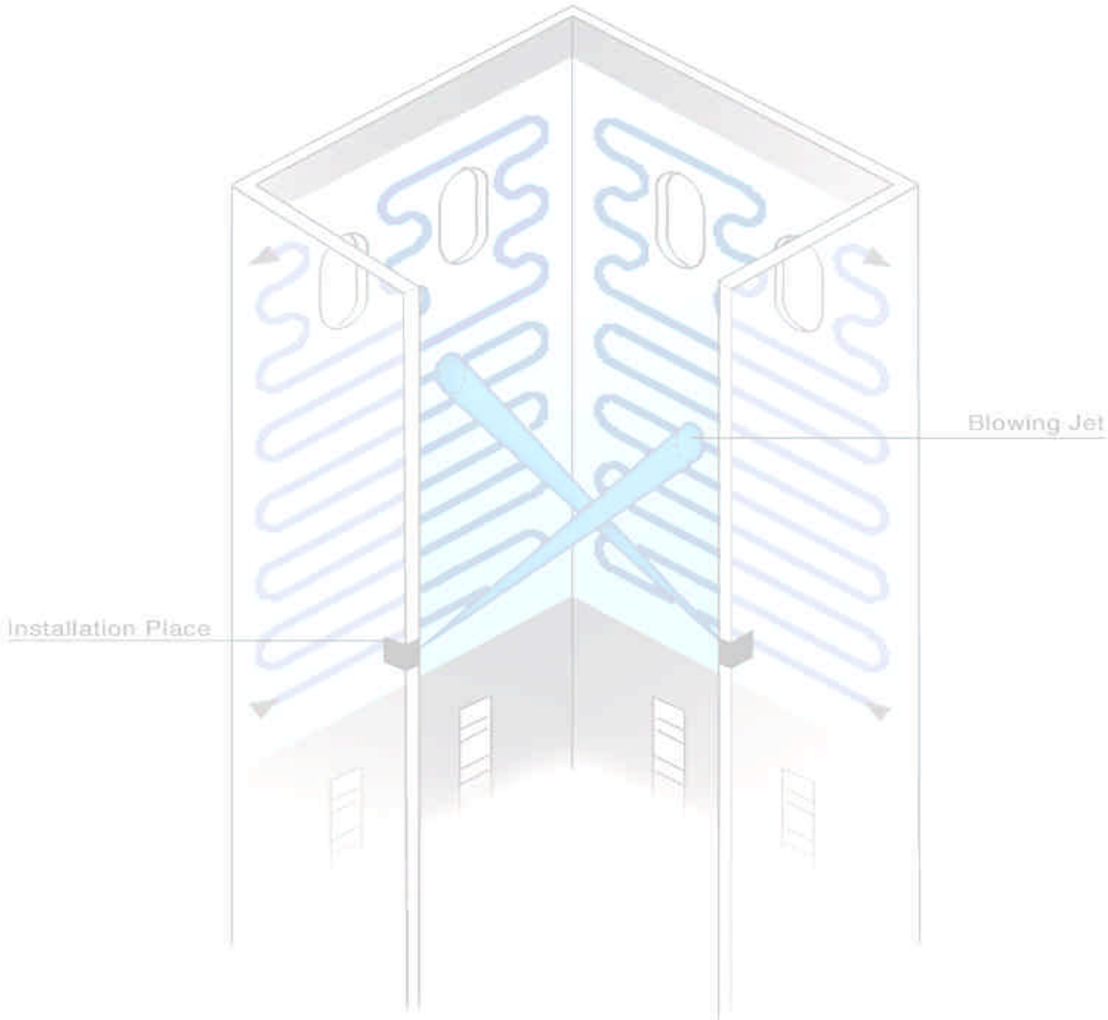
Bergemann-Lance-Type Water Blower for Coal-Fired Boilers



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Bergemann Lance-Type Water Blowers for Coal-Fired Boilers

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Residues from the combustion of coal fuels lead to considerable problems during the operation of boiler plants. The efficiency of steam generators is negatively affected by slag and ash deposits on the heating surfaces, which sometimes are quite tenacious, and the boiler operating time is reduced.

