New Developments and Applications of the Steinmüller Mass Burn Grate System

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ABSTRACT

The L. & C. Steinmüller GmbH (LCS) mass burn grate system has been extensively used in numerous mass burn waterwall waste-to-energy (WTE) facilities around the world. Among those are three WTE plants in the U.S.; Portland, Maine; Long Beach, California; and Montgomery County, Pennsylvania. Since these facilities started operations some 8-10 years ago, the Steinmüller mass burn grate system has undergone further development in order to adapt the system to new applications such as tire burning, burning of highly contaminated wood and the co-firing of sewage sludge, hospital waste and other portions of the waste stream. The paper gives a detailed overview of the new improved design of the grate and boiler system.

The first section of the paper describes in detail the continuous improvement process for the design of the top supported boiler in conjunction with the grate hanging in the waterwalls. The new feed chute design and its modified geometry is described as well as the newly introduced high alloy cladding on the stoker side wall weartubes.

The second section contains an outlook on the next generation of mass burn grate technology employing the new Steinmüller water cooled mass burn grate system, a quantum leap in stoker technology.

Finally the paper summarizes the future potentials and directions of further research and development on the Steinmüller mass burn grate system for continuous applications well into the 21st century.

INTRODUCTION

Today's heightened environmental awareness, and the waste disposal techniques developed as a result, have contributed to the fact that the grate is still most relevant as a well proven and reliable firing unit. Among all known alternative waste disposal measures, whether biomechanical treatment or carbonization at low temperatures, the grate remains one of the most important waste disposal technologies. Indisputably for that very reason, great demands are inevitably made on this component. In this paper it is shown how the diverse and increasing tasks posed in waste combustion, particularly with regard to operating and commercial viewpoints, are resolved by the LCS moving grate.

GENERAL

It may be assumed that the principle of operation of the moving grate is well known based on its decades long use in many plants.

As can be seen in Figure 1, the grate consists of several sections, each of which has an independent grate element and its own primary air zone. Depending upon the number of sections, there are one or two grate steps. In large plants the grates are laid out in two or, if necessary, multiple lanes. The combustion of waste on the grate takes place on the grate bars through which primary combustion air is supplied from underneath. Thus, the primary air cools the grate bars before flowing through the waste bed. Due to the physical design of the grate surface, the air is uniformly distributed over the entire grate area. The movement of the grate bar rows conveys the waste fed, in continuous combustion and forward motion, in the direction of the ash discharge.

Each grate element (see Figure 2) is made up of alternately fixed and movable roofing tile-like rows of bars lying on top of one another. The grate bar supporting members, i.e., every second row, are combined on a grate carriage, which is driven hydraulically.

With regard to the fields of application of the moving grate, in the present state-of-the-art there are two basic applications for thermal waste disposal: in refractory-lined furnaces and in conventional membrane wall boilers. In both cases, the geometry of the combustion chamber is of special importance because of the intended combustion temperatures.

Furnaces constructed of refractory material are used, where high heat release is intended with correspondingly high furnace temperatures. These chambers are not cooled and permit temperatures of around 1150° C. This application is especially suitable for the combustion of waste of low heating value, not classified as municipal waste only, whose pollutants can be destroyed only at high temperatures.

Most widespread is the use of grates in conventional membrane wall boilers. In waste combustion, only the geometry of the combustion chamber is of importance: the boiler type - horizontal or vertical boiler configuration - is secondary (see Figure 3).

In connection with furnace design, basically the specifications of the grate are determined by technical combustion and statutory requirements.

FURTHER STRUCTURAL DEVELOPMENT OF GRATE MOUNTING

New designs are based on suspended boiler design, integrated with the boiler room framing (see Figure 4). Accordingly, the grate is connected to the boiler system. This results in well-defined expansion conditions and relative motions are avoided.

For many years in the conventional design, the grate was connected hanging over a supporting structure on the side walls of the boiler. The result of this was, that upon assembly, the grate support carriers had to be adjusted practically as individual components and at considerable expense. The grate modules, as individual prefabricated parts, were set in place, aligned and made operational which requiring a great deal of time. In order to ensure accuracy of fit beforehand and to limit this on-site expense, preassembly in the shop was required.

