CLAIMS

1. An ash removal system for removing ash which accumulates on a heat transfer tube group of a boiler, the ash removal system comprising:

at least one pressure wave generation device for generating a pressure wave;

at least one movable nozzle configured to be capable of moving inside the boiler, for discharging the pressure wave generated by the at least one pressure wave generation device;

a monitoring device for monitoring an accumulation state of ash which accumulates on a heat transfer tube of the heat transfer tube group at each of a plurality of positions inside the boiler; and

a control device configured to control at least one of a position or an orientation of a tip of each of the at least one movable nozzle on the basis of the accumulation state monitored by the monitoring device,

wherein the at least one movable nozzle includes a plurality of movable nozzles for discharging the pressure wave generated by the at least one pressure wave generation device,

wherein the control device is configured to control at least one of the position or the orientation of the tip of each of the plurality of movable nozzles on the basis of the accumulation state monitored by the monitoring device,

wherein the at least one pressure wave generation device includes a first pressure wave generation device for generating the pressure wave,

wherein the ash removal system includes:

a first pipe part which is connecting to the first pressure wave generation device and through which the pressure wave generated by the first pressure wave generation device passes;

a plurality of second pipe parts each connecting the first pipe part and corresponding one of the plurality of movable nozzles; and

a valve disposed in each of the plurality of second pipes,

wherein the plurality of movable nozzles include:

a first movable nozzle configured to be capable of discharging the pressure wave into a first space inside the boiler; and

a second movable nozzle configured to be capable of discharging the pressure wave into a second space inside the boiler disposed at a downstream side of the first space, and

wherein a distance between the first pressure wave generation device and an inlet of the pressure wave of the first movable nozzle is smaller than a distance between the first pressure wave generation device and an inlet of the pressure wave of the second movable nozzle.

2. The ash removal system according to claim 1,

wherein the monitoring device includes: a combination of a scale and a camera; a laser displacement-measuring device; an optical fiber thermometer; or a combination of two or more of the above three types of instruments.

3. The ash removal system according to claim 2,

wherein a plurality of fins are provided so as to intersect with a heat transfer tube of the heat transfer tube group, and

wherein the monitoring device includes a camera configured to capture the scale disposed along the fins.

4. The ash removal system according to claim 2 or 3,

wherein a plurality of fins are provided so as intersect with a heat transfer tube of the heat transfer tube group, and

wherein the monitoring device includes the laser displacement-measuring device configured to emit a laser along a longitudinal direction of the heat transfer tube at a position higher than upper ends of the plurality of fins.

5. The ash removal system according to any one of claims 2 to 4,

wherein a plurality of fins are provided so as intersect with a heat transfer tube of the heat transfer tube group,

wherein each of the plurality of fins has a cut-out at a position on the same straight line, and

wherein the monitoring device includes the optical fiber thermometer disposed along the longitudinal direction of the heat transfer tube at the position of the cut-out of each of the plurality of fins.

6. The ash removal system according to any one of claims 1 to 5,

wherein the control device is configured to control the position and the orientation of the movable nozzle such that the tip of a movable nozzle of the at least one movable nozzle which discharges the pressure wave into a convection heat transfer chamber of the boiler is oriented toward a wall of the convection heat transfer chamber in a flow-passage width direction.

7. The ash removal system according to any one of claims 1 to 5,

wherein a plurality of fins are provided so as intersect with a heat transfer tube of the heat transfer tube group,

wherein the plurality of fins are disposed along a flow direction of combustion gas of the boiler, and

wherein the control device is configured to control the tip of a movable nozzle of the at least one movable nozzle which discharges the pressure wave to the fins to be oriented in a direction intersecting with the flow direction of the combustion gas.

8. The ash removal system according to any one of claims 1 to 7,

wherein the monitoring device is configured to be capable of monitoring whether a parameter related to the accumulation state of ash at each of the plurality of positions is not smaller than a threshold value, and

wherein the control device is configured to, if the parameter related to the accumulation

state of ash is not smaller than the threshold value with regard to at least one position of the plurality of positions, move a tip of the movable nozzle toward the position where the parameter is not smaller than the threshold value.

9. The ash removal system according to claim 8,

wherein the control device is configured to, if the parameter related to the accumulation state of ash becomes smaller than the threshold value as a result of discharge of the pressure wave from the movable nozzle, stop operation of the pressure wave generation device supplying the pressure wave to the movable nozzle.

10. The ash removal system according to any one of claims 1 to 9,

wherein the boiler includes a stoker-type incinerator.

11. The ash removal system according to claim 1,

wherein the boiler includes:

a stoker-type incinerator;

a radiation chamber through which exhaust gas discharged from the incinerator passes; and

a convection heat transfer chamber disposed at a downstream side of the radiation chamber in a flow direction of the exhaust gas, including a heat transfer bank disposed therein,

wherein the plurality of movable nozzles include:

a first movable nozzle disposed so as to be capable of discharging the pressure wave into the radiation chamber; and

a second movable nozzle disposed so as to be capable of discharging the pressure wave into the convection heat transfer chamber, and

wherein a distance between the first pressure wave generation device and the radiation chamber is smaller than a distance between the first pressure wave generation device and the conviction heat transfer chamber.

12. The ash removal system according to claim 8,

wherein the control device is configured to enhance the pressure wave generated from the first pressure wave generation device, and/or increase the generation frequency of the pressure wave, as the position where the parameter related to the accumulation state of ash is not smaller than the threshold value approaches an upstream side in a flow direction of combustion gas.