NOTES ON IRONSTONE MINING IN CLEVELAND.

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The story of the discovery of the main seam of the Cleveland ironstone by the late Mr. John Vaughan has frequently been told. It was on June 8, 1850, in company with the late Mr. John Marley, that he picked up the pieces of ironstone on Eston hillside which led their steps to a quarry-hole where the seam 16 ft. in thickness was exposed. The stone was, in the first instance, either quarried in the open, or worked by means of drifts, from the outcrop. From the date of its discovery, down to the present time, the conditions under which it has been worked have become much altered, for, as the seam is followed from the outcrop to the south, the stone becomes much harder, owing to its greater depth from the surface, and the use of drilling machinery of some kind becomes almost a necessary adjunct to its economical working.

Although Mr. John Vaughan was credited with the discovery of the main seam of ironstone, which led subsequently to the enormous development of the iron industry in Cleveland, there had been many previous indications that Cleveland was destined to become a large iron-producing district. Without going back to the time when Romans or monks worked ironstone in its valleys, as indicated by the heaps of slag which remain to prove that such an industry existed in ancient times, it may be interesting to refer to attempts which were made in the early part of the present century to bring the ore into use, and to prove that it had a commercial value. In 1811 the late Mr. W. W. Jackson, of Normanby Hall, sent some samples of ironstone from Upsal to be tested at the Lemington Iron Works on the Tyne, but the results were not reported to be satisfactory. In 1836 about 50 tons of ironstone were sent from Grosmont to Whitby, and thence by sea to the Birtley Iron Works, near Newcastle, but the results obtained were doubtful, and several succeeding experiments left the matter in such a position that in 1846, when Ord published his "History of Cleveland," he stated the ironstone to be of "little value, except as ballast, and scarcely of sufficient importance to encourage speculation."

There was another man deeply interested in the iron trade, and well known in the north of England, who had formed a shrewd idea that Cleveland's wealth of iron would one day be proved, although it did not fall to him to prove it. It is related of Mr. Charles Attwood that in the spring of 1830 he was riding from Thirsk, across the Hambledon Moors, when he noticed that the country roads were being mended with the same oolitic ironstone which he had previously found in the neighbourhood of Northampton, and he succeeded in tracing the stone to the quarry from which it was procured. He mentioned the matter to his brother-in-law, Mr. Matthews, a well-known Staffordshire ironmaster, and later in the same year proposed that he should accompany him to Thirsk, where they together visited the quarry where Mr. Attwood had found the stone. He pointed it out to Mr. Matthews, with this remark: "Rely upon it, it will be brought into connection with the Durham coalfields before long, and give rise to quite a new iron trade." About this time the first geological map of Yorkshire was published by William Smith, a relation of the late Professor Phillips, and guided by this, Mr. Attwood suggested an expedition with the object of tracing the ironstone from Scarborough to the Tees, indicating Eston Nab or Roseberry Topping as the points nearest to Middlesbrough where the main seam would be found. Mr. Attwood's attention was at this time diverted to the mineral wealth of Weardale, and it remained to Mr. John Vaughan to claim the credit of the discovery of the main seam of ironstone in Cleveland. In the spring of 1850 Mr. Vaughan paid a visit to Mr. Attwood at Tow Law, where the latter had erected blast furnaces to smelt the "rider ore" of Weardale. His object was to offer Mr. Attwood a supply of ironstone, which he said he could deliver to him at Tow Law for 6s. per ton, and in an ambiguous way stated that he had found it not far from Darlington. Mr. Attwood's previous knowledge at once led him to the conclusion that it was the Cleveland stone which had at last been discovered, and to Mr. Vaughan's surprise, he produced his geological map, and said, "I know the geology of Darlington very well; there is no stone to be found thereabouts. At one or other of these places (putting his fingers on the spots indicating Roseberry Topping and Eston Nab) you must find your ironstone." The locality was admitted; but as Mr. Vaughan asked that it should not be made known, he was assured that he need have no fear on that head, and was advised to "go on, as he had got hold of a good thing."

Messrs. Bolckow, Vaughan, and Co., and the Derwent Iron Company, were the first to obtain extensive leases of the Cleveland stone, which they worked in the first place entirely from the outcrop.

