



## L. On smelting of lead

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flags and whetstones from Hutton-Roof, about six miles north-east from Lancaster.

There is a thin seam of coals, which apparently originating in a valuable but limited colliery near Ingleton in Yorkshire, extends by Hornby to within a few miles of Lancaster, when it *bassets*, (in the language of miners,) or runs out upon the common above the town. It is not found in a stratum of argillaceous stone, but (contrary to what occurs in this country, and in general in this kingdom) in a most compact quartzose or flinty one; the particles of which are so compact and hard, as not only to strike fire with steel, but to be almost inaccessible to the tool.

L. On Smelting of Lead. By Mr. JOHN SADLER\*.

DEAR SIR, **M**OST of the lead of commerce is obtained from that species of ore which is by mineralogists called *galena*, *potter's ore*, or sulphuret of lead. Indeed, it is the only species of lead ore which is found in sufficient quantities to be worth working.

There are many other species of lead ore met with occasionally; but these, occurring but seldom, are regarded as curiosities, and are generally carefully selected for the cabinet of the mineralogist, or as ornaments for the mantle-piece of the miner.

The ore, as it is first raised from the mine, is mixed with a considerable proportion of the matrix or gangue of the vein, from which it must be in great measure freed before it is fit for the operation of smelting.

For this purpose, the ore is delivered to the *dressers*, who either break it into small pieces with hand-hammers of a peculiar construction, which are called *buckers*, or it is passed between rollers worked by machinery, or under stampers. It then undergoes the operation of washing, to separate it from the lighter foreign matter, after which it is ready for the smelter.

*Construction of the Ore Hearth.*

The smelting of lead is performed differently in different districts. In most parts of the North, particularly in Cumberland, Durham, and Northumberland, smelting is performed in the ore hearth by means of bellows. In some parts of Yorkshire, in Derbyshire, and in North Wales, lead

\* From Clennell's New Agricultural and Commercial Magazine.

is smelted in reverberating furnaces: this kind of smelting is distinguished from the other by the name of cupola smelting: each of these methods has its advocates.

The superiority of either depends much on local circumstances, and, perhaps, also on the skill of the workmen.

Ore-hearth smelting shall be first described.—To render the description intelligible, it will be necessary to commence with a description of the hearth.

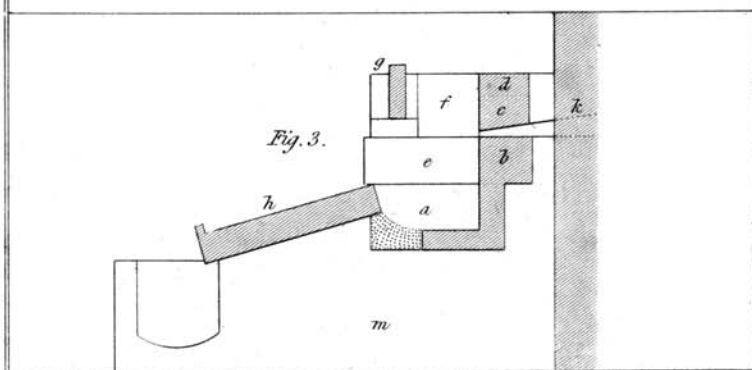
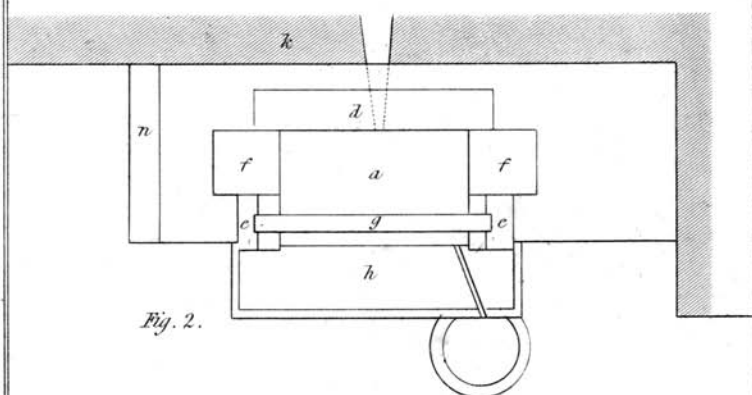
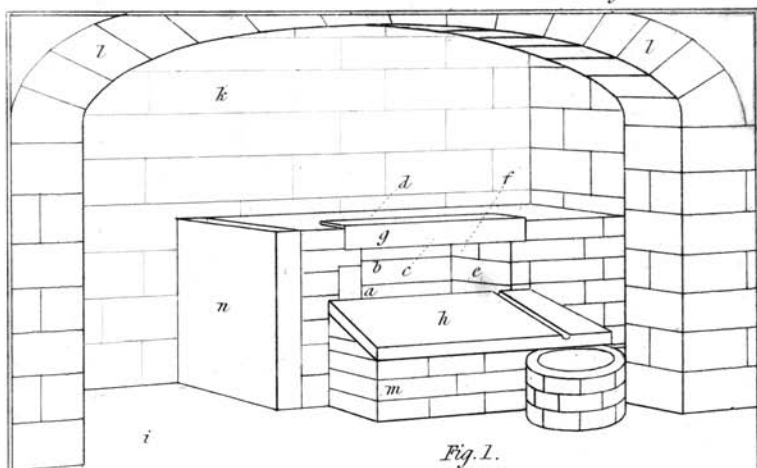
Fig. 1, (Plate VIII.) is a sketch of the hearth: it is constructed principally of pieces of cast iron, which are called generally iron stones or metal stones; each different casting has a distinguishing name: they are the (*a*) pan, (*b*) back, (*c*) pipe-stone, (*d*) spark-stone, (*e*) bearers, (*f*) keys, (*g*) fore-stone, and the (*h*) work-stone.