This design had a basic disadvantage or limitation in that, in large plants and hence high grate weights, the available side wall limited the load acceptance. In addition, it was later found in performing maintenance work that it was difficult to replace or repair the grate side-wall tubes subject to wear. The side walls carried down for accommodation of the grate carriers made accessibility impossible.

These disadvantages are eliminated by a new design concept. In principle this consists of suspending the grate independently of the side walls on downpipes connected into the evaporator circuit and carried on the outside of the boiler (see Figure 5). This design was applied for the first time in a plant in Great Britain which has been in operation for several years now. Today it is part of the standard design.

Structurally, the grate understructure now consists of a closed supporting frame (see Figure 6), which is completely prefabricated in accordance with transport dimensions and provided with field connections. The complete grate and modules, operationally tested in the shop, are combined on the supporting frame in an auxiliary basic frame.

This preassembled composite unit, split up as required according to transport dimensions, i.e., basic frame with supporting frame and modules, is brought up into place under the boiler. In a comparison of the old and new concepts, the following advantages are found in favor of the modernized design:

- Possibility of introducing any size load on appropriately sized support pipes.
- High accuracy of fit of grate elements.
- Good accessibility of grate side wall tubes and hence reduced inspection/repair times.
- Simplified grate assembly requiring less time because of high degree of prefabrication.
- Installation not dependent on boiler assembly, since the boiler body is separate from the grate unit; the same applies to the supporting pipes.

MODIFICATION OF FEED CHUTE SUSPENSION

Consistent with the new grate suspension, the present feed chute attachment was designed and combined with the modified grate support concept. According to the previously proven standard, the feed chute suspension is in principle a system separate from the grate mounting (see Figure 7).

The load-transmitting connection is made through a fastening on sling tubes borne laterally which have their fixed point in the region of the refuse bunker cover and the feed hopper. So that the differential thermal expansion produced between boiler body and effective sling tube length can be equalized, a complicated shear system is required which forms the location between the discharge opening of the refuse chute and the fill opening of the boiler fitting over one another.

To strengthen the new grate suspension, the boiler support grid connected to the sling tubes was lengthened and the waste feed units were set up. Feeder and chute rest on this understructure, thus omitting the shear structure (see Figure 8), while the hopper and shut-off valve components are mounted in the proven fashion.

Shop and assembly routines, and the advantages resulting from them, derive from the grate suspension.

WATER-COOLED GRATE SURFACE

Another possibility in plant improvement is the use of zoned water-cooled grate surfaces instead of conventional temperature-resistant grate bars. This idea, highly touted by many manufacturers, is basically not new. Back in 1930, Steinmüller received a patent for a "water-cooled grate" designed as a grate panel. Today, for reasons of high combustion temperatures and the associated greater tendency to wear, cooled grate surfaces are again gaining importance.

As Figure 9 shows, the grate surface provided is designed as a generally hollow member adapted to the bar geometry. It replaces a complete row of bars and is connected to a cooling system by flexible tubes. Built-in vanes provide for forced flow. Depending upon need and specification, corresponding air slots for the primary air supply are incorporated.

Structurally, such a surface module is produced as one entire welded structure. The whole surface unit is split centrally to facilitate handling, assembly and weight, and can be adjusted to requirements of assembly on site. The air passage openings in the module provide for equalization and good distribution of primary combustion air.

The following advantages may be expected with the use of a water-cooled grate:

- Reduction of wear; hence low costs for replacement of parts and shorter inspection times in connection with extended inspection intervals.
- Avoidance of welds of individual bars and hence no grate shutdowns interfering with operation.
- Equalization of primary air supply over grate cross-section and lateral slots hence improvement of combustion quality and burnout.
- Increase in combustion temperature.

In addition to these advantages offered by a water-cooled grate surface in terms of the combustion process, it becomes possible to utilize the heat obtained by heating the water.

"CLADDING" ON GRATE WEAR TUBES

The composition and consistency of refuse have changed in recent years. Thus, for example, refuse containing large pieces or barely combustible substances or high percentages of chloride is not unusual. This spectrum of hard-to-burn refuse necessarily leads to increased erosion and hence attendant corrosion. Particularly the grate side-wall tubes are subject to increased wear.

