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# MINES, SMELT MILLS AND WORKS: DESCRIPTIONS BY AN EDWARDIAN TRAVELLER

by Peter C.D. Brears

Research into the history and development of the mining industry in this country depends heavily on the use of archival sources coupled with accurate surveying techniques. The purpose of this paper is to present a comparatively unusual, but still highly relevant body of information which takes the form of a series of eye-witness accounts of a number of mining and extractive enterprises working in 1907-8.

During these years, Mr. W.A. Atkinson of Leeds set out on a number of 'geological rambles', cycling into the Yorkshire Dales or taking trains into Furness in order to visit a variety of mines, smelt mills and a lead-works. On returning home, he carefully recorded his experiences in a flowing copperplate script on foolscap sheets which now form MS 745 in the archives of the Yorkshire Archaeological Society.

One of the great qualities of Mr. Atkinson's writing is his freshness and innocence of prior knowledge of his subject. No detail is too small to be recorded, ranging from surprise when the water-level in an adit reaches the laces of his cycling shoes, to perceptive observations on the health of the workmen or their techniques of working.

As a result of his careful descriptions of three sites in the lower Dales, it is possible to follow each stage of the manufacture of lead products. Starting at the Valley Scar mines between Ramsgill and Lofthouse in upper Nidderdale, he describes his tour of the workings guided by the smith 'a crochety old fellow (who) improved wonderfully on acquaintance' and who even provided him with a set of overalls. Here he noted the techniques of mining and ventilation, the rates and methods of payment, and the initial sorting and washing of the ore.

The extraction of the lead is then detailed in an account of the Heathfield Smelt Mills, (a brief description and photograph of this site being published in R.T. Clough's 'Lead Smelting Mills of the Yorkshire Dales' p.70 and 73) which enables the whole operation of this mill to be accurately reconstructed.

Finally, he describes the production of lead sheet and lead pipe at the Craven Lead Works, the buildings of which still survive virtually intact at the side of the Leeds and Liverpool Canal near the centre of Skipton. Although his sketch-plans fall far short of the quality of today's carefully-measured drawings, they are invaluable in recording the techniques and operation of the works in the Edwardian period, when local lead was still being processed, although the bulk was now being imported from Australia.

In a further 'ramble' Mr. Atkinson visited the iron mines of Lindale and Dalton in Furness, but here his account is restricted to a survey of the surface plant of a number of mines, no underground excursions being made.

In the following pages, the original manuscript notes and sketch plans have been reproduced in full to present a uniquely personal view of these metalliferous mines and works in 1907-8. I would like to express my most grateful thanks to the Yorkshire Archaeological Society for permission to reproduce these papers from their manuscript collections, and the staff of both the Society and the West Yorkshire County Archives Department for their usual combination of service and efficiency. Sincere thanks are also due to Mrs. I. Rhodes, both for her assistance in transcription, and for typing the paper.

## VALLEY SCAR LEAD MINES ON MIDDLESMOOR

On Tuesday last, Sept. 17th, I cycled to Pateley Bridge, in order to re-visit the Heathfield Smelt Mills, but, as on my first visit, I found the works idle, and in charge of the workman, Marshall.

I had intended to ask this man to accompany me to the Valley Scar Lead Mines, near Middlesmoor or Lofthouse, and I thought that, if I stayed overnight this plan could be carried out on the following day. But, after a brief consultation with the man, I came to the conclusion that I could pay my visit alone that same afternoon, and perhaps reach home before nightfall. Directed by Marshall, I returned to Pateley for my bicycle, and set off at once.

The run proved a pleasant one, the road being less hilly than that between Knaresboro' and Pateley, much of it lay close by the side of the lowest portion of Bradford's Waterworks, the Goulthwaite Reservoir, with the new railway line of the Bradford Corporation in view all the way. I passed through Ramsgill, and then began to look out [5] for the wooden bridge on the left, which I had been told led to the Mine. Before long I came upon it, and crossing over it, I followed a short dusty road leading to a small group of buildings on the first rise of the slope leading, I presume, to the moors.

When I reached the buildings, I found them to consist of a shed in which the lead ores are washed, a smith's and joiner's shops, and perhaps a stable and tool-house. Besides these there were one or two walled tanks for ore-washing, and low staithe from which to load the carts. The general plan of the structures was somewhat like this, but I am by no means sure of every detail:-

One or two sturdy young fellows gathered near the pits seemed rather amused when I asked if I might look inside the mine. Mr. Peacock, the foreman, for whom I had been told to inquire, had gone home, and the men seemed to think that was conclusive against my going into the mine. Besides, my clothes were quite unsuitable but when I mentioned Mr. Boord's name, and showed them my permission to visit the Smelt Mills, their manner changed at once. They became anxious to help me. One of them said they would find me some overalls, which the inspectors used, and the smith would take me in.

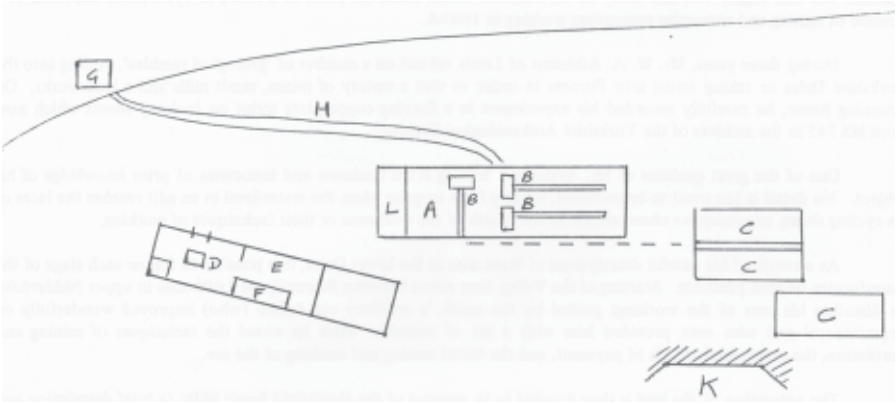



Fig.1 A Shed. BBB "Sieves" or jigging machines. CCC washing tanks or "slime" pits. D Smithy. E Joiner's shop. F Office. G Entrance to mine. H Rails – course rather doubtful. K Staith. L Raised platform in shed.

The smith seemed rather a crochety old fellow at first, but he improved wonderfully upon acquaintance. I donned the overalls in the joiner's shop. They were a pair of trousers, which I tied round my waist with a stout cord, a jacket, and a shooting-cap, the latter of which the smith warmed over his forge fire, to prevent my catching cold, I suppose. Unfortunately I could not get a pair of stouter shoes or clogs, and I had to make use of my cycling shoes. The smith took a couple of candles and a wooden lantern. The latter was half of a wooden cylinder with the ends closed. In the lower end there was a hole about the size of a sixpence, and on the top there was a simple loop of leather which served as a handle.

The entrance to the mine is an adit, running in somewhat obliquely to the hillside, and nearly horizontally. A pair of rails, about 18 or 20 inches wide, occupied the centre portion of the track, leaving about a foot at each side. A stream of water, an inch or perhaps two inches deep, flowed out of the adit, and as the tops of the rails were for the most part above the water, I copied the trick of the smith, and walked with my feet straddling on the rails. At times, however, the water covered the rails, and if by chance we missed them with our feet we found the mud and water reaching well up the laces of our shoes and boots.