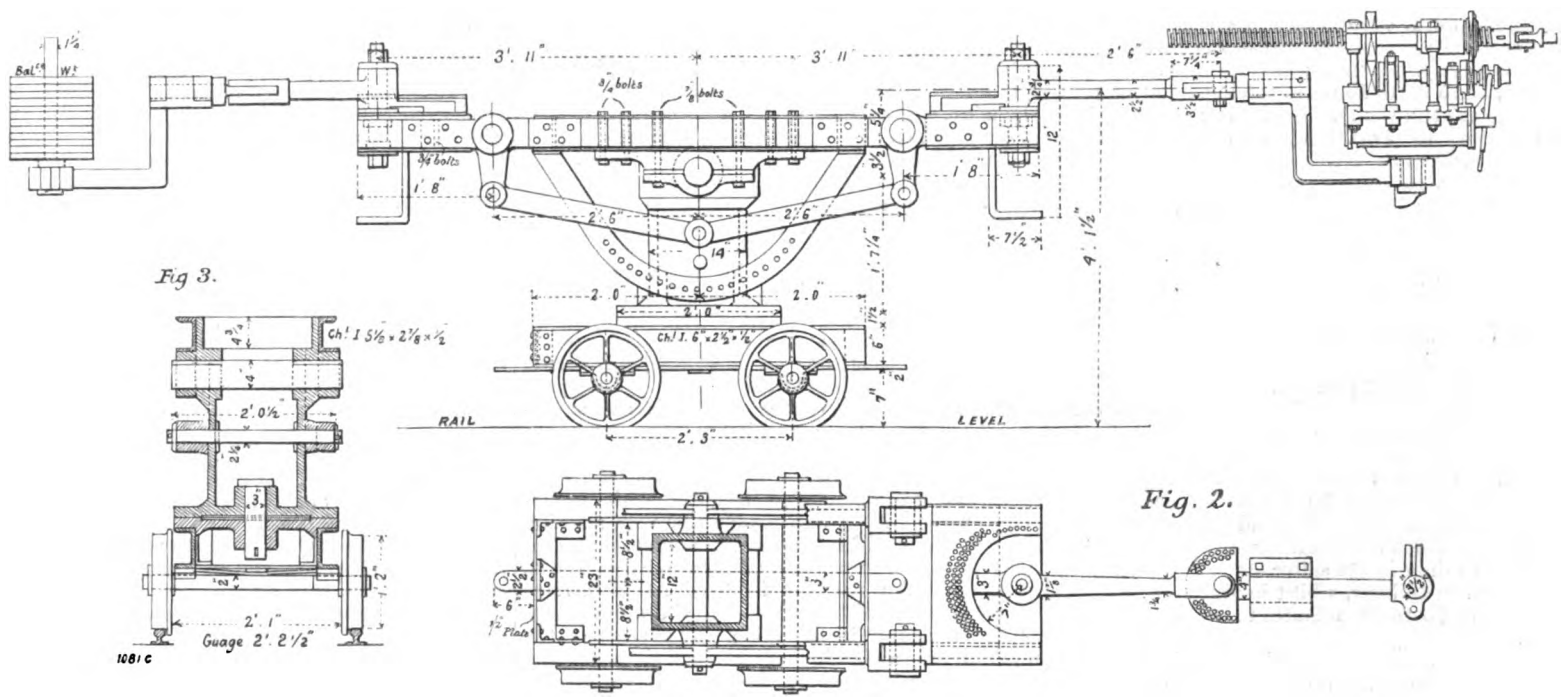

Fig 3.

Fig. 2.