Previous protective measures, in the form of pounded refractories, have proven themselves only to a limited extent, because of frequent repair. In contrast, "cladding," a sort of welded surface coating applied as replacement, proved to be excellent. Here the endangered tube regions are manually or mechanically provided with a plating about 1.5 mm thick of NiCr 625 Hastelloy (see Figure 10).

Several plants have already been successfully retrofitted in this manner. In new plants the cladding is done in the shop on the wall elements prefabricated as tube panels.

EXPANDED AREAS OF APPLICATION

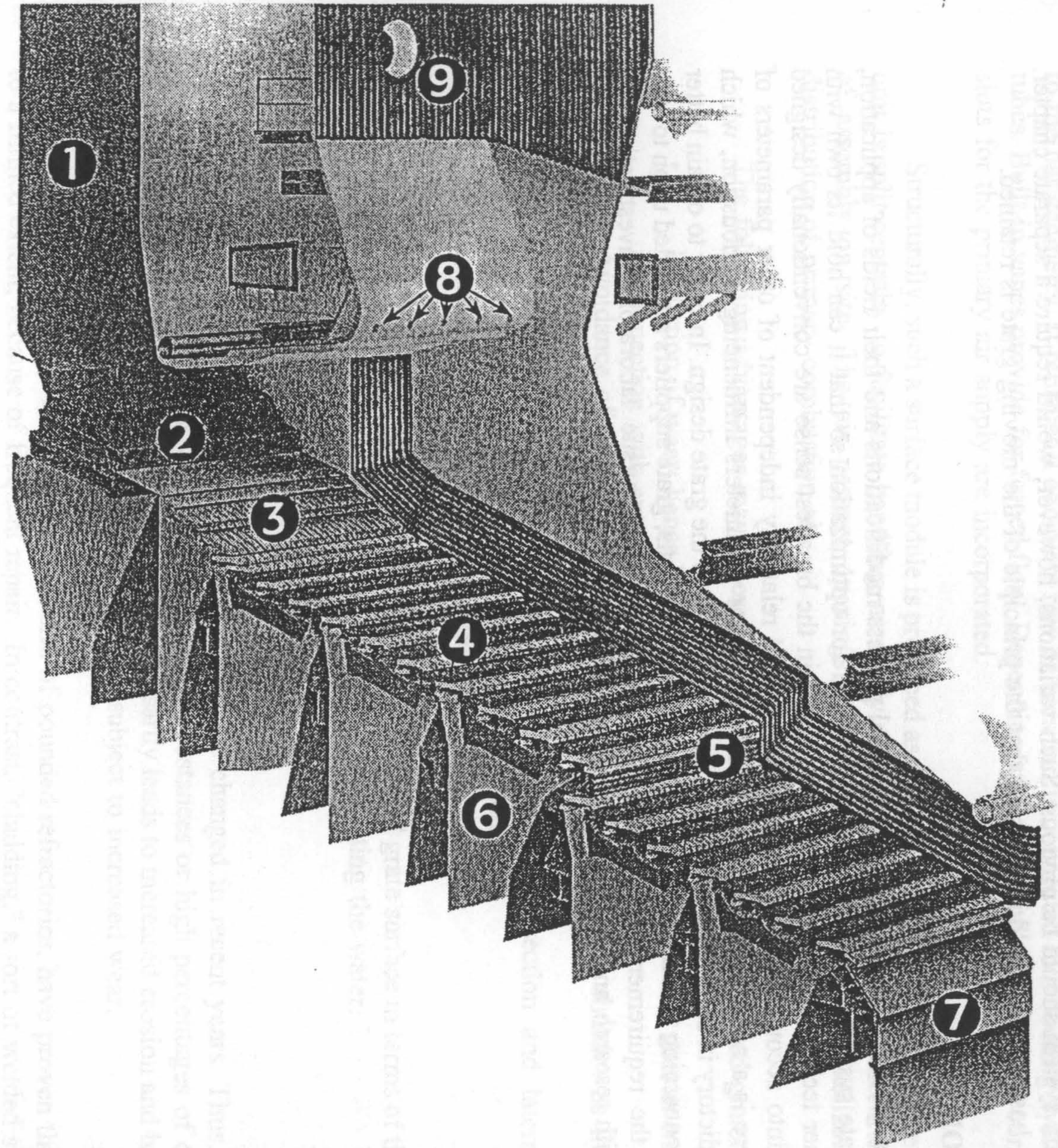
The grate has recently also acquired particular importance with regard to the combustion or addition of special fuels. For example:

