NORTH OF ENGLAND INSTITUTE OF MINING

AND MECHANICAL ENGINEERS.

TRANSACTIONS

VOL. XXXIX.

1889-90.

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CONTENTS OF VOL.XXXIX.

APPENDICES.

1

PROCEEDINGS.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

GENERAL MEETING,Saturday,October 12th,1889.

Mr.John Marley,President,in the Chair.

The Secretary read the minutes of the previous meeting,which were confirmed.

The Secretary reported the proceedings of the Council of this Institute,also of the first meeting of the Council of the New Federated Institution of Mining Engineers,embodying the election of representatives from this district as follows:—

Sir Lowthian Bell,Bart. ; and Messrs.W.Armstrong,Jun. ; M.Walton Brown ; W.Cochrane ; J.Daglish ; T.Douglas ; G.B.Forster ; G.C.Greenwell ; J.Marley ; G.May ; J.B.Simpson ; A.L.Steavenson ; J.Willis ; and L.Wood.

Among the members co-optated by the new Council were Messrs.W.Armstrong,Sen.; T.J.Bewick ; R.F.Boyd ; and D.Dale.

Mr.Cochrane asked the meaning of the word "co-optate,"and whether the "co-optated" members had a seat at the Council ? He confessed his ignorance as to the precise meaning of the term.

The President—One of our Past-Presidents has asked the same question. Perhaps the Secretary will explain.

Professor Lebour said he learned from Webster's dictionary that to "co-optate" meant to choose together,and when a committee had power to add to its members,then they "co-optated" or "together chose" such other members as they agreed to have on the committee. "Co-optated" members of any council were those not elected by the general body of constituents,but appointed by the council themselves. They "together chose."

Mr.Cochrane—Do they always sit ?

Professor Lebour—Yes.

Mr.Cochrane—They may do so by right ?

The President—Yes.

Professor Lebour—They become part of the whole body.

Mr.Cochrane—I presume "elected by the council" would have a similar meaning ?

Professor Lebour—Precisely.

The President The Secretary having been referred to Webster's dictionary by one of the Past-Presidents is able to answer the question.

The following gentlemen were elected,having been previously nominated:—

Ordinary Member—

Mr.Thomas Robert Maddison (Associate Member),Mining Engineer,Wakefield.

Associate Members---

Mr.Frederick Gosman,Mining Institute,Newcastle-on-Tyne.

Mr.John Hodgson,Mining Engineer,Edmondsley Colliery.

Mr.Edward Hopkins,Mining Engineer,Weardale Place,St.John's Chapel.

Mr.R.Norman Redmayne,Chemical Manufacturer,26,Grey Street,Newcastle-on-Tyne.

Mr.W.Topley,F.R.S.,F.G.S.,of H.M.Geological Survey,28,Jermyn Street,London,S.W.

Students—

Mr.Walter Bell,Mining Engineer,23,Windsor Crescent,Newcastle-on-Tyne.

Mr.Percy Octavius Weightman,Mining Student,Barrow Colliery,Barnsley.

Members—

Mr.T.Colquhoun,Mining Engineer,West Stanley Colliery.

Captain William Charles Chitty Erskine,Inspector of Mines.Kimberley,South Africa.

Mr.William Tasker Hallimond,Mining Engineer,Manager of Van Ryn Gold Mining Company,Limited,Boksburg,Johannesburg,Transvaal.

Mr.Jethro Longridge,Colliery Manager,Burradon Colliery,Newcastle-on-Tyne.

Mr.Thomas Lowden,Colliery Manager,Hamsteels,near Durham.

Associates—

Mr.William Draper,Assistant Under Manager,New Seaham Colliery,Sunderland.

Mr.John William Forster,Assistant (Certificated Manager,under Act),Silksworth Colliery,Sunderland.

Mr.John Charles Hall,Surveyor,Trimdon Grange Colliery,Co.Durham.

Mr.Francis Burdett Johnson,Mechanical Engineer,1,Charles Street,Marsden Colliery.

Mr.John Riddell,Under Manager,Shilbottle Colliery,Lesbury,R.S.O.

Mr.John Southern,Master Wasteman.Heworth Colliery,Newcastle-on-Tyne.

Mr.Matthew Walton,Assistant Manager,Dearham Colliery.

Mr.Simon Tate read the following paper:—

3

Winding,Banking out,and Screening plant.

WINDING,BANKING OUT,AND SCREENING PLANT AT EAST

HETTON COLLIERY.

By S.Tate.

It having been found necessary to fit up the upcast shaft at East Hetton Colliery for drawing coals and to erect new screening plant,the writer attached great importance to the plant being so constructed as to require the least possible amount of adult manual labour in its working. Banking out in particular is costly owing to the heavy character of the work,and none but the strongest men can perform it in the manner usually performed. To diminish the labour cost and to improve the condition of the merchantable coal were the objects which the writer had in view.

The shaft is 10 feet 6 inches in diameter,and 131 fathoms deep,and has been fitted with iron wire rope guides,the only peculiarity of which is the exceptional manner in which the weights are attached at the bottom. Owing to the small size of the shaft it was found inconvenient to have a separate set of "weights" on each rope,and instead of this a "swinging tree"was attached (see Plate I.) to each pair of ropes,and one set of weights was attached to it.

The advantage of this method is apparent as it allows sufficient shaft room in the centre of the shaft for persons to pass. This is especially useful when the weights are hung midway down the shaft,as it is then somewhat awkward to get past them. The only other remark that need be made concerning these guides is their proximity to each other at "meetings,"the intermediate distance being only 6 inches. It would have been preferable to have had them 10 or 12 inches apart,but in practice we have had no trouble with them.

At the shaft bottom the hanging on is fitted up on the same principle as is the No.3 shaft at Seaham Colliery,from which in fact it is copied (see Plate II.) at the hanging on,each cage road is made as near the size of the cage as possible,with a strong wooden frame carrying sliding doors. When the cage enters this is completely filled,and in its descent it strikes a spanner which is connected with a series of levers,etc.,which lifts up the sliding doors on each side of the casing and allows a clear road through the cage for changing the tubs,etc. By the use of these sliding doors the disadvantage of having separation doors on the engine planes or shaft sidings is avoided.

At the shaft top a strong circular walling of brick and stone is built up a sufficient height to support the pulleys,guide ropes,etc.,and to carry off the smoke and fumes ascending the pit.

The winding engine is an ordinary vertical single cylinder,40 inches diameter,of the lever type,and was formerly used with flat ropes.   The drum,etc.,has been altered and round ropes substituted.

Pit Head and Heapstead.

Plate III. shows the pit head,from which it will be seen that the tubs are moved by gravitation and by engine-power.

The whole of the power required for driving the cleaning belts,tub haulage belts,and the jigger screen is obtained from a single cylinder engine,14 inches diameter and 2 feet stroke,running 90 revolutions per minute,with an average boiler pressure of 35 lbs.per square inch.

Winding,Banking out,and Screening plant.

When the cage is at rest upon the keps the inclination of the tub way in the cage is 1 in 48,and as soon as they are struck by the empties entering the full tubs leave the cage and run on to the full roads,which here continue at the inclination of 1in 48.

They then pass singly (or in pairs as arranged at one colliery) into an improved self-righting patent kick-up,working automatically (see Plate IV.),and so constructed as to enable the emptied tub or corve to be propelled through by the next full tub following in to be emptied. The automatic action is obtained by applying to the bottom of the kick-up a vessel containing liquid,so that after the tub is emptied the weight of the liquid causes it to right itself. Attached to the tippler is a self-indicating weighing machine (see Plate V.),and as soon as the tub enters the tippler the weight is registered,and almost simultaneously the tippler turns over,empties the coals from the tub,and returns to its original position. The empty tub is then weighed,and by this means every tub is weighed both full and empty,and only actual coals passed into the screens are paid for. To enable the weighman to ascertain the hewer and putter of each tub of coals the tokens are hung through a hole in the ends of the tub,and as soon as the tub enters the tippler the attendant calls out the number of the token for both hewer and putter.

The empty tub remains in the tippler until the boy allows another full tub to follow in,which propels the empty one through and on to the line at the point A ; it then runs round the semi-circular line to the point B,where the rising gradient begins. An endless belt driven by the screen engine and having projections attached is here kept constantly running. The projections catch the tub axles and draw them up the gradient of 1 in 9 to a point C whence the tub runs down an incline of 1in 15. At this part the tubs pass over an india-rubber greaser,and then reach the point E when the token boy attends to the switches and sends the cage load of four empties into the proper sidings ready for the arrival of the cage at bank. (See Plate III.)

The whole of the banking out is done by four boys paid as follows:—

1 Boy at Cage Snecks	...	1s. 8d.	per day.
1 „ „ Tippler	... ...	2s. 0d.	,,
1 „ Shover in	... ...	1s. 6d.	„
1 „ Token Boy	...	1s. 0d.	„

Total cost	... ...	6s. 2d.	per day.

Under the old method four banksmen were employed and paid by the score (these men being allowed houses and coals),and their average wage (including value of houses and coals) was 5s. 3d. per day,besides which there was a man to take the tubs on to the weigh,and he was paid at the rate of 3s. 10d. per day,making the total cost £1 4s.10d. per day,being 18s.8d. per day,or 3.5 times nearly more cost than the cost on the new method.

The total amount of cost and saving per ton for one year,gained by the adoption of the new system of banking out,is as follows:—

	Days Worked per Year.	Tons Drawn Annually.	No of Men or Boys.	Wages per Day.	Total Wage Cost per Year.	Cost per Ton.
				£ s. d.	£ s. d.	d.
Old System	280	172,000	5	1 4 10	347 13 4	0.48
New System	280	172,000	4	0 6 2	86 6 8	0.12
Saving		...	1	0 18 8	261 6 8	0.36

Winding,Banking out,and Screening plant.

Screening Arrangements.

When the coals leave the tippler they fall down a spout into a jigging screen (see Plate VI.),where they are assorted into three kinds—viz.,bests,nuts,and peas and duff. The best coals are carried along a cleaning belt,56 feet long and

4 feet wide,where they are cleaned by boys placed along each side of it. The nut coals are delivered out at the side of the jigger on to a belt 33.5 feet long by 3 feet wide,parallel with the first-belt,but at a different angle,and in travelling the stones are picked out,and the coals cleaned are delivered over a set of screen bars or gauzes,by which the trebles and doubles are separated into their respective wagons. The peas and duff coals drop out at the bottom of the jigger on to a smaller belt,31 feet long by 2.5 feet wide,running in a direction contrary to the other belts,and which carries the coal to an ordinary "beeswing" elevator.

The whole of the cleaning of the coals is done by boys with one man as overlooker or "keeker." The coals are now much better cleaned than they used to be,and at a very much less cost. The comparative wage cost per day is shown in the following table:—

Description	Old Method.						New Method.					
	No.	Rate					No.	Rate.				
		s.	d.	£	s.	d.		s.	d.	£	s.	d.
Underkeeper	1	4	0	0	4	0	1	4	0		4	0
Screenmen,including Houses and Coals to same	12	3	3	1	19	0	...	...			...	
Attending Wagons	1	2	10	0	2	10	1	1	8	0	1	8
,, Best Spout					...		1	1	0	0	1	0
,, Nut ,, ...	1	2	10	0	2	10	1	1	4	0	1	4
,, ,, ,, ...	1	2	0	0	2	0	...	...			...	
,, Treble ,, ...	2	1	6	0	3	0	...	...			...	
Apparatus	1	1	6	0	1	6	1	1	2	0	1	2
Small Runner	2	2	11	0	5	10	...	...			...	
,, ...	1	1	10	0	1	10	...	...			...	

Jigger Trap and Handle	1 0 10		0 0 10
Picking out Stones	20 0 10		0 16 8
Total	3 2 10	... ...	1 6 8

This shows a saving of £1 16s. 2d. per day or £506 6s. 8d. per annum. The total annual saving on banking out and screening is thus £767 13s. 4d. or 1.07d. per ton.

In this comparison allowance ought to be made in favour of the new method,inasmuch as we now pick out the stones from the double and treble nuts,whereas formerly we only picked out a few stones from the trebles,but never attempted to pick any from the double nuts.

The advantages derived from this system of banking out and screening may be summarised as follows:—

(1.) Cheapness of labour cost,consequent on the utilisation of steam instead of manual power.

(2.) Cheaper class of labour employed.

(3.) Only coals actually delivered on the screens are paid for.

(4.) Coals are better cleaned and with less breakage.

Discussion—Winding,Banking out,and Screening plant.

Mr.G.B.Forster said there were three kinds of coal referred to in the paper : best,nuts,and peas and duff ; did Mr.Tate mean that peas and duff were one kind ?

Mr.Tate—There are three kinds of coal : best,treble nuts,and best nuts,then peas and duff.

Mr.Forster—There are only three sorts by the one operation.

Mr.Tate—After the nuts are taken out they are screened by another operation.

Mr.Forster said it was not an uncommon thing to get three kinds. He had found the revolving screen better for making nuts than the jigging screen.

Mr.Tate said they were under the impression that the revolving screen broke the nuts.

Mr.Forster—Perhaps your coal was very soft,and ours very hard. We had to abandon jigging and put up a revolving screen which makes better nuts.

Mr.Tate—We have now no complaints and we used to have a large number.

The President said this might seem a very short paper,and a subject the details of which it was at one time considered unnecessary to give so much attention to,but he was sure that where they could put an increased value of one shilling a ton on some classes of their coal it was a matter of great importance. Mr.Daglish,through whose personal kindness he had an opportunity of visiting one of his screens,was present,and that gentleman might perhaps give them some information or make some remarks on the subject.

Mr.Daglish said this was a subject of great importance,as they all recognised,and was becoming so much so that all new plant was arranged upon some system of the kind indicated. The first place he saw it tried was,he thought,at Mr.Walker's ironstone mines ; there the tub ran right round and the system was very effective. This system had been put in at Marsden,but was not in full operation yet. In Wales at several collieries they had elevators,not creepers,which ran the tub round. He did not know whether in Mr.Tate's arrangement the bottom of cage lifts.

Mr.Tate—No,it was found inconvenient.

Mr.Daglish said with regard to the kick-up he had not seen one of that kind before,but usually the kick-ups revolved entirely ; some ingenious arrangements were made to accomplish this. He thought there was an arrangement of the kind at Heworth,Mr.May had also put one at Boldon,and they had another at Marsden,all effective he believed,but all done in different ways. The kick-up was turned over by machinery,either by friction wheels or surging belts,but it was so little that it could be stopped at the right moment for the tub to be taken out and a fresh one put on. There was no doubt Mr.Tate had taken advantage of all that was known on the subject and had succeeded in arranging a very nice plant. With regard to the jiggers,other jiggers separated the coals in the manner described,they took out best,nuts,and peas and duff.

Mr.Tate—Not at the sides,I think.

Mr.Daglish—Yes ; Marsden was at the side,and cleaned by a belt. He did not know whether Mr.Tate's belt was arranged the same as that he (Mr.Daglish) first saw at Heworth and adopted at Marsden,namely,with a separation in the middle of the belt to put the stones on.

Mr.Tate—Ours has not got that.

Mr.Daglish—It is an extremely clever arrangement,and very important ; and where they had to take out another kind of coal,as they had to do at Marsden,it would be very troublesome to have to sort them out behind.

The President—Mr.May,I think,is not here to-day,or he would have been able to give us more information.

Mr.Forster said he did not quite agree with Mr.Daglish as to the second belt. If they had a second belt on the top for stones--

Mr.Daglish—It is not a second belt,it is a division.

Mr.Forster—It is the same thing. It complicated matters,and added great extra weight to the belt. The way he had done was to put coarse coal on one side and stone on the other,and after work was done run them over the belt.

Mr.Tate said he had considered this point ; but in his case it was unnecessary to take them further down than the level of the stone heap.

Mr.Thos.Bell—Mr.Corbett had it at one of his Rainton pits. I think he took it off.

Mr.W.C.Blackett said he had had an opportunity of seeing Mr.Tate's arrangement,and could testify to its economy. To him the most striking feature was the kick-up ; as regards novelty it was the feature of the whole arrangement. He had seen all the arrangements Mr.Daglish had mentioned,and for simplicity he thought Mr Tate's beat them all. Nearly all he had seen,if they went right round,had to be assisted by machinery. Mr.Tate's could go right round as easily as part way,and it did so of its own gravitation. As regards the centre belt for stones,in many case it was not adopted, because boys were paid by the piece. The owners of his colliery decided some time ago to put in belts for the purpose of cleaning unscreened gas coal ; this had not been previously done in many cases for unscreened. All their boys were paid by the number of boxes of stone,etc.,picked out. One belt they had was 90 feet long and 4 feet wide ; another 70 feet long and 5 feet wide ; and very great economy had been found in simply cleaning the coal for gas purposes. He believed in the coal going over the belt ; they saved nearly a farthing a ton,without considering greater efficiency,and they were picking out almost double the quantity of stones.

Mr.W.J.Bird said he,like Mr.Blackett,had had the pleasure of seeing Mr.Tate's arrangement,and he agreed that the kick-up was the most striking feature. Another point he was struck with was the belt bringing the empty tub to the requisite height to run by gravitation to the shaft. He had seen arrangements somewhat similar in Wales,where the necessary elevation was obtained by an elevator,a man attending to it ; and although there was an attendant available and plenty of power to carry the tubs the necessary distance Mr.Tate's had the advantage : instead of using the whole of his steam power he used only a portion of it,and dispensed with the services of an attendant.

Professor Merivale said he was not quite clear as to the kick-up. He gathered that it was not quite automatic ; had a boy to start it,or did the the weight of the tub set it going ? He saw that it came back automatically.

Mr.Tate said it could be hung so as to go itself. As they had it,a boy just give it a touch,but it would without.

Professor Merivale said he would like to hear an opinion expressed as to the width of the belt. There appeared to be a great difference of opinion on this point. Some approved of 5 feet and upwards ; others said that was too much,and made their belts as narrow as 3 feet. In the belts he had put in he had tried to hit the happy medium,and made them 4 feet 6 inches. The wider belts were an advantage if the lads could really reach.

Mr.G.B.Forster---I find I must apologise,Mr.Tate. I thought you meant a screen underneath the other jigger.

Mr.Tate---No,sir.

Mr.Forster---I was wrong in saying I had used it before.

Mr.Daglish---It has two gauzes on the jigger,I suppose ?

Mr.Tate—Yes.

Mr.Daglish---That is the way we have it at Marsden.

Mr.T.E. Forster said in the Midlands they would see as many as four kinds of coal seperated. The belts of 40 to 50

feet were generally made in halves---one half going forward,the other backward,but to the same shaft. He would like to

ask one thing about the nuts. Were there many wet coals? In Northumberland they had found the revolving screens

the best on account of the wet coals ; they could only use the jigging screens for dry coal. As regards the width of the

belts,he thought they would find nearly every colliery was in favour of about 4 feet. Some had 5 feet,but if boys were wholly employed that was too wide ; 2 feet 6 inches was too far for a boy to reach for stones. With a middle partition

a much wider belt was required ; in some cases 6 feet. A middle partition was good where one class of coal was picked out,but where there were two or three classes it was rather confusing,as they could only put one kind in the

middle. He was not present when the first part of the paper was read,and had not heard what percentage of coal was

picked out. As regards paying the boys,he thought it would be best to fix a certain price---say,for picking out stones, and pay them all the same average,for,of course,the boys standing nearest the shoot would have the best chance of

picking out most stones,and the lads furthest away the least chance.