After going a few yards along the adit, the smith found a little soft clay in the chinks of the rock, and taking a pinch of it, he thrust the head of my candle upwards through the bottom of the lantern, smeared the chink with the clay, and then, striking a match, he lighted both the candles, and gave me the one in the lantern.

We trudged on together along the passage for perhaps a quarter of an hour, chatting all the way. The passage was mostly hemmed in by hard rock upon each side and sometimes overhead. It was really a natural seam, which had been cleared of lead 'stuff as the miners had advanced, and here and there the cleft extended for

a good way upwards where the ‘stuff had been worth working in that direction. A good portion of the roof of the gallery was timbered, [6] however, by means of pit-props placed across the seam, which supported planks in the usual way. Sometimes too one or both sides of the gallery would be protected in the same way, more often one side, I think, than both. I imagine that the timbered roofs usually touched the roof of the gallery, but at other times they cut off, I think, the upper parts of a lofty excavation, and formed, perhaps “bye” workings. Wherever the gallery was made through shale of any thickness it was built of stone in the form of a tunnel. The gallery was rarely less than five feet high and never very low. The water dripped from the roof in most places in a steady shower but the adit led gently upwards and the water became less troublesome after we had advanced some distance into the mine.

After a considerable journey, we came to a doorway in the gallery, the door standing wide open. There was a small walled space between the head of the doorway and the top of the gallery, and through this a tin pipe, 4 or 5 inches in diameter, was passed and carried along the roof of the gallery beyond the door. I learned that this was a ventilation pipe working in conjunction with the door to form a circuit. On our return we held the candle to the end of this pipe and saw the flame was blown outwards, from which I concluded that the air entered by the main gallery, through the open door, and after performing its journey to the working faces, returned through the pipe. The smith pointed out many lengths of similar pipes breaking from the gallery in various places and ways, as we went along, and also some which had been discarded, the doubling back of the seams, etc., having rendered them unnecessary. The ventilation system must be elastic and responsive to suit the requirements of the works. One sees too, by inspection, how serious a matter it becomes to keep each door open or closed, according to the part which it plays in maintaining the circulation.

Here and there on our way we passed the ends of small wooden shoots projecting through the roof on one side of the gallery. Their lower ends were closed by sliding doors. The upper parts of the shoot opened, or had opened, at some working level, and the ore and ore-stuff were thrown into it. The trucks were loaded by withdrawing the sliding door, and allowing the ore and debris to fall directly into them. The trucks were drawn in and out by horses, but they were not working today.

At length we came to a vertical shaft on the left side of the line, or “trolley” shaft. It went up by the side of one of the shoots, I suppose the fact was that the timbered shaft had been divided by a brattice to form a shoot and ladder shaft. The latter was only about three feet square, as well as I could judge, and the ladders were placed vertically against the timbered sides. There were, I think, four lengths of them, and they sometimes changed from one side to the adjacent one on the right. At the head of each there was an exceedingly limited platform. The rungs of the ladders were made of iron and all of them were sound. At the tops of the ladders, strong square staples were driven into the timbers to afford a hold for the hands.

I followed the smith up these ladders without much difficulty, especially when he gave me the candle instead of the lantern. It was impossible to see anything but our immediate surroundings, otherwise I might have experienced some dizziness; but the incidents were too novel to permit me to imagine danger.

At the top of the shaft we found ourselves in another gallery somewhat like that which we had left. We trudged on as before, and I was utterly lost as to my direction. I had a compass upon me, but I had tied myself up in such a way that I could not reach it conveniently. This gallery was dry. After some time we passed a closed door on our left at a bend in the passage. It led, I think, to some old workings. Presently we caught the glimmer of a light, and soon I was at the working face of the rock. Two men were working at two places separated by a few yards, and they were excavating in directions at right-angles to each other. They were boring holes by means of rather slender jumpers in an ordinary sandstone rock, which is afterwards blasted with gelatine, and cleared away with pick and shovel. There was no trace of lead ore. The productive vein had been lost, and these men were simply prospecting for it. As I understood the smith, two veins had met each other at nearly right angles, and one of them had been thrown out of its direct course, possibly faulted. There were one or two thin streaks of ore stuff, which, if followed up, might prove productive.

Leaving these men after a few minutes, the smith and I turned back along the gallery, and after going a little distance, branched off to the right (as we were going, on our left as we entered the mine) and continued down it a little way. My guide was not quite able to locate the working place this time until we had called out and received an answer from above. Then, looking around, he found a small square upward shaft without a ladder, but having a bar or two placed across it and a few ledges at the sides. It was only a short shaft, however, and it was not bratticed. The smith called out to the workers not to throw anything down, and with his help I soon scrambled up.

At the top of the shaft we found ourselves in a short narrow gallery, at the blind end of which two young miners were at work, their candles stuck to the ledges of the rock by means of lumps of clay. The floor was littered with loose debris, mostly sandstone chippings, though there was also some dark coaly-looking stuff which was the lead ore. The seam of ore ran along the roof of the gallery, about two feet over our heads. It was from about 9 ins to about 2ft. wide, and looked rather like black lead, and not very unlike metal lead in a crystallised form.

[7]

This hole in the rocks was certainly warm, and I, having on two suits, and having done some rough climbing, was very hot; the air was not at all foul, or deficient in quality.

After a short chat with the men, one of them suggested that I should dig out a little ore and carry it away with me. I took up a pick and did so. I found the ore harder in its bed than I should have imagined from the appearance of it.

It had taken us about 30 minutes to reach the first workers, and I found myself chatting with these men at the seam forty minutes after we had started from the smithy.

We returned by the same route. I asked the smith if any shafts had been sunk downwards below the adit level. He said that they had, and he took me into a side gallery (above the adit level I believe) and showed me a square hole full of water, and protected by a ladder and poles laid across the shaft. This was the mouth of a downward shaft, which had not proved remunerative, and, being abandoned, was now filled with water. The gallery in the vicinity of it was the dirtiest and wettest part of the mine which I saw.

Continuing our journey, we descended the ladders leading to the 'valley' shaft. At the bottom I should have turned the opposite direction from that which the smith took, so completely was I bewildered. Ten or fifteen minutes walking brought us to the mouth of the gallery and the open air.

All the men in this mine, the smith included, came from Swaledale. The miners are paid by the fathom of rock excavated, the rates varying from perhaps 50s to £6 or more the fathom. The character of the rock makes a great difference to their earnings, and more may often be earned when the rate is low than when it is high. The men often voluntarily do a little extra work in the deserted bye-workings to add to their regular pay. They are paid, I believe, monthly.

After a short chat with the smith in his smithy, I left him, and went to inspect the shed and the ..... (?) In the shed I found two or three 'sieves' for washing the ore. They were similar to the one at Heathfield Smelt Mills in principle, but they were rather larger, I think, and they were certainly worked with more energy, if I may judge by the operations of the stalwart young fellow who, stripped to his shirt, jerked the lever of the sieve placed across the shed, opposite the door at the rear. I noticed that he knocked the tail of the lever against the beam under the eaves of the shed with considerable force. The sieve corresponds to the Cornish jigging machine for copper ores, described in he South Kensington Catalogue, Mach.II, No. 1129, but it is not so large. I should imagine it to be about 36 ins long 18 ins. wide and 15 ins. deep. The classifying and sorting of the contents of the sieve corresponds to the description in the Catalogue – the upper part is thrown away, the middle is piled up for further treatment, and the bottom layer is ready for the furnace. A boy attended to the sorting. He used a scraper of iron somewhat like a stave from the end of a barrel, which he loaded by drawing it towards him in the sieve.