- Combustion of wood
- Combustion of old tires
- Co-firing of sewage sludge
- Co-firing of shredder light weight aggregate
- Co-firing of spent activated carbon

That these special fuels demand corresponding structural and process technique modifications in the combustion system should be obvious. Such variations, however, would require a separate chapter. Nevertheless, basically it should be stressed that the principle of the moving grate is retained.

CONCLUSION

With regard to structural design, technical process modifications and their fields of application, the classic grate system offers considerable potential for optimization so that it can hold its own with respect to other technologies. However, since grates in the broadest sense are conventionally designed only to take into account thermal and mechanical load relatively independent of other parameters of influence, there is a need for information concerning other parameters influencing combustion, which can be contradictory in some cases, and their incorporation into the grate design. In order to obtain better information concerning this expressed in mathematical algorithms, grate suppliers are called upon to take into account the requirements of operators and, in addition, to pursue laboratory investigations in connection with research and development.



1. Feed chute
2. Feeder
3. Inlet slope
4. Grate bars
5. Cooled step
6. Screening hopper
7. Discharge chute
8. Secondary air
9. Auxiliary burner

Figure 1. **Moving Grate System**

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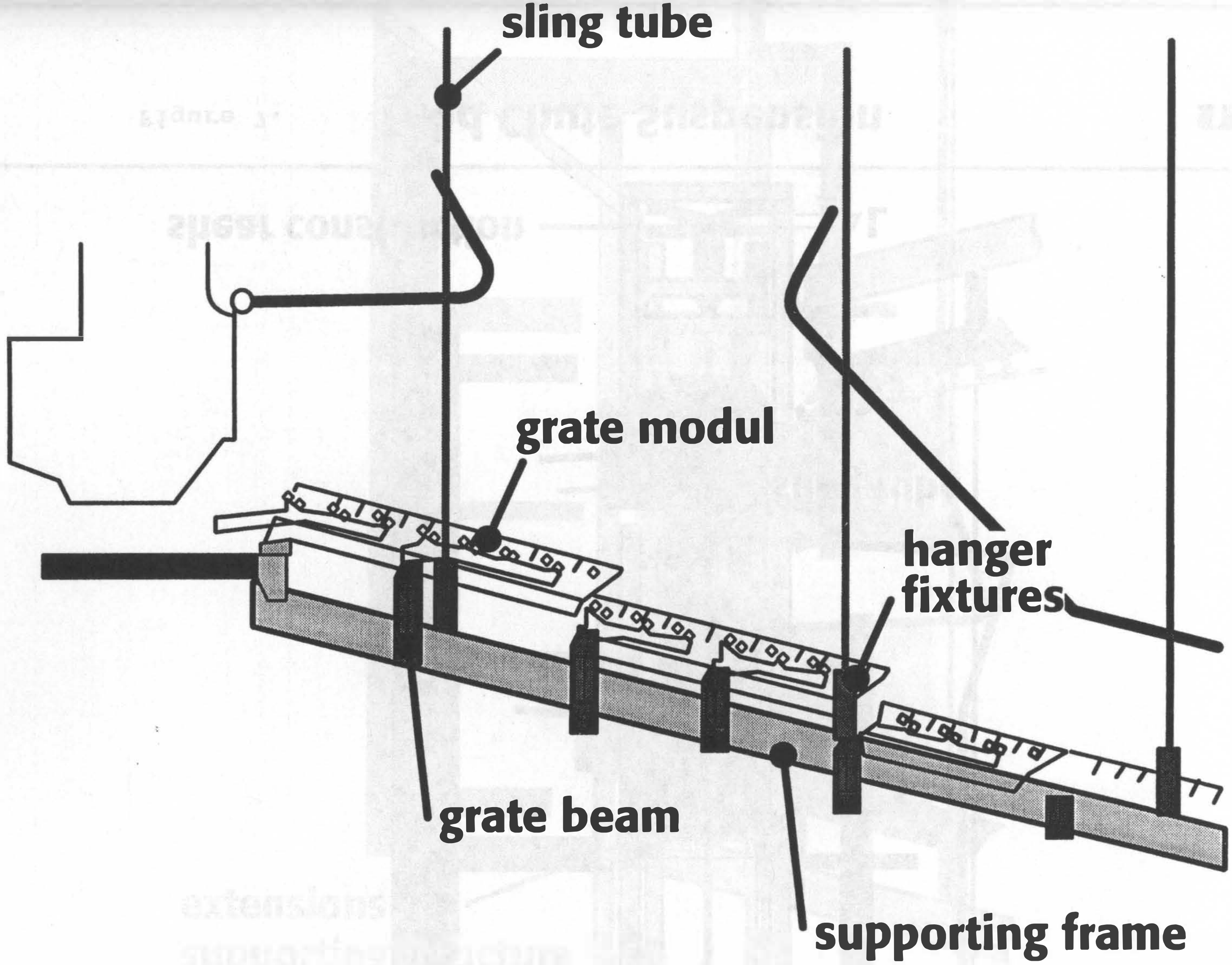