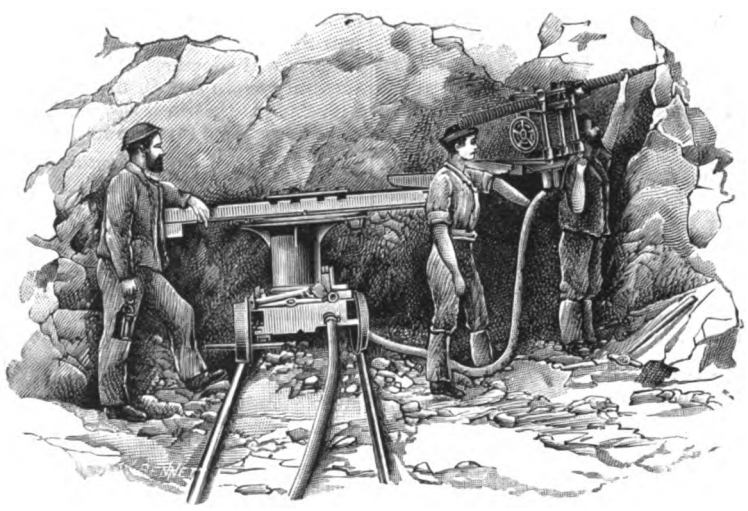

Fig. 4.

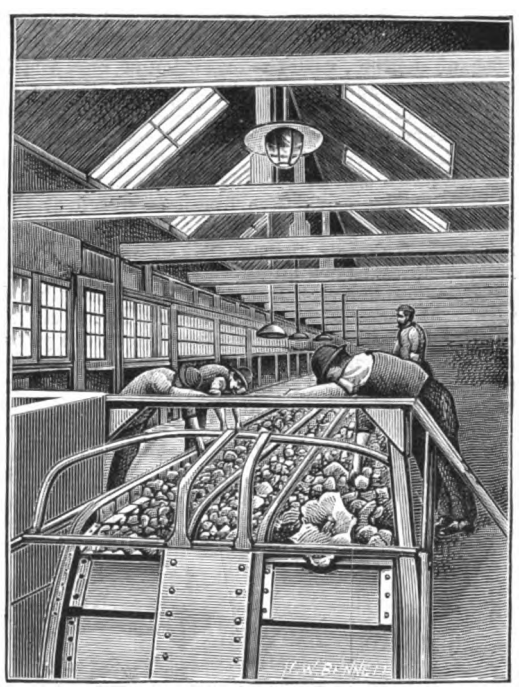

Fig. 5.

They were quickly followed by Mr. Attwood, who secured for the Weardale Iron and Coal Company a royalty of about 5000 acres, near to Guisborough, as he did not wish to be shut out from obtaining a foothold in the Cleveland district. It was not, however, until 1870, that under his direction two blast furnaces were built at Tudhoe, in the county of Durham, by the Weardale Company, for smelting the Cleveland stone.

So much for the earlier history of the mineral wealth of Cleveland. In the first place its working presented no great difficulty, but the further the ironstone lies from the outcrop on the Eston and Upleatham hillsides, the more does the stone deteriorate in the percentage of iron which it contains, and the more difficult and expensive does it become to work, owing first to its increased hardness or density, in consequence of the greater thickness of overlying strata ; and secondly, to a band of shale of 15 in. to 16 in. in thickness having been found to exist in the middle of the seam, which it is necessary to throw back, or separate in some other way, from the ironstone proper.

The increased hardness of the stone, and the band of shale, added so much to the cost of production, that in depressed times it was found impossible to work one or two important mines to a profit, and they were consequently closed.

In order to meet the additional cost of winning the stone, brought about by its increased hardness, considerable attention was given so long as twenty years ago to the question of mechanical drilling. It was seen that the skilled part of the labour required in working ironstone centred itself, and was comprised almost entirely, in the drilling of holes for blasting (the breaking up and loading of the stone being little more than ordinary labourer's work), and that relief must be sought in substituting drilling machinery of some kind for hand labour. The rate at which hand drilling can be carried on by a good miner in the softer stone is stated to be about 5 ft. in an hour, whilst in the hard stone it takes from 75 to 90 minutes to drill a hole 3½ ft. deep.

The hand auger was tried, and although not generally adopted, was found in some cases to be of assistance to the miner, and has continued to be used in one or more of the mines down to the present time. Other descriptions of drills were attempted to be used, but were laid aside in favour of hand drilling, with the exception of one, which was designed and patented by Mr. Wm. Walker, of Saltburn, and of which the results have been so satisfactory as to have led to the reopening of more than one mine which had been closed on account of the increased cost of working the stone.