There were three 'slime' pits outside, but I did not discover how they were worked. But in truth I did not thoroughly investigate this branch of the work as nothing but simple jigging was in progress.

There was, I think, a sort of stamping, or crushing machine in the shed, and I was told that all the ore and ore-stuff had to be crushed.

Some of the galleries have, I was told, worked out to the surface at or near How Stean.

Folio Note 21.
**HEATHFIELD (LEAD) SMELT MILLS, PATELEY BRIDGE.**

I cycled to Pateley yesterday, and paid a visit to these works, which are owned by Mr. T.E. Yorke of Bewerley Hall. I had previously obtained permission to do this from the agent, Mr. W.B. Boord

The work goes on intermittently, and I found, unfortunately, that today was one of the idle periods, chiefly, as I was told, because the men are occupied with hay-making. I found the mill in charge of one labourer, a Wm. Moor Marshall of Greenhow Hill, who was engaged in washing some of the broken slag which had come from the furnaces. On seeing my card of introduction, he unlocked the doors, and took me over the mill, doing his best to make all as clear to me as he could. There were many puzzling points in his account, and the impression which it left was vague but large. It did not quite correspond with anything which I had read, but this was, I think, due to a slight confusion of alternative operations, varying with the nature of the ore to be smelted. I found it impossible to separate any typical [8] operation, though I got a good general idea of the whole of the work. Of course all the colour of fire and the vigour of motion were lacking.

The principal part of the mill is a long, straight range of stone buildings, built in 1855 near the bottom of the steep slope of a valley. The ground rises so quickly behind it, that there is a narrow alley at the back of the mill, across which the flues of the various furnaces are carried upon arches, and thence run up the hill buried in the ground, but having the crown of the flue level with the surface. On the higher ground there is a “condenser”, containing the waterwheel by which its fans &c are put in motion.

The main block is divided into three portions. The centre one which is, perhaps, the largest, is the smelting house. At one end of this is the blast-house, communicating by a door with the smelt-house. The other end of the block is divided into two or three cottages, which, beyond being under the same roof, have no connection with the work-rooms. The plan of the block would be something like this – see Fig.1.

The smelt house contains two reverberatory furnaces and three hearths, arranged in a row along the back wall of the building, through which their flues pass. I have attempted a general view of the room, looking from the blast-house end. It is a memory sketch, and the details are not to be relied upon at all; but it will probably suggest more than any amount or word-painting.

The reverberatory furnaces are very similar in general form and principle to puddling furnaces for iron. This kind of furnace, or cupola, and its use are described in Holland’s “Manufacturers in Metals” III, 55-58. Its chief peculiarity, as it seems to me, is that it has a central lateral door on both? sides, the labourer’s

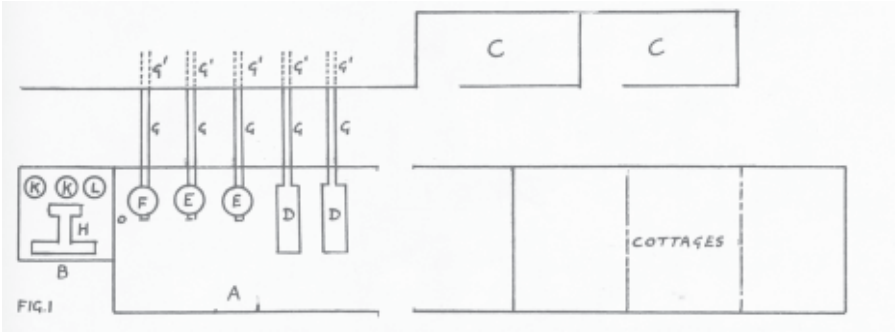
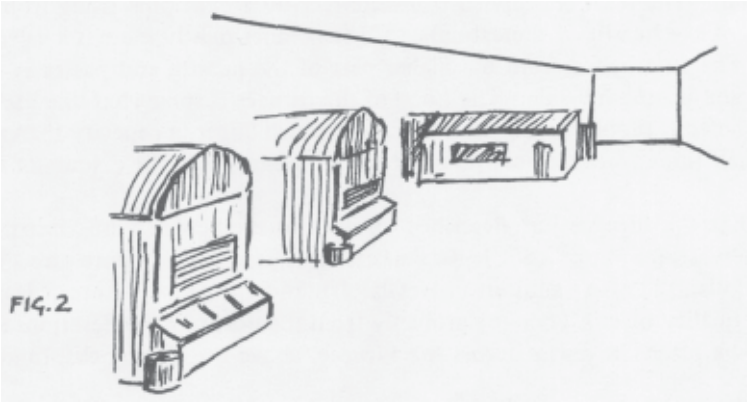



Fig.1

| | | | |
|---|---|---|---|
| A: | Smelt House. | GG: | Flues carried across the rear alley as arches. |
| B: | Blast House. | $G^1G^1$: | The same continued in the ground. |
| CC: | "Fume" deposit collecting houses. | H: | Water-wheel and Shaft. |
| DD: | Reverberatory furnaces. | KK: | Blast cylinders. |
| EE: | Smaller open furnaces. | L: | Air vessel (these three are a little displaced. |
| F: | Longer Furnace. | | |

Fig.2. General view of smelt-house showing two reverberatory furnaces and two open-hearth furnaces (from memory).




and the working. I did not notice any other openings on the sides, but there is a small one at the end under the flue. It is I think one which [9] may be opened or closed, and I was told that its use was to let the draught blow through. Under the working hole was a tank full of water. Its use I do not know, or whether, even, it is always full of water. The lead pan is placed above the end of this tank, just under the working hole. I saw nothing of a crown hole, the position being out of sight, and there was no feed hopper. I find nothing quite like it in the descriptions of reverberatory furnaces in the South Kensington Catalogues, though several of the points are found in the copper furnaces (I198 & 1199) described in Part II, p.73. Both of these have a hole under the flue, in one case for inspection, in the

other for working. There is a description of the use of the reverberatory furnace for smelting lead by Price in Mackenzie's "Record of the Exhib. 1862", p.175. It is evident that the details of practice vary considerably, and the process at Heathfield seems a little different from any of those given as types.

The hearths remind me of nothing so much as large smiths' forges. There are two kinds, the one nearest the blast-house being of a somewhat larger kind than the other two.


This is a representation from memory of the appearance of the smaller kind of hearth. It consists of a little square receptacle, now, when the hearth is not in use, full of cold lead. At the back of this receptacle is the back wall of the ... (diagram) ... "open-hearth for Lead Smelting (from memory) – see Fig.3.

..... hearth, through which there is a blast pipe, which issues a few inches above the top of the now solid lead, but does not project from the wall. In front of the receptacle or lead well there is a large iron plate, forming a hearth, level with the edge of the wall on the inner side, but falling away from it a little outwards. A rather shallow and small groove leads from the well to one corner of the hearth, by which the lead is conveyed to an iron pan at one corner of the furnace. The sides of the well are made higher by stout oblong blocks of iron, two of which are built up on each side. Each of these blocks is pierced with a longitudinal hole, probably to help to keep the blocks cool. These blocks are braced to the outer portion of the furnace by stout wrought iron bars or clamps, as I am told that the action of the furnace tends to draw them in. The blast is supplied from the rear by a bent pipe rising from the floor, and bending at right angles at the height of the hearth or thereabouts. If I remember rightly there is a valve, controlled by a wheel and spindle, at the angle. The flue opens from the higher part of the hearth, and passes at once to the outer wall, across the alley at the rear, and up the hill-side. The hood of the furnace is somewhat like that of a smith's forge, but I am not sure that I have depicted it properly. The iron pan is not much larger in capacity than an ordinary bucket, but it is probably an inch and a half thick. When empty its inner surface gleams with the colours of silver and gold.