Figure 6. **Supporting Frame Connection**

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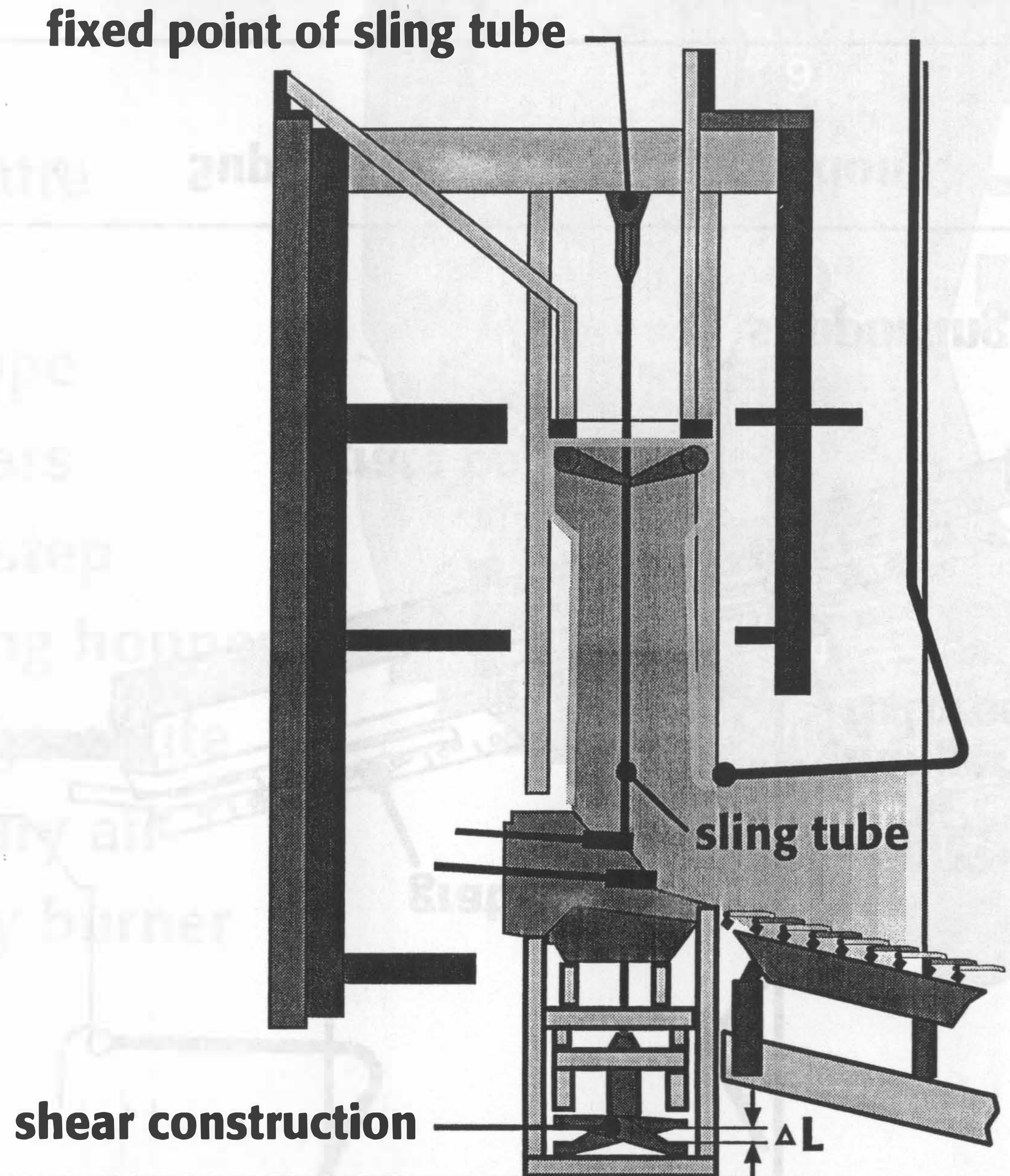