Mr.Blackett said they found no difficulty in paying every boy for his own work. It would be a mistake to pay a general

average,because there was a great differance in boys. Some would earn twice as much as others,not for the reason

that one had one end of the belt and the other the other,for they were moved every day. They were never in the same

position on the belt two days running

Mr.Tate said as regards wet coal they had not much. If the coal was very wet it might be difficult ; but at Castle Eden they had a jigging screen,and he thought they screened a considerable quantity of wet coal.

Mr.T.E.Forster---Making nuts?

Mr.S.Tate---Yes.

Mr.T.E.Forster---I thought their screen was a jigging screen.

The President said,although there would be further opportunity for discussion,he thought it was a subject they were

all familiar with,and as they were all more or less aquainted with new arrangements he would be glad to hear any further

questions or observations.

Mr.Thos.Bell thought it was a mistake to have the belts too wide where they had boys to clean the coal. The boy who had to reach a long way got very tired before night,and would go to sleep half the day if he had the chance. With a 4 feet belt they would get the coal better cleaned than with one 5 feet. He had another reason,too,for saying belts should be narrower. He thought they made a mistake in having boys for this work. If they had women the coal would

be better cleaned,and with more peace and satisfaction than with boys. He would advise them to get women to clean

the coals ; it was a great mistake not to have them.

Professor Lebour---At the collieries we visited last month in Belgium nearly all the work of this kind was done by women.

Mr.Bell---Yes ; but nearer home than that. Go into Lancashire,Derbyshire,Staffordshire,or North Wales.

The President---The Inspection Act is just passed.

Mr.Bell---Inspection has nothing to do with it.

Mr.Blackett apologised for speaking again. He had tried to employ women,and had done everything in his power to

do so ; he had put out notices asking the men to let their daughters come,and had even offered rewards if one or two

would come as a start ; but there was a prejudice against it in this county.

The President---Against their acting as screeners,you mean?

See library for image.

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To illustrate Mr S.Tate's paper "on the Winding,Banking out and Screening Plant at East Hetton Colliery."

Vol.I.Plate II.

See library for image.

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To illustrate Mr S.Tate's paper "on the Winding,Banking out and Screening Plant at East Heaton Colliery."

Vol.I.Plate III.

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To illustrate Mr S.Tate's paper "on the Winding,Banking out and Screening Plant at East Hetton Colliery."

Vol.I.Plate IV.

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To illustrate Mr S.Tate's paper "on the Winding,Banking out and Screening Plant at East Hetton Colliery."

Vol.I.Plate V.

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To illustrate Mr S.Tate's paper "on the Winding,Banking out and Screening Plant at East Hetton Colliery."

Vol.I.Plate VI.

See library for image.

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Mr.Blackett—Quite so ; but he did not think they would be able to get them. Even if they could get the women to act as screeners they would have to contend with the union officials.

The President asked if Mr.Logan had anything to say on the subject of the paper ?

Mr.Logan said he put in two belts lately,and he was of opinion that they could not draw a hard and fast line,and say that 4 feet,4 feet 3 inches,4 feet 6 inches,or even 5 feet was the proper width. Every colliery-manager knew his own circumstances best,and could best decide on what would suit him both as regards width of the belt,and whether or not he should have a centre compartment. He thought,however,they should not expect a boy to stretch more than about 2 feet 3 inches. He thought cleaning coal from the belt was the most efficient system yet adopted.

The President said,as there were no other remarks offered,it was his pleasing duty to propose a vote of thanks to Mr.Tate. In the first place that gentleman had given him,some time ago,the opportunity of examining the jigger screens and belts,as had also Mr.Daglish and Mr.May. He regretted the last named gentleman was not present to-day,as he would no doubt have been able to give them a good deal of information as to the systems in use at Boldon and St.Hilda. These jigger screens were all the creations or improvements of the last six years ; they had been put in in place of old machinery,and they were therefore not at all free agents as to the width of belts,etc. When the paper was open again for discussion each member would no doubt be prepared to discuss it in a practical way,and he hoped they would have the pleasure of Mr.May's and Mr.Lawrence's presence,and that they would all hear of something more suitable for their own particular requirements than what they had had hitherto. He had pleasure in moving a vote of thanks to Mr.Tate for bringing this interesting subject forward.

Mr Tate acknowledged the compliment,

Mr.T.O.Robson's paper on "Faults at Redheugh Colliery,"was opened for discussion.

The President—Have you anything new to add,Mr.Robson ?

Mr.Robson said he had another section (which he proceeded to draw on the blackboard) which went still further to show the inconsistency between the faults described in the previous sections. The one now drawn on the board was proved,since the paper was read,in the Brockwell seam,and represented the same fault at a point 180 yards further west than that shown on the Plate XYZ. Following the seam again for 32 yards they had a dip fault,the extent of which, however,he could not say,as it had not been proved,but from levellings made at both sides,he took it that the dip fault on the one side would be pretty nearly equal to the rise fault on the other. Instead of having a practically level seam at 180 yards further west they had a distinct riser and dipper. It showed that these faults were altogether abnormal and probably,as Professor Lebour had suggested,they were abnormal for the reason that they were a series of conglomerations of faults proved at different depths and showing different characteristics at each point where they were proved. Whether there was any correlation or not he did not know—it was difficult to prove—but he should think not.

Referring to the sketch on the blackboard,the President asked if there was a hading as shown ?

Mr.Robson said there was little or no hade ; the sketch was a very rough one and not quite accurate.

The President—You have no doubt about it being a dipper ?

Mr.Robson—No,sir,not the least ; we have the seam on the other side. In printing the Transactions the sections had unfortunately been reversed,the sections on Plate I. should have been on Plate II. and vice versa.

The President suggested that the error might be corrected by an errata slip in the next part.

In the absence of Mr.Pitkin,the Secretary exhibited two of that gentleman's new electric safety-lamps. The older and larger lamp weighed about 8.5 lbs. (not quite),cost £2 10s.,would burn from 20 to 30 hours,and give a light of about three candle-power. This lamp,however,the maker had abandoned in favour of the smaller one,weighing 6 lbs.5.5ozs., costing £2,and giving the same light as the other lamp,for from 10 to 12 hours. It was said there was no danger whatever of breakage,and the lamp could be shaken about a good deal without hurt,but it could not be turned upside down. The principle of the lamp was the secondary battery,the large containing four cells,the smaller one three.

The Secretary then read a further communication from Mr.Pitkin and said he had also a note stating that the lamps had been in use at the Waltham gunpowder factory for two and a half years ; also at a colliery in Glamorganshire.

Mr.Tate asked if Professor Lebour could say how long it took to recharge the lamps ?

Professor Lebour—No,I have no further particulars.

Mr.M.Walton Brown said there was one point Professor Lebour had not mentioned. There was a resistance coil in the lamp which enabled it to be burned at two different powers. (This was demonstrated with one of the lamps.) With regard to recharging of secondary batteries,in most cases,except where an exciting fluid was used,it took somewhat longer to recharge the lamp than it would afterwards burn. A lamp burning eight hours would probably take ten hours to recharge.

This concluded the business,and the meeting terminated.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL

ENGINEERS.

GENERAL MEETING,Saturday,December 14th,1889.

Mr.John Marley,President,in the Chair.

The Secretary read the minutes of the previous meeting,and in reporting the proceedings of the Council said there was not much new to tell except with reference to the Federated Institution of Mining Engineers. Since the last general meeting the Council had met at York,and it had been decided that the first general meeting of the members of the different Institutes should take place at Sheffield on the 22nd and 23rd of January. A full programme for those days would be issued as soon as the necessary details were obtained from the officials of the Midland Institute,who had most of the arrangements in hand. But,in a general way,he was already in a position to explain that the first day would be taken up by the reading of papers,visits to a few works in the immediate neighbourhood,a dinner,etc. The next day would be given up entirely to visits to works and collieries,especially such collieries as had any specialities worthy of notice. As soon as the programme was ready,it would be sent to all members ; and as Secretary he would like them to let him know as early as possible whether they were going or not,as a good many of the arrangements depended on the number of members going,and it was only fair to those who had taken the trouble for them that they should have some idea of the number likely to attend.

Mr.Cochrane asked if the arrangements for the Sheffield meeting would be such as to allow of members leaving Newcastle on the morning of the 22nd,or must they be there the previous day ?

The President said he had visited Mr.Rhodes,the President of the Midland Institute,the previous week,with a view to making some arrangements for the meeting,and amongst other things it had been arranged that any one who had a special wish to see coal-cutting and electrical appliances in connection with coal mining,would not only have an opportunity of seeing these things the day after the meeting on which papers would be read ; but special arrangements would be made by which they could see them in the morning prior to the meeting,and by that means members could make their arrangements to suit their own convenience. Those who liked could go on the Tuesday night,and time tables and other particulars would be given in a few days. Inasmuch as the Midland people thought they had something to show both as regards coal-cutting by machinery and the application of electricity to various acts of mining,the transmission of power,and so on the privilege had given of seeing these various machines before the discussion as well as afterwards. Those whom it would suit best could go on the Tuesday night,others could go on Wednesday morning.

The following gentlemen were elected,having been previously nominated:—

Members—

Mr.T.Colquhoun,Mining Engineer,West Stanley Colliery.

Captain William Charles Chitty Erskine,Inspector of Mines,Kimberley,South Africa.

Mr.William Tasker Hallimond,Mining Engineer,Manager of Van Ryn Gold Mining Company,Limited,Boksburg,Johannesburg Transvaal.

Mr.Jethro Longridge,Colliery Manager,Burradon Colliery,Newcastle-on-Tyne.

Mr.Thomas Lowden,Colliery Manager,Hamsteels,near Durham.

Associates—

Mr. William Draper,Assistant Under Manager,New Seaham Colliery,Sunderland.

Mr.John William Forster,Assistant (Certificated Manager,under Act), Silksworth Colliery,Sunderland.

Mr.John Charles Hall,Surveyor,Trimdon Grange Colliery,Co.Durham.

Mr.Francis Burdett Johnson,Mechanical Engineer,1,Charles Street,Marsden Colliery.

Mr.John Riddell,Under Manager,Shilbottle Colliery,Lesbury,R.S.O.

Mr.John Southern,Master Wasteman,Heworth Colliery,Newcastle-on-Tyne.

Mr.Matthew Walton,Assistant Manager,Dearham Colliery.

The following gentlemen were nominated for election :—

Member—

Mr.Daniel Henry Bayldon,Mining Engineer,Thames Gold-Field,New Zealand ; and 3,Drapers'Gardens,London,E.C.

Associates—

Mr.Sidney Bates,Surveyor,etc.,The Grange,Prudhoe-on-Tyne.

Mr.John Bell,Under Manager,Wardley Colliery,Newcastle-on-Tyne.

Mr.Thomas Hepburn,Under Manager,South Street,Langley Park,Durham.

Mr.Robert Richardson,Under Manager,Throckley Colliery.

Mr.George D.Ridley,Colliery Surveyor,Tudhoe Colliery,Spennymoor.

Mr.Andrew Watson,Colliery Engineer,New Seaham Colliery,Sunderland.

Mr.Thos.Bell,H.M.Inspector,referring to the list of members for election, asked what part of the Mines Act provided for an "assistant manager" ?

The Secretary—I don't know.

Mr.Bell—Nor I. I see there is also ''assistant under manager"; I don't know that official either.

Mr.G.B. Forster—I don't think he comes under the Act.

The President—I suppose the particulars are copied from the nomination paper as it comes to us.

Professor Lebour—That is so.

Mr.R.F.Boyd read a memoir of the late Mr.E.F.Boyd,F.G.S.,which is published separately with a portrait in pamphlet form,an abstract of which,containing the particulars of his professional career in connection with the coal trade,will be given in the next part of the Proceedings.

13

Proceedings.

The President said it fell to his lot to perform a pleasing duty,and yet a feeling one. They had heard a memoir of one who,twenty years ago,was President of the Institute,and therefore one of his predecessors. He (Mr.Marley) also appeared in another capacity as a pupil of Mr.Boyd,so that he felt it was especially his duty,as President,to move that they pass in silence a vote of thanks to their Past President's son,Mr.Hugh F.Boyd,for his kindness in contributing,and to Mr.Robert F.Boyd for reading,this memoir. With these few words he would do his duty best by simply putting the motion,after it had been seconded,for the meeting to pass in silence with a full show of hands.

Mr.G.B.Forster said he was privileged in being allowed to second the vote of thanks. He was sure,of all people in the district,the Mining Institute owed perhaps more to Mr.Boyd than anyone else ; and,whether they considered his connection with this Institute and with the College of Science,his efforts to advance the education of both professional men,and,as his memoir said,of those under him,or his integrity and worth,his diligence and skill in his professional,or geniality and amiability in his private character,he thought they might well say they would be a long time before they would look upon another like him.

The President—Gentlemen,you will kindly show,by holding up your hands, that this vote is fully and unanimously acquiesced in.

The vote of thanks was carried in silence.

Mr.Wm.Cochrane submitted the following "Obituary Notice of the late M.Theophile Guibal":---

14

OBITUARY NOTICE OF THE LATE PROFESSOR GUIBAL.

OBITUARY NOTICE OF THE LATE M.THEOPHILE GUIBAL.

By W.Cochrane.

Theophile Guibal was born at Toulouse on the 31st May,1814. At 19 years of age,after private tuition,he was attracted by the reputation of the Ecole Centrale des Arts et Manufactures de Paris to resort to it for the purpose of a scientific education. He entered in October,1833,and passed the three years'course with considerable distinction, developing his inventive genius,even at this early age,in a remarkable degree,his principal bent being towards mechanical appliances for mining purposes. As an illustration may be mentioned the study which gained for him his diploma of mechanical engineer. In this he worked out the use of two long spear rods,like the so-called "man-engines"of the Cornish mines,for the delivery of coal up a shaft,baskets which were in use at that date being automatically attached and detached at the end of each stroke of the engine,similarly to the progress of a miner up or down,with the result of delivering a full bucket at the top and an empty one at the bottom for each stroke.

His first practical work was in the service of Eugene Flachat,a leading French mining engineer,under whom he assisted to carry out various mechanical engineering works.

In October,1837,the project of a School of Mines in the province du Hainaut,Belgium,was started,the chief professorial chair of which seemed to M.Guibal to satisfy his ambition to have a large field of study in every department relating to the working of mines. His application for the post,backed by the reputation he had acquired,was successful, and he settled at Mons to carry out the duties he had undertaken. His teachings and his investigations covered the whole range of mining experience. He had a marvellous facility for imparting information,as is gratefully acknowledged by those who were in his classes,and is known to some of the members of this Institute,who had the privilege in later years of knowing him and deriving the benefit of his varied knowledge. His original works for the improvement of mining science are also of world-wide reputation. Among these was the sinking through water-bearing strata at a great depth where pumping power was inapplicable. An interesting description of this will be found in a biographical notice in the "Publications de la Societe des Ingenieurs du Hainaut,"a copy of which is in the library of this Institute. It will be seen with what fertile resource and determination he met the many difficulties which were encountered.

Another,perhaps the most important,of his works to which much of his life was devoted,was the improvement of machinery for the ventilation of mines. His system of ventilation is so well known to this Institute,and is so fully discussed in the Transactions,that it need only be referred to. The introduction of it into this country,about 1863,gave an impetus to the investigation of mechanical ventilation,which it may be said has led to the adoption of machine ventilators in almost all important collieries.

Prior to 1863,the earliest reference to mechanical ventilators in the Transactions is in Vol.III.,by J.J.Atkinson,in the year 1854-5,and the earliest application recorded in your Transactions in this country was by the same author in Vol. XI.,that of Elsecar and Tursdale Colliery,on the "Biram"principle. The useful effect

Obituary Notice of the late Professor Guibal.

was given as 12.69 per cent. The Guibal form was first adapted to the Tursdale Fan in 1863,and subsequently in its entirety at Elswick Colliery. The results are embodied in Vol. XIV.,in the year 1864--5.

So decided an advance was established in the useful effect of centrifugal action ventilators that,since then,it has been largely adopted,and it may,without fear of challenge,be asserted that it has established the supremacy of centrifugal action against all others for the purpose of mine ventilation. It was in view of this important invention that you elected M.Guibal an honorary member of this Institute in April,1870. The Academie Francaise awarded him for the same work the prize for the most important invention of his time for the health of miners. He died 16th September, 1888.

The School of Mines in Hainaut has decided to erect some monument to his memory and in lasting recognition of his life's work,which they consider has so largely benefited the mining world. This opinion is already confirmed by other countries than Belgium,which was only the country of his adoption,and you are invited to support this object,which will only be a confirmation of the honour to the Institute of having such a man enrolled upon your list of honorary members.

Mr.Cochrane said,he had not had time to give all the details,but there was a complete French memoir in the library which any member could refer to who wanted to know the particulars of the very difficult works that,as a young man entering his profession,Mons.Guibal encountered.

The School of Mines at Hainaut had decided to erect some monument to him.

The Council of this Institute had considered the matter,and he understood the members would be asked to-day to confirm a contribution from the fund of the Institute to assist in raising that monument,which was to be considered international. M.Guibal was not a Belgian,though that was the country of his adoption,and France,where he was born,Germany,and Belgium itself were combining to put their names on such a monument as would be raised to his memory,that it might be shown that the work he did was universally approved,and that he was in his time a most important contributor of mechanical appliances to the development of the mining industry.

The President—The Secretary will read the minute of the Council.

Professor Lebour read the following:—

Memorial to the late Professor Guibal.---On the motion of Mr.Douglas,seconded by Mr.W.Armstrong,Jun.,that the sum of £25 be subscribed to the Guibal Memorial Fund now being formed in Belgium ; and Mr.Cochrane undertook the correspondence on this subject with the manager of this fund.—Minute of Council,30th November,1889.

Mr.A.L.Steavenson regretted that he had not been able to hear the paper read but from his knowledge of the fan invented by M.Guibal and his different works as an engineer,he (Mr.Steavenson) was sure that whatever Mr.Cochrane had said was well deserved. He was a man belonging to no nation,but to every country,and his discoveries were invaluable to the whole world. He (Mr.Steavenson) had pleasure in proposing a vote of thanks to Mr.Cochrane for writing the memoir.

Mr.M.Walton Brown seconded.

The President said he cordially agreed with Mr.Steavenson's remarks,and put the motion to the meeting. It was unanimously adopted.

Mr.Cochrane,in thanking the meeting for the vote of thanks,said he was glad to find that what little he had written was corroborated by Mr.Steavenson's remarks. What M.Guibal did in his life was of world-wide importance. He hoped he would have the pleasure of communicating to Mons.Briart the confirmation of the Council's recommendation.

The Chairman put the recommendation of the Council to the meeting,and it was unanimously confirmed.

Mr.Cochrane said he would communicate to Mons.Briart the vote of the Institute,and also their reception of the memoir.

The President stated that,owing to the absence of Mr.Bayldon,that gentleman's paper on "The Hauraki Mining District (Northern Section),Auckland,New Zealand,"would be read at the next meeting.

The following paper by Messrs.T.E.Forster and H.Ayton on "Improved Coal Screening and Cleaning"was read :—

17

Improved Coal Screening and Cleaning.

IMPROVED COAL SCREENING AND CLEANING.

By T.E.Forster and H.Ayton.