It appears to me that the furnace just described answers to the Scotch "ore" hearth, described in the Sth. Kensington Catal. – Machinery II, p.63 no. 1165, 1. In that case it is used for very pure ores. The method of working is there described (cf. also Holland's "Manufacturers in Metals" III. 54-55 & 48). The ore at Heathfield is smelted with peat or turf and a very fine quality of coke, coming probably from the north. The operations are described in Cutting 91. – 7. A flat iron bar can be placed edgewise across the furnace, above the side blocks, to hold up a good charge of ore and fuel.

The third furnace is very similar as a furnace, but the arrangements for the delivery of metal and slag are more like those of a blast furnace. The metal runs into one compartment of a receptacle, and the slag into another; and there is yet a third compartment or separate receptacle into which, I believe, the last remains of metal at each operation flow. The blast of this furnace is single and similar in detail to that of the others, but the pipes are larger, and there is a double consumption of air. This furnace is charged, I think, at the side some distance up the shaft; and, if I remember rightly, with the slag or refuse of the reverberatory furnaces or hearths. I imagine that this is really the Scotch "slag" hearth of the S. Kensington Catal. II. p.63, no.1165, 2. (cf. Holland Ill, 54-55, & Price in Mackenzie's "Record of Exhib" 1862, p.175b).

[10]

The molten lead is ladled out of the pots with long-handled ladles, and cast into cast-iron moulds, each of which runs upon wheels. At the bottom of the mould there is a name in raised letters, which is, of course, imprinted on the pig. Several names are used upon the pigs at Heathfield – such as "Heathfield Smelt Mills", "Appletreewick?", "Craven?". The pigs are also stamped "I.T." on the opposite face with the aid of a die and hammer.

From the smelt-house we passed into the blast-engine house by a door near the end hearth. The motive force of the blast-engine is water falling on a large wheel – a breast wheel, I believe. On entering this part of the building, we found ourselves in a narrow space between the wheel and the Cylinders or air-pumps of the blast engine. The wheel is a fairly large one, and carries a cog-wheel on its axle which drives a large spur wheel with a short axle, upon the opposite end of which there is a crank and a vertical connecting rod which drives the piston of one of the blast cylinders placed above. There is a cylinder upon each side of the axle of the water-wheel, and the connecting rods are attached to crossheads above the cylinders, and the blast-pipe is, I think, below them. Near the door there is another cylinder, which is I suppose an air-vessel for equalising the force of the blast. The plan is somewhat like this:- (see Fig. 4).

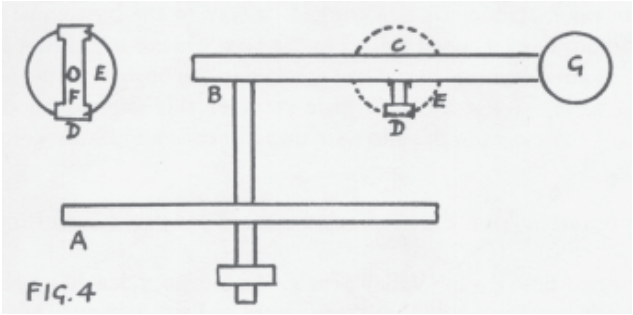


FIG. 4

A. Water wheel.
B. Pinion.
C. Spur-wheel.
D. Connecting rods.
E. Cylinders for blast.
F. Cross-head.
G. Air-cylinder or vessel.

The flues of the furnaces, after crossing the alley behind the smelt-house, are carried separately for some distance up the hill, after which they unite, and are continued as one flue for a distance of at least a mile and a half, if not two miles, further on to the moors – The top of the flue is level with the surface, I believe, throughout. From point to point there are places where it may be opened out by removing a few flags, but these are closed up with lime or cement to make air-tight joints. The object of this long flue is two-fold. The fumes from the lead mills are poisonous. They blight the vegetation upon which they fall, and they are deleterious to human beings. The flue removes them to a distance. Still more important, however, is the fact that a deposit condenses from the fumes, which, collected and treated as a lead ore, yields a profitable supply of excellent lead. From time to time, therefore, this long flue is washed out and raked out, and the slimy deposit is collected in two rooms behind the mill (C.C. of the plan) where it is allowed to drain and consolidate somewhat, after which it is transferred to the reverberatory furnaces (and thence to the hearths?) and smelted. The lead produced is of good quality, and soft enough to be easily marked by a thumb-nail.

According to this workman, this is the paying part of the business. The best deposit, he says, comes from the extreme end of the flue, and it would have paid to have made it twice as long.

I saw the deposit in the store-houses. It resembles a leaden or slate-coloured clay, of about the consistence of white lead. It lay, perhaps five feet deep, and had sunk a foot or more in drying. It is dug out like so much clay as required, and wheeled across the alley to the smelt-house.

The work of extracting this deposit from the fumes is aided by a “Condenser” situated in the line of the flue a little distance up the hill. The “condenser” in this instance is a rectangular wooden building, the inside of which I did not see. In all probability it is similar to the lead fume condenser described in the S. Kensington Catal. Machinery II, p.69, no. 1184, and also in the Report of Juries, 1851, p.8b.

Close to the actual condenser is another building of about the same size containing the water-wheel which supplies such power as is required for this work. The wheel is a very large one – 10 yards diameter, I should think – and substantially

larger than the blast wheel. It is an over-shot, and the water is conveyed over the wheel in a narrow wooden trench. The overflow is a vertical shoot opening from the trench on the near side of the wheel, that is to say, before the wheel is reached.

This wheel drives a pair of drums near the roof, by means, I think, of an inner ring of cogs. The drums drive a circular fan (or pair of fans) between the wheel-house and the condenser by means of belts. On the other side of the wheel there is a long wooden connecting-rod, which seems to give a reciprocating motion to a horizontal piston or rod [11] near the roof, working apparently in two little cylinders a trench conveyed a current of water quite through the building, I think, and on to the condenser (?). This was about all the mechanism which the building contained.

I did not succeed in solving the details of the work which this engine performs. The Wanlock (Duke of Buccleuch's) condenser had a very lofty chimney, which would probably aid in producing a powerful draught. Probably the fans at Heathfield have a similar function to perform. The gridiron slide is, I imagine, put in motion by the wooden connecting-rod and the horizontal piston. The wheel of the Wanlock condenser pumped up the water to the tank of the condenser (cf. S. Ken Cat.), but at Heathfield, I think, the water is conveyed to the tank along a trench near the roof of the wheel-house (cf. S. Kensing. Catal. & Reports of Juries, 1851). A reference to one or two subsidiary matters will complete this note. I found the workman at Heathfield washing the broken slag from the hearths, preparatory to its resmelting. A wooden lever, somewhat resembling a forked shadorf, was erected near a little pool or tank of water. To the forked end of the lever a square box or pan was attached, which, the lever being but little elevated, was almost covered with water. The box, I was told, had a coarse grate or sieve at the bottom. It was quite full of slag, broken rather smaller than peas, and the box and its contents were swished in the water by working the tail of the lever. As I understood, the description, the metalliferous slag worked its way to the bottom of the box and through it (?) while the lighter and non-metalliferous slag remained behind in the box, whence it was scooped out from time to time by means of a flat piece of iron. A good layer of heavy slag was laid in the bottom of the box, and this, rather than the grate, constituted the effective sieve. I was shown a little stack of this slag, which the workman estimated would yield about three pigs. Some of the pieces in the pile were quite flexible and leaden-coloured, nearly pure lead in fact.