Especially the combustion of several coal types with a broad fuel range not only places specific demands on stable operation of the firing equipment but also leads above all to questions regarding the control of slagging at the various steam generator heating surfaces. Particularly tenacious slagging can be produced at the evaporator heating surfaces of the combustion chambers, which not always can be removed by steam and air as blowing fluid.

In German power stations therefore water was introduced as alternate cleaning fluid, already some 40 years ago. In the initial tests they still used hand lances. In this process it was observed that, due to the high kinetic energy, the water jet penetrates the pores of the slag layer on the evaporator tubes, evaporates and the resulting abrupt increase in volume causes the tenacious slag to chip off.

Logically, mechanizing of water blowing started after the good cleaning results already in the 1950s, and the well-known steam sootblowers were converted to water.

At that time, Bergemann used ist own wall blower system and, with the support of RWE, improved the water blowing technology under operating conditions in a lignite-based power plant over several years.

The Bergemann water blowers SK 58 E and later SK 80 E work according to the well-known water blower technology with a spindle which, being shifted axially, rotates the nozzle head and introduces it into the boiler. At the beginning of blowing, the water blower introduces the nozzle head with ist reverse nozzle into the boiler, screws it over a short section and thus admits the water jet in helical form to the burner wall. Opening of the blower valve is controlled through a conical roller in order to spray the water leaving the nozzle as a directed jet onto the hot slagging of the burner wall.The water jet can be admitted, as required, to circular surfaces from 30° to 360° (Figure 2).
An almost uniform velocity of the water jet can be achieved during the blowing process by means of frequency control of the drive motor. This long-standing, proven system is still used and Bergemann water blowers are working in many power plants to full satisfaction of their owners/operators (Figure 3).
This blower technology, however, presents some disadvantages:

- The nozzle distance from the combustion chamber wall varies constantly due to the axial movement of the tube spindle.
- The path velocity of the water jet in the combustion chamber wall is not uniform.
- The combustion chamber walls are cleaned with differing water flows.

This results in major risks of thermal shocks.
Due to the circular shape of the cleaned areas, it is not possible to clean the whole surfaces of the combustion chamber walls, for the risk of thermal shocks and erosion is very great because of the repeated admission of water when the blowing cycles overlap.