Perhaps in no department of above-ground colliery plant has a greater change taken place during the past few years than in that which appertains to the treatment of the coal after reaching the surface.

The introduction of mechanical means for screening and cleaning coal is now taken place on so extensive a scale, and has been proved to be so economical and efficient,that the old-fashioned fixed screens,with their heavy charges for the labour required for screening,cleaning,and banking out,with in many cases comparatively unsatisfactory results, are being rapidly superseded in most parts of the country by the introduction of machinery to do their work.

Although various systems of mechanically treating coal have been applied for a considerable number of years,they appear only to have been utilised in isolated cases until the evolution of the travelling picking table or belt,generally in

combination with the vibrating screen,drew attention to the economy and advantages to be gained by the application of this particular system.

Its success is,no doubt,due to the very much greater ease and economy with which coal,and more especially that from either mixed seams or those which contain a very high proportion of refuse or inferior coal,can be treated as well as to the reduction in the amount of breakage which takes place,and the consequently improved state of the coal when ready for market. In addition to this,it may,perhaps,to a certain extent be accounted for by the,comparatively speaking,low cost of installation,and the ready adaptability of the system to existing heapsteads,and to places where it is impossible to make any great alteration in the structural arrangements and general disposition of affairs.

There is also,no doubt,a considerable advantage to be derived from the ease with which the banking-out operations can be performed,especially in the case of large outputs and the saving which may in consequence be effected under this head,not to mention the greater facility with which the small coal can be collected for further manipulation where it is so required.

The general arrangement of a screening and cleaning plant of the above nature varies to so great an extent with the quantity to be treated,the nature and amount of the refuse to be separated,and the specific purpose for which the coal is to be subsequently marketed,in addition to the local requirements of each individual colliery,that it may perhaps be more expedient to describe certain details and arrangements,suitable for general purposes,before offering any remarks as to the main principles and points to be taken into consideration in laying out a plant for any definite purpose.

Motive Power.

The position of the engines used to drive an apparatus is frequently a matter of some consideration. It is,of course, advisable to place the engine as near as possible to its work,and to complicate the gearing to as small a degree as possible. At one time it was considered to be a great advantage to drive the belts from the leading end,but except, perhaps,in the case of very long and heavily loaded belts (where a separate engine is frequently employed),it is now more usual to find the driving power applied at the back end,owing to the fact that it ; is usually the most convenient point and being close to the screens,allows a large amount of shafting to be dispensed with.

In cases where there is very little variation in the nature and class of the coal produced,and the amount of separation which is required,it is generally found sufficient to drive both belts and screens from the same engine,as under such circumstances it is highly improbable that any variation between the ratio of the screen and belt speeds will be required.

In some instances,however,it may happen to be necessary to alter the relative speeds,either frequently or at intervals,and it is therefore preferable to employ an independent engine to actuate the screens. Cases such as these may occur where there is a great variation in the nature of the produce of different parts or seams of a colliery,in the relative proportions of coal which is to be passed over the belt at any time,as,for instance,in the case of a plant making unscreened coal at frequent and irregular intervals when the belt speed requires to be increased to thin the coals down to a proper degree for easy picking,and the screens,if fitted with dumb plates,require to be slowed down.

It is,furthermore,at times a matter of great difficulty to estimate the correct speeds in the case of unopened seams or collieries,although such difficulties may be to some extent guarded against by arrangements for regulating the feed and length of stroke of screens.

Fig.1,Plate II.,represents an arrangement which was applied to an apparatus sent to the New South Wales coal-field,with the view of enabling the engines either to be run as a pair working the entire plant or to be disconnected and used independently. The left-hand engine can be employed to drive the belts and the righthand one the screens,   or the two can be coupled by means of a coupling between the cranks. Each cylinder also is made sufficiently large to drive the whole plant in case of accident to the other so as to avoid any long stoppage.

It is also a matter of some consequence where engines and machinery are placed on a heapstead,as frequently occurs,to pay some regard to the general construction and balancing of the machinery,so as,to minimise,as far as possible,the vibration which is often unavoidable without having to employ an unnecessary amount of material on the erection which carries it.

Screens.

These may be divided into two classes,viz.,the mains screens,on to which the whole produce of the colliery is passed,and secondary screens for the treatment of the smaller classes of coal.

Main screens. The amount of fall required on a vibrating screen varies,of course,with the nature of the coal,and also to a smaller degree with that of the screen itself and its speed and throw. Approximately speaking,a fall of about 3 to 3.25 inches per foot,or an angle of 14-15 degs.,will be found suitable for most classes of coal in this district,the necessary angle (other things being equal) being slightly less for bars or locket-work screens than for square wire gauze or "sectional" locket-work.

The simplest form of screen is a tray containing the gauze suspended on short vibrating arms carried from the fixed sides of the screen frame. (Fig.6a,Plate III.)   In some instances a dumb tray is added underneath for the collection of the small,where it is required for further treatment,and where a hopper cannot advantageously be placed. (SeeA,Fig.15, PlateIV.) In other cases the whole body of the screen is slung from above and subjected to the jigging motion,the screening surface being fixed inside it,with a flat hopper underneath to deliver the small at one point. (Fig.2,Plate I.) This entails the movement of an extra amount of weight,and is consequently only suitable for screens of ordinary dimensions ; but,on the other hand,it is possible to arrange a screen of this description so that the angle may be varied without much difficulty or delay. Where two or more screens are in use,and worked from the same shaft,the eccentrics are set so that a balance is effected by the simultaneous opposite movements of the screens ; and where unusually long screens are required,it is better to cut them so as to form two consecutive screens,each driven by its

eccentrics and balanced as above. (Fig,21,Plate VIII.)

Provision is also desirable,where screens are in duplicate,for throwing either out of gear,and for varying the length of throw,which is usually done by variable eccentrics (Fig.16,PlateII.) or otherwise.

The width and length of the screening surface depends on the quantity of small to be extracted,the condition of the coals,and,where the screen is not fed by a regulator,on the size of tub which is used.

The general width is from 4 to 5 feet or more,and in most cases a gauze of 8 to 10 feet in length is found sufficient.

The most important point to be watched is the passage of the coals on to the screening gauze in a regular and even layer,so that the whole of the small may be eliminated. Where coals are allowed to rush forward on to the gauze in a heap a longer gauze is required,and perfect separation becomes a matter of difficulty or chance. This may,however, be ensured by the employment of a fixed shoot at the head of the screen,on to which the coals are tipped,passing gently forwards on to the gauze,which is in consequence preserved from undue wear and tear. The addition of a regulating trap above the gauze is further,and more especially for rapid teaming,a great advantage ; and where the space at disposal does not allow of a sufficient length of shoot a "spreader" (B,Fig.15,Plate IV.),consisting of a plate slightly hollowed in the middle so as to prevent the coals sliding forward in a mass,and fixed immediately above the gauze,with which it vibrates,is perhaps as efficient,and requires no attention.

The material of which the screening surface is composed is usually either—

1. Steel bars,made as light and as deep as is possible in order to ensure the clearance of the small,and occasionally

plates with openings arranged on different plans.

These are,however,somewhat heavy,and the actual amount of surface open for the passage of small is less in comparison than with steel or wire gauzes,which are commonly preferred.

2. Square wire gauze. (Fig.3,Plate II.) This has the advantage of lightness and cheap first cost,and appears to be most commonly employed. Where the coal contains long thin or "shivy" pieces,they can be passed over without dropping into the small,as sometimes happens with bars or locket-work. This is frequently of importance where stones of the above nature are present,and the small coal receives no further treatment.

With large and heavy coals there is sometimes a tendency for the cross wires to spread,which can,however,be to some extent obviated by using a double crimped wire gauze,or by increasing the gauge of the wires.

3. Locket-work. (Fig.4,Plate II.) This is formed of continuous wires running the full length of the gauze,and turned at intervals (generally of 4.5 to 5 inches) over round iron bars. It presents a smoother surface,and is self-supporting,

requiring no stretching-frame,as in the case of square wire gauze. The first cost is higher than the latter ; but it is sometimes preferred as showing little or no tendency to lose its gauge. The thickness of the wire used is dependent to some extent on the gauge of the screen,a certain number of turns on the bar having to fit with the open spaces between the wires.

4. Sectional locket-work. (Fig.5,Plate II.) This form of locket-work has been introduced with the object of facilitating any repairs which may be required. It is constructed so that the section between every two bars is formed of an independent

wire,and can be removed and replaced by a fresh section. The wire is twisted round the two bars,alternately passing from the bottom of one to the top of the other,and vice versa,as shown. This destroys the smooth surface,and forms a number of lodgments in which small pieces of coal are apt to catch,and so tends to destroy the efficiency of the screen.

The relative duration of the different forms of wire gauzes is a subject on which it is difficult to obtain reliable information,but as far as can be gathered the cost of repairs and renewals to the screening surface is less than in the case of fixed screen bars.

The following shows the different gauges of the wires which are usually employed for screen gauzes,with the approximate cost per square foot.

	Square Gauze.	Locket-Work

Size of Mesh.	B.W.G. of Wire.	Approximate Cost per Square Foot.	B.W.G. of Wire.	No. of Turns on Bar between Wires.	Approximate Cost per Square Foot.
Inch.	No.	s. d.	No.	No.	s. d.
.1875	13	1 6	...	...	...
.25	11	1 9	...	...	...
.3125	11	1 6	...	...	...
.375	9	2 0	...	...	...
.5	9	1 9	3	2	3 6
.5625	...	...	2	2	4 0
.625	9	1 6	1	2	4 0
.75	4	1 9	00	2	5 0
1.0	3	1 9	0	3	4 6
1.125	4	1 6	00	3	5 0
1.25	1	1 6	1	4	4 0
1.5	0	1 6	...	...	...

Locket-work bars usually .5 inch to .75 inch diameter and 4.5 inch centres,leaving about 3 inches clear space. Prices are for complete gauzes,ready for screens of ordinary sizes.

The speed and throw of screens vary inversely,and are also dependent on the nature of the coal and fall of the screen. From 90 to 110 vibrations may be taken as a very usual speed,with a throw of about 5 inches.

Secondary Screens.

The general form of nut screen is a reproduction of the main jigging screen,and fitted as a rule with square wire gauze.

The manufacture of more than one class of coal on it,either by employing a long screen having the necessary number of gauzes of different mesh and separated by short plates (Fig.21,PlateVIII.),or by placing the gauzes in succession,one above the other. (Fig.17,Plate V.) The latter plan is perhaps hardly so well adapted to most classes of coal,and is not so generally in use as the former by which the passage of the coals over the whole length of each gauze is secured.

When working with a small mesh it is frequently found that the clogging of the gauze by wet coal is a serious defect, so much so that at some collieries arrangements are made to keep this coal out of the nut screens altogether,and in some places revolving nut screens are used as exhibiting a tendency to clog in a lessened degree.

It is,of course,desirable to feed the nut screens if possible by gravitation from the main screens,but where re-elevation is necessary the employment of elevating belts where possible will generally be found to be an improvement on the old form of bucket elevator. The belt elevator delivers the small in a more regular and con-

tinuous stream,and with a smaller amount of wear and tear. For elevating small coal,angle or bucket plates may be attached to the plates at intervals,the depth and number being proportioned to the load and speed of the belt.

Fig.6,Plate III.,is an illustration of the method in use at Ashington Colliery,the elevators taking the small direct from the main screen to the nut screen,which is placed immediately behind and in the same line. A trap is here provided at b for separating any wet coal from the small.

Where there is sufficient height at disposal a nut screen placed immediately under the main screen,either in the same line or at right angles to it,is a ready and economical arrangement,but it is better where room is small to re-elevate rather than run the chance of inferior screening due to insufficient space.

Belts.

There is,comparatively speaking,but little difference in the general design and construction of belts in use at the present time. The form which is almost universally in use consisting of steel plates attached to endless chains composed of links usually 12 to 14 inches (centres) in length,the chief dissimilarities resting in the form and materials of the links,and the methods of attaching the plates to them.

A variety of designs have been in use from time to time,such as flat hemp or wire ropes,wire gauze,chains,and plates on wire ropes,but these have in most cases given place to the above-named generally adopted pattern. Plates bent so as to pass round a circular tumbler and others of a corrugated form have also been tried,but apparently with a similar result.

The chain links are generally either jaw links (usually cast steel) (Fig.7,Plate1.) with a projecting bracket for the attachment of the plate,or double and single links (wrought iron or steel). (Figs.8, 9,and 10,Plate1.)

The former constitute a lighter chain,but are not so easily repaired as the latter which are occasionally made with a swelling at the ends so as to ensure longer wear. The plates are attached to single and double chains,either by riveting through the single links and to short pieces of angle iron which are again riveted to the side of the double links,or the angles may be dispensed with and the double link swelled near the end to admit a direct rivet. (Fig.8,Plate1.) It is,however,an undoubted advantage to be able to substitute a plate without cutting any rivets,and with this object in view,the attachment is made either by riveting the plates to angle irons,which are bolted to the links (Fig.9,Plate1.),or by hook bolts which grip the link through a hole in the side and are secured by a nut above the plate. (Fig.10,Plate1.)

The chains are usually carried on rollers placed at intervals of about 2 feet 6 inches apart on the upper or loaded side, and double that distance on the return side. The abolition of rollers and substitution of slides is a practice which has recently obtained to some extent,belts of 200 feet and upwards being in operation on this principle. It is,however, difficult to suppose that as far as power and durability are concerned there can be any advantage although the first cost is lessened. The tendency to sag,which roller belts often have,unless fitted with rollers at very frequent intervals is sometimes objectionable,and may be obviated by carrying the plate ends on angle irons,which also serve to confine the coals to the belt. (Fig.11,Plate1.) For belts up to 60 or 70 feet long and 4 feet wide,carrying an ordinary load,two chains are sufficient,but with a greater width or length a treble chain is used. The tumblers should be kept as small as possible at the leading end in order to reduce the fall over the belt end into the shoot. For long and heavy belts the driving tumblers should be fitted with projecting jaws,but for smaller sizes this is unnecessary. A sliding tightener should be provided for the trailing end,although this is sometimes dispensed with on short belts.

The main points to be considered in determining the length,breadth,and speed of the belting are the amount of the load,the nature of the coal,and the nature and proportion of the stone or coal requiring separation.

The speed is governed by the fact that,if increased beyond certain limits,it becomes more difficult to ensure perfect cleaning,except at the cost of unnecessary extension of the belt,and if decreased,the heaping of the coals upon the belt becomes a serious evil. It is of the highest importance that the belts should only be loaded with coals sufficient to form a tolerably thin layer so that the refuse can be easily detected,and overloading belts should be carefully avoided. The most suitable speed for picking appears to be about 50 feet a minute,and above this it is doubtful whether,except, perhaps,in some special cases,the thinner layer obtained by the extra speed counterbalances the greater difficulty in picking,especially where chipping is requisite. Irrespective of speed the length is governed by the amount and nature of the refuse.

For an average coal containing anything up to 4 per cent,of refuse on the total load it will generally be found sufficient to provide 45 to 50 feet of belting for a load of 300-350 tons to be passed over the belt in ten hours at a belt speed of 50 feet per minute,the width of belt being 4 feet,but where much chipping has to be done in addition it is better to extend the length to 60 or 70 feet. At higher speeds,or with a heavier percentage for separation,belts up to 100 feet and even more are necessary. It is always,however,best to err on the safe side and allow a considerable margin in view of any unforeseen contingency. The width (where there is no middle division for stones) is usually 4 feet,and from this to 4 feet 6 inches will be found the most convenient. Five feet belts are occasionally used,but it is a question whether the increased amount of space obtained compensates for the greater distance the pickers (especially in the case of boys) have to reach. The most convenient height is about 2 feet 6 inches.

In laying out a plant it is always advisable to duplicate as far as practicable,and although it may be possible to run a large quantity on to a screen and over a belt at a quick speed,it will be found a much safer course,as a rule,to work with two screens and shorter belts at slower speeds. The latter plan has the additional advantage of enabling either screen and belt to be worked independently in case of need,and at a higher speed so as to avoid any loss of time should any breakdown happen to the other. There is always a possibility,reduced it is true by careful inspection and attention to a very slight one,of a stoppage where machinery is used,and it is,generally speaking,a satisfaction to minimise the chance,as far as can reasonably be done,without any heavy increase in the first cost.

It is sometimes requisite to gain additional elevation at the delivery end,and this can be done by placing the belt at the requisite angle,which is limited by the sliding power of the coal. The greatest angle which has been employed (without special appliances) being,it is believed,about 4.5 inches to the foot.

Loading Shoots.

The loading of the coal from the belt into the trucks is performed by a shoot placed as close to the tumbler as possible,and slightly below the line of the tumbler shaft. Several schemes have been devised for minimising the fall from the belt on to the shoots,none of which appear to be particularly successful in practice. Careful adjustment of the shoot and a small tumbler is perhaps the best and simplest plan. The fall from the fixed shoot end into the empty truck,and consequent breakage,can be to a great extent avoided either by a short shoot hinged to the end of the fixed one,and counterbalanced,or,better,by a telescopic plate (see C,Fig.15,Plate

IV.),which may be run out towards the bottom of the empty truck and drawn up gradually as it is filled. The very objectionable drop which takes place from fixed screens is thus done away with,and rapid loading facilitated.

The above remarks refer generally to the nature and construction of the various parts,many or all of which are required in every apparatus.

It will now be necessary to make some observations as to the different methods in which they may be arranged,so as to form a plant which is most likely to be suitable for any given purpose.

The subject may be considered under two main heads,viz.,(1) where the screening precedes the cleaning,and (2) where the coal is first cleaned with or without subsequent screening.

The first is by far the most usual system employed,and will be found to be the best in the case of collieries where the output is,as a general rule,classified,and where no large proportion of unscreened coal is made.

In many cases the quality of the small coal is sufficiently good to enable it to be marketed without further treatment ; but when picking is required,it is perhaps more easily and economically effected on a separate belt,where it is free from the larger coals,and the small stones can be more easily detected.

Where the proportion of unscreened to be made is large,it is sometimes found better to tip the coals directly on to the belt,and place the screen at the leading end,arranged in such a way that the unscreened may be loaded direct into the trucks without passing over the screens. Unscreened is always more difficult to clean,especially when the coal is particularly uneven in size. Under any circumstances,however,an extra area of belt space is most desirable for this class of coal,so that it may be run down to a much thinner layer than is otherwise necessary. At some works where only one class of coal is made,and the best results desired,a series of short belts are used in preference to one of considerable length,in order that any one may be stopped,should the coal be specially dirty,without undue interference with the remainder of the work. The short belts either deliver direct into wagons or on to a main collecting belt,running at right angles to them,and into a loading shoot in the usual way,or on to screens as an alternative.

When small quantities of unscreened coal are required at irregular intervals and short notice it is sometimes best to employ a dumb spout feeding directly on to the belt. This is generally practicable when the screens are at right angles to the belts,the only disadvantage being that it occupies a certain amount of belt space. With screens and belts in a line the difficulty is greater,and is usually surmounted by fixing a plate over the gauze. In this case,unless the screen speed can be slowed down,it is necessary to supply some device in order to prevent the coal sliding down in a heap on to the belt ; and for this purpose an angle iron may be fixed at the foot of the dumb plate,or the plate end bent slightly upward,so as to retard to some degree the passage of the coals in a body. There is also a certain amount of time wasted in altering the screen,especially when frequent changes are unavoidable,and to obviate this difficulty arrangements may be made to remix the best and small by means of a trap at the screen foot. This method is adopted at Cowpen Mill Pit,but can only be utilised when the screen is fitted with a double tray. (D,Fig.15,Plate IV.) It has the advantage,where the belt is not fully loaded,of keeping the two sizes partly separate on it,and allowing them to be more easily cleaned.

