with copper, iron and zinc, as a common metal, and since the discovery of the fused bath process, no progress has been made, although a great many men have struggled with the problem.

Clay is popularly supposed to be the great source of supply for making the metal cheaply, but its undesirable qualities cause it to be kept in the background, while cryolite ($Al_2 Na_6 F_{12}$) from Iceland and bauxite ($Al_2 O_3, H_2O$) from France, Ireland and the Southern States, can be obtained so cheaply. Clay is hard to treat to remove the silica, lime, and especially iron, and as the fattest clays (kaolin) contain no more than 20 per cent. of metal, as compared with bauxite at 50 per cent., no comparison as to cheapness exists.

To Chas. M. Hall, inventor of the fused bath process, now vice-president of the Pittsburg Reduction Co., which operates his process at Niagara, is due the honor of being the one who, at least in America, has brought the price down and quality up, so as to render it commercially useful. M. Heroult, of France, invented the same process at the same time, and developed it at Menhausen, Switzerland, where several thousand horsepower is in operation. The British Aluminum Co. is using the same process at the falls of the Foyer in Scotland. It has been in operation but two months, but even now is making money. J. B.

SMOKE PREVENTION FROM A MECHANICAL STANDPOINT.*

BY PROF. C. H. BENJAMIN.

Quite a number of experiments were made several years ago on very black, dense smoke. It was all collected, and the amount of solid matter was determined by weight. It was found to be in all one-third of one per cent, or 1-300 of the weight of coal burned at that time. Probably one-half of this solid matter was carbon, showing that the amount of coal which is actually wasted in soot is 1-600 part of the coal. This shows that there is no economy in burning smoke, as far as the manufacturer is concerned. It is his neighbor that would profit by the change.

In preventing smoke the principal requirements seem to be:—

1. That the coal shall be evenly heated.

2. That there shall be a free supply of hot air raised to the temperature of combustion.

3. That the volatile matters distilled from the coal shall pass through gases of such temperature that they shall be burned, so it shall be impossible for these gases which distill from the coal to escape by the chimney, or to become cooled after once having been ignited.

The great mistake that many manufacturers have made in trying to invent a smoke-preventing device by the introduction of air about the fuel or at the bridge wall, is that they have not made their air hot enough. The introduction of cold air is a disadvantage rather than an advantage, as far as preventing smoke is concerned. It will produce smoke where none existed before. There are a number of stokers on the market which, under ordinary conditions, with uniform firing by a careful fireman, will operate to prevent smoke successfully and with good economy. These different types of stokers all have a common principle, that of maintaining the thickness of the fire uniform, and of supplying the air either by means of steam jets or otherwise at a high temperature above the coal, and insuring that all the volatile matter should pass through a hot place on the way to the chimney.

One of the more common forms of stokers consists of the inclined grates, all the gases being obliged to pass over the incandescent coal before escaping into the chimney, and the clinkers being deposited on the bottom.

Another type has a cooking plate at the upper end, and one inclined grate running lengthwise of the boiler. Both have shaking grates.

Still another device consists of a traveling grate with an endless chain over two pulleys and a coking course at the front end, the gas passing over the incandescent coal on the way to the boiler.

There is an underfed stoker, where the coal is placed in the ash pit and forced up through the grate, this being the same as our ordinary baseburner, only the other side up.

One other type is the so-called down draft furnace, which is not a mechanical stoker, in one sense of the word, but consists of a water grate connected to the bottom of the boiler by risers, at the rear usually having a drum at the connecting point and a supplementary grate underneath on which the half-burnt coal is dropped and the combustion completed. Most of the air is obliged to pass over the grate down through the fuel, a small amount of air being admitted underneath. The principle of all these is the same, that of supplying air at a high temperature and forcing the volatile matter to pass over incandescent fuel.

I presume there are other varieties that will work under ordinary circumstances with good results, and give good economy. The steam jet is applicable to all these, and is used in many of them as a means of introducing air at a high pressure.

The great difficulty with all mechanical stokers is the fact that in many establishments there are many sudden demands for steam pressure, and there is a possibility of its being necessary to double the amount of steam used inside of fifteen minutes or half an hour. Many stokers are not adapted to that kind of treatment. This is one reason why they have failed of adoption. A stoker cannot respond so readily to a sudden demand for more steam. I will say, without prejudicing any of the other stokers, that the down-draft furnace is the most successful stoker for all such emergencies. It involves the use of hand firing, the coal being fed to the grate the same as to any grate. It allows the same treatment as the ordinary open grate, and the fireman has the same liberty that he would have on any grate. In a paper read by two experts, of St. Louis, last year, it was stated that in their opinion this form of grate was best adapted to cases where there were sudden demands for large amounts of steam, and great fluctuation of the pressure and consumption of steam. They said that this form of grate had done a great deal to diminish the amount of smoke made in St. Louis, where they are more unfavorably situated than we because they do not get as good coal.

I will mention what seems to me to be the requirements of a good smoke preventing device:

In the first place, variable feed. It is necessary that it should be possible to vary the feed of the stoker quickly and conveniently. In the second place it is necessary that the spacing of the grate bars should be variable; that the air spaces between the bars may be varied, and the coarseness and fineness of the grate may be quickly adapted to the particular kind of coal used. Third, it is necessary that the grate bars should

* A paper read before the Civil Engineers' Club of Cleveland.