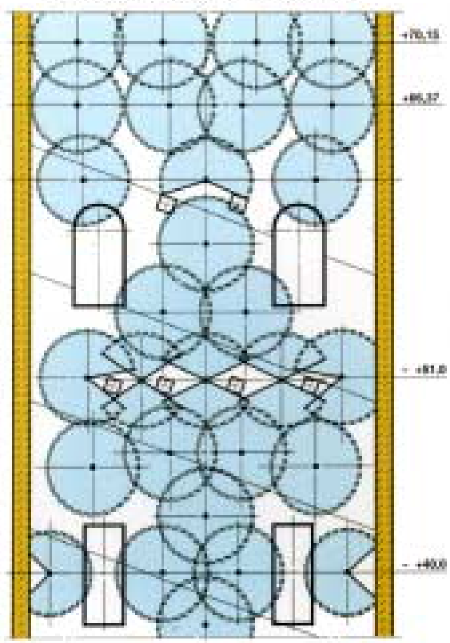

Figure 2 – Effective circular surfaces up to 360°

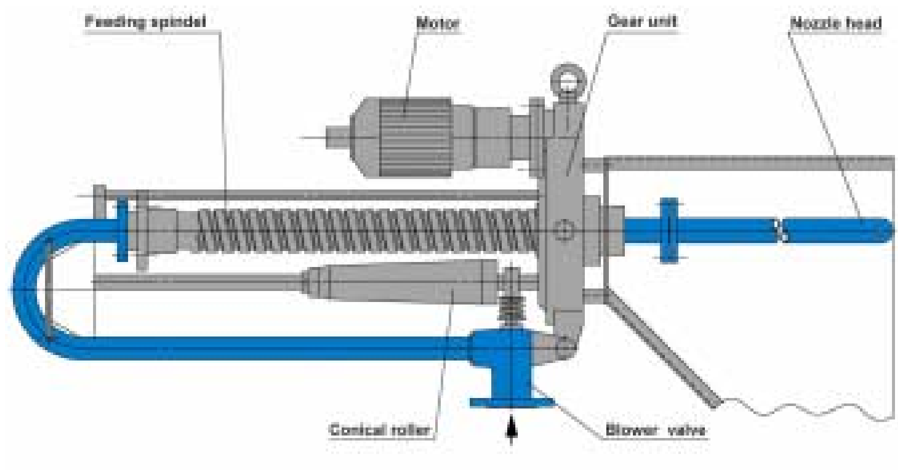

Figure 1 – Water blower SK 80 E

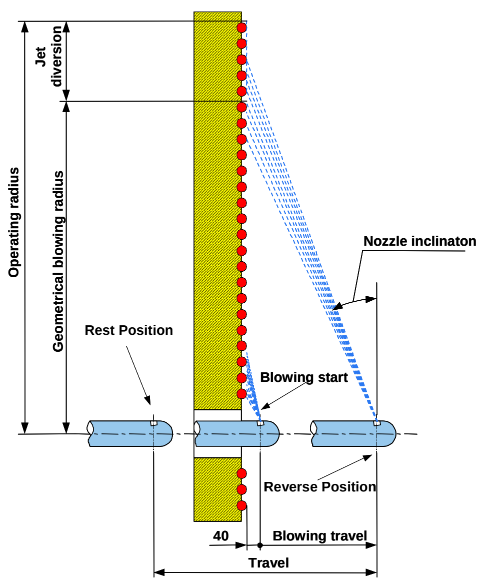

Figure 3 – Functioning principle of SK 80 E

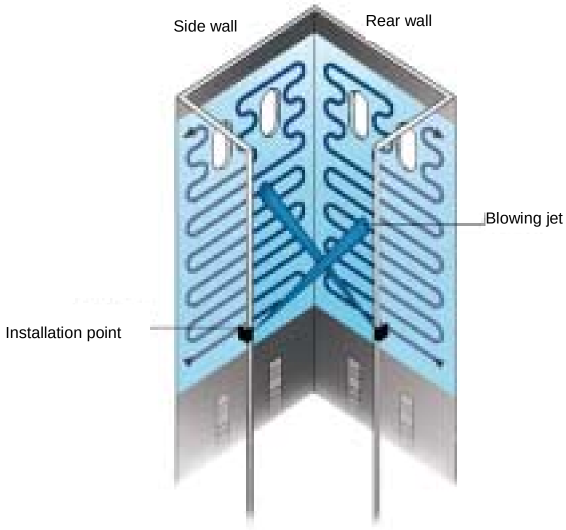

Figure 4 – Functioning principle of WLB 30

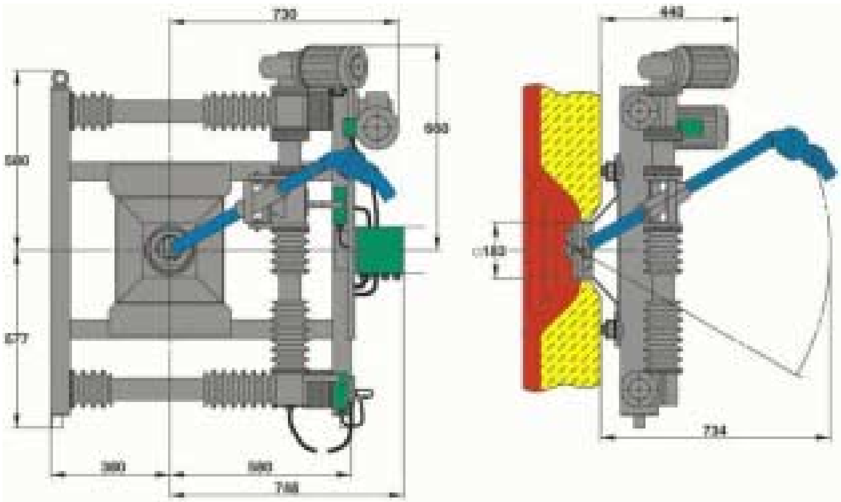

Figure 5 – Principle of WLB 30

Now a new technology is available with the lance-type water blower WLB 30. In the former GDR, combustion chamber cleaning tests were conducted with the lance-type water blower technology in the 1980s, in parallel with the conventional technology.

