Engineering, Civil & Mechanical.

THE EARLY DAYS OF BESSEMER STEEL.

Under this title, the London *Engineering* of a recent date gives a concise history of Sir Henry Bessemer's struggles, which resulted, as the world now well knows, in the production of malleable iron in a fluid state, which was cast into molds and rolled into bars. It is the old story over again, and ever interesting. When Mr. Bessemer, by the advice of Mr. G. Rennie, the President of the Mechanical Section of the British Association, read, on the 13th of August, 1856, his paper on "The Manufacture of Malleable Iron without Fuel," practical men were prepared to treat the whole affair as a joke, and eminent manufacturers of iron came to enjoy the fun and to ridicule the author of the "absurd" proposition. But it was a case of coming to scoff and remaining to pray. One iron master offered to place his works at Mr. Bessemer's disposal for experiments. Mr. James Nasmyth, who was present, in his appreciative enthusiasm, held up at arm's length one of Mr. Bessemer's samples, exclaiming: "Here's a true British nugget!" This identical bar of iron," says our contemporary, "is now before us; it was rolled, cut, piled and re-rolled at Woolwich Arsenal, and fully proves the soundness of the principle on which the invention is based." The London *Times* reprinted the paper the morning after it had been read, and three days later a formal offer of $250,000 was made for the English patent, which was declined. A month after the appearance of the paper in the *Times*, $140,000 had been received for licenses to use the invention in Great Britain alone.

Then came a reaction, trials hastily made at various works having ended in a fiasco. "A brilliant meteor has flitted across the metallurgical horizon, dazzling all beholders for a moment, only to die out and leave no trace behind." Although this might be the general opinion, as voiced by one journal, it was not quite that of Mr. Bessemer, who at once set to work. At the end of three years, "steel of excellent quality was made from molten pig iron in fifteen minutes, wholly without the employment of skilled labor, or manipulation of any kind, and without the employment of fuel."

Another illustration of the irony of life is found in the fact that when Mr. Bessemer, having thus finally triumphed over every difficulty, read his second paper on "Iron and Steel" before the Institute of Civil Engineers, on May 24th, 1869, with the evidence of practical success before all in various and beautiful specimens, the merits of the invention were stoutly denied, and the process was ridiculed by members present. Hostile critics were Mr. Bramwell, Mr. T. Brown, Mr. T. M. Gladstone and Mr. Riley. The Sheffield steel-makers would not give the process a trial; and it was not until Mr. Bessemer determined to erect steel works at Sheffield and undersell the steel maker in his own market, that the Bessemer process was introduced. In Great Britain alone, the quantity of steel produced in 1880 was a little over twenty times the entire production of steel in that country prior to the invention. A remarkable fact, which will undoubtedly be mentally commented on by all thoughtful readers without any suggestions from us, will be found in the final statement of our authority, that for twenty-five years, owing to the clamor of interested or ignorant partisans, the original paper has been excluded from the Transactions of the British Association.—*Manufacturer and Builder.*

BOILER EXPLOSIONS IN 1881.

The number of boiler explosions in 1881 that have been of sufficient importance to attract the attention of local press reporters is not as great by about half a dozen as was reported in 1880. But the number is quite sufficient, being 160 explosions, by which 250 persons were killed or fatally injured and died soon after from the effects of their injuries, while over 300 more were seriously but not fatally injured.

Of these explosions almost exactly thirty per centum were in mills that use light and quick burning fuel, sawmills standing far ahead of any of the class in number and disastrous results. The class includes besides sawmills, all such as use the refuse timber and shavings from wood cutting machinery, and should also include such thrashing engine boilers as are fired with straw. But it is not practicable to separate such for the purpose of classification from others that use coal for fuel. It is probable that one-third of all the steam boilers that explode with destructive violence are such as use flashy, quick burning fuel. The furnace doors of such boilers must be often opened, and in the case of green sawdust the draught must be strong, so that when the furnace doors are opened a sudden chill of the furnace plates is caused by the inrushing cold air. The effect of the sudden cooling of parts of the boiler is to unduly contract and strain them, the contraction being resisted by those parts that are not so suddenly cooled. In long cylinder flue boilers, externally fired with flashy fuel, the contraction of the bottom of the shell is resisted by the rigid internal flues. Then the strain causes slight bending of the head flanges, if they have pliable wrought iron heads; or if heavy unyielding cast iron heads, then the strain caused by the contraction of the lower side of the shell is concentrated at the transverse seams, the weakest of which will yield and begin to leak, or it will pull in two between the rivet holes, perhaps one-third the way round the boiler before exploding.

The strains on the flanges of wrought iron heads from contraction of the bottom of the shell of this type of boiler, which contraction is resisted by the rigid internal flues, causes bending at the angle of the flange, and the strained and yielding line near the angle of the flange is at once attacked by the boiler water. The slight imperceptible motion is sufficient to crack off any lime scale that may have been deposited from the water and lay bare the disturbed molecules of the iron, and they are acted on over a larger area than when undisturbed, and with only a small area, that which lies in the general surface of the plate, exposed to chemical action of the water.

The weak line becomes weaker with every recurrence of the motion, and if the weak line is sufficiently long it may give way suddenly on the whole weak line, when an explosion may occur immediately on the escape of the free steam which presses on the highly heated water.

Weaknesses caused from this or any one of the many causes of deterioration of boilers, are, however not necessary conditions for an explosion, In fact it has been often remarked, and with propriety, "the stronger the boiler the greater the destruction." But it is plain that the force must be greater than the resistance to it when the boiler breaks open. It is only necessary to prevent the escape of the heat by radiation from the exterior surface of a boiler and through all steam outlets, and to continue the fire in the furnace at a temperature higher than that of the boiler water in order to effect a continued gradual increase of heat and of pressure in the boiler. This may be done sufficiently to accomplish the destructive explosion of the strongest boiler by fastening down the safety valve, closing the steam stop valves, and keeping up a moderate fire in the furnace. It is by the accidental arrangement of these conditions that many, perhaps most, explosions of strong boilers that occur are brought about.

It is fair to conclude that farmers and lumbermen who undertake to run their own steam boilers are more likely to make the fatal mistake than almost any other class of steam users. Therefore we need not wonder that so large a proportion as 33 per cent of boiler explosions are in saw and lumber mills.

Next in order of their numbers and effects come the explosions in iron works of various kinds. Something less than 11 per per centum of the exploded boilers were in this class of manufactories. The most notable explosions have been in rolling mills and furnaces, but for convenience in classification, boiler shops, machine shops, and foundries are included in this class.

The most important, however, and the most numerous explosions in this class are iron manufactories proper, and it is these that give this class its right to have this second place in the order of classification, and to these the reader's attenion is invited.

Most of the boilers used in iron works in this country are externally fired, although there are a few of the English Rastrick and a few upright flue boilers still in use.

Of the externally fired varieties there are the plain cylinder, the cylinder flue, the cylinder tubular, and the French double cylinder boilers. In iron furnaces it is a common practice to heat the boilers by means of the waste gases from the furnace, and for this purpose the furnace top is closed with a cast iron cover, and a large pipe is let into the side near the top, which conducts the gases to the chamber beneath the boilers, when sufficient air is sometimes admitted to complete the combustion of the gases and heat the boilers.

The sulphurous vapours from the contents of the furnaces are condensed by contact with the cool parts of the boilers, and corrosion sometimes goes on very rapidly, especially near the feed water inlet. Leaks occur, and the moisture from them increases the activity of the corrosive agents, and if not repaired the plates are soon reduced to such a weak condition that they give way. Now, if the break is of considerable ex-