This machine drill was first introduced at the Stanghow mines in 1875, and its working was subsequently tested by Messrs. Bell Brothers at their Normanby and Park mines.

Considerable improvements have been introduced into the machines by the patentee, Mr. Walker, since their first introduction about seventeen years ago, and in his evidence before the Royal Commission on Labour, Mr. Walker stated that they are now in use at seven of the mines in Cleveland. Six of these mines are in the Association of the Cleveland Mine-owners, and at three of these all the stone worked is won by the machines, and at the other mines it is won partly by hand. Besides others in other parts of the world, there are at present thirty-three Walker machines in use at the following mines in Cleveland, viz. :

	Machines.
At the Stanghow Mine	4
,, Liverton Mine	4
,, North Skelton Mine	6
,, Skelton Park Mine	4
,, Lingdale Mine	3
,, Grinkle Mine	4
,, Lofthouse Mine	7
,, Upleatham Mine	1
	33

In the first two of these mines all the stone is got by the machines, and until their introduction one mine had been standing idle for ten years, and the other for about seven years, owing to the hardness of the stone and band of shale which runs through it, representing from 17 to 18 per cent. of its thickness. Whilst the question of the employment of machine drills was before the Royal Commission on Labour, a good deal of the attention of the Commission was directed to the alleged displacement of labour through the use of the machines and other labour-saving appliances.

It may be taken that the quantity of stone which a skilled miner can work, where hand drills alone are employed, varies from 4 to 6 tons per shift, according to the conditions under which he is working, and the nature of the stone. The quantity of stone which can be worked by one machine may be stated at from 100 to 150 tons per shift, according to circumstances. Notwithstanding this it was contended before the Commissioners that there was no displacement of labour, owing to the fact that without the aid of the machines, certain mines would have remained closed, and a large number of men who have been employed would have had to have sought work elsewhere.

The motive power which is employed to drive these machines is compressed air, which of necessity requires an air-compressing engine to be placed near the top of the shaft. The compressed air is conducted down the pit shaft by a pipe and follows the main roadway to the several districts of the mine, into each of which it is conducted by a lesser main, and again to the face of the stone, where the machine is to be employed, by a 1½ in. iron pipe. The machine again is connected to this pipe by a short length of elastic tubing which enables the men in charge to place it in any position convenient for drilling the holes in the face.

In a machine drill, one of the principal objects to be obtained is obviously to secure an arrangement by which the drill can be directed towards any point, at any height, and at any required angle, which in the judgment of the man in charge, will secure the best results when the shot is fired. The speed at which the holes can be drilled is also an important element in economical working, and both these objects have been secured by the Walker drilling machine. Figs. 1 to 3, page 653, show the arrangement of one of these machines with its carriage, while Fig. 4 is a perspective view showing the manner in which it is used in a mine.

From the illustrations just mentioned it will be seen that the machine is fixed on a carriage which is mounted on wheels of the same gauge as the tramway in the mine. The arms of the machine are carried by a pillar, and the arms can be raised or lowered vertically. They can also be moved horizontally so as to obtain any angle or position which may be desired. A small double-cylinder engine is fixed on the arm, and by means of gearing driven from the crankshaft, the auger-shaped rotating drill is caused to revolve at a very great speed. The gearing by which the auger is driven is so arranged that it can be altered to suit either hard or soft stone. The drillings travel back in the auger as the hole is being made. By reversing the engine the drill is withdrawn, and it is usual to commence the hole by fixing a comparatively short drill in the machine, and to complete it to the full depth required by means of a longer drill, thus requiring two augers, short and long respectively, to obtain a hole of the requisite depth. It is found that it is most advantageous to put in a range of holes near the top and another near the bottom of the seam.

