“The Equalisation of Hot-Blast Temperatures for Blast-Furnaces.”¹

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THE importance of regularity, both in the materials for the blast-furnace, and in the operations connected with its working, is being more and more recognized. Irregularity in the chemical or mechanical condition of the materials charged, or in the method of charging them, causes irregularity in the working of the furnace, and in the quality of the iron produced. Irregularity in the temperature of the hot blast causes the same evils. The hot blast supplies oxygen for the combustion of the coke, and also heat which would otherwise have to be provided by the burning of coke. It is clear that, if the temperature of the hot blast varies, the quantity of the coke at the melting-zone should also vary, so as to keep the heat constant; but this is impossible.

Hot blast, supplied by the reversing regenerative stoves now almost universally used, varies by an amount ranging between 200° F. and 300° F., owing to the rapid cooling effect of the cold blast passing through them. The effect of these variations is to alter the position of the melting-zone in the furnace. Higher blast-temperature concentrates combustion at a lower level: which, following immediately after a comparatively low temperature of blast and more extended combustion, has the effect of leaving above the new melting-zone the materials that had been partly fused. In extreme cases, the natural mechanical formation and condition of the partly fused materials combine to form an arch or dome across the furnace. Parts of this adhere to the walls, forming “scaffolds,” which cause the furnace to “hang,” and to produce iron of low quality and reduced quantity, until the scaffold is fused off. A serious loss is thus occasioned in the value of the product; and the whole plant becomes disorganized, owing to a deficiency in quantity and quality of gas for the stoves and boilers. With the old-fashioned pipe-stoves there is no sudden variation in the temperature of the hot blast; hence a “hanging” furnace is rarely known where this kind of stove is used, together with uniform materials; and a larger proportion of high-grade iron is produced. In America the regular practice is to cool down the hot blast with cold blast to a temperature which the stoves can maintain con-

¹ *The Engineer*, vol. xcv. p. 629. *Engineering*, vol. lxxv. pp. 826 and 839. *Iron and Coal Trades Review*, vol. lxvi. p. 1714.

tinuously, in order that the blast temperature shall be uniform, although at the lowest point given by the stoves, and requiring continuous regulation of the cold-blast admission.

Perfect regularity of hot-blast temperature, with practically no loss of heat, can be obtained by interposing in the course of the blast, between the stoves and the furnace, a mass of firebrick chequer-work, which takes up heat from the blast when the latter is above the average temperature, and gives heat back to it when its temperature is below the average. This apparatus, known as an equaliser, is similar in appearance to a Cowper stove. A brick-lined steel shell, with slag-wool between the lining and the shell, is filled with firebrick chequer-work, divided centrally by a wall, so as to form two chambers communicating at the top. The hot blast from the stoves is made to pass up one chamber, down the other, and out at the bottom to the furnace, *Figs. 1.*

The blast from a freshly-heated stove is at its highest temperature; and, on entering the equaliser, comes in contact first with that portion of the chequer-work which has been to some extent chilled by the blast that has previously been entering at its lowest temperature from the stove which has just "gone off" blast. The hotter blast from the freshly-heated stove parts with some of its heat to the chequer-work; but, as this stove's run continues, its blast gradually falls in temperature below that of the equaliser, and the chequer-work then returns heat to the blast passing through it. In this way there is a constant interchange of heat between the blast and the chequer-work, with the result that the hot blast passing to the furnace has a perfectly uniform temperature, which is practically the average of its varying temperature on entering the equaliser. Thus the equaliser produces blast of uniform temperature, in the same way as a fly-wheel produces uniform speed in an engine. The equaliser has no valves, no attention of any kind is required, and no cleaning has to be done, because no gas is put into it.

One of these equalisers, 20 feet in diameter by 55 feet in height, was put to work at the Normanby Iron Works, Middlesbrough, in May, 1901, and gives hot blast of perfectly uniform temperature. The diagrams (*Figs. 2*) are accurate copies of autographic records from an Uehling pyrometer, showing the temperature of the blast as it goes into the equaliser, and as it leaves it. The pyrometer is a double instrument, having one fire-tube in the inlet to the equaliser, and the other in the horse-shoe main round the furnace; and the two records are made simultaneously. It will be observed that the equalised temperature shown on the

Figs. 1.

Figs. 2.—Normanby Iron Works, Middlesbrough.

AUTOGRAPHIC RECORDS FROM UEHLING PYROMETER.

Figs. 3.—Newport Iron Works, Middlesbrough.

exit side is about 25° F. below the average of that on the inlet side. This difference is the actual loss of heat, and is the only loss due to the apparatus.

A second equaliser was put to work on 31 March in this year, at the Newport Iron Works of Sir Bernhard Samuelson and Co., Middlesbrough, and is giving the same regular blast-temperature, as shown in *Figs. 3*, which are accurate copies of Uehling pyrometer records taken in the same way as the preceding. Here the averages of the temperatures in the two records show a loss of only 22° F. In this instance the record from the inlet side is slightly smaller in temperature-scale than that from the exit side, because a second recorder had to be borrowed from another furnace for the purpose of getting simultaneous records.

A third equaliser is being erected at the Park Gate Iron and Steel Works, Rotherham.

"Hanging" has occurred in the Normanby furnace which has worked two years with an equaliser; but in every instance it has been directly traced

either to the irregular quality of the ore, which is all imported and of greatly varying character, or to irregular charging of the materials. No such trouble has occurred from irregular temperature of the blast.

Professor Lupton and Messrs. B. H. Thwaite and H. Bauerman took part in the discussion of the subject.

“Steam-driven and Gas-driven Blowing-Engines.”¹

By TOM WESTGARTH.

THE older kinds of steam blowing-engines must have been very suitable for the work to be done, judging from the few changes that have been made, and the long time they have worked. But they were found a few years ago to be unsuitable for the harder work and higher blast-pressures, required first in the United States, where iron-masters had a great advantage in being able to erect entirely new works, and therefore could adopt the experience of other countries. The same requirements followed in Europe, commencing about 10 to 15 years ago, when some of the more progressive iron-masters began to erect engines of much heavier design, having compound steam-cylinders and capable of running faster and blowing at higher pressure. The class of engine now used is fairly illustrated by a set built by the Author's firm—namely, twin vertical engines, having compound steam-cylinders 40 and 84 inches diameter by 60 inches stroke, exhausting into a separate condenser, with a boiler-pressure of 150 lbs. per square inch. As the engines had to run in ordinary work at 50 revolutions a minute, and to blow up to 30 lbs. per square inch, it was decided to equip the air-cylinders, which are 84 inches diameter and 60 inches stroke, with the sliding-valves of the Southwark Foundry and Machine Company, of Philadelphia. These valves proved to be a great success, as the clearance is reduced to $1\frac{1}{2}$ per cent.; the inlet-valves are worked by mechanical gear from the fly-wheel shaft, and the outlet-valves are closed mechanically, but are reopened automatically by the air-pressure. The arrangement is such that, when the pressure in the cylinder and in the

¹ *The Engineer*, vol. xcv. p. 629. *Engineering*, vol. lxxv. pp. 827 and 840. *Iron and Coal Trades Review*, vol. lxxvi. p. 1715.