Fig.12, PlateVI.,represents a device which is employed at the St.Hilda Colliery for plating the gauze with as little delay as possible,and consists of a plate which can be raised or lowered at will by means of levers actuated by a worm and spur wheel.

Disposal of Pickings.

The method of disposing of the different kinds of refuse or coal which may be picked off the belts requires some notice. The most usual custom is to throw the pickings on to benches or hoppers at either side of the belts,from whence they can be collected by means of shoots into wagons,or reloaded on to the belts and into wagons as opportunity offers. The question is,of course,largely dependent on the amount and number of classes of coal or refuse which are separated,and on the general arrangements and facilities which prevail at each individual colliery.

The addition of a stone partition in the middle of the belt (A,Fig.9,Plate 1.) has been largely adopted recently,and is perhaps best suited to places where only a single class is picked,such as stones or other small refuse,and where the delivery can be effected without any interference with the loading shoots. The adoption of this method,of course, necessitates an increase in the width,and consequently in the weight and cost of the belt,but on the other hand the space occupied by and the cost of erecting benches is reduced. Where considerable quantities are picked off and separated into different classes it has been suggested that a collecting belt placed at a lower level and fed from a series of hoppers,into which the different classes of coal and refuse can be thrown,might be employed as an economical substitute for the ordinary bench deposit,and could be arranged to load each class at intervals direct into wagons at either end.

Laying out Tubs.

The difficulties which were at one time anticipated with regard to the laid out tubs under this system have been found in practice to be very slight. The custom usually is to station a man at the foot or side of the screen who can readily detect an undue quantity of refuse in the coal from any tub,and on suspecting one he places a mark or token at each end of the space occupied by its contents on the belt. Boxes are then placed on the belt and the refuse collected for weighing. Any ordinary amount of laid out tubs can easily be dealt with in this way,cases having occurred where as many as 150 tubs have been so treated in a day often hours on a single belt.

Design.

The particular design of a plant most suitable for a given purpose is dependent to a great extent on the local circumstances and conditions which are peculiar to each individual colliery,and in the case of substitution for obsolete methods is largely governed by the buildings which are already erected and which may in most cases be utilised. It is,perhaps,preferable to arrange screens and main belts in one line if practicable where double screening is used without re-elevation,as this allows the different classes of small to be more easily loaded on to separate roads by means of cross belts of different lengths. For single screening the arrangement of placing the belts at right angles to the screens is most suitable,and can generally be most easily adapted to buildings previously occupied by a range of fixed screens. It is in this case perhaps better where duplicate belts are being erected to run them in different directions in line with one another,and loading from their respective ends by curved shoots. This prevents one screen having to be made unusually long as occurs where the belts are placed side by side.

It appears desirable in order to illustrate more clearly the various arrangements which may be used and are more adapted to the requirements of different classes of coal,to give a description of several existing designs,and for that purpose the following examples may be taken.

Mill Pit,Blyth. (Figs.13,14, and 15, Plate IV.)—This apparatus is designed for the treatment of an average quantity of 1,000 tons in ten hours,with a maximum of 1,200 tons.

The coal after being tipped from a 12 cwt. tub on to either of the two screens furnished at the top with a curved spreading plate,and each carrying .5 inch locket-work gauzes 10 feet long by 5 feet wide,is separated into best and small,a certain proportion of the latter being sub-divided into nuts and duff,and provision being made for cleaning the round coal and nuts,and for keeping separate the entire produce of either of the two screens and belts.

The screens lie at an angle of 15 degs.,and are run at 100 vibrations per minute. They are driven direct from an independent single horizontal engine,10 inches by 16 inches,placed immediately behind by means of variable eccentrics having a throw of from 5 inches to 6.5 inches. The round coal is delivered by shoots on to the main picking belts,and the small is collected by means of vibrating dumb trays attached underneath the gauzes with traps for the disposal of the small in the following ways:—The two higher traps (E,F, Fig.15, Plate IV.) when open allow the small to drop into a hopper (H) placed underneath,whence it can be loaded on to the best coal roads. The third (G) deposits the small on to the cross belt (A,Fig.14,Plate IV.) for elevation to the nut riddles,or for loading by means of a separate shoot (B,Fig.14,Plate IV.) on to a separate way. By closing this trap the small passes down a shoot (D,Fig.15,PlateIV.) underneath the best coal spout,and is remixed on the belt to form unscreened.

The belts are two in number,each 70 feet centres by 4 feet wide,and are placed in line with the screens. They are driven from the back tumblers by shafting and spur gearing from the main engines (12 inches by 24 inches) (A,Fig.13, Plate IV.) which are placed near the screen engine,both being separated from the screening and picking shed by a partition. The belt speed is 45 feet per minute with the engine running 96 strokes. Both belts are fitted with clutches at the back end. The loading spouts deliver on to two parallel rods and are fitted with telescopic shoots,5 feet 6 inches by 4 feet wide,which are counter-balanced. (C,Fig.15,Plate IV.)

The weigh tables are placed immediately beneath the shoots,and are occupied by the wagons during filling in order that the extra labour employed at an adjusting bench,which would be otherwise required in loading to a standard weight,may be avoided,and also to enable the tare to be taken if desired. The steelyards are placed on the platform level.

The percentage of round coal is about 75,out of which about 2.5 per cent,is picked in the form of stones and brasses,in addition to 2 per cent,of second class coal.

The cross elevating belt is 3 feet 6 inches wide by 45 feet centres,rising at an angle of 23 degs.,and having 2.5 inch angle irons attached to the plate at intervals of 7 feet,the whole being carried on a lattice framing. It is driven from the top end by a horizontal shaft connected to the main engine,and runs at a belt speed of 45 feet per minute. The elevator delivers either into the small coal shoot or by means of a breeches spout (C,Fig.14,Plate IV.) into the two revolving nut screens,4 feet diameter,fitted with a square mesh gauze,9 feet long. They lie at an angle of 18 degs.,and are driven by bevel gearing on a counter shaft worked by a belt from the horizontal shaft above-mentioned.

The duff is delivered into a hopper common to both,and the nuts,from which about 2.5 per cent,of refuse is picked,on to a belt 35 feet long,and similar to the main belts in all other respects.

St.Hilda Colliery. (Figs.17 and 18,Plate V.)—This plant is intended for the division of the coal treated into a considerable number of classes suitable for house-

hold,gas,and manufacturing purposes,and is a good instance of the facility with which the frequent changes and combinations required under these conditions may be effected with economy both of time and labour.

The coal is of such a nature as to allow of its sub-division by means of screen gauzes placed in succession immediately below one another,and carried on the same locking arms.

It is first tipped (by means of revolving kick-ups driven from screen shafting) into hoppers (a,Fig.17,Plate V.) fitted with regulating feed traps,and thence passes on to the main screen gauzes. Each of these is 10 feet by 4 feet,with 1.25 inch square mesh lying at an angle of 15 degs. and delivering the round coal direct on to a picking belt. The two belts are each 48 feet long and 4 feet 10 inches wide,including a 10 inch middle division for stones,and are speeded to run at about 55 feet a minute.

The coal passing through the top gauze falls on to the nut screen,9 feet by 4 feet and .625 inch square mesh,the nuts being delivered on to a small cross belt (b,Fig.18,Plate V.)—12 inches wide,and running 90 feet a minute—which conveys them to a 4 feet (c,Fig.18,Plate V.) picking belt parallel to the main belts,and having its trailing tumbler depressed so as to permit delivery from the cross carrying belt.

The third gauze converts the remaining coal into peas,which are loaded by a small jigging tray into wagons,and duff, which falls into a hopper placed immediately beneath.

For the manufacture of unscreened a lowering plate similar to that noticed above (Fig.12,Plate VI.) is provided,and by means of a well-arranged series of traps the nuts and peas can be remixed and loaded as one class of small

(best household) the peas and duff as another (factory),or,if desired,the three descriptions can be recombined.

Both belts and screens are driven by an engine having a pair of 12 inch by 16 inch cylinders. The screens are worked by connecting rods from slotted adjusting discs (d,Fig.17,Plate V.) fitted to counter shafts and driven by 18 inch spur gearing at equal speeds with the main screen shaft,each screen being supplied with friction clutches. The screen speed is 100 strokes per minute,and the produce,with a 6 inch throw,is:—Best coal,37.5 per cent.; nuts,28.5 per cent.; peas,25.5 per cent.; and duff,8.75 per cent.

The picking belts are all driven from the leading end,and are clutched there,the power being transmitted by shafting and bevel gear. The loading shoots are constructed with hinged reversing plates at the top (e,Fig.17,Plate V.) and double spouts,so as to allow the coal to be loaded on to either of two parallel roads at will.

The coal is drawn and tipped at two levels,one screen and belt being reserved for each level : the gross quantity which the apparatus is capable of treating being 750 tons to each level,or 1,500 tons in all,in 10 hours,the amount of refuse picked out being about 2 per cent,of the gross quantity.

Beamish Colliery. (Figs.19 and 20,Plate VII.)—The difference in the general design of this apparatus from that of those already described is due to the fact that it is intended for the cleaning of a coal containing a considerable proportion of small refuse,which it is equally important to eliminate from all the classes into which it may subsequently be divided.

To ensure this object the cleaning is done on four short belts (a,Fig.19,Plate VII.) prior to screening,the produce of the picking belts being conveyed by means of a cross carrying belt (b,Fig19,Plate VII.) to the screens for further treatment.

After being deposited in hoppers (a,Fig.20,Plate VII.) the coal is fed on to each belt by a trap,with a small roller at the outfall (b,Fig.20,Plate VII.) to ensure a regular and even distribution. Each belt is 35 feet in length and 4 feet 10 inches

wide,including a 10 inch stone division,and travels at a speed of about 50 feet per minute. They are driven from the leading ends and are fitted with friction clutches,so that any belt may be thrown out of gear without any stoppage of work on the others. The stones are discharged into hoppers,from which they can be dropped into wagons for removal. The delivery of the coals is on to a cross belt 35 feet long by 5 feet wide,which conveys the coal to a screen (c,Fig.20, Plate VII.) placed at one end and parallel to the picking belts. The main screen is fitted with cast iron plates,having diagonal openings varying in size according to the class of coal to be made,and an underneath tray for the collection and delivery of the small—directly,if required—on to a nut screen (d,Fig.20,Plate VII.) placed immediately below,with a hopper for delivery of duff. The speed of both screens is about 70 vibrations per minute,with a 7 inch throw and an angle of 16 degs.

The whole of the machinery is driven by shafting from a 12 inch by 24 inch engine placed at one end,and is arranged with a view to being subsequently duplicated for separate treatment of the produce of two shafts,so that the number of picking belts employed for each pit may be easily varied with the fluctuations of the outputs by altering the respective lengths of the cross carrying belts.

That part of the plant of which a sketch is given is capable of treating a gross output of 900 tons in 10 hours.

With the elimination of the cross belts and screens the design is similar to that most frequently adopted at collieries treating entirely unscreened coal.

Some mention of the system of picking and loading large coal into trucks by hand,which is common in the Midlands, may perhaps be of interest.

Under this system the most improved method seems to consist in cleaning and picking the coal on a belt placed at such a level that the large coal can be easily loaded by hand into trucks standing on roads placed on either side of and parallel to the belt.

The coal is tipped direct on to the belt,which may be 100 to 200 feet in length according to circumstances,and after cleaning and hand-picking,the residue is raised by a belt elevator (Fig.22, Plate VIII.) to a level sufficient to allow of its

separation by screening into (usually) three sizes,viz.:—cobbles,nut,and slack.

The screen (a, Figs.21 and 22, Plate VIII.) is placed at right angles to the belt,having gauzes of different mesh,and delivering the different classes made on to separate ways.

The size of screen and length of gauzes is,of course,proportioned to the quantity of coal which remains after picking has taken place. It is in this case shown as a double balanced screen capable of treating about 1,000 tons in eight hours.

Cost.

The cost of treating coal on the above described principle compares as a rule very favourably with that under systems hitherto generally adopted. The saving under ordinary circumstances may be estimated at a .5d. to .75d. per ton on the gross output. This is due mainly to the reduction of manual labour to that required merely for the picking and chipping,which renders possible the employment of boys for a large proportion of the work. At many collieries in the North of England where screeners are supplied with houses and fire-coal,the lower rate of wages paid is still further accentuated.

It must not,however,be supposed that the mere saving of labour is the only advantage to be obtained,as the greater ease and certainty with which the separating and sorting can be performed and the superior class of coal which results are benefits of much more serious importance.

The following table has been prepared from data obtained from various collieries where the system is in operation, and may,perhaps,be of some interest:—

Referance to page 28

Table of Costs,Etc.

See library for image.

The actual cost has in each case been reckoned only on such labour as is employed for screening,cleaning,and loading,and is taken on the wages ruling in October,1889.

Banking out.

Amongst other advantages which the introduction of this system of mechanical screening offers,mention has already been made of the economy effected by the concentration of and consequently lessened amount of labour necessary for banking out.

Where the long range of fixed screens gives place to one or two of the newer type,it will readily be seen that the lessened distances the tubs have to travel opens the way to an appreciable reduction in the number of hands employed as banksmen.

Where it is possible a system of banking out by gravitation is,of course,the best that can be devised,and reduces the class and quantity of manual labour employed to a minimum.

The simplest arrangement for this purpose is that in which the tubs are conducted round a more or less circular course. The full tubs gravitate from the cage to the tip,preferably of a side-teaming type,and arranged so that the tub passes out at the opposite end to that at which it enters. The body rests upon rollers,to one of which motion is given when required by means of friction clutches (Fig.23, Plate IX.) or wheels,or the motion (Fig.24,Plate X.) may be regulated by means of a hand brake and stop. About three tubs per minute can be teamed by this means without any further labour being employed than that necessary for stopping and starting the tippler,and the arrangement can also be duplicated so as to empty two tubs at one operation on the same or separate screens.

The objectionable fall and breakage of coal which usually occurs with the employment of kick-ups is reduced considerably when the tub is turned sideways and a clean team is always ensured.

In situations,however,where an end team is indispensable an automatic sliding cover,such as that shown in Fig.25, Plate IX.,is a useful adjunct.

The empty tubs,after leaving the kick-up,are raised by mechanical means to a level sufficient to allow them to gravitate into the cage. For gaining the necessary elevation in such cases the design known as a "creeper"or "finger chain,"which is described below,is perhaps the simplest and most satisfactory,as well as the cheapest,device that has hitherto been introduced.

Fig.26,Plate VI.,represents an arrangement on this principle now in course of erection at Harton Colliery,where the banking out is performed on two flats,the lower level being shown in full lines whilst the upper level is indicated in dotted lines. The coals from the high flat are tipped into a hopper,and screened at the same level as those from the low one.

The amount of power required can almost always be obtained from the screen engine,and the methods of attachment and detachment of the tubs being perfectly automatic,no attention or labour is required.

The form of creeper most generally in use consists of an ordinary link chain of the double and single link type,having links with projections,of sufficient height to catch the tub axles,placed at intervals varying with the speed and amount of work to be done.

On a level road,or for slight loads,it may be driven from either end,and at a speed of not more than about 80 feet per minute ; but for heavy angles or loads it is better to drive from the leading end,and to use jaws on the driving tumbler.

For haulages over comparatively short distances,such as sometimes occur between the shaft and screens,a creeper will be found to be both economical and advantageous.

At Cowpen Mill Pit,where the heapstead is about 70 yards from the cages,the haulage is performed by a creeper 200 feet long,rising at a gradient of 1 in 7 to a total height of 24 feet. (Fig.27,Plate V.) The chains are driven by an independent engine (10 inch by 20 inch cylinder) placed at the top,and are carried in cast iron troughs or channels,that containing the full chain being fitted with rollers. The returning portions of the chains are carried in angle iron slides suspended in hangers from the gangway. (A, Fig.27, Plate V.)

The engine is geared 16 to 1. The speed of the chains being 47 feet per minute,and the distances between the fingers 12 feet,the number of tubs (19 cwt. gross weight per tub) which can be raised per hour is 240.

The President said it would be well to let the members know at the outset that the discussion on the paper would be adjourned,but still he would be glad if some gentleman was in a position to commence the discussion to-day. There was an immense amount of most valuable information in detail and in principle laid before them,and he would be very glad to hear the remarks of any gentleman on the subject,especially if anyone had anything in the shape of questions on any points on which they desired information at the next meeting. It was a matter of great importance.

Mr.A.L.Steavenson said perhaps the subject was not one on which much could be said until they had the paper before them for further consideration,but there could be no doubt that it was a very useful paper to have for reference,and although in their district the first thing to do was to clean the coals and the next to press them into a disintegrator,it was a subject of very great interest ; the system described by Mr.Forster and Mr.Ayton was a very excellent one,and he could only suggest that on some other day,when the weather was warmer,the Institute should visit the pits and see these appliances for themselves.

Mr.J.R.Breckon asked what would be the cost per ton to treat a given quantity of coal by the means described ?

Mr.G.B.Forster pointed out that the information was all given in the table accompanying the paper,a copy of which was hung upon the wall as a diagram.

Mr.Breckon said he had listened with pleasure to the reading of the paper,and also gathered some idea of the operation of the system described from the sketches on the walls. There was no doubt this was a move,in the right direction,of vast importance. Having had something to do with the disposal of coal in the market,it had been his experience that when the coal was treated in a careful manner at the screens,and sent into the market in a good clean condition,its disposal was a comparatively easy task,and a price could be realised for it far beyond that realised for coal not treated with such care. The system of screening by belts was a valuable and important invention,both as regards means of cleaning,ease with which it could be erected,and its economy,and so he felt certain they were moving in the right direction with regard to the treatment of coal,especially when they had to consider how to get the utmost price for it. For every penny expended for cleaning coal he ventured to say at least threepence or more might be realised on the price per ton vended—speaking in general terms. A system had been introduced in Scotland,at the works of Messrs.Murray & Cunningham,Motherwell,which seemed to him to deserve attention. The plant had been erected by the firm of Simon & Luhrig. Mr.Simon was a gentleman whose name was connected with the coke ovens introduced in Durham,notably at Peases West and Bearpark. Mr.Luhrig was a German engineer ; his plant had been extensively erected in Silesia,where 50 or 100 could be examined : but that at Motherwell was near at hand,and those interested might,if they thought it worth while,pay a visit to see what was done there. He might mention that the firm of Simon & Luhrig had been in treaty with one firm in the County of Durham to deal with an output of 1,800 tons per day,at a cost of a farthing per ton,being the entire cost of treating the coal. The system is worked by gravitation very largely and by belts,and whereas in the

case of the colliery he referred to (with 1,800 tons per day),the cost was given by the colliery as £3,572 a year ; with Simon & Luhrig's system,after allowing for the steam-power and machinery,it was only £562,which left a saving of £3,010. Another useful part of their appliance was this,speaking of coal picked out,they had an ingenious and simple contrivance by which they took the coal—which might have pyrites or shale attached to it—and by squeezers of sufficient force detached it from the pyrites and shale,and in that way at a very slight cost a considerable quantity of coal was obtained,for which a ready market could be found at a fair good price ; and from other advantages in connection with this plant,he thought it might be said to be the most perfect contrivance yet known,and it seemed to him to recommend itself strongly to gentlemen considering this subject. He could not describe it from any drawing or from any accurate knowledge ; he could only speak of its advantages in a commercial sense,and he thought it well to direct the attention of this meeting to the plant and the advantages it appeared to offer. It might be that in some respects the designs put before the meeting were better adapted to the requirements of collieries here,but in considering the subject he thought the plan adopted at Motherwell should be taken into account.