Figure 7. **Feed Chute Suspension**

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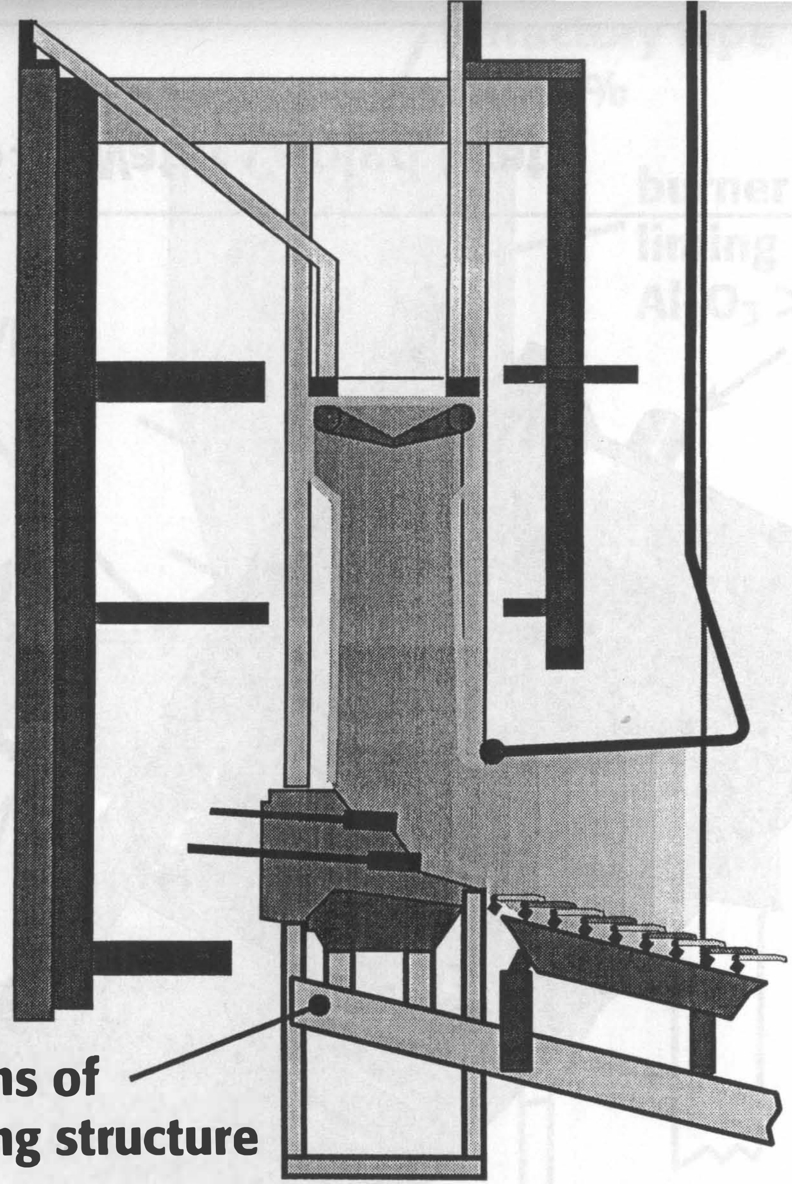