After the takeover of these activities by Bergemann in 1991, the lance-type water blower WLB 30 was further developed to a market ripe product. Bergemann acquired a worldwide licence or the master patent which after the unification is held by VEAG and completes this by quite a number of own patent applications.

Unlike conventional wall blowers, the WLB 30 blower cleans opposed heating surfaces by means of a directed water jet. The water jet shoots through the combustion chamber and when impinging on the heating surfaces causes a different effect than with the conventional technology, which is due to other impact angles and water flows.

The lance-type water blower is a compact unit whose blowing tube has a horizontal and vertical swiveling range of 90° maximum (figure 5). Installation is easily accomplished by means of 4 fixing bolts at an appropriate frame structure. Movement of the blowing tube is effected by 2 electric motors with worm gears.

For the horizontal movement of the blowing tube, 2 drive spindles are driven through a gear motor. A roller chain connects the top spindle with the bottom one and cares for synchronous movement. For the vertical movement of the blowing tube, a spindle guided at the top and the bottom is driven directly by the gear motor.

At the front end, the blowing tube with the blowing nozzle is firmly connected with a universal joint. At the rear end, the blowing tube is held by means of an appropriate guide at the vertical spindle. A tube hinge is provided at the end of the blowing tube to absorb the torsional movements.

The vertical and horizontal movements of the blowing tube are absorbed through a flexible hose which is arranged between the tube hinge and the piping/valve group.

At the front end of the blowing tube there is a high-capacity nozzle which sprays a well directed water jet through the combustion chamber onto the opposite combustion chamber wall.

Depending on the movement of the blowing tube, the water jet describes a meander-type blowing pattern on the surface to be cleaned. As a result of the vertical and horizontal movement of the blowing tube it is possible to admit the water jet to large surfaces. At utility boilers such as those of RWE at Weisweiler some 400 m² of heating surface are cleaned by one WLB 30.

An important advantage of the control system which Bergemann developed specifically for the lance-type blower, is the possibility to bypass certain sections such as recirculation shafts, burners, etc. and avoid damage by water.

The intelligent Bergemann control system with integrated frequency control, in addition, allows a gradual change to the motor speed and thus adjust the path velocity of the water jet to the actual fouling of the furnace walls. In this way it is possible to carefully clean the combustion chamber walls including with differing fouling. The water used for blowing can be taken from the existing water system.

The necessary pressure is produced by means of a booster pump. The water used should be free of impurities in order that, for example, the solenoid valves installed before each WLB 30 function without any problems. Upstream of the valves, Bergemann uses to install dirt traps which must be checked from time to time.

To provide an optimum cleaning effect, it is necessary to check the blowing jet at regular intervals. Practice has shown that, in case of deposits in the high-capacity nozzles, the water jet loses some of its quality and the cleaning effect decreases.