Mr.H.Ayton,referring to the diagram on the wall,explained that the cost of treating coal under the method described in the paper varied from .62d. to 2d. on the gross quantity.

The President asked if there was any special leading charge into which the cost was divided ? Of course,the tables on the wall could be examined in detail by any gentleman after the meeting ; but what were the leading features ?

Mr.Ayton read several of the particulars given on the table of costs.

The President—Then sufficient details are given,so that comparisons can be made with other systems.

Mr.Ayton—Yes. Rates of wages are also given.

Mr.Breckon—Does the cost given include steam-power or use of machinery ?

Mr.Ayton—No ; just wages.

The President said it was important that questions should be asked to-day on any point which it was desired should be brought out.

Mr.M.Walton Brown thought the number of enginemen and men on the screens might be shown separately.

Mr.Ayton said as a rule only one engineman was employed,and sometimes he was only partly employed. He acts as screener.

Mr.Brown—That might be shown. There will be differences.

Mr.Ayton—The numbers of men and boys employed are generally in proportion to the length of the belt,and the lengths are given.

Mr.W.J.Bird asked if the authors of the paper knew of any particular arrangement of the system applied to accumulated and reserved stocks of screened coal,or unscreened and separated coal,which might be useful under circumstances with which they were all acquainted ?

Mr.Ayton—The apparatus at Harton,which is not yet erected,has been adopted for that use.

Mr.Blackett asked if there was any means of turning the coal on the belt ?

Mr.Ayton said that to turn over so that coal would not rest on the belt in large blocks a "spreading plate" was adopted (Fig.13, Plate IV.) in the arrangement at Mill Pit. It had answered very well.

Mr.Blackett—But I am speaking of turning it over on the belt to look for stones.

Mr.Ayton—Nothing but hand-power.

Mr.T.H.M.Stratton said he presumed it would be too much to ask for the first cost.

Mr.Ayton said they had not gone into the question of first cost,it varied so much according to the conditions of individual collieries. They had gone into the matter of the maintenance of screens,but the time the screens had been running was hardly sufficient to give any fixed idea on the subject. So far as they had gone into the question they found that the locket work compared very favourably with the old fixed screen bars,taking quantity for quantity.

Mr.Douglas asked if there was any difficulty in driving the belt from the other end ; if it could not be got at from the leading end,or in the case of a heavy inclination ?

Mr.Ayton said he remarked in the paper that when this first came out the belts were often driven from the leading end ; they are now,in the case of heavy loads. If the load was heavy,it had generally been found best to drive from the leading end ; with a light load,and with a light inclination,it was matterless.

Mr.J.R.Breckon asked if there was any experience to show whether the coal treated by this means,as compared with the old-fashioned screens,found more favour with the buyers ? To put it even more strongly,whether any portion of the coal—nuts,small,peas,or screened coal—had been found to realise any higher prices ? After all it came very much to the question,how will these operations tell upon the balance sheet ? If there were any such particulars they would be interesting.

Mr.Ayton said he was sorry they had no data one way or the other on that point.

Mr.Kenneth Guthrie said he would be glad to have some information as to revolving tables. He believed they were used at many collieries,and were very well suited for laying out tubs to get at the dirt.

Mr.Ayton said,although they had touched on mechanical screening,they had not gone into the question of revolving tables. They had found it best to confine themselves to the methods in use in the North of England. Revolving tables were more used in the South and Midlands.

Mr.G.B.Forster said,with regard to one set of screens described,he would be glad to adopt Mr.A.L.Steavenson's suggestion,and,when the temperature was rather better,to see the members of the Institute at Cowpen Colliery,if they would care to examine the screens and anything else there. They would also have an opportunity of visiting the rising port of Blyth.

Mr.M.Walton Brown proposed a vote of thanks to the writers of the paper for the clear way in which they had put the matter before the members.

Mr.J.R.Breckon seconded.

The President said he was sure they would all join in the vote of thanks. The subject of the cleaning and manipulation of coal after they had got them to bank was,he thought,of great and vital importance. Of course, Mr.Breckon must not expect them to get any chemical change in the condition of the coal which he thought he seemed rather to aim at,they only got mechanical change. If he succeeded in getting coal which he did not get before,the balance sheet would no doubt be very much improved. He would only remind them that this would be one of the papers published in the next part of the Proceedings of the Federated Institute,but at or before the end of March he expected they would have it in full print to discuss it,and he hoped the weather before that time would be sufficiently genial for their friend Mr.Steavenson and other members to accept Mr.Forster's invitation.

The vote of thanks was cordially adopted.

Dr.F.Colet Larkin exhibited and explained "A new Mechanical Device for the rapid fixing of Surveying Instruments."

The proceedings then terminated,

Referance to followering pages.

To illustrate Mess'rs Forster & Ayton's paper "on Mechanical Coal Cleaning."

Vol.I.Plate I. Fig.2. Fig.7. Cast Steel.Jaw-Link. Fig.8. Single and Double Link Chain. Fig.9. Shewing Angle Iron Attachment. Fig.10. Shewing Hook-Bolt Attachment. and Fig.11. Shewing Rollers and Slides for Carrying Belt.

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To illustrate Mess'rs Forster & Ayton's paper "on Mechanical Coal Cleaning."

Vol.I.Plate II. Fig.1. Arrangements for Disconnecting Engines. Fig.3. Square Mesh Gauze. Fig.4. Locket Work. Fig.5. Sectional Locket Work. Fig.16. Adjustable Excentric.

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To illustrate Mess'rs Forster & Ayton's paper "on Mechanical Coal Cleaning."

Vol.1.Plate III. Fig. 6. Arrangement of Screens and Elevating Belt at Ashington Colliery.

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To illustrate Mess'rs Forster & Ayton's paper "on Mechanical Coal Cleaning."

Vol.1.Plate IV. Fig.13. General Arrangement of Screening Plant. Mill Pit. Cowpen Colliery. Fig.14. Elevating Belt and Nutscreens. Fig.15. Arrangement of Screens and Belts. Mill Pit. Cowpen Colliery.

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To illustrate Mess'rs Forster & Ayton's paper "on Mechanical Coal Cleaning."

Vol.1.Plate V. Fig.18. Hilda Screens. Fig.17. Fig.27. Creeper Mill Pit Cowpen Colliery.

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To illustrate Mess'rs Foster & Ayton's paper "on Mechanical Coal Cleaning."

Vol.1.Plate VI. Fig.26. Banking-Out Arrangements Harton Colliery. Fig.12. Arrangement for Plating Screen.

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To illustrate Mess'rs Foster & Ayton's paper "on Mechanical Coal Cleaning."

Vol.I.Plate VII. Fig.19. Arrangement of Belts at Beamish Colliery. Fig.20. Arrangement for Cleaning and Screening at Beamish Colliery.

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To illustrate Mess'rs Foster & Ayton's paper "on Mechanical Coal Cleaning."

Vol.I.Plate VIII. Fig 21. Balanced Screen. Fig.22. Arrangement for Elevating and Screening after Hand Picking.

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To illustrate Mess'rs Foster & Ayton's paper "on Mechanical Coal Cleaning."

Vol.I.Plate IX. Fig.23. Design of New Revolving Kick-Up Harton Colliery. Fig.25. Design of End-Tip. Cowpen Colliery.

see library for image.

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To illustrate Mess'rs Foster & Ayton's paper "on Mechanical Coal Cleaning."

Vol.I.Plate X. Fig.24. Plan Showing Construction and Position of a Tippler in use at Marsden Colliery.

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33

Proceedings.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL

ENGINEERS.

GENERAL MEETING,Saturday,February 8th,1890.

Mr.John Marley,President,in the Chair.

The Secretary read the minutes of the previous meeting,which were confirmed.

The Secretary reported that since the last general meeting two meetings of the Council had been held,and among the business done it had been decided to print Mr.Hugh Boyd's memoir of the late Mr.E.F.Boyd in full,as a separate publication,with a photographic portrait,to be issued to the members of the Institute. An abstract of the memoir, consisting of an account of the purely professional career of Mr.Boyd,would be published in the Proceedings of the Federated Institution.

The following gentlemen were elected,having been previously nominated:—

Member—

Mr.Daniel Henry Bayldon,Mining Engineer,Thames Gold-Field, NewZealand ;

and 3,Drapers'Gardens,London,E.C.

Associates—

Mr.Sidney Bates,Surveyor,etc.,The Grange,Prudhoe-on-Tyne.

Mr.John Bell,Under Manager,Wardley Colliery,Newcastle-on-Tyne.

Mr.Thomas Hepburn,Under Manager,South Street,Langley Park,Durham.

Mr.Robert Richardson,Under Manager,Throckley Colliery.

Mr.George D.Ridley,Colliery Surveyor,Tudhoe Colliery,Spennymoor.

Mr.Andrew Watson,Colliery Engineer,New Seaham Colliery,Sunderland.

The following gentlemen were nominated for election:—

Member—

Mr.Hiram Craven,Jun.,Mechanical Engineer,Sunderland.

Associate—

Mr.Edgar Ormerod Bolton,Mining Engineer Exors. of Col.Hargreaves, Burnley.

In the absence of the author,the Secretary read the following paper by Mr.D.H.Bayldon,on "The Hauraki Gold Mining District (Northern Section),Auckland,New Zealand."

THE HAURAKI GOLD MINING DISTRICT (NORTHERN SECTION), AUCKLAND,NEW ZEALAND.

By D.H.Bayldon,M.E.,Thames,New Zealand.

The Hauraki mining district,in the Province of Auckland,New Zealand,lies between latitudes 36° 25' and 37° 40' S. and longitudes 175° 20' and 176° 0' E.,is about 100 miles long by an average of 25 miles wide,the greater portion being known as the Coromandel Peninsula

It is bounded easterly by the Pacific Ocean and westerly by the Firth of Thames and the beautiful fertile valley of that name,the extreme northern limit being Cape Colville,and extends southward beyond Te Aroha mountain,3,173 feet high.

The country for the most part is rugged and mountainous,covered with dense forest of evergreen trees,intersected by innumerable streams of various sizes,which afford at all times of the year a magnificent supply of pure water for mining,timber floatage,and domestic use.

The timber on the ranges is of vast extent. Here is found the celebrated Kauri pine,from 70 to 150 feet high,some of the boles of which have been known to exceed 20 feet in diameter. Other valuable timbers exist,suitable for building,cabinet,fencing,mining,and domestic purposes. The Kauri gum,a hard substance somewhat like amber in appearance,and which is exuded from the pine of that name,is found in the existing and extinct forests in great profusion,and is a source of wealth to the country ; it is exported to England and America,where it is highly esteemed and manufactured into the finest carriage varnish.

The valleys are salubrious and fertile,composed of deep alluvium,and are,to some extent,cultivated by the Maoris, miners,and settlers. The crops are such as are grown in England. All English fruits are abundant and good. Stock of all descriptions thrive and do well.

The situation of the Hauraki mining district is somewhat unique as a gold-field,the facilities offered for the export or import of material being all that can be desired,sea carriage being afforded almost up to the pit mouths in the instances of Thames and Coromandel. The noble and picturesque harbour of Auckland is within 40 miles of the former and 30 miles of the latter town,where ships of any draught may lie and discharge at the wharves with the greatest safety.

Local steamers,carrying passengers and freight,run at regular and frequent intervals between Auckland,Thames, Coromandel,and Mercury Bay,from whence they distribute their freight to other points by drays,coach,or river.

The Thames or Waihou river drains the south-western section of the district ; it is navigable for small steamers and craft for some 60 miles of its course. Inside the river,for several miles,exists a natural harbour,suitable for vessels up to 600 tons register. The land is rich and fertile,forming a broad valley 15 to 20 miles wide,perfectly flat,intersected by other streams. The ground is somewhat swampy,which is natural from its conformation,but for the most part easily drainable. Here the Phormium tenax,or native flax,covers large areas and fringes the river banks ; the white pine,a very useful timber,is also abundant. Much of this land,especially in the upper part of the valley,is reclaimed,and flourishing farms are to be seen as far as the eye can reach.

The lands on the eastern bank of the river are now nearly all occupied by a hardy,industrious class of farmers,many of whom are now and have in days gone by been engaged in mining pursuits.

Such is a brief outline of the Hauraki mining district,and it will be seen that mining and agriculture can go hand in hand. Twenty years ago it was a howling wilderness,now there are many small towns and villages,the country dotted over with farms,the miners penetrating the hills in search of the precious and other metals,and the country made accessible by roads and bridges. The future of such a country is not hard to predict.

The principal centres of mining in the district are Coromandel,Hastings,Thames,Hikutaia,Ohinemari (comprising Karangahake,Owharoa,Waihi,and Waitekauri),Te Aroha,including Waiorongomai.

Gold was first discovered at Coromandel in the year 1851,and attracted a considerable number of miners,but through native troubles,and superior attractions elsewhere,the diggings became comparatively deserted till 1861,from which time mining has been carried on,with more or less success,to the present day. Considerable tact required to be displayed in dealing with the natives to induce them to open their lands to the miners for prospecting and mining. All these difficulties have for many years been overcome ; cordiality and mutual good understanding now prevails on both sides.

Coromandel is situated on a beautiful little harbour,and mining for gold is carried on from the sea beach across the main range toward the east coast. Coal and other minerals are found throughout the district,but are undeveloped.

The principal gold mines are the Kapanga and Coromandel (English companies),Tokatea,West Tokatea,Royal Oak,Pride of Tokatea,Success,Onslow,and many others.

Throughout this district the outcrop of a main or mother reef can be traced for many miles,averaging 25 to 30 feet thick,with a northerly strike and westerly underlie of about 45 degrees. It has not been found payable,but the lateral veins,which have an east and west strike and northerly dips of varying angles,are found to yield good paying ore,which, as a rule,lies in"chutes"or chimneys of varying widths and depths. These lateral veins vary from a few inches to several feet in thickness. The Tokatea Mine,in which this system of reefs is well illustrated,is situated on the main range,the highest point being about 1,400 feet above sea-level ; it is worked by adits down to a depth of 900 feet,the lowest level being about 2,500 feet long.

The Kapanga Mine is situated about one mile westward of the main reef ; two well defined reefs have been worked from the surface to a depth of 550 feet. It is worked from a main shaft,properly equipped with pumping and winding machinery,capable of going to a much greater depth.

Some of the ore from this mine was exceedingly rich,and in places highly charged with metallic arsenic,which,in the course of amalgamation,had the effect of sickening the quicksilver,which,consequently,did not do its work,entailing considerable loss of the precious metal.

The Coromandel Mine is situated on the sea shore,above high water mark. The company are doing good work, opening up new blocks 280 feet below sea-level.

The pumping and winding machinery is situated on the sea beach,the mine being worked by two shafts about 450 feet apart. The inland shaft,being about 120 feet above sea-level,and the deepest by 100 feet,is connected by sweep rods to the pumping engine,the water being pumped to the 180 feet level,from whence it runs back to the seaward shaft,and is then forked to the surface. The drainage water from the mine is settled in a reservoir and used for milling purposes.

The Country rock in which the lodes are encased is of igneous origin,of a tufaceous nature,highly charged with undecomposed pyrites,below water-level,sometimes coarse and rotten,in other cases fine grained and hard,and has been

termed "tufaceous sandstone,"and in this class of country rock only have the lodes been found payable. Alternating with the tufaceous sandstone are to be found slates,diorite-porphyry,and felsites.

Hastings,some 20 miles south of Coromandel,is a small mining township. Considerable quantities of gold have from time to time been found in the various gullies and spurs off the main range,chiefly in decomposed slate and tufaceous sandstone. No deep mining of any consequence has been done here.

Thames is the centre and most important locality in the Hauraki mining district. It was opened for mining in the latter part of the year 1867,and has been constantly worked since that date.

The population was at one time 10,000 to 11,000,but being chiefly composed of miners,otherwise diggers,who are a roving set of men,attractions elsewhere has reduced the number to something like 4,500 at the present time.

The auriferous portion of the Thames is several miles wide,and the distance back into the ranges uncertain,as not more than about six miles in a straight line has been explored for gold.

The country rock is composed of tufaceous sandstone,alternating with diorite or andesite dykes. The latter are extremely hard to penetrate,and are known locally as "hard bars." The highest points in the locality are chiefly composed of this class of rock. The country is broken and irregular,intersected by gullies and cracks,which afford excellent opportunities for mining by means of adits or tunnels.

The lodes have varying strikes between 10 degrees and 80 degrees north-east and usually underlie to the north-west at angles ranging from 22 degrees to 80 degrees from the horizon. They are variable in thickness,from a few inches to 20 feet,and all are more or less gold-bearing while traversing the tufaceous sandstone.

The pay ore,as is usual,lies in "chutes"of varying lengths and depths,the best paying reefs have hard walls,to which the quartz,in a great measure,adheres,which gives the impression that when the rocks were in a state of fusion they emitted certain gases,which,with other combinations when the rocks cooled,caused the deposition of gold in the veins. The deposition of gold is especially noticeable where lateral breaks occur,and which have the appearance of water channels.

Where the break does not cross the lode the chute of rich ore is of much greater extent,and the lode richest on that wall which has been subject to fracture,and the deposit of gold becomes weaker the further it recedes from that fracture. In many instances where a break crosses the lode the deposition of gold will be at the junction,and so marked is this in some instances that the cross courses are followed for the purpose of intersecting the junctions,and the lodes only worked at those particular points. The pay ore forms a pipe or chimney at the junction. Black veins,rich in pyrites,striking from the country rock into the lodes is a most fruitful source of gold. Flinty veins,barren in themselves,frequently run parallel with a lode,and when a contact takes place there is almost a certainty of gold being deposited.

There are also at the Thames several main slides or clay cross courses,which have an influence on the deposition of gold. The lodes are always more productive when in contact or in the immediate vicinity of these slides,and, moreover,the lode is not productive on both walls of the slide but usually on the hanging wall contact. (Plate I.)

The veins are very numerous and sinuous in their course,and frequent junctions occur,which complicates mining to a very great extent. As a rule the lodes maintain their underlie well. It may be as well to mention that where variations in strike and dip occur,the productiveness of the lode is influenced.

All these eccentricities entail upon the management constant care and watchfulness,as many instances have been known of mines abandoned as unprofitable on further development turning out highly profitable dividend paying concerns.

The mines,for the most part,are small,none exceeding 100 acres,some of the richest have not exceeded a few acres in extent.

The principal mines are worked from shafts on the low ground adjacent to the sea beach,and the workings are,for the most part,below sea-level. The deepest shaft is 748 feet,being over 720 feet below the sea. No trouble is experienced from sea water,the whole of the drainage being coped with by a main pump.

An assessment is made annually on the various companies benefited by its operations ; it is by that means maintained and managed by a board elected from the contributors.