The peat used in part for smelting is obtained from the moors and stacked for use. (cf. Cutting 91. 6 : 7).

The nearest mines for the ore at the present time are the Valley Scar at Middlesmoor, leased by Mr. Craddock. He had been at Heathfield a little before I arrived, and I was told that there would be little difficulty in getting a look into the mines. There is a shortness of ore just now, as the veins are not very productive. There is, in fact, no ore at Heathfield at present, and it is not known when new supplies will arrive. Lead-mining is a highly speculative business, the veins being

erratic, and the ore sometimes good and sometimes poor. I was told that even yet there are individual prospectors who work here and there in search of veins. None of these make a living out of this pursuit alone, but all have some other occupation, usually farming. They are permitted to make what they can of their luck, until they discover some really profitable vein, when the landlord charges a rent, or takes over the vein, or leases it to a company.

Lead-smelting on a large scale is carried on in shifts, one set of workmen following another continuously. Here, at Heathfield, one shift a day suffices, when the mill is working, and there appear to be considerable blanks. It is, however, a winter occupation as well as a summer one. It is unhealthy, chiefly on account of the fumes, I suppose, and continuous workers “do not last long”.

..... There follow notes on the chemistry of smelting.

Folio Note 53.
**THE CRAVEN LEAD WORKS**

Yesterday, Thurs. July 30th, I cycled to Ilkley, and going on to Skipton by train, paid a visit by arrangement to the Craven Lead Works, owned by Messrs Robert Fell & Sons.

A clerk took me over the works. We entered first a very long, large room on the ground floor, which was almost entirely occupied by the rolling-machine for rolling lead sheets.

A general plan of the rolling-mill and its machinery is given in Fig. 1. The rolling machine is a kind of table, perhaps 40 feet long and 10 feet wide. The top of the table is formed, however, of a number of wooden rollers (D) extending across the frame from side to side, and turning freely in sockets in the side frames. They are laid side by side a few inches apart from end to end of the machine, I believe. Near the centre of the machine, supported in massive standards on each side, are two large, smooth, steel rollers (E), arranged one above the other, the rim of the lower one level with the upper surfaces of the wooden rollers. Between the rolling machine and the remoter wall of the room, in the space marked A, is a powerful horizontal engine which drives these rollers round. It is provided with a link-motion, which is controlled by a lever and slide, like those of a locomotive, placed at B, so that the engine can be reversed, stopped, and started by a workman standing in that position.



The upper roller can slide vertically in its standards for a distance of 6 inches or more. It is raised or lowered by a stout vertical screw in the standard near B. At the top of the screw there is a large, horizontal cog-wheel, which is turned by a rather smaller but similar wheel by its side on the same axle as the latter, I think, but higher is a worm wheel (or bevel-wheel) turned by a horizontal worm (or bevel), which is put in motion by a cog-wheel geared with a chain by the side of

the machine to another cog-wheel which is turned with a winch-handle. As the roller slides up and down in its standards, it carries with it a pointer, working along a vertical brass scale set on the standard. This scale is divided into inches and eighths of an inch, and by its aid the workman turning the winch can adjust the separation of the rollers to any eighth from one to 6 inches, I believe.

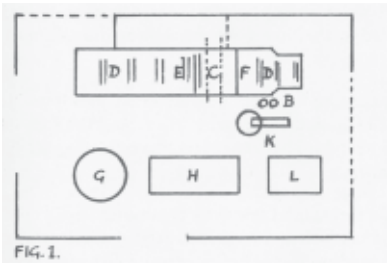


FIG. 1.

Fig.1 – Rolling Mill

| | |
|---|---|
| A | Rolling engine, controlled by levers (reversing &c). at B. |
| C | Donkey engine under machine. |
| DD | Rolling machine. |
| E | Rollers. |
| F | Guillotine. |
| G | Melting-pan. |
| H | Casting-box. |
| K | Crane. |
| L | Sheets. |

A few feet back from the steel rollers, and parallel to them, at the point F, a guillotine knife is set across the table. This slides in vertical standards, and is put in motion by a small engine under the table, in the space marked C. This engine has its length in a direction across the machine, and in addition to moving the guillotine, it performs some other useful operations. It is controlled by levers near B.

Where the table is shown to be contracted in width on the plan, a portion of an older rolling-machine has been joined on to increase the length.

The lead is melted in an open pan or vat, G, resembling a large brewing pan. It is placed near the outer wall of the building, and it is heated by a simple fire and flue below it. Any waste parings of lead are put into the pan, as they are produced. Before I came away, Mr. Fell told me that this pan contained 10 tons of lead, and that it was cleared once a day; and if there was a brisk demand, it would be started again in the day, though I am not sure that it would be cleared again, unless a night shift were set on.

The lead was first cast into square slabs, about 8 or 9 feet square, and 6 inches thick. I did not see this operation performed, but from what I saw of the apparatus, and of work in other departments, I was able to form a good idea of the way in which it was done. The slabs were cast in a square iron tank, H, having sides about 8 inches deep, placed on the floor of the workshop near the bottom of the pan. Three or four of the sheets, separated by wooden bars, I think, were laid upon each other at L. They were each 5 or 6 inches deep, and rather metallic grey black, like iron hammer-scale.

The lead would be run into H along a moveable iron trench. Lead melts at a comparatively low temperature, so that there is no need for clay linings to the trenches or clay plugs for the pans. In the other rooms the pans were furnished with taps and wheels (of iron) just as a water-vat might be; and I presume the same construction was adopted here.

The chief peculiarity of the iron tank was that there was a little door in the middle of each side, as shown in Fig. 2.

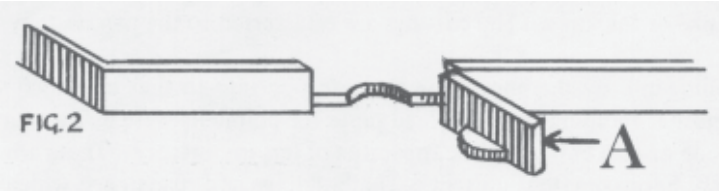



Fig. 2. – Door, A, in the side of lead-casting tank.

At the bottom of the inner side of this door there was a horizontal, semi-circular lug, as thick as the bottom plate of the tank, and this lug fit into a corresponding recess in the bottom of the tank when the door was closed. The doors being closed, the tank received its charge of lead. When the slab was set, while still hot and comparatively soft, the doors were drawn back on their hinges. and the slabs were raised by the crane at K. The recesses in the bottom of [13] the tank allowed the hooks on the crane to be inserted under the slab at four points, one in the middle of each side, but the slab was supported upon iron rods placed under it and supported by the chains, the metal being too soft in its hot state to be lifted by the hooks alone.