The working of the machines was described as follows by Mr. Walker in his evidence before the Labour Commission :

"In the employment of machines two skilled men are required to do the principal part of the work—the one to work the machine and the other to charge and fire the holes after the machines have drilled them ; both men are required to thoroughly understand the work ; the one who accompanies the machine from place to place does all the drilling and must possess the knowledge how and in what direction to make the holes ; the other has really the hardest and most dangerous part of the work to do, invariably charging and firing as many as sixty to eighty holes per shift. These two men are paid a fixed rate per ton, which usually includes the wages of a youth to assist the man at the machine to drill the holes, and the cost of the powder and squibs. About 55 to 65 lb. of powder are used by the shot-firer in one shift. The rest of the men engaged in connection with the machines are confined entirely to breaking the stone up after it is got and filling it into tubs. The youths who are employed as assistants to the drillers in the course of time acquire the necessary knowledge how to work the machines, and in what position to drill the holes ; and eventually take the place of a driller. But in no case does a person become proficient at the work until he has had two or three years' experience ; and even in the case of the drillers' assistants, these youths are drafted for that position from some other occupation in the mines in which they have obtained some knowledge of the work. When an assistant has assumed the position of a driller, the shot-firer for a time may have to assist him with his knowledge as to where the holes would be best put in ; but, as a rule, the driller is quite competent to perform his part of the work without assistance from his shot-firer. The best workmen are generally selected for the machine work."

During the last ten years between 6 million and 7 million tons of ironstone have been won by these machines, and in that time only three fatal accidents have occurred in connection with them. This is a much less percentage than that which obtains in working the stone by the ordinary hand drill.

At the Liverton and Stanghow mines a very useful and important application may be seen of the endless belt, upon which the stone is tipped as it comes from the mine, and the band of shale, to which reference has been made, is sorted from the good stone and carried by the belt to a wagon into which it falls, and, when the wagon is full, is taken to the spoil-heap. At the Liverton Mine the tubs, as they are drawn up, run automatically from the top of the shaft to a point where the contents are tipped on to the endless iron belt, there being placed on each side of the latter, men and boys, who, as it moves, separate the ironstone from the shale band and allow only the worthless material, which is destined for the spoil-heap, to travel forward. Although to an outsider it would be difficult to distinguish between the band and the good stone, to the initiated it is easy to make the selection. The ironstone is loaded into trucks from the side or end of the platform. An improved form of belt has been introduced by Mr. Walker at the Stanghow Mine, by which the whole of the material raised, band and stone alike, passes forward as the belt moves, the central part being divided from the rest in such a way that the boys stationed on each side can pick out the band, and by throwing it into the central division, it is tipped into a wagon independently of the ironstone proper. A sketch of the arrangement is given in Fig. 5, page 653.

Hitherto the Walker drilling machine has held its own against all competitors in the particular industry of mining in Cleveland. Whether it is destined to have a serious competitor in the shape of a drill driven by the electric motor or by a petroleum oil engine in place of compressed air, the future will decide. All that can be said with certainty as to the future of ironstone mining in Cleveland is that in it the machine drill in one form or another must form an important element.

(To be continued.)

THE PERIYAR IRRIGATION PROJECT.

By Mr. A. T. Mackenzie, A.M.I.C.E.

For many years large sums have been spent by the Indian Government on the collection and utilisation of water for irrigation purposes, and a vast amount of practical knowledge and experience has been amassed, so that enterprises of this nature are, no doubt, carried on better and on a larger scale at the present time in India than in any other country in the world. The Cauvery system, for instance, irrigates 900,000 acres, the Godavari 600,000, the Kistna 400,000, the Sone 350,000, the Western Jumna 300,000, the Bari Doab 500,000, the Sirhind 475,000, the Lower Sutlej 350,000, to mention only a few of the largest, and there cannot be less than 20,000,000 acres (at a very moderate computation) irrigated artificially throughout India by works carried out by the Government during the last forty or fifty years, works on which many lives and many millions have been expended. The principal motive for these large undertakings is, from the point of view of the administrators of India, protection from famine first and foremost, apart from the indirect benefit induced by increased food stocks and the improved condition of the cultivator ; but such is the economy of construction and the value of the water supplied, that most of the large irrigation systems return a sufficient (in some cases a magnificent) dividend on their cost besides paying for their own maintenance, and this though the interest of the cultivator is always the ruling factor—that is, the water is supplied to him at a rate which allows him a handsome profit. There is no compulsion on him to take it against his will, and the rate is wholly, or in part, remitted in bad seasons. In Madras, where results would seem to show that the construction and administration of