The pumping machinery consists of a low pressure Buhl engine of 250 horse-power,82 inch cylinder,8 feet stroke, with a 25 inch column,and four Cornish boilers ; two balance bobs,one at the surface,the other at the 300 feet level, placed over a shaft 12 feet by 8 feet inside measurement,depth of shaft 640 feet. This machinery at present does all the pumping for the field down to the 500 feet level,working about six strokes per minute.

Mining in the hills is carried on by means of adits,of which there are a great number,varying in length from over half a mile to a few hundred feet.

Roads and tramways are constructed up the creeks,by means of which the ore is brought to the flat and distributed to the various reducing plants for treatment.

There are about 180 stamps at work in seven mills,a Newberry-Vautin chlorination plant,and several other establishments for the treatment of tailings by grinding processes.

All these mills are driven by water-power. The water has been brought on to the ground by a water race,fifteen miles long,constructed by the Government,and now administered and controlled by the Thames County Council,who let the water at a moderate rental per cubic foot per week—one cubic foot being equal to about 12 horse-power,consequently crushing operations are conducted at a very low cost. This water is not only useful for milling purposes,but is supplied to the foundries,cabinet factories,for household purposes,and small machinery generally.

In addition to the peculiarities mentioned in connection with mining at the Thames,it has been proved beyond doubt that the gold not only lies in chutes,but that these chutes have a southerly dip,and strike across the reefs at a low angle. (Plate II.)

Carbonic acid gas is frequently found in the mines below sea-level ; it is not noticeable except during easterly weather,the prevailing winds being westerly. Several fatalities have occurred through its sudden influx,but greater caution is now observed and accidents are avoided.

Mining at Thames is carried out in a thoroughly systematic manner. The machinery is of a superior description, subject to biennial inspection by a Government officer. The administration of the gold-field is conducted by the warden or magistrate,who hears and decides all cases of dispute which may arise from time to time.

The southern portion of the district,including Hikutaia,Ohinemari,and Te Aroha,are most interesting. The lodes are different to those at Thames and north-ward,and different classes of machinery are being put up for treating the ores, which are of a much more complex nature.

A short notice would not do them justice,therefore,as time will not permit. I have deemed it preferable to confine the foregoing paper to the northern section only.

The President said,the author of the paper,who had that day been elected a member of the Institute,had, unfortunately,been obliged to leave for Africa. The paper was postponed from the last meeting in order,if possible, that Mr.Bayldon might be present,but as this was not possible,it might be well if there were any questions to ask or remarks to make on the paper that these should be forwarded,through the Secretary,to Mr.Bayldon,in order that that gentleman might reply in time for the adjourned discussion.

There being no remarks offered,

The President moved that a vote of thanks be accorded to Mr.Bayldon for the paper,which was apparently very full of information on the subject of the gold-fields in New Zealand.

Mr.C.Z.Bunning's paper on the "Warora Coal-field,India,"was opened for discussion.

The President said he was glad to see the author of the paper present. Had he any further information to give by way of introducing the discussion ?

Mr.Bunning said he had not much to add,and as the other paper on the agenda was of more interest to the members,he would prefer that this be taken last.

Mr.A.L.Steavenson proposed a vote of thanks to Mr.Bunning. He said the paper was not one which could be very much discussed,but both this and the paper just read would be very valuable additions to the Proceedings,and of great assistance to anyone about to visit the districts described. He had read Mr.Bunning's paper carefully ; there seemed to have been a great deal of labour involved in its preparation,and the writer deserved very much credit for the way in which he had stored his information.

The President thought it might perhaps be as well,if anyone had anything to say on the paper,to follow the order of the agenda.

Mr.Thos.Bell (H.M.Inspector) asked if it was compulsory under Act of Parliament in India to record every accident, however trifling ? If so,the relative number of accidents there appeared to be very much lower than in this country,the ratio in England being nearly double,if as he understood from the paper,every little accident was reported.

Mr.Bunning thought he had remarked in his paper on this head that every accident which incapacitated a man from work for 48 hours had to be reported. With reference to Acts of Parliament,coal mines were included in the Factories Act ; there was not a separate Mines Act.

Mr.Thos.Bell—The Factories Act being a Government Act ?

Mr.Bunning—Yes. The only matter to which he would like to draw the attention of any mining engineer going abroad, and especially to India or the Brazils,was with regard to the water. They should take care to avoid illness from parasites which the water of the mines contained ; and all water before use should be properly filtered. He was in India four years,and his recent illness was due to ignorance of the dangers from the source mentioned.

Professor Lebour asked if there were any plant remains at all in the coal-seams at Warora ?

Mr.Bunning—Yes,the ordinary catamite is found there,out very rarely.

Professor Lebour—Is that all !

Mr.Bunning—Yes.

The President said he had very much pleasure in seconding Mr.Steavenson's proposal. Their most cordial thanks were due to Mr.Bunning for his paper. With regard to the warning as to water,although of course a very proper one,the remark would apply to all sorts of impure water,at home or abroad,and mining water was often impure.

The vote of thanks was agreed to with acclamation.

Mr.Tate's paper on "Winding,Banking-out,and Screening Plant at East Hetton Colliery" was opened for discussion.

The President asked if the author of the paper had anything to add ? If not,he would invite the other members to discuss the subject.

Mr.Tate said he had very little to add. He had ascertained that previous to using the belt they picked out rather better than a half per cent. ; now it was about 1.25 or 1.5 per cent,of stone.

The President—You have increased the quantity removed ?

Mr.Tate—Just about doubled it.

Mr.Willis—Trebled,is it not ?

Mr.Tate—No,not quite. It varied from a half upwards before ; now it is 1.25 to 1.5.

The President said the question of screening and cleaning was a matter of importance,deserving,in the coal-fields of the North,as well as elsewhere,special attention,so much so that he was asked the other day to take into consideration the question of spending between £5,000 and £10,000 in this respect ; and when such large sums as this were involved,the matter became one for serious consideration. Another paper,by Mr.Forster and Mr.Ayton,had been read on the same subject,and he hoped both this and Mr.Tate's paper would elicit much discussion.

Mr.Bell thought the President would naturally be anxious to have full information on the subject.

The President—Yes,very full,before spending so much. As he mentioned at the last meeting,he had seen

Mr.Tate's arrangement,and was very much pleased with it.

Mr.J.G.Weeks asked if Mr.Tate had just one kick-up,and,if so,what quantity per day could be put over it ?   What was the average daily quantity ?

Mr.Tate said the apparatus had not been fairly tried at their pit ; the most they had put over it was seventy scores.

Mr.J.G.Weeks—Over one screen ?

Mr.Tate—Yes,one screen ; one kick-up ; but they could do over double that.

The President asked what tonnage seventy scores represented ?

Mr.Tate—Over a thousand tons.

Mr.Bell supposed it was not fully occupied.

Mr.Tate—Not half.

Mr.Bell asked how the weighing was arranged ? He saw the tubs came out in front according to the diagram on the wall,but where was the indicator of the machine ?

Mr.Tate explained the diagram. The machine was not finished yet,but it was intended to be hung on four rods within the kick-up ; the tub could be weighed full and again empty when the kick-up brought it back to its original position. This was the only place where the machine could be arranged so as to weigh the tub full and empty. Messrs Pooley thought it would work nicely. Of course it was not always necessary to weigh the tub full and empty ; they would weigh it either full or empty,or both,as circumstances required.

Mr.Bell asked whether boys or men were employed on the belt ?

Mr.Tate—All boys.

Mr.A.L.Steavenson—I think you should ask us to go and see it and discuss it there.

Mr.Tate—We shall be glad to see you at any time.

Mr.Blackett cited a colliery in Derbyshire where a thousand tons a day went over one kick-up,and there the full tub was pulled in and the empty one pulled out. Mr.Tate's was an improvement on that,for the tub ran through the kick-up and a full tub coming displaced the empty one.

Mr.Bell—Yes,that is a saving of time.

Mr.Stratton said he did not consider a thousand tons a day a large quantity to deal with,but he thought it was perhaps rather an extreme case to say that the quantity going over the one machine could be doubled. If the apparatus worked full nine hours a day that only allowed,on the seventy scores Mr.Tate referred to,about twenty-four seconds for each tub : he could hardly bring that down to twelve seconds,especially if the tub was twice weighed.

Mr.Tate—The tub just goes over and back again ; we can team it quicker than we can draw it out of the pit.

Mr.Thos.Bell thought the kick-up and travelling belt were quite capable of taking twice their present quantity.

Mr.Blackett said it might be some guide to mention that it was usual with them to change the tub and draw the coals from the bottom of the pit in twenty seconds.

Mr.Bell—What depth ?

Mr.Blackett—Forty fathoms.

Mr.Bell—What is yours,Mr.Tate ?

Mr.Tate—One hundred.

Mr.Blackett—I am only speaking of changing and drawing out of the pit—twenty seconds—as against the kick-up.

Mr.C.C.Leach asked what brought the tub to rest in the kick-up ?

Mr.Tate explained (illustrating with a sketch on the blackboard) that the road was "dished" a little.

Mr.Bell said many cages were fitted in the same way without the sneck. The full tub coming in knocked the empty one out.

Mr.A.L.Steavenson said Mr.Tate did not debit himself with cost of steam,nor did he give the horse-power required. This information would be useful.

Mr.Stratton hoped the discussion on this paper would not be closed to-day,but that this paper,and that by Messrs. Forster and Ayton,would be discussed together.

The President—But anything you do to-day will assist the further discussion of the other paper. Don't stop the discussion of this paper for the sake of the other. They would be sure to come together afterwards,and he would suggest that the present discussion be carried as far as possible.

Mr.Stratton said there was one point,then,which he might mention,which was of interest to those who had belts. How did Mr.Tate deal with stones ? Did he run more than one kind of coal at a time ? Were the stones loaded into wagons,and how ?

Mr.Tate said there were three kinds of coals. Referring to the diagram on the wall,he explained that the peas and duff went out behind ; the stones were just teamed by a shoot into wagons.

Mr.Stratton—By hand ?

Mr.Tate—Yes.

Mr.Stratton said he meant by his question the different kinds of good coal separated.

Mr.Tate said they made only one kind of best. If other separation were desired they could have a middle partition for the best,and run it into a separate wagon.

Mr.Bell said it was rather objectionable to have a separate box and belt. It had been tried at Rainton,and failed. It got mixed at the far end,and got wrong in other ways,and was eventually taken out.

Mr.J.G.Weeks asked if Mr.Tate anticipated any difficulty in "laying out" when running at such a speed ?

Mr.Tate said 1,000 tons a day were being put over the screen at a Durham colliery. If the manager had been present he could have told them something about it. They had an ordinary old-fashioned kick-up,and there was no difficulty in laying out. As soon as a tub was teamed and ran down the spout,the lad at the handle saw if it was dirty,and if so he put a box on. It stayed there till it got to the end,and was laid out in the usual way.

Mr.Bell supposed the belt was running at such a speed that when a tub was on there was an empty space on the belt,and the box would be put on the space represented by the dirty tub.

Mr.Tate—Yes.

Mr.J.G.Weeks said that was not his experience ; it was generally one continuous stream from one end to the other.

Mr.Stratton said his attention had been drawn to this very point not long ago by a gentleman who had a large belt running a thousand tons a day,and it was,as Mr.Weeks said,a river of coal and no space. It ran uninterruptedly for the half hour he watched it.

Mr.R.L.Weeks—But we get an opportunity of cleaning the best and small,whereas at the colliery named they have treble nuts and double nuts and have not a chance to clean them.

Mr.Bell thought perhaps the colliery named was a different case,because they had a very wide screen,something like 1.25 inch mesh,and not fifty per cent,of the coal went on the belt,the other went through into the common hopper. They had the chance of sending a thousand tons over the belt and cleaning it.

Mr.J.G.Weeks—Then,there will be only about 500 tons going over the belt ?

Mr.Bell—That is what I mean ; the other is going through into the common hopper.

Mr.Blackett said,over the belts he had in use they cleaned nothing but unscreened,and it was not possible,as far as he could see,to do anything like a thousand tons over a belt. There might be a thousand tons over the kick-up,in the ordinary way,but screen them,and they did not get much more than half that to clean on the belt. When he put up a belt at Kimblesworth—the first they had— he had no idea how much unscreened they would get over the belt, and the very utmost they had been able to do at Kimblesworth was 500 tons,and even that could not be properly done ; still,they had no difficulty in cleaning the coals.

Mr.R.L.Weeks—How many screens had you before you adopted the belt ?

Mr.Blackett—About eight ; and now we have a belt we are able to work with one belt and two screens.

Mr.J.G.Weeks—What is the length of the belt ?

Mr.Blackett—90 feet,and 4 feet wide. We have another,70 feet and 5 feet wide.

Mr.J.G.Weeks—Do you find the wide width as easily worked as the narrow ?

Mr.Blackett—Yes. They had a novel way of turning coals over on that belt,by fixing an ordinary ploughshare above the belt in the first instance to turn the heap of coals over,and other ploughshares further along to turn them back. He was uncertain at first as to whether these ploughshares would break much coal,but there was no breakage to any appreciable extent.

Mr.J.G.Weeks thought they had something of the same kind at Heworth Colliery.

The President—The object desired to be attained by cleaning was a very important one in many collieries in the North,because it affected the question as to whether the coke was to be clean or dirty. That perhaps caused it to be a matter of greater importance than if it was simply a question of quantity. Each gentleman,however,might now prepare himself against the time Mr.Forster's paper came on,and if it was the opinion of the present meeting that the discussion should be adjourned,to come on at the same time as that on Mr.Forster's paper,perhaps some one would propose it.

Mr.Bell said he thought when Mr.Forster's paper was read,that gentleman was kind enough to say he would invite the members to visit the colliery. He would respectfully suggest that such visit should take place before the next discussion ; it would materially help the discussion,and be of advantage to the Institute.

The Secretary stated that the paper would be published in March.

The President thought Mr.Bell's suggestion valuable. He would endeavour to have it carried out if possible.

Mr.Tate said,as far as he was concerned,he would be glad to see the members of the Institute,individually or collectively,at East Hetton.

The President asked if it was the wish of the meeting that the discussion on this paper should be adjourned as suggested ? As Mr.Tate had been kind enough to give them a challenge,and say he would be glad to see them,they would now have an opportunity of seeing the screens in operation.

Mr.Willis thought it would be a pity to formally close the discussion. Let it remain open.

The President—Then it is understood that the discussion stands adjourned.

The Secretary—To be taken with that on Messrs.Forster and Ayton's paper ?

The President—Yes.

The President said he supposed that most of the members knew,and it was only necessary perhaps for him to make a formal report,that what might be considered a very successful meeting had been held at Sheffield on the 22nd and 23rd of January in connection with the Federation of Institutes,and,in order that they might know a long time in advance,it had been decided that the next Federated meeting would be held in London on the last day of April,but of this due notice would be given.

This concluded the business,and the meeting terminated.

Referance to followring pages.

To illustrate Mr. Bayldon's paper on "The Hauraki Mining District,New Zealand."

Vol.I. PlateI. Fig.I. Fig.2. Fig.3. Fig.4. Fig.5. Fig.6. and Fig.7.

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To illustrate Mr.Bayldon's paper on "The Hauraki Mining District,New Zealand."

Vol.I. PlateII. Section across Thames Flat.

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Proceedings.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL

ENGINEERS.

GENERAL MEETING,

Held at the Wood Memorial Hall,Newcastle-upon-Tyne,

on Saturday,April 12th,1890.

Mr.John Marley,President,in the Chair.

The President said that the minutes of the last meeting could not be read,and the proceedings of the Council could not be reported,owing to the absence of the Secretary (Professor Lebour) through illness.

The following gentlemen were elected,having been previously nominated:—

Member—

Mr.Hiram Craven, Jun.,Mechanical Engineer.Sunderland.

Associate—

Mr.Edgar Ormerod Bolton,Mining Engineer,Executors of Colonel Hargreaves, Burnley.

The following gentlemen were nominated for election :—

Members—

Mr.C.H.Eden,Mining Engineer,Old Etherley.

Mr.Leonard Francis Gillett,Mining Engineer,Derby.

Mr.W.H.F.Maddison,Mining Engineer,The Lindens,Darlington.

Associate—

Mr.John William Fryar,Mining Student,Seghill Colliery,Seghill,Northumberland.

A paper by Mr.W.Ramsay on "Ramsay's Patent Improved Levelling Staff for use in Mines"was read.

RAMSAY'S PATENT IMPROVED LEVELLING STAFF FOR USE IN MINES.

By W.Ramsay.

Various kinds of levelling staves are described in treatises,but few of them have been found to be practically applicable to general use for mining purposes.

The old construction,the non-speaking staff,has many adherents,although the observations are recorded by an assistant required to possess sufficient intelligence to be trusted with the responsible duty of recording the results.

With the speaking staff,if the sights exceed a very limited distance,the observer soon begins to experience difficulty in reading the figures through the telescope.

This difficulty arises from many causes : it may be from moisture or dust in the air,indistinctness in the graduated face of the staff,and most frequently from the difficulty of illuminating the face of the staff with a miner's lamp.

The writer,in consequence of these difficulties,has devised an arrangement which he believes will prove useful in practice.

The staff is formed after any of the ordinary constructions,except the part a (Plate I.) carrying the scale,which is formed of any transparent material,such as white opal glass,with a ground or enamelled surface. The staff consists of two parts,b and c,which are packed together by sliding,and when drawn out for use form a staff of convenient length.

The divisions are placed upon the transparent surface with any opaque colours,so that when a lamp or other source of light is held behind the staff,the reading can be distinctly observed at considerable distances through the telescope by the surveyor.

Comparative trials with the staves,side by side,have shown that using the same telescope the improved staff is read with ease when a speaking staff of the ordinary construction is read with difficulty,or even cannot be read at all.

The improved staff is read with facility where an ordinary staff could only be read by means of an improvised vane placed in front of it.

With the improved staff all chance of error in the readings is eliminated,except on the part of the observer himself. Further,there is the advantage that the lamp placed behind the staff illuminates nearly the whole of the scale,and the observer can,in most cases,take his reading without any alteration in the position of the light.

The advantages as regards accuracy and saving of time are so great,by the use of the improved transparent levelling staff over those of the old constructions,that the writer believes that its universal adoption will be ensured.

The President asked Mr.W.Ramsay,who was present,to exhibit the staff and explain its advantages.

Mr.Ramsay said he found,from experience,that mistakes were frequently made in the readings with the old style of staff. When working at a distance the man at the staff was frequently told to run his finger along the staff,and the surveyor called to him to-stop and read off the figures ; if there was a mistake the responsibility always fell on the man at the staff. With the staff just described,the figures could be plainly read by the surveyor,when a light was placed behind the transparent staff,the figures being painted with opaque pigment on a white background of frosted glass or other transparent material. The operator is able to make his own readings,under all circumstances,when used underground,or on dark nights.

Referance to following page.

To illustrate Mr.W.Ramsays paper on "Ramsay's Patent Improved Levelling Staff for Use in Mines."

Vol.I. Plate I.

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Discussion—Ramsay's Patent Improved Levelling Staff.

Mr.W.Lishman (Witton) said that such a staff must prove very useful,and especially for underground work,where its use appeared to enhance the accuracy of the results.

Mr.W.Ramsay then explained the sliding arrangement,by which the staff could be used in seams varying from 3 to nearly 6 feet in height. The staff has been in use for nearly a year,and he found that the work could be done with it in about one-third of the time required with the old staff.