I did not see a slab lifted from the pile on to the rolling machine, and do not know definitely how it was done. But I suppose it was lifted by the crane, in the ordinary way, and laid upon the rear end of the table. The rolls would then be opened to their widest extent and the slab would be passed to and fro between them, the rolls being set a little closer every time, until it was gradually reduced to the required thickness.

When I entered the shop, the machine was just finishing off a sheet, and I saw work commenced upon another, which was lying on the rear of the table. It was, however, only about an inch in thickness to begin with. It was drawn forward to the centre of the machine by ropes which were passed round sheaves or hollow, capstan-like reels, standing out horizontally from the machine, and put in motion by the donkey-engine under the machine.

Then it was passed and repassed through the rolls, being reduced in thickness, perhaps from 1/16 to 1/8 inch, each time, until it was one-eighth thick, though owing to the splay of the edge it looked thicker. As it passed out of the crushing rolls every journey, there must have been some steam-driven bearing rolls to bring it back to the main rolls every time, though I did not notice them. The sheet increased only in length, and the fore and rear edges rolled out to a wavy form. When the sheet was reduced to a thickness of 1/8 inch, it was doubled by the men in the middle, and trampled down flattish with their clogged feet. The folding edge was, I believe, drawn over by some portion of the machinery. The folded sheet was then rolled as a single one, until the two thicknesses were rolled to 1/

8 of an inch combined. Preparations were then made for cutting it. During one of the last turns there was a smart but harmless explosion, which I was told was caused by the escape of the air enclosed between the sheets. It usually occurred at the second passage of the folded sheet.

Preparatory to the cutting operation, the doubled sheet was run out to the rear of the machine. Circular cutters were then fixed at the sides a little in front of the rollers. They were turned, I think, by the friction of the sheet passing under them. Fig. 3 represents a side view of one of the cutters.

The rim, was, I think, flat, or practically so; but the edge indicated was sharp, as I found when I applied my finger to it.

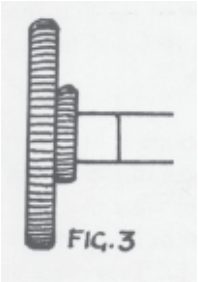



Fig. 3 – Lead-cutter (side view).

The cutters being fixed, the sheets were run forward through the rolls again, and under the cutters, and a thin strip of metal was pared off each side, leaving the edges quite straight. When the sheets had run so far forward as to bring the rear edges to the guillotine, the rolls were stopped, and the knife of the guillotine was brought down by the donkey-engine, and cut the rear edges straight. The rolls were then started again, and the sheets were run quite out to the front of the machine. The front edge was marked and cut off by hand, after which the sheets were drawn off the machine, rolled up like a carpet, and tied. The rolls were subsequently weighed, and I believe they are classified and sold by weight rather than by size or thickness. The cuttings are transferred to the pan, as they are made.

Passing out of the rolling-mill by the engine, on the side opposite to that by which we entered, we crossed a yard, and made our way to another building in which lead pipes for plumbers were being manufactured. We stayed in the yard, however, to notice one or two buildings and apparatus of less importance. These are indicated on the general Plan, Fig. 4. This plan is only approximately correct. The buildings and machinery which are marked upon it are actually in existence, and occupy something like the relative positions assigned to them. But the proportions are certainly faulty, and the surrounding spaces, which I had no occasion to study, are probably very much exaggerated and wrongly delineated.

A Ore jigger.
B Ore crusher.
C Pipe-house, with raised floor or open upper storey CC.
DDD Lead pans.
EEE Pipe presses.
F Tin lined pipe box.
G Engine.
H Wash-bowl.

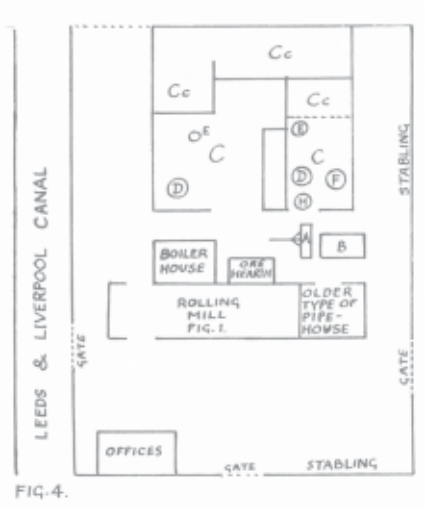



Fig. 4 – Approx. General Plan of Works.

Delaying the description of the works in the yard, I will pass on to the building in which the pipes were made, as this is the operation of the most interest, and perhaps also of the most importance. It was a large square room, having its back portion raised some 7 to 10 feet, in order to form a kind of upper floor to which there was access by a flight or two of wooden stairs. The fore portion on the ground level was divided in two by a wall, which extended as far, I think, as the raised floor, but no further. We entered the division to the left, and found an arrangement of apparatus somewhat like this – Fig.5.

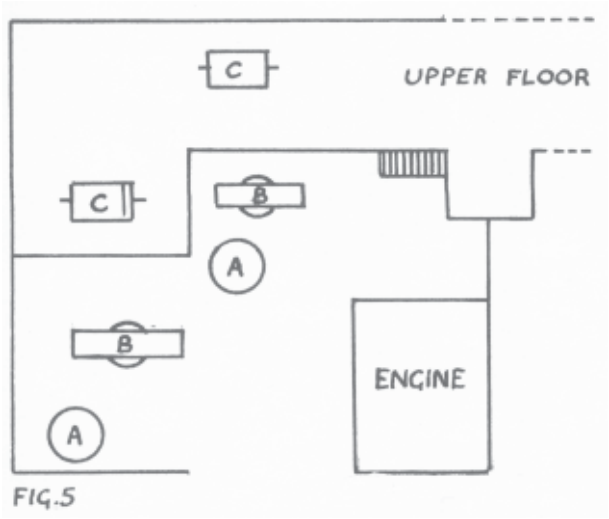



Fig.5 - Part of Pipe-house.
AA Pans.
BB Presses.
CC Reels.
D Steps.

A vat of melted lead, similar to that in the rolling mill but smaller, occupied the left corner of the building near the entrance. Within two or three feet of the vat was one of the presses, consisting of a vertical cylinder, perhaps rather more than 2 feet tall, and about 5 ins. in internal diameter, and of a plunger descending into it from a sort of stout and bulky cross head above. As the plunger descended, the bright lead pipe issued from the top of the press, which reached to the height of the upper floor, and this pipe was rolled on a suitable reel (C) by a workman on the upper floor.

When the plunger of the machine had descended to its full extent, and the supply of lead in the cylinder was exhausted, the plunger was raised again. The pressure had been so great that a film of lead had been deposited upon the circumference of the plunger and came up with it. The withdrawal of the plunger revealed a vertical steel rod standing up in the centre of the cylinder, and passing through a hole in the centre of the plunger. It was easy to see how the tube was made. The upright rod, the core as it is technically called, formed the open centre of the pipe, which was made by the lead being forced through the space between the core and the hole in the plunger, which determined the external dimensions of the pipe. As a matter of fact the hollow plunger is closed with a perforated disk or die as it is technically called.

[15]

In various parts of the works near the presses of one kind or another, I saw a great number of detached dies, having various sized holes, to form pipes of different dimensions externally, and also a number of detached cores of varying diameter, to form pipes of different dimensions internally.

