the iron of the boiler, and any deviation from these conditions produces smoke and great loss of heating power; and that while with hard coal too great a draft only wastes a small quantity of heat in the stack, with soft coal too great a draft may be as bad, or even worse in its effects, than too little.

With soft coal the required high temperature over the fire may be produced by intercepting the radiant heat of the fire by a fire-brick arch or dome, which radiates back again to the fire, heating the products of combustion from both sides.

This was first introduced by Mr. C. Wye Williams, many years ago, and has been frequently revived in different forms since. In some devices air is introduced at the bridge, or at the edges of the arch or dome.

The great trouble with such arrangements has always been the lack of durability of the brick, used in the arch or dome. In fact, the more refractory the material the hotter the fire, and the destruction of the arch becomes only a question of, what is comparatively, a short time. One of the satisfactory ways of obtaining a high temperature is by using so thick a bed of coal that the passage of too great a quantity of air is prevented by its friction upon the fuel, the thickness of fire being regulated by the size of the coal used, and kept so that it will not clinker too much. This effectually raises the temperature of the fire; it may also be done by the use of a damper, but not in so satisfactory a manner, although there is found to be in many cases a marked improvement by decrease in the draft. The general opinion in this country is decidedly in favor of thin fires, and the experiments of Professor Johnson at Washington favor this practice; but the experiments at Wigan, England, gave generally "the thicker the fire the better the result." Experiments with a pyrometer are needed in each case, but we may safely say that great improvement can be made in our practice in this respect, and that the only secret in smoke prevention is to have a hot fire with room and time to let all the gas burn before coming to less than a red heat, and to fire in small quantities over a part of the grate at one time only.

Losses of heat by radiation and conduction from the furnace and ash-pit of externally fired boilers are to be provided against by making the walls, if of brick, in two thicknesses, with an air space between them; by keeping the ash-pit doors partially closed, and covering all radiating surfaces of metal with some good non-conducting material, such as thick felt faced on the inside with one-quarter inch of asbestos.

The amount of heat which may be lost by radiation from