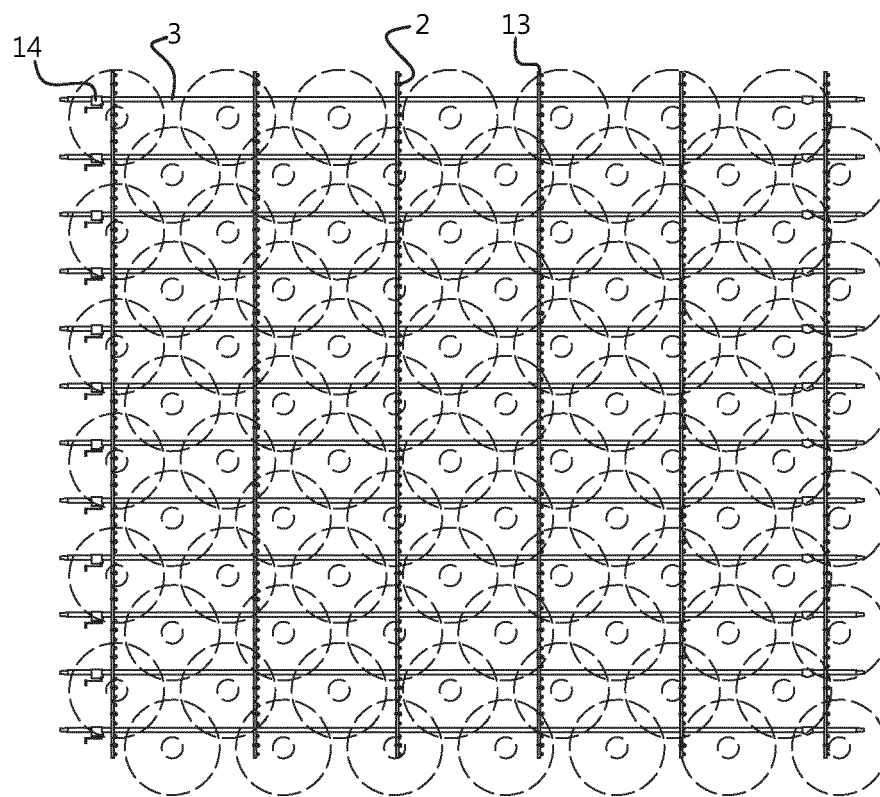


Fig. 6

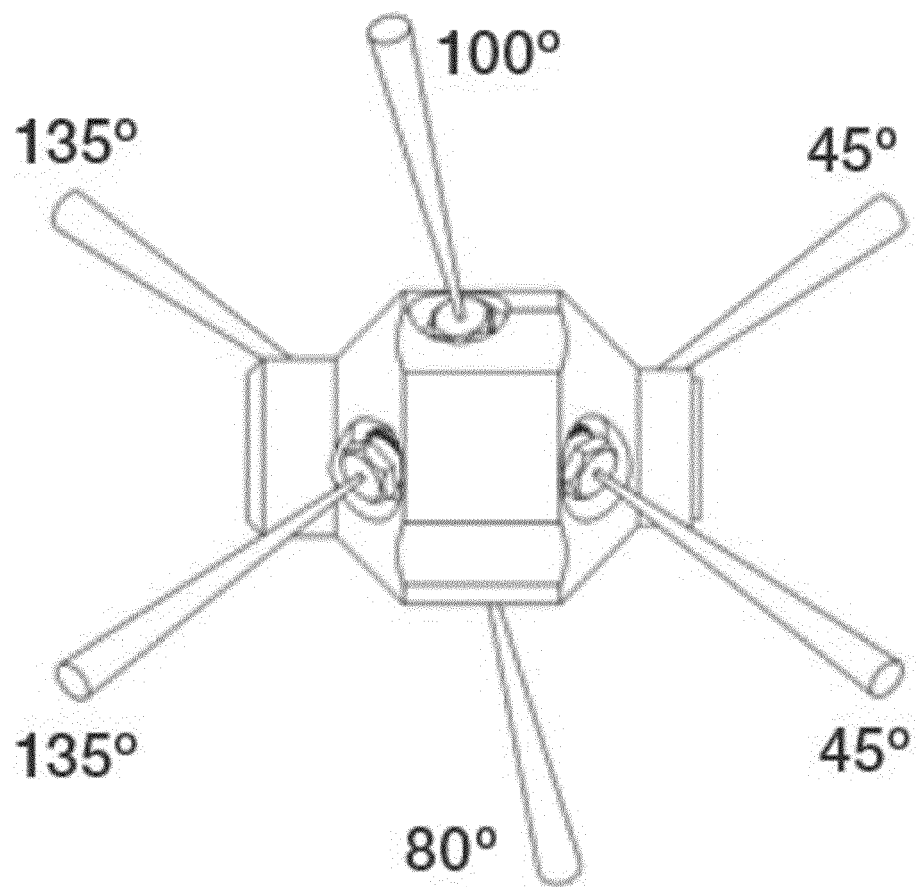
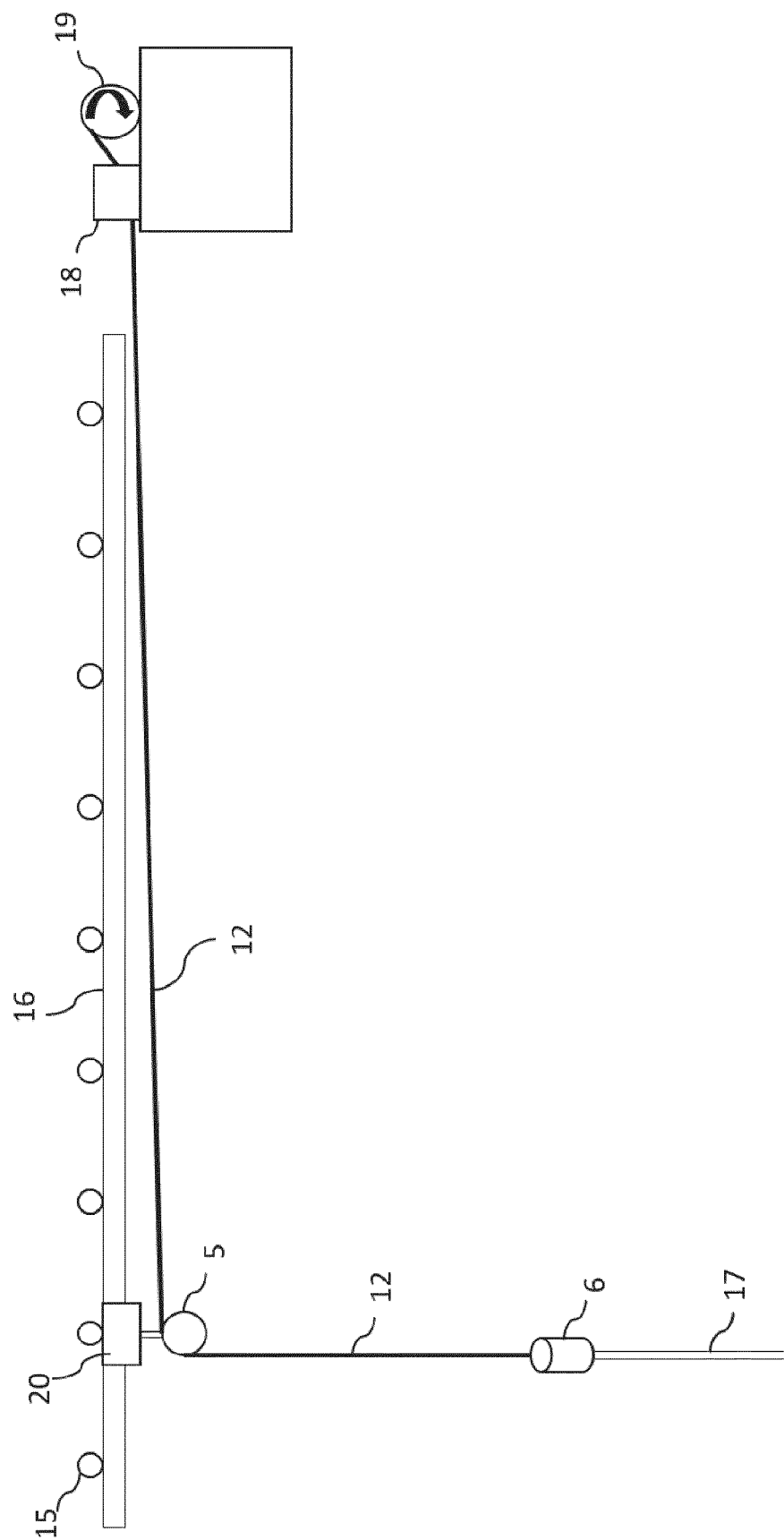


Fig. 7





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Application Number

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			F23J F28F F28G
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 16 March 2023	Examiner Theis, Gilbert
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