When the plunger of the press was fully raised, a workman re-adjusted the core exactly in the centre of the cylinder, by measuring its distance from the sides of the cylinder with a pair of callipers, and tapping it gently towards the true centre. It appears that the core, fixed only in the bottom of the cylinder, cannot sustain the great pressure to which it is subjected without being sometimes thrust a little out of truth, so that it has to be adjusted in this way.

Having centred the core to his satisfaction, the workman placed a short iron trench from the bottom of the lead pan to the top of the empty cylinder. By turning a lever above the pan, the workman opened a tap, or other outlet, and the lead flowed to the cylinder in a beautiful silver stream. The lead was allowed to fill the cylinder within an inch or an inch and a half of the top. A film formed on the surface, by oxidisation I suppose, and this the workman was careful to skim off with a spoon, I think, until the clear undimmed metal was laid bare. All this time the lead was cooling or setting a little, which is essential to the working of the press, and I noticed that the process of oxidation ceased to be rapid as the metal cooled a little. At last, when the lead had stood in all three or four minutes, the press was set to work, the plunger descended, and a new pipe began to issue from the top. The lead appears to have been rather fluid at first, since the first two feet of pipe which issued from the press bent over a little with its own weight.

As soon as a few feet of pipe projected from the press, a workman seized the end of it, protecting his hands with a cloth, and hooked it by its bend under a pin on the end-plate of a horizontal reel somewhat resembling the portable reels upon which garden hose-pipes are wound. I have attempted a sketch of the reel in Fig.6. It is a memory sketch, of course, and I am not certain of all the details; but the general idea is correct. The pipe was coiled two or three turns deep on the central part of a horizontal cone, in which there were several longitudinal slits (E). There was a back-plate to the coil, and I think the whole was turned by handles arranged as on a steering wheel. When the coil was finished, it was tied up with hempen cord, before it was removed from the reel. It was tied round at the points where it crossed the slits, the ends of the latter projecting sufficiently on both sides of the coil to permit the cord to be passed through them and under the coils. When tied the coils were easily drawn off the small end of the cone. It follows from this that the small end of the cone must have been unobstructed by any sort of bearings or handles.

Tin-lined pipes are also made at these works, and I was shown several short sections of these pipes in which the two metals were clearly distinguishable, the tin as a bright silvery-looking ring within the duller and thicker lead. As a rule the two layers of metal were quite concentric, but in one or two instances the core had deviated a little from the central position, and the lining of tin was considerably thinner on one side than the other.

I did not quite succeed in clearly understanding how these tin-lined pipes were made; but I think it was accomplished by first casting a length of pipe in a box, similar to that described in Holland; “Manufactures in Metals: III, pp.68-69, and afterwards in some way forcing it through the ordinary press to extend it. There was certainly a box of this kind in the other half of the pipe-shop (F, Fig.4), and I was told that it was used for this purpose along with the press near it. I saw, however, no rolls or drawing-bench, such as are mentioned by Holland (III 69). As I did not see any tin lined pipes actually made, and as I did not clearly understand the workman’s descriptions, it would be idle to speculate; further upon this matter.

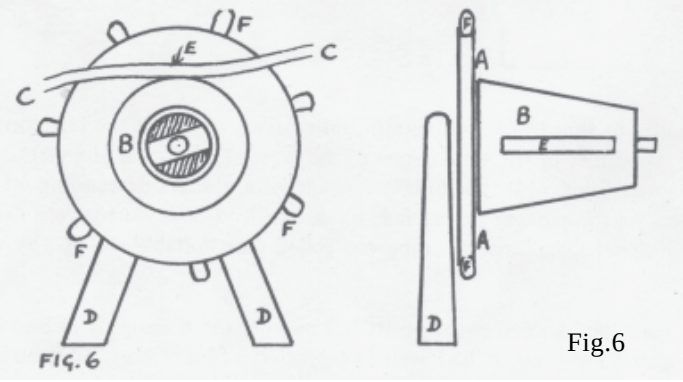



Fig.6

Near to the press in this part of the pipe-shop was a wash-basin conveniently fitted up (H. Fig. 4). It was evidently placed there for the workmen to wash their hands, whenever they thought it necessary, especially before eating. I questioned the clerk about the extent of illness due to lead-poisoning. He naturally made light of it, and told me of several men who had worked for some thirty years with them, and retired at a fairly good age, apparently none the worse. This evidence was probably not worth very much. Of course, as he remarked, if men were careless, and took no trouble to wash their hands before they ate, they paid the penalty, perhaps, in attacks of lead colic; for it [16] appears that this disease arises from lead taken into the alimentary canal. But notwithstanding the clerk's assurances, two or three of the men looked very unhealthy, one was ghastly white and haggard. One or two others had an unnatural pink hue, not rosy in patches, but a uniform hue, like a feverish child.

Across the yard, somewhere near the end of the rolling-mill, was an older pipehouse, not much used and containing, if I remember rightly, a press or two of a somewhat older kind. Here I saw many dies – thickish cakes of steel having a hole through the centre.

In the yard were an ore-crusher (Fig. 4, B) and a jigger (A), the latter like that which I saw at Heathfield (F.N. 21 – - 13). There was also an ore-hearth such as those at Heathfield, which is occasionally used, perhaps not oftener than once a year. In this instance there was a central gutter or channel down the iron fore-hearth, along which the metal flowed, while the slaggy metal was raked out of the fire (cf. F.N. 21 pp 5-7). Sth. Kensing. Mach. Catal. II p.63, No.1165 1).

Numbers of pigs of lead were stacked in the yard at various places. Much of this lead came from Australia.

Folio Note 29
**IRON MINES NEAR LINDALE AND DALTON IN FURNESS**

On Friday, Sept. 6th, I took train from Cark to Lindale and set upon a geological ramble. Leaving Lindale station, I passed through part of the town on my way to Martin.

Near the outskirts of Lindale I turned aside to the left, attracted by the sight of the headgear of two pit-heads. They are not marked, I think, on the Geological Map (1 inch), and I do not know their names. 1 had no difficulty in reaching the pit-heads.

I visited the smaller place first, and found it a shaft mainly devoted to pumping. 'There was an engine-house for a pumping engine and the boilers were by the side of it. I saw no men about, but there were some inside the boilers knocking off scale, as I could tell by the sound of the hammers. A square well seemed bratticed off from the pumping shaft, and there was a ladder down it. There was also space, apparently, for a single cage to descend, which was worked by a

capstan turned by hand. The whole shaft was carefully fenced off. Above it was a tall derrick of four legs, I think, which carried the pulley over which the cage rope passed. A wooden trough about two feet wide, raised two or three feet from the ground, carried the water away to the distance of a dozen yards, perhaps. Its sides were tinged with red, the colour of the menatite ore.

The plan of all the structures about the shaft was something like this – (Fig.1).