Figure 8. **Modification of Feed Chute Suspension** STEINMÜLLER

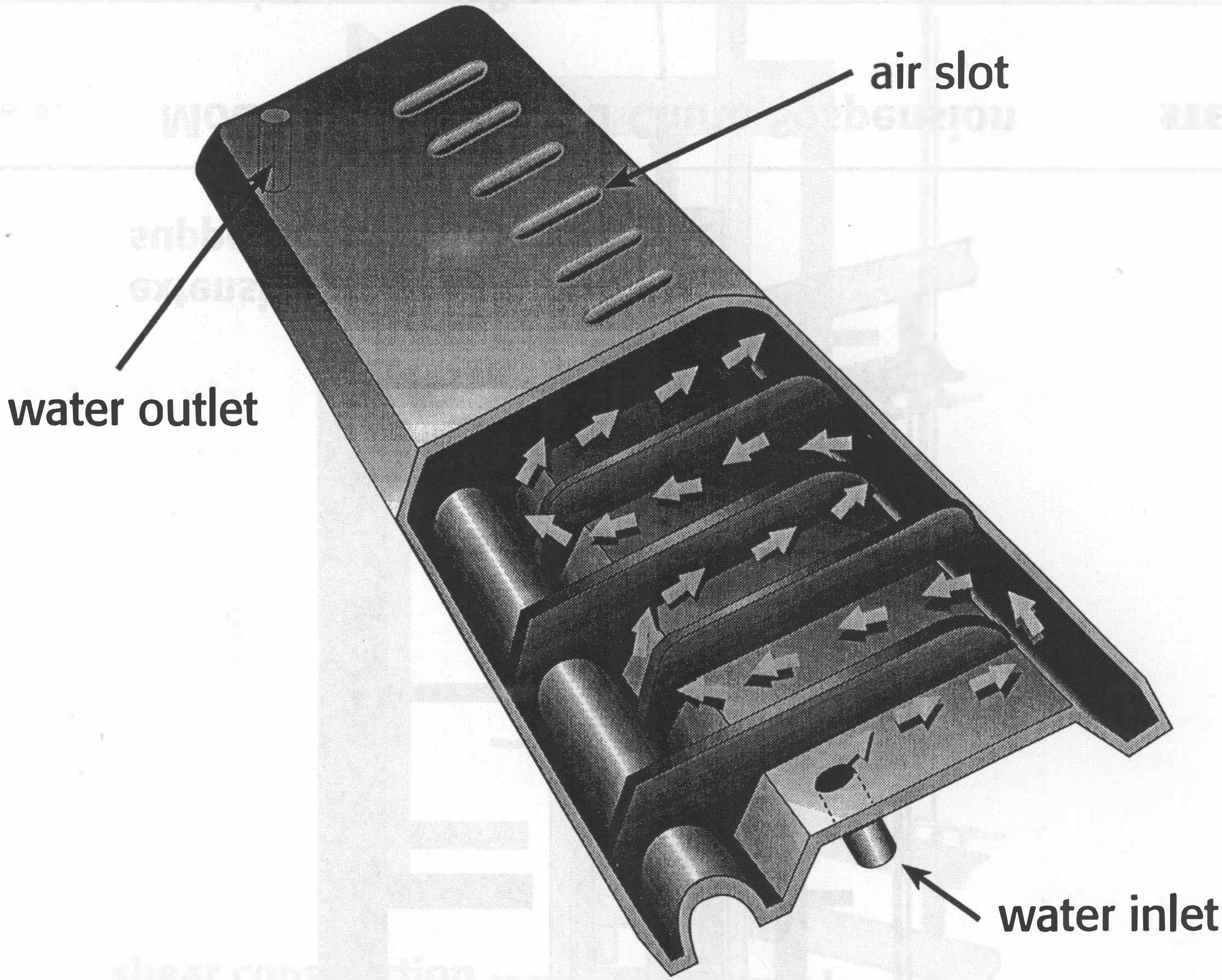

Figure 9. **Water Cooled Grate**