The hearth is erected under a spacious chimney, and nearly in the centre; one side of it is called the water-side, being near the water wheel, which urges the bellows; the opposite is called the land-side.

Figs. 2 and 3 are plans and sections of the ore hearth: the same letters in the different figures are placed to the same parts.—(*i*) the floor of the smelting-house, (*h*) the back of the chimney, (*l*) the front of the chimney, (*m*) the foundation on which the hearth is constructed: it is built of rough masonry, and levelled and run in at the top with thin mortar or grout; the pan or bottom of the hearth is laid steadily in mortar on this bed: upon the posterior part of the pan is placed the back, its face being even with the inner edge of the pan.

The work-stone is next arranged; its upper edge three or four inches from the anterior part of the pan, and parallel with the back; the bearers are placed on the sides of the pan, one end of each butting against the back, the other ends resting on the upper edge of the work-stone. Two thin pieces of stone, (about half an inch thick,) generally slaty sandstone, are laid on the back, and on these is placed the pipe-stone, the inner face of which overhangs the back near an inch. The keys are set on the bearers, their faces even with them; two pieces of brick are set on edge on the bearers, next to the keys, and on these, a few inches from the keys, rests the fore-stone; the spark-stone laid on the pipe-stone completes the hearth.

Before laying the foundation, a large flat stone (*n*) called the cheek-stone is fixed firmly in the ground, and determines the extent of the land-side of the hearth; the spaces between the water-side, the back of the chimney, and the cheek-stone are filled up with pieces of sand-stone, bricks, or old



iron-stones, and the interstices levelled up with dust. The fore-stone is wedged tight by its ends, generally against two old keys.

The space between the pan and the work-stone is filled with a mixture of bone and fern ashes well beaten in, and those between the keys and the ends of the fore-stone with stiff clay.

Care is taken in constructing the hearth to lay the bearers square, or at right angles with the back, and also to direct the blast immediately through the centre.

The hearth being completed, the operation of smelting commences with kindling the fire. The whole space between the fore-stone and back is filled with peats or chop-wood: an ignited peat or live coal being placed in the midst, the bellows are set to work: as soon as the combustion is sufficiently advanced, or that the whole are well on fire, one of the smelters (there are two to each hearth) throws a few shovels of half-smelted ore, (the remains of the last operation of smelting,) which is termed brouse, on the top of the fire, gradually adding more as the contents of the hearth settle; he also adds a few small coals occasionally to keep up the combustion: when the whole of the brouse is thrown on the hearth, the other smelter watches out; that is, with a long pointed crow-bar, called a gavel or gable-hook, he stirs up the whole of the brouse, and brings forward a great part of it upon the work-stone: this is effected by introducing the gable-hook into the hearth six different times, in the following order: he first forces it under the brouse a few inches on one side the centre, until the point touches the back; he then forces as low down as he can the end he holds in his hand; this lightens up the contents of the hearth, and as the bar is withdrawn, a part of the hot brouse comes forward on the work-stone; the gable-hook is then entered below the brouse, about the same distance from the centre, on the other side, where the same operation is performed: it is next introduced close to the side of the hearth; here the workman forces the end of the gable-hook from him, at the same time he presses it down, so as to bring the point of the bar into the middle of the hearth; this brings part of the brouse, which was next the side, into the middle, and what was in front, out on the work-stone. The gable-hook is again introduced in the same place, and the point raised close to the side, to remove any brouse that may adhere to the bearer or key. The same operation is performed at the other side, to remove the brouse from thence also. Whilst the watcher is performing his part, the man who supplied the