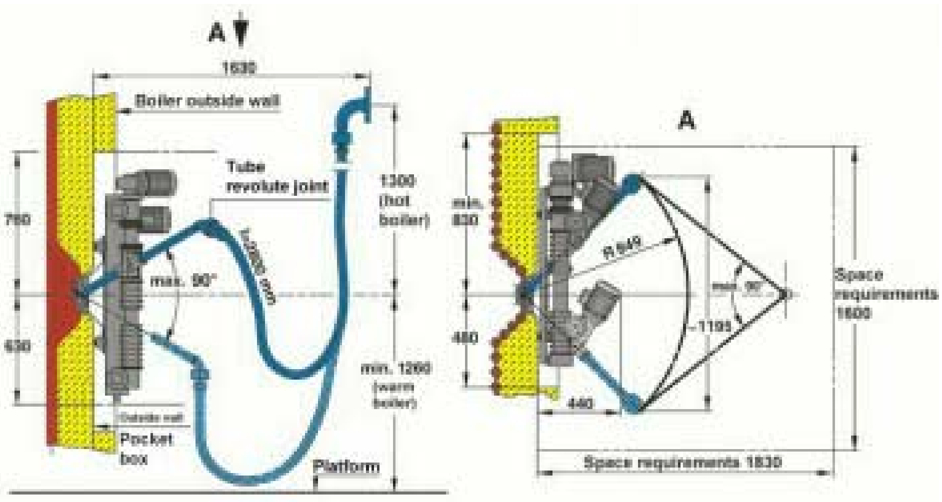

Figure 6 – Installation conditions of WLB 30

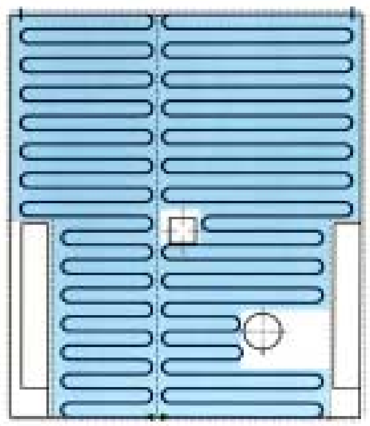

Figure 7 – Blowing patterns

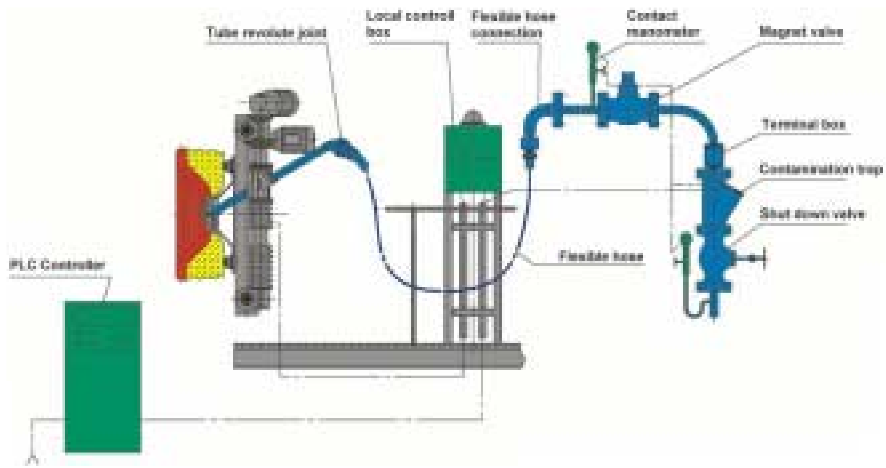

Figure 8 – Arrangement scheme of WLB 30

The Weisweiler power plant is the West German plant in which the first WLB 30 was installed. With considerable support and in cooperation with RWE the use of the
WLB 30 was tested under practical conditions and its functioning mode was studied.

The first WLB 30 lance-type water blower was installed in the right side wall at +54.0 m of boiler "G" in the Weisweiler power plant during a short revision in December 1991. Commissioning took place in February 1992. Through this WLB 30 the water jet is admitted to the opposite left combustion chamber wall. The area from +44.0 m to +64.0 m is cleaned. The side length of the combustion chamber of boiler "G" is 20.850 m. That means a surface of more than 400 m² is cleaned by this WLB 30. Formerly, 15 units of SK 58 wall blowers were necessary for cleaning this area.