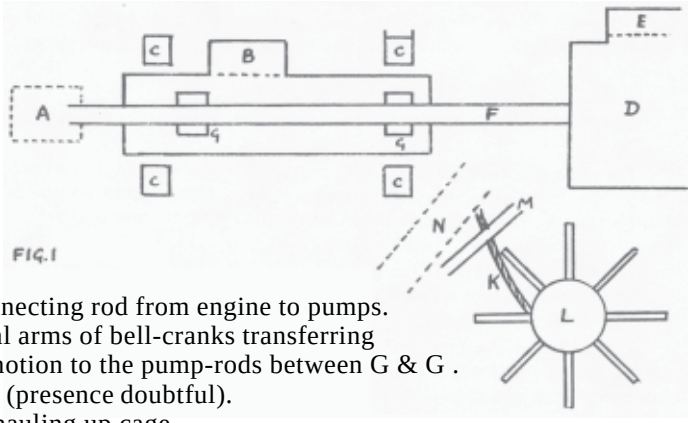


FIG.1

Fig. 1
A Pump-shaft.
B Cage-shaft.
C Derrick Legs
D Engine House.
E Boilers
F Horizontal connecting rod from engine to pumps.
G Ends of vertical arms of bell-cranks transferring motion to the pump-rods between G & G .
H Counterweight (presence doubtful).
K Wire rope for hauling up cage.
L Capstan
M Foot-plank over rope-track.
N Trough. [17]

The preceding sketch represents, as far as my memory will recall it, what the appearance of the pit-head was like. It is only a memory sketch, and probably few of the details are exactly correct, but the general impression is more realistic than a long description.

The pumping engine communicated motion to the pump-rods by means of a long, horizontal connecting rod (a stout beam of wood), which is connected to the upper and vertical arms of elbow or crank levers. The horizontal arms of these levers are connected to the tops of their corresponding pump-rods. The result is that when the horizontal connecting-rod is moved to and fro by the engine, the pump-rods are moved up and down. By turning the two horizontal arms towards each other, they are made to rise and fall in opposition to each other, one being raised when the other is depressed, and vice versa, thus – (Fig. 2).

By this means they are made to counter-balance each other. Assuming that the two pump-rods and their connections in the shaft are equal weight, then the falling rod relieves the weight of the rising one, and all the engine has to do is to overcome the friction of the mechanism and to lift or force up the water contained in the pump-barrels and pipes. The horizontal connecting rod is continued a short way beyond the cranks and may have a counter-weight at the end. I thought at first

that this counterweight was adopted as a means of more exactly balancing the pump-rods; but this it hardly can do. It may however, balance the horizontal connecting rod between the engine and the pumps, and may thus contribute to the smooth and regular working of all parts. The connecting and pump-rods are of wood.

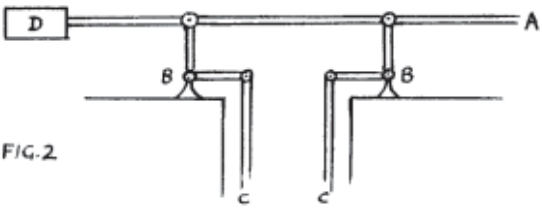


FIG. 2

Fig. 2

| | |
|---|---|
| A | Connecting rod. |
| BB | Reversed crank levers. |
| CC | Pump Rods. |
| D | Counter-weight. |

The cage is raised and lowered by means of a wire rope passing over the wheel at the top of the head-gear. The hauling end of the rope is carried downwards, and passed under a wheel or sheaf at ground level or below it, whence it is carried to the capstan along a ditch or trench, and connected to a drum on the lower end of the capstan. These are all the details which need comment.

From this pit-head, I passed to the other which was a much more important place, and resembled in fact the pit-head of a coal mine. There were two engine-houses, one near the shaft and the other further away behind it. The former contained the pumping engine, and the rods of the pumps were close to the end of it between the building and the shaft. The other house contained the winding engine, as I knew by the dip in the ropes. The mouth of the shaft was very much encumbered with wooden sheds, and seemed rather a sort of well in an outhouse rather than the entrance to a pit.

The regular work of the mine had been suspended for some necessary repairs.

The engineman took me to see both engines. The pumping engine was not a large one, and was placed quite near the pumps. From a window recess in front of it the engineman could see most of the connections outside. It was, if I remember rightly, a vertical engine and seemed in good order and neatness.

The winding engine was a horizontal one. The sketch below will convey a better idea of the general arrangement of the engine than any description though the sketch is only made from memory.

The valve lever was a horizontal one, fixed on the top of a pedestal. Near to it was the lever of the brake just rising above the floor, and within convenient reach of the engineman's foot. Beyond this was the reversing lever of the ordinary type, sliding in a sector. All were in convenient reach. Upon the wall near them was an iron tube extending along the room and out through the end of it to the pit-head. It served as a speaking-tube.

In front of the engineman, as he stood near his levers, was a black iron plate or dial with a single hand or pointer. The dial was, perhaps, about 2 feet in diameter. A circle was marked upon it in chalk and four points, if not more, were marked upon it in chalk; these were, I think, to indicate something of this sort "upper rope, top"; "upper rope, bottom"; "lower rope, top"; "lower rope, bottom"; but the marks did not in any case seem to tally. I noticed that there was a segment of the circle not marked, and I discovered that this space was left for future extensions of the [18] shaft. For the same reason the marks were made in chalk, so that they might be rubbed out and replaced by others, as the deepending of the shaft required a longer course for the moving pointer.

I was told that it was the practice at this pit for the man in charge of the pit-head to ring a bell when he saw the ascending cage, or when it reached the mouth of the shaft. The account seems rather incredible, but it seems at least certain that the engine did not automatically ring a bell at a certain interval before the cage reached the top or bottom of the shaft. In exceptional circumstances when any explanation or instructions were requisite, the speaking tube, which communicated with the pit-tank and engine-room, was brought into use.

Outside the engine room I saw a pile of cores which had been obtained from a bore-hole. They were all of limestone, and about 4 or 5 inches diameter. Specimens of other strata may probably have been carried away.

In the illustration of the engine-room I have, I think, placed the drums too far back from the, spectator. They were, I imagine, more nearly in line with the reversing lever, which was probably a little further back, by the side of the cylinder. The drums were, therefore, probably driven by gearing, and not placed on the main shaft. The shaft was 150 yards deep.

Leaving these two pit-heads, I returned to the road and continued my journey towards Martin. On all sides there were indications of mining activity and I had not gone far when I saw on the right of the road a small shaft worked by a horse-gin.

The general appearance of this pit-head is shown here. The actual shaft could not be seen for the superstructures. The ore was evidently drawn up in wheelbarrows to an elevated stage, and wheeled to a tip at the end. The whole arrangement was very simple and primitive.

About Martin the mines dis-appeared, and the rest of my walk to Treleth was through an agricultural and pastoral country. Near Treleth there are extensive ironworks on the coast.

Returning by the main road to Dalton-in-Furness, after a walk of nearly two miles, I again reached the outcrop of carboniferous limestone and saw iron mines on either hand. The work at one place was interesting in various ways.

In a huge hollow, perhaps 50 or 60 feet deep, which I was told was caused by the falling in of old workings, there was a little shaft furnished with a windlass put in motion by a couple of men. It was a sort of small trial shaft. Near it was a small cabin, by the door of which a group of tallow-candles was hanging. From the mouth of the shaft the ore was drawn up to the road level along a steep wooden incline, the motive power being supplied by a horse, running out on a level track alongside the road and at right-angles to the incline, the rope passing over suitable wheels or sheaves. I had an interesting chat with a young miner at this place. I gathered from him that the shaft was about 45 feet deep.

A few score yards away there was a deserted shaft. An old pumping engine lay, if I remember rightly, in the open air, left just in the position in which it had worked. It had stood idle some years. It was attached to the pumping rods by a horizontal beam, as I have described and sketched above. The shaft is about 60 feet deep.

I saw many other pits and works as I finished my walk to Dalton and thence to Ulverstone, but I remember nothing specially worth mentioning, except a miner returning from work with a candle stuck in his cap.

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