Mr.T.W.Benson said the usefulness of the staff was not to be judged by the length of the paper ; it would be extremely useful. He knew,from recollections of the time when he had to take levellings himself,that there was nothing more tedious than making a levelling down the pit,and from the description of Mr.Ramsay's staff he thought it would enable a surveyor to do his work in very much less time,and,instead of being dependent upon the assistant,he would make his own readings,which was a very important advantage. He did not think they should deprecate the reading of short papers ; they were probably of more practical value than those occupying more space,and it was with much pleasure that he proposed that the thanks of the Institute should be given to Mr.Ramsay. It was not a staff essentially for underground use ; he thought it would have proved very useful fifty years ago to those who made flying surveys at night for projected railways at the risk of having men with pitchforks after them.

Mr.M.Walton Brown said he had great pleasure in seconding the vote of thanks to Mr. Ramsay. He had seen the staff in use,and it was incomparably superior to the ordinary staff,owing to the clearness with which the readings were made ; when seen in use,its value was at once appreciated. There was a great difference between the use of the new staff and the old one ; with the new staff,a light placed behind it was sufficient.

The President asked if it was necessary to raise or lower the light to take readings of the first three feet ?

Mr.Ramsay said it was not necessary ; a light placed behind the staff illuminated its whole length.

Mr.Blackett thought that for use in the daylight it would be better than the old white painted staff with black figures.

The President agreed with Mr.Blackett,but he thought the light from behind was an advantage.

Mr.C.C.Leach asked if the red figures showed clearly with the light behind,and also how many staffs he had broken ?

Mr.Ramsay said the figures showed clearly with a light behind,and that he had not broken a staff ; if a man had one of these staves he would be careful,and ordinarily there was not much risk of breakage. (He showed the tin case in which the staff was carried.)

The President asked the weight of the staff,and who was the maker ?

Mr.Ramsay said that the weight was about 1.5 lbs.,and about 3 lbs. inclusive of case ; Mr.T.B.Winter made it.

Mr.Elwen asked if dust and dirt would have any effect upon the figures.

Mr.Ramsay—Not the least,it is glass on both sides,and can be freely cleaned with water.

The President invited the members to handle and examine the staff. Levelling was one of those practical matters which they had to deal with daily,and the staff was most valuable if they performed a levelling with it in one-third of the time occupied with the ordinary staff,and more especially if the work was done without the necessity of bullying the staff-holder.

Mr.Leach asked if Mr.Ramsay had noted the greatest distance at which the staff could be used ?

The President thought that this distance would depend a good deal on the power of the telescope used. What was the general length of the sets between the telescope and the staff ?

Mr.Ramsay said they had taken very long sights,and had experienced no difficulty in making the readings. It was perfectly clear at a distance of 100 yards in the dark with a light behind the staff,but this of course depends upon the power of the telescope used.

The vote of thanks to Mr. Ramsay for his paper was unanimously agreed to.

The President then stated that one of their Vice-Presidents,Mr.A.L.Steavenson,who had been visiting some parts of Spain,would make some remarks on his visit,and illustrate them by photographs,adding a few words on the advantage of photography to the mining engineer.

ON THE VALUE OF PHOTOGRAPHY TO MINING ENGINEERS.

Mr.A.L.Steavenson said that about two months ago he received instructions to visit a mining property in Spain. He started with a friend,journeying first to London and Paris,next day to Bordeaux,where they met with the mosquitoes,and the following day to Bilbao,which they reached at five o'clock,the fourth night of a long but very interesting journey. At Bilbao they met with a friend who could speak Spanish,and was acquainted with different matters of interest connected with mining,knowing the different mines and their values,and without the advantage of his company it would have been a very difficult matter to complete their business. The first day was devoted to seeing the shipment of ore,and in order to realise what they saw and to bring home some little information for his friends he had taken with him a small camera.

The ore was shipped in steamers,and he was told there were at that time about 200 steamers waiting for ore. (Photographs exhibited.)

In the afternoon they went to one of the mines,adjacent to Bilbao,and not more than a mile and a half distant,and found the ore being carted in ox-carts,down roads about two feet deep in mud.

In some cases they found the ore being brought down by wire-rope tramways. He did not know whether the members present had seen any of these tramways at work ; the ropes were run at a considerable speed,and carried boxes containing from 7 to 8 cwt. of ore. (Photographs exhibited.)

The following day,in order to make themselves acquainted with peculiarities of the ore,and to see a really good mine, they went to the Orconera mine or quarry. (Photographs exhibited.) They found that immense deposits of ore were being worked. The deposit was from 40 to 50 feet thick,and he believed that they had other 40 or 50 feet below that. After separating about 10 per cent,of dirt,the residue contained 50 per cent,of iron,and they had no chance of competing with that in England,if it were not for the distance from this country and fuel.

In one mode of shipping (photograph exhibited) a spout was lowered towards the ship,and a trunk lowered to the bottom of the hold ; this photograph was taken at six p.m.,when the light was not very good,but it showed the details of the machinery.

Before reaching the mines they had been deputed to visit,they went to a branch railway station and stayed at a little hotel,so as to make an early start the next morning. Carriages were ordered for seven a.m.,but when they got up a heavy

snowstorm was raging,and they were told it was impossible to think of going to the mountains,either that or the next day. They considered the best thing they could do was to go away to some cathedral town,where there would be something to see and better accommodation than in a country railway station hotel ; and they went to see one of the finest cathedrals in the world—

Burgos—(photograph exhibited) and stayed there until they received a telegram saying the mountains were clear of snow.

In going up the mountains,of considerable height,they had the pleasure of seeing eagles soaring above them,an opportunity not often met with in England.

On the hill side they found the deposit they had gone to inspect ; it extended for some distance.

(Photograph exhibited.) The deposit was a curious one,and as far as they could see,it was neither a lode nor stratified.

From the average of some eleven or twelve bore-holes the thickness of the ore did not amount to more than 10 yards,but it extended from the top of the hill to the bottom,a distance of about 300 yards,and perhaps 200 yards wide. He had never seen anything of the kind,before ; the deposit appeared as if it had been simply poured over the side of the hill. People who understood the geology of the district said it was a cretaceous formation,and was really a deposit of iron from a hot spring.

He took one or two photographs of the style of houses,and it would be seen that the cattle were housed below,in the bottom part of the houses,the people living above. (Photograph of roadside hotel exhibited.)

He would just take the opportunity of pointing out the advantages of a knowledge of photography to engineers,more especially as there were a number of young members present. For the purpose of taking the photographs submitted, everything required could be carried on a long day's walk,and there was the advantage of obtaining views of not only matters of interest to oneself but to others who could not or did not go to see them. The negatives being obtained, copies could be printed off to the number desired,and any of the photographs exhibited to them could be enlarged to the size of the diagram on the wall.

Mr.Steavenson said after exhibiting a few more photographs,that if anyone wished to ask any questions he would be pleased to answer them.

The President said they were greatly obliged to Mr.Steavenson for bringing forward such a useful and interesting subject,and invited discussion.

Mr.W.J.Bird asked if there was,in Mr.Steavenson's opinion,any foundation for the idea,more or less prevalent,that the richer ores of the Bilbao district were approaching exhaustion,and the average richness of the ore was now diminished ?

The President said he had been over the mines referred to by Mr.Steavenson and,therefore,appreciated his remarks. Did Mr.Bird apply his question to vena,rubio,campanil,or the ores generally ?

Mr.A.L.Steavenson said that the existing mines were exhausting the best of the ore ; but in a large district of an area equal to that of the county of Northumberland,when one hill of ore was exhausted they might find another by looking for it ; although they were exhausting the known supply,they were perhaps not exhausting the available supply. There was one thing,they had to go further inland for fresh supplies,and future workings would have to bear the cost of longer railway carriage. The mine railways were very simply made,and the cost of carriage by rail would be very much the same as in this country,except that fuel was a little dearer. The oxen carried loads of about two tons in carts ; they were very powerful animals and travelled very slowly,but it was disgraceful to see the roads they had to travel.

Mr.Blackett said he could corroborate Mr.Steavenson's remarks as to the great value of photography to mining engineers,he had found it extremely useful as a means of providing evidence of anything which was likely to change,or about which evidence might be valuable in the future. It was almost as easy now to take photographs underground as on the surface. He would like to compliment Mr.Steavenson on the excellence of his photographs,which spoke highly of his ability as a photographer.

Mr.W.Lishman (Witton) said they were all very much obliged to Mr.Steavenson for his remarks,and asked what kind of light was required for photographing underground ?

Mr.Blackett said he thought the magnesium light was the best.

Mr.Steavenson said,while he was speaking of the advantages of photography,he would add a word or two about underground photography. He had on two or three occasions tried to take photographs underground,and one of his results,a waggon running round a curve with a rope underneath,was now hanging in the Council chamber. It was not a difficult matter ; he preferred magnesium wire to the use of magnesium powder for obtaining a light sufficient for photographing. The best way was to give each assistant—they generally had one or two with them—one or two feet of magnesium wire to light and hold near the object to be photographed.   He started to take photographs underground some eight or ten years ago of some fungus in the Cleveland mines ; they often had very large fungi,and he thought them so beautiful that they would be interesting as photographs ; since then he had taken views of tubs and machinery underground. The magnesium light could not be used in a fiery mine,and,as it made a good deal of smoke there should be a sufficient current of air to carry it away at once.

Mr.W.Lishman (Witton) proposed a vote of thanks to Mr.Steavenson for his entertaining remarks.

Mr.M.Walton Brown seconded the proposal,which was carried with acclamation.

FLAMELESS EXPLOSIVES COMMITTEE.

Mr.W.Lishman (Witton) referred to the appointment of a committee some years ago to report on the use of fiameless explosives in mines ; he wished to know if any experiments had been made,and,if so,when would the results be communicated to the members of the Institute ?

Mr.M.Walton Brown said he was a member of the Flameless Explosives Committee ; they had prepared and approved a scheme for the carrying out of the experiments,and obtained estimates for the erection of their apparatus, which would cost about £300. The matter had been laid before the Council,who proposed to ask the Coal Trades Associations for monetary assistance.

The President said it was now only a question of ways and means.

Mr.W.Lishman asked what was the best step to take to raise the money in order that the experiments should be carried out ?

The President said he thought the best course was that proposed by the Council,to apply to the coalowners' associations for subscriptions.

Mr.W.Lishman said it was a most pressing matter so far as the trade was concerned.

Mr.Thos.Bell (H.M. Inspector of Mines) said it had been pressing for some time,but it had now become a most important matter.

The President said the Council proposed to bring it before the owners'associations,together with a digest of the principal points of the proposed scheme of experiments,and a request for a contribution to the expense.

Mr.Lishman apologised for being so imperative,but he wished to know,if they received an unfavourable answer from the coalowners,were there any other means of getting subscriptions. If the owners refused as an association they would not refuse to subscribe individually.

The President said he thought the coal-owners would be more likely to subscribe as a body than as individuals.

Mr.Blackett asked if there were any precedent for an application to Government.

Mr.Thos.Bell said the Government would no doubt think they had already gone to great expense in carrying out the elaborate experiments of the late Royal Commission on Accidents in Mines,and would probably not feel inclined to spend more money at present,and if applied to for a subscription it is possible that the reply would be a refusal, accompanied with a copy of the Report of that Commission.

This concluded the business of the meeting.

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Proceedings.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

GENERAL MEETING.

Held in the Wood Memorial Hall,Newcastle-upon-Tyne,

on Saturday,June 14th,1890.

Mr.George Baker Forster,Past-President,in the Chair.

The Chairman said he had much pleasure in informing the members that their President,Mr.Marley,was very much better,and hoped soon to be with them again.

The confirmation of the minutes of the previous meeting was postponed.

The Secretary said the Council that day had among other things agreed to recommend that the next meeting of the Federated Institution should take place towards the end of July—about the 24th—at Edinburgh. Full details of the proceedings on that occasion would be issued to members in due time,and he would like to notify that if any member had any special paper to send for that meeting it should be sent in early,as it would take some time to get the papers properly ready for the meeting.

The following gentlemen were elected,having been previously nominated:—

Members—

Mr.C.H.Eden,Mining Engineer,Old Etherley.

Mr.Leonard Francis Gillett,Mining Engineer,Derby.

Mr.W.H.F.Maddison,Mining Engineer,The Lindens,Darlington.

Associate—

Mr.John William Fryar,Mining Student,Seghill Colliery,Seghill,Northumberland.

The following gentlemen were nominated for election:—

Member—

Mr.J.R.M.Robertson,M.D.,F.G.S.,Mining Engineer,Linton,Mitson's Point,Sydney.

Associates—

Mr.Edward Taylor Cheesman,Colliery Manager,Blaydon Main Colliery, Blaydon-on-Tyne.

Mr.Thomas Rontree,Colliery Manager,Harton Colliery,South Shields.

The Chairman called upon Professor Lebour to read a paper "On Ancient Washes in the Coal-measures."

Professor Lebour said he must apologise for appearing as the writer of a paper,but the President,although much better,had not sufficiently recovered from his recent illness as to be able to read his promised paper on "Salt in South Durham ;" he therefore submitted a few observations on the subject of "Ancient 'Washes' in the Coal-measures."*

* This paper will be printed in Vol.II. of the Transactions.

DISCUSSION ON PROFESSOR LEBOUR'S PAPER ON "ANCIENT 'WASHES' IN THE COAL-MEASURES."

Mr.J.B.Simpson said he had listened with very much interest to the remarks of Professor Lebour. What he had to say would be very brief,and referred to underground "nips-out,"of which he had only had time that morning to make diagrams. In the Five-quarter Seam,at Towneley Colliery,about 300 yards distant from the shaft,they came across a "nip-out"(Fig.1,PlateI.),and after driving forty yards through it they got into the coal again. There was no fault,they went perfectly straight through,and the workings went 2,000 yards further before another "nip-out" was met with. A section of the first "nip-out"at C D (Fig.1,PlateI.) is shown in Fig.2,PlateII. On the east side of the " nip-out,"the coal was of the usual thickness,although it tapered sharply as shown on the section (Fig.2,PlateII.). The seam before coming to this "nip-out,"was about 3 feet 4 inches thick,and after passing through 40 yards of sandstone,they found on the west side that sometimes it fortunately increased to 6 feet or 8 feet,and this extended over an area as large as that which had been washed out. In some places there was no thickening of the seam on the western side,but he felt quite sure that if they made an exact calculation they would find they had got as much additional coal on the thicker side as would make up for the loss of coal "nipped out." The same held good with regard to the second "nip-out" (Fig.2,PlateI.) ; on the western side they found a thicker seam as shown in the section (Fig.1,Plate II.) of the drift A B (Fig.2,Plate I.). Contrary to what the geologists alleged to occur,there was no fault,and the coal was nearly always found without any rise or dip on the other side of the "nip-out." They had pretty much the same thing in other parts of the colliery. The two "nips-out"shown on the diagrams were the largest ones they had ; they had not proved how far they extended to the north and south,bat he supposed each had been proved about 1,000 yards. The peculiarity was that in the seam 15 fathoms above there were no signs of them,they were purely local to the seam. Of course,the seam resumed its normal thickness when they got a considerable distance away towards the west.

Professor Lebour asked whether the coal on the side where it was thickest was of the same quality ?

Mr.Simpson—Yes ; a peculiarity is that there is a band,and on the west side the band is not quite as thick,but more

"higgledy-piggledy." The strata here are mostly hard sandstones. We have never found a single boulder.

Mr.W.C.Blackett said he would like to ask Mr.Simpson whether he thought it possible that the top part of the thicker seam was upside down ? He would also like to ask Professor Lebour whether he thought,from Mr.Simpson's description,that it was a true "nip-out?"

Mr.Simpson said he could hardly call it upside down,but it was very much

Referance to following pages.

To illustrate Mr.J.B.Simpson's remarks "On Ancient Washes in the Coal Measures."

Vol.I PlateI. Stella and Towneley Collieries. Emma Pit. Plan shewing Nips Out in Five Quarter Seam.

Fig.I. No.I. Nip Out. Fig.2. No.2. Nip Out.

See library for image.

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To illustrate Mr.J.B.Simpson's remarks "On Ancient 'Washes' in the Coal Measures."

Vol.PlateII. Stella & Towneley Collieries.

Section A.B. (Plate I.) of Nip Out in Five Quarter Seam. Fig.I.

Section C.D.(Plate I.} of Nip Out in Five Quarter Seam. Fig.2.

See library for image.

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mixed up. Of course,in a colliery they knew their own seam when they saw it again,but the upper part he could not recognise as the same they had before ; the lower part was recognisable,but not the upper part.

Mr.Daglish said the terms,"roll," "nip,"and "wash-out"had been used somewhat indiscriminately. He ventured to think they were three distinct things. They met with "rolls"—especially with a post-roof—where the roof came down,it might extend a considerable distance,but it was of the same material as the roof,and these "rolls"were local. They met with "nips-out"underground like that described by Mr.Simpson—he (Mr.Daglish) had experienced several in Wales—no change being met with in the overlaying seams,but a great thickening extending over the seam affected in approaching the "nip-out;"there was no deterioration except,perhaps,that the coal was a little softer,but still of excellent quality,and in some cases a 4 feet 6 inch seam became 10 feet and even 12 feet high,and somewhat dangerous to work. In this district,too,they had action of that kind. The Low Main Seam was "nipped-out,"not by alluvial deposit but by rock,over a great portion of the Belmont estate,and over the whole of the Grange estate. Then,again,they had the ''wash-out,"such as the Team "wash"or "drift"(described in Messrs.Nicholas Wood and E.F.Boyd's paper,in Volume XIII.of the Transactions of the North of England Institute),which passes beside Kimblesworth,and where he (Mr.Daglish) thought there was no alteration of the seams except a little reddening,and they passed from the seams into alluvial matter of a totally different character to the Coal-measures.

Professor Lebour said he ventured to think Mr.Daglish was perfectly right in saying the three terms,"roll," "wash,"and "nip-out,"should be applied to different things. They were three distinct phenomena,and it would be well to describe them by those terms which were now but loosely applied. A "wash "—that is,an ancient "wash "—being often described as a "nip-out,"and sometimes by other terms. "Roll" was more generally limited to what it meant—a thinning of the coal—and as Mr.Daglish mentioned,there were a great many of these in the Low Main Seam in certain parts of the Durham coal-field. He would very much like to ask Mr.Daglish if he had any knowledge of the "nip-out"at Whitley ?

Mr.Daglish said he was not familiar with it,but he did not think if it had been met with underground that the thinning out of the seam would have had anything to do with it. From the diagram,he would say it was a "wedge-out,"not a "nip out." Was the diagram properly drawn ?

Professor Lebour agreed that it was a case of "wedge-out." He thought it was properly drawn,although there was a great deal of false bedding in the sandstones.

Professor Merivale said he was familiar with the "wash-out,"or "nip-out,"or whatever it might be,in the neighbourhood of Gosforth,and he thought it was drawn correctly,but he could not tell what it was ; he had often been puzzled over it.