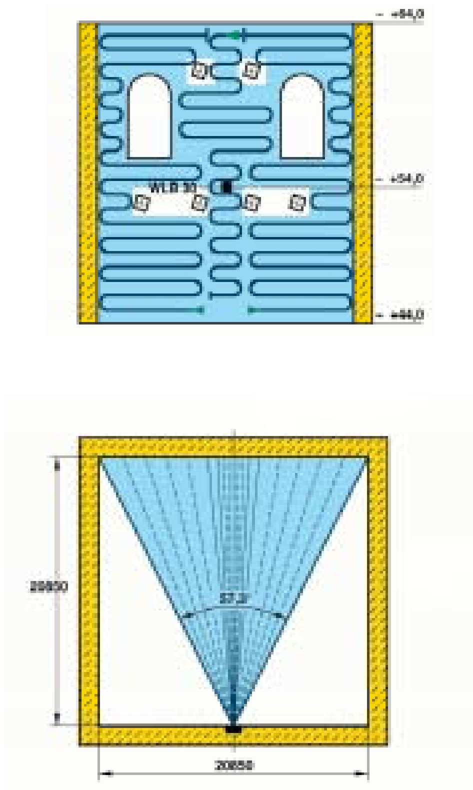

Figure 7, Blowing pattern

With this furnace size the maximum length of the blowing jet is about 26 m. Distributed over the width of the left side wall, 3 blowing patterns are used.
The ABL nozzles and the recirculation ports are bypassed.

The vertical side distance of the meander-type blowing pattern is 2.0 m. That means the same patterns are used for a second time, in each case vertically staggered by 1.0 m. Thus, double admission to the combustion chamber wall during one cleaning cycle is avoided.

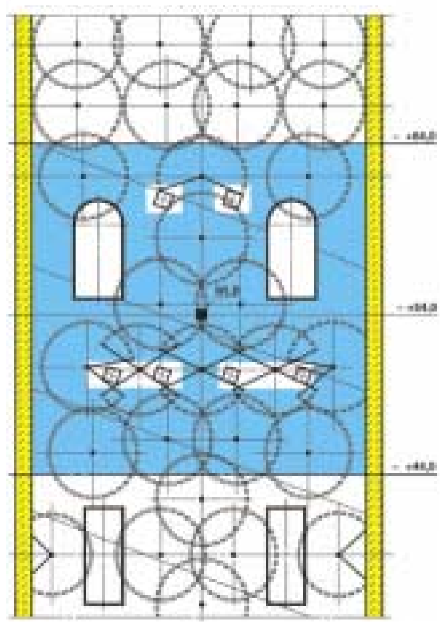

Figure 10 – Effective surfaces WLB30

<u>Technical data of boiler "G"</u>

- Side length of combustion chamber 20.8 x 20.8 m
- Helical winding abt. 19°
- Tube diameter 31.8 x 4.5, pitch 50 mm
- Material 15 Mo 3 = 1.5415
- Combustion chamber wall tube-web-tube
- Cutout in combustion chamber wall 450 x 4350 mm for WLB 30

<u>Technical data of WLB 30</u>

- Nozzle size 16 mm
- Water consumption 3.5 m³ for one blowing operation
- Blowing time abt. 8 min/blower
- Blowing frequency 3 times per day
- Drive by 2 motors of 0.75 kW each
- Operation through stored-program control system and local control cubicle

The WLB 30 installed in the Weisweiler power plant was regularly operated for about 2 years.

Checking of the cleaning effect during that operating period and during boiler outage in August 1992 showed that the cleaning effect was at least as good as at the 3 combustion chamber walls with the former water blowers SK 58 E. So far no damage was detected at the left combustion chamber wall. In the RWE report on the Weisweiler power plant the following is stated regarding temperature measurements at the left combustion chamber wall of boiler "G" in the area of the water blowers:

First, 36 SK 58 E units each were installed at boilers "G" and "H". Due to increasing fouling, so far more than 100 SK 58 E units were installed at each boiler.

When boiler "G" was commissioned in <u>1975</u>, RWE conducted at Weisweiler temperature measurements at the clean boiler wall with thermocouples in the area of action on one SK 58 WE. About 30 thermocouples were fixed in the webs between the wall tubes. Overall, 3 blowing nozzles of differing sizes were tested. The blowing pressure before the blowing nozzles was 12 bar maximum.