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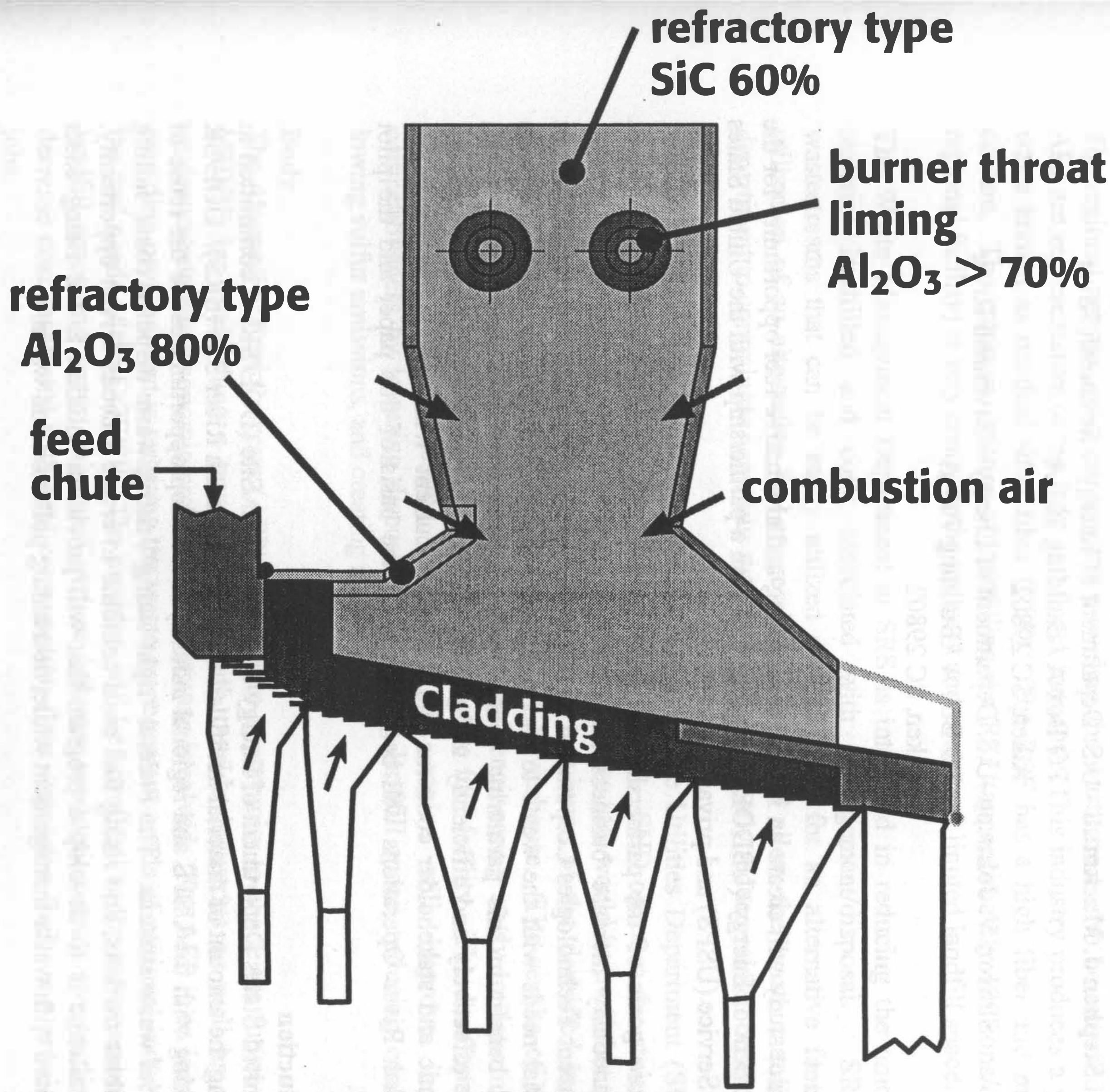

Figure 10. **Water Wall Protection**

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