the hearth, and who is called the setter-on, thrusts his shovel down into the hearth, a little below the entrance of the blast, and forces the brouse sufficiently forward to allow him to place a peat or a handful of chopwood horizontally before the orifice of the bellows: this he generally gets done nearly as soon as the other has finished watching, who changes his gable-hook for a shovel; the setter-on comes to the front with his shovel, and they together throw the whole of the brouse again into the hearth, over the fore-stone, with a small quantity of coal as they see necessary, carefully separating the slags, which they throw into a corner, and breaking down the larger masses of brouse: when the whole is in the hearth, the setter-on goes again to the side, levels the top of the brouse, and covers it with fresh ore, laying this thickest against the spark-stone: the working of the hearth, after watching, is called setting-up. When a hearth is well set-up, and works properly, without an excess of coals or blast, and pretty free from slags, small reddish white flames issue from all parts of the breast, from below the fore-stone, nearly to the edge of the work-stone: these flames should not issue more than a few inches from the breast. The hearth does not continue long in this state; as the peat burns away, the blast is less equally distributed; it forces itself through more in some parts than in others; the covering at the top is perforated, or, perhaps, perfectly ignited, and the whole mass is condensed and settled in consequence of the evaporation of one part of the ore, and the separation of the metal; copious blueish flames issue from two or three parts of the hearth, as if occasioned by the combustion of some metal. The brouse must be again watched-out, a new peat put in, and more ore thrown on the top. The operations of watching and setting-up require to be repeated about every three minutes. After a few times setting-up, the metallic lead begins to flow down the channel of the work-stone, into a pot, where it is kept hot until collected in sufficient quantity to cast a pig.

It is necessary, for the easy management of the hearth, that a considerable quantity of fluid lead should remain in the bottom for the brouse to float on. The watcher, after throwing up the brouse, allows the lead to flow freely down the gutter for a short time, and then prevents any more escaping, by lightly raising up the brouse against the gutter with the corner of his shovel.

Two men will smelt about six bings of good ore a day, and from these produce 24 pigs of lead, weighing 154lbs. each.

It

It is advisable to draw the hearth at the end of every twelve hours, in order that it may cool; for a cool hearth works pleasanter, and makes better produce than one which has been suffered to heat. The hearth should be drawn about two watchings after throwing on the last of the six bings of ore. As soon as the hearth is watched-out the last time, the action of the bellows is stopped, and the smelters draw out the whole of the hot brouse with their shovels, and throw it on the floor to cool, picking out such slags as they may observe; they also remove whatever adheres to the sides or back.

If the hearth has been properly attended, and a due proportion of fuel used, it will scarcely appear hotter in one part than another; and, if it has been working with a free ore, should not appear hotter than a very dull obscure red heat.

With a free ore, the hearth, when fresh set-up, works as described page 280, the blast finding its way equally through all parts of the breast. The brouse, when watched-out, is dry, and mostly in small pieces, the slags firm, and easily distinguished by their cavernous appearance and brighter colour, and the lead flows from the hearth scarcely red hot. Lead ore, which contains much silver or copper, or which has not been properly cleared from the gangue with which it is mixed in the vein, requires particular attention on the part of the smelter: instead of working dry and open, it becomes soft and pasty; the slag, instead of separating in firm pieces, is diffused through the whole like a half-melted scoria, and the least inattention to the fire will set the whole contents of the hearth into a solid mass, or cause it to boil and flow down in a liquid state on the work-stone—the lead flows very hot, and the hearth appears hot and foul. The addition of lime is necessary to correct this defect in the ore, which combining with the fluid scoria, solidifies, and thus assists its collecting in masses: care should be taken not to add more lime than is absolutely necessary for the purpose intended, as all extraneous matter thrown in with the ore lessens the produce of lead.

[To be continued.]

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LJ. *Notice respecting Native Concrete Boracic Acid.* By SMITHSON TENNANT, Esq. F.R.S. &c. Communicated by L. HORNER, Esq. Sec. of the Geological Society\*.

THE boracic acid is not found, like the greater number of substances, in almost every country; but, as far as our present

\* From the Transactions of the Geological Society, vol. i.

knowledge