Certainly there was no thickening of the coal as was noticed in so many of the "washes"or "nips-out" in their collieries. He thought one of the largest of these was at Broomhill. About 440 acres,he estimated,of their Main Seam had been swept away,the seams both above and below remaining intact,and the thickening of the coal near the "wash"and in an island of coal in the middle of the "wash" was very marked indeed. It ran 6 or 7 feet of clean coal,without a band in it,in the neighbourhood of the "wash-out,"but half a mile away the seam thinned down to 4.5 or 5 feet of coal with a band in it. The rock was hard—he understood Mr.Daglish wished to make a distinction between the hard rocks of the "rolls" and the softer rocks in the "wash." Whether that really had anything to do with it or not he did not know,or whether with the hard rock they would expect the seam to be thicker,and with the softer beds they

would not expect it to thicken. He did not quite know whether there should,be any connection in this way,but at Broomhill the seam was certainly very much thicker. It seemed possible that they would get a thickening,if the vegetable matter was washed away before it had begun to consolidate,for it would then have had a better chance of being pushed aside and accumulating on either side of the "wash,"whereas if it had begun to consolidate it would more probably have been swept away. He did not understand how the smaller "washes"—or whatever they should be called—were formed. One would have supposed the river would have washed a way through a considerable distance instead of picking out a bit here and a bit there.

Mr.J.B.Simpson—Would it not rather depend on the level at which the stream was running ?

Professor Lebour—And the plane along which the river was running may have altered.

Mr.J.B.Simpson said there was an interesting "wash"at Prudhoe and Mickley ; interesting from a scientific point of view,though not interesting to the coal owners. The Five-quarter Seam was washed out for a width of about 800 yards; and the Six-quarter and Three-quarter Seams were not so much washed out as the upper one. They had just reached the same "wash"in the Brockwell Seam,which was denuded for a breadth of about 40 yards. This large "wash"had been proved,in the Five-quarter Seam,to have a length of about 2.5 miles,and was situated at a considerable height above the sea-level,but joined,he supposed,the great Tyne "wash"and the Team "wash,"the latter of which was so ably described by Mr.Wood and Mr.Boyd. No doubt,it was the same "wash,"and might be made the subject of a very interesting paper,especially if the observations of Messrs.Boyd and Wood were continued up and down the Tyne.

Professor Lebour—I always thought Mr.Simpson was busy on that.

Mr.W.C.Blackett said,with regard to the Team "wash,"the coal in approaching it did not thicken at all,but simply deteriorated in quality.

The Chairman—Is it an alluvial "wash ?"

Mr.Blackett—Yes ; and he would like to draw attention to the great difference between the alluvial "washes"and the other "nips-out"mentioned. No deterioration of the coal was found in those described by Mr.Simpson,and that would seem to point to some difference in the ways in which the coal had been denuded,and in the length of time during which the denudation was effected. They had had great difficulty in going over the royalties at Charlaw,Kimblesworth, and Sacriston,where there were some curious "nips-out." In one place the seam went suddenly down in the form of an ordinary "nip,"from 3 feet to 10 inches,and continued evenly at this height for a long distance. They had not explored it right through,but it eventually resumed its original height of 3 feet. In another case they had a clean "nip-out,"260 yards wide,and the coal immediately adjoining was as good as anywhere else.

Mr.Simpson asked the length of the 260 yards' "nip?"

Mr.Blackett said they had not been able to find out. The great difference was—and it was most noticeable—that in the ancient "nip-out"where they usually had a post-roof the coal did not deteriorate in quality even to the very edge, while in the alluvial "washes"the coal was bad for perhaps 100 yards before reaching it. He wished to know whether,in some of the cases of thickened coal approaching a "nip-out,"which had been mentioned,it was possible by any means whatever that the seam which had occupied this space could have been turned bodily over ?

Professor Lebour said he was afraid he could not answer Mr.Blackett's question.

It might possibly have drifted over,but then it would be,as Mr.Simpson described it,"higgledy-piggledy," and not turned over bodily.

Mr.T.H.M.Stratton said that,bearing on the question of "washes-out," they had a series of them at Tredegar which affected every seam in a royalty of over 5,000 acres. These "washes-out,"or "barren grounds"as they were there termed,were,as suggested by Professor Merivale,like the bed of a river,but they were not continuous,and in the middle of the "barren ground" little islands of coal were frequently to be found. A "wash-out"or "barren ground" could always be calculated on in a certain general position,but they were not always of the same description ; in this one royalty they had all the kinds mentioned to-day. In some cases the coal was good right up to the edge of the "nip-out;"in others it was soft and inferior for a considerable distance. It gave the general impression that a river had removed the coal when in a soft state,and this was confirmed by the fact that frequently the washed out coal was simply deposited on the top of the adjacent seam,thus doubling and sometimes tripling the normal thickness of the seam. The course of the seam could always be traced ; the thill or clay was under where the seam once had been. In one case he thus traced a seam,for nearly half a mile. It was difficult to explain,and no theory was perfectly satisfactory.

The Chairman said he had much pleasure in moving a vote of thanks to Professor Lebour for his very interesting notice of these ancient "nips-out," and now that the point had been raised he thought that they should try to elucidate the facts and gather up examples from which alone they could,perhaps,derive a theory.   He thought himself there was some difference between alluvial "washes" and what they called "nips-out" underground. In the alluvial "washes" there was no pressure,whereas in the large "nips" found underground there must have been considerable pressure. He had seen some of the Midland "washes" Professor Lebour alluded to,and there was always disturbance of some sort. He recollected one case where the cannel had been carried to another part of the seam,which became a seam with two distinct beds of cannel. With regard to Professor Merivale's suggestion as to the course of the river bed,they did not know whether there may not have been large pools or holes in which the sand was deposited. He had noticed,too,in places along the shore,where the tide some times came and sometimes did not,a kind of peaty vegetation grew up,in which there are often hollows. How this was caused he did not know,but it seemed to him that something of this kind might have prevailed and had its effect in regard to the action of the ancient "washes." He hoped they would follow out Professor Lebour's advice and continue this subject,and more especially that Mr.Simpson would proceed with his paper.

The vote of thanks was carried with acclamation.

DISCUSSION ON MESSRS.T.E.FORSTER AND H.AYTON'S PAPER ON

"IMPROVED COAL SCREENING AND CLEANING."

The Chairman announced Messrs.T.E.Forster and H.Ayton's paper "On Improved Coal Screening and Cleaning"   open for discussion.

Mr.Ayton said,before entering on the discussion,he would like to mention that one or two alterations had been made in the table of costs since the publication of the paper,as follow:—

On page 94,

Table of Costs,Etc.

Column.	3.	11.
Total percentage picked out	8.44	19.40
Total load on belts in tons	482	140
Percentage of load picked out	15.06	33.25
	d.	d.
Cost per ton on coal cleaned	1.10	2.28

On page 98,line5,for "bucket" read "locket."

Professor Merivale suggested that some date should be put to the table of costs.

Mr.Ayton said the costs had all been calculated to the same time (October,1889) ; in some cases they had found it necessary,from the prices prevailing at different times,to reduce them all to a basis or standard.

Professor Merivale said he would like to ask Mr.Ayton if he had had any difficulty with the belt ? Theirs had been most successful,and they picked out 25 per cent,more stone,saving about 0.5d. per ton,but it made a fearful squeaking.

The Chairman—It wants a little oil.

Professor Merivale—We spend about 15s. a-week on grease,so it is not that.

Mr.Ayton said he had not experienced any difficulty in that matter. Perhaps the rollers were set a little too low.

The Chairman asked Mr.Steavenson if he had any remarks to make ?

Mr.Steavenson said he had not. The object in their district was to get the coal small ; if they did not get it small enough they smashed it with a breaker.

Mr.J.B.Simpson—I think Mr.T.E.Forster might give us his experience on this subject in Australia.

DISCUSSION ON MR.ARNOLD LUPTON'S "NOTES ON THE MEDIUM FAN."

The Secretary stated that Mr.Lupton had intended to be present,but he had that morning received a letter from that gentleman stating his inability to be present,and saying that he had sent some diagrams for the meeting. These,however,although it was ascertained that they had arrived in Newcastle,had not yet been delivered,but they were reproduced in the paper,of which copies were on the table,and could therefore be referred to by any gentleman who wished to take part in the discussion. Mr.Lupton was anxious that the discussion should be proceeded with in his absence,and any question which might be asked would be forwarded to him.

Mr.A.L.Steavenson said the subject of fans was one which had often been discussed here,and he would not now occupy the attention of the meeting many minutes. The paper seemed to be another instance of the mistakes inventors were apt to fall into. As was pointed out when the paper was first discussed at the Midland Institute,the results said to be attained—107 per cent.—meant more than perpetual motion ; it was therefore quite clear that the experiments given were a mistake. He agreed with much of the paper. It was essential that a fan should "produce the required ventilation without breakdowns," "work with the maximum

of economy,"and"require the minimum of capital outlay,"and under ordinary circumstances he agreed that "the centrifugal machine is first and the rest nowhere." As a general rule they might take it that the centrifugal fan was quite unapproachable for all ordinary work. On the next page,however,it was stated that the Capell fan was "cutting a road to the front." This he entirely disputed. Mr.Capell was,like Mr.Lupton,labouring under a mistake ; they made experiments without sufficient care,and showed more air than really existed. He also disputed the statement that "the ordinary method of measuring the velocity for a half minute or one minute is a mere approximation." If the experiments were properly made and the anemometer carefully handled,the results obtained would be accurate. He had proved this over and over again by repeated experiments which gave exactly the same results,provided the conditions were such as permitted accuracy. And with regard to the effects of currents of air on the water-gauge,Professor Herschel had suggested that the mouth of the water-gauge tube should be placed in such a position that the air could not blow into it. With the Schiele and small fans the water-gauge was often very far in excess of what it actually put upon the mine, because they were able to get a vacuum,under which the mine afforded more air than the fan could swallow,and the consequence was that at a certain distance from the fan the water-gauge almost disappeared,while that at the fan was constant. This occurred with all the small fans,but least of all with the Guibal. "A glance will show that there are many inconsistencies,and all that can be said for them is that with such appliances as were at hand,and such time as he could spare for the work,an honest endeavour was made to ascertain the facts." He (Mr.Steavenson) was perfectly ready to accept that. He had not the slightest doubt that Mr.Lupton,Mr.Capell,and other gentlemen who got so far wrong had done it accurately—so far as they knew how. They would no doubt remember that on one occasion a gentleman said he got 70 to 77 per cent.,but when Mr.W.Cochrane and himself,with one or two others,went over to the colliery to spend a day over the experiments they obtained very much less. Then as regards the table on page 71. Mr.Lupton gave the water-gauge which he calculated as due to the velocity as 2.14 inches,with 90 revolutions of a 20 feet fan. If they had taken a Guibal fan—where they had the benefit of a chimney—and with the same speed of periphery,the water-gauge due to the speed would have been nearly double what the writer of the paper took it as—viz., V Squared. divided 32 instead of V squared. divided 64. As to the fan described,it seemed to be a sort of cross between the Guibal,Schiele,and Waddle ; they were all mixed in it a little ; it was a combined fan. In the discussion which followed the reading of the paper there was not much said except that it was quite clear the figures could not be right. He (Mr.Steavenson) quoted one or two extracts from the discussion in question,and,concluding, said he hoped that Mr.Brown,who had had a great deal of trouble in testing various fans,would some day have this one tested,when he was quite sure it would be found to give the usual results of an open running fan,somewhere about 46 to 50 per cent.

The Chairman—I think it should be pointed out that Mr.Lupton says in a foot-note that this 107 per cent,is evidently a mistake.

Mr.A.L.Steavenson—Yes ; he admits it is impossible ; but my argument is that if one of the experiments is wrong, they all are and must be.

The Chairman asked Mr.May if he had anything to say on the subject ?

Mr.May said he had no observations to make,except that with the Guibal fan there was little difference between the water-gauge close to the fan and at the pit bottom.

Mr.M.Walton Brown said,if the Guibal fan had been under the same conditions as the Waddle fan it would have shown an equally great resistance and con-

sequent loss of water-gauge at the bottom of the pit. In order to compare the results of Mr.Lupton's experiments on the Medium fan,they should have been made at the same velocity of rotation. The influence of the variations of the velocity could,however,be eliminated by the application of the fundamental principle that in any mine,under the same conditions,the volume of air is proportional to the velocity of rotation,and the water-gauge or depression varies with the square of the velocity of rotation of the fan. The following table shows the results of the experiments when reduced to a normal speed of 4,000 feet of rim,or 63.66 revolutions of fan per minute:—

No.of Experiment.	Water Gauge	Volume of Air per Minute.	Efficiency of Fan and Engine.
	Inches.	Cubic Feet.	
1	1.22	65,100	.754
2	1.23	67,200	.782
3	1.07	54,520	.655
4	1.20	56,430	.730

The experiments being made under the same conditions,it is difficult to understand why the volumes and water-gauges observed in the experiments do not accord when reduced to a normal velocity of rotation ; and where the manometrical efficiency is as high as .63 with the volumes of air observed,some doubt attaches naturally as to the accuracy of a mechanical efficiency of .655,and more especially as to the accuracy of the higher results recorded. It would have added to the value of Mr.Lupton's paper if he had named the colliery where the Medium fan had been applied and could be seen at work. It was a matter of regret that Mr.Lupton was not able to be present at this discussion.

The Chairman said the Secretary would of course send this discussion to Mr.Lupton,and allow him to make any reply at the next meeting. They could hardly expect him to come to Newcastle,but he would no doubt send some reply on the points raised.

FEDERATED INSTITUTION OF MINING ENGINEERS.

GENERAL MEETING,

Held in the Exhibition Lecture Hall,Edinburgh,on Thursday

July 24th,1890.

Mr.William Cochrane,Vice-President,in the Chair.

The Chairman said he was sorry to have to occupy the chair that day,in consequence of the illness of their President,who still remained too unwell to leave his home. He was sure the members would hear of this with regret, and that they would join in expressing sympathy with Mr.Marley in his indisposition,and in hoping that he would be soon restored to health. The President had been very anxious to be present at this meeting,and quite recently—in fact,only the previous week—told the Secretary he thought he would be strong enough to attend. Unfortunately,however,that hope had not been realised,and they must,therefore,get on as best they could in his absence. The occasion of meeting in Edinburgh was in consequence of the Exhibition. It was,accordingly,felt that but little in the way of outside excursions should be arranged,in order that the members might have an opportunity of examining everything of interest there ; the electrical portion was,he believed—though he had not had an opportunity of examining it himself—extremely valuable. Excursions,had been arranged for the following day,under the charge of Mr.Morison,to the Lothian Collieries, which could be reached by going to Dalhousie Station,from which they were distant about a mile,and during the whole of the day any member of the Institution would be welcomed. These collieries were principally interesting in consequence of the very steep seams being worked. On the same day,the manager of the haulage and tram-car arrangements in Edinburgh would be at the central works of the Cable Tramway Company,at Henderson Row,and would be glad to give explanations upon the machinery during the whole of the day. He had only to add that there was a dinner—at which he would like to see as many members as could meet together—arranged for six o'clock that evening,and the Secretary would be glad to take the names of those who would attend. The business for the present meeting was Messrs.Armstrong and Bird's paper on the subject of "The Economical Working of Steam Boilers at Collieries."

Mr.A.L.Steavenson then read Messrs.Armstrong and Bird's) paper,as follows:—

THE ECONOMICAL WORKING OF STEAM BOILERS AT COLLIERIES.

By W.Armstrong,Jun.,and W.J.Bird.

I.—Introduction.

This elaborate enquiry arose from a desire to test thoroughly the comparative advantages of mechanical stoking and hand-firing,before fitting up a series of the Henderson mechanical furnaces on a range of Lancashire boilers at Wingate Grange Colliery. The results,as will be seen hereafter,were sufficiently satisfactory ; and the writers were induced to continue the enquiry into every circumstance affecting the subject,so far as the colliery plant would allow.

Beyond the economic advantages of mechanical over hand-firing—and this more especially applies to boilers of the Lancashire type—the regular and steady supply of fuel,forming a fire of constant thickness,and the automatic cleaning arrangement of the bars,result in an avoidance of those severe and destructive strains throughout the entire structure of the boiler (shortening its life,causing constant leakages and frequent repairs),occasioned whenever the fires require stoking,and more especially cleaning,under the old system.

The experiments have been continued over many months in order to accumulate materials of sufficient interest to lay before the members of this Institution.

All the evaporative tests were made of 48 hours' duration. This is very much longer than tests are usually made,but it was adopted with a view of showing the results obtained under the ordinary working conditions of colliery practice. In the case of the Lancashire boilers,the ordinary working pressure was 35 lbs. from 6 a.m. to 6 p.m.,and 60 lbs. from 6 p.m. to 6 a.m.,the latter pressure being required during the night for the steam-supply of a large underground pumping engine. In the case of the egg-ended boilers,however,35 lbs. was the ordinary working pressure day and night.

In all evaporative tests,the condition and size of the fires must,of course,be the same at the end of the test as at the commencement,and this is a matter which personal judgment alone can decide. Any error in such an estimate may be a materially disturbing factor in tests of short duration,but over a long period of 48 hours the proportions of any possible mistaken comparison of the fires become infinitesimal.

When the Admiralty experiments were made at Newcastle to determine the evaporative efficiency of Northumberland coal,the test period was fixed at 5 hours only,and the experiments may,therefore,show erroneous results.

The amount of coals burnt,and the resultant ash was ascertained by careful weighing.

A Siemens' water-meter was fixed on the feed-water pipe to record the amount of water evaporated. Its accuracy was tested at intervals during the period over which the experiments extended,by comparison with a tank of known capacity. The instrument was specially adapted for hot water,and registered up to 1,000,000 gallons,and care was taken that the water-level in the boiler was the same at the end of each test as at the commencement.

The weight of water evaporated is frequently computed by estimating 10 lbs. = 1 gallon,irrespective of the temperature of the feed. How serious an error this may occasion will be seen from Table I.,which shows the true proportions at different temperatures,and by which all results of these experiments were computed.

The feed water for the Lancashire boilers is heated in a Twibell's Economizer,placed at the end of the main flue ; and that for the egg-ended boilers by the exhaust steam from the engines. The temperatures were taken by thermometers screwed into the feed pipe.

The apparent duty is calculated by dividing the weight of water evaporated by the weight of fuel burnt. Then the variations in the temperatures of the

Referance to page 61.

TABLE I.

Weight of a Gallon of Water at various Temperatures.

See library for image of Table I.

feed-water and of evaporation require correction to one common standard to ascertain the real comparative duty. The standard adopted was 212 degs.Fahr. temperature of feed-water,and 212 degs.Fahr. temperature of evaporation,the corrections being made by the following formula:—

$$C = \frac{A\,[\,1,081.4 + (.305 + t)\,] - (t - 32)}{L}$$

In which C = Corrected duty,

A = Apparent duty,

t = Temperature of evaporation in degs.Fahr. deduced from the average steam pressure,and

L = Latent heat of steam at 212 degs.Fahr. = 966 units.

The corrected duty is used as the proper standard of comparison.

The rate of fuel combustion is shown per square foot of fire-grate surface per hour.

The cost of evaporation of 1,000 gallons of water is also shown. The standard temperature of the water is taken at 62 degrees Fahr.,and the quantities are corrected accordingly. The relative positions of the boilers are shown in Fig.1, Plate I.

II.—Experiments upon a Lancashire Boiler,Hand-Fired,and Fitted with the Henderson Mechanical Stoker.

The first series of tests were made on a Lancashire boiler 28 feet long by 7 feet 6 inches diameter. Three 48 hour tests were made by hand-firing with rough small coal,and two with duff coal. The boiler was then fitted up with the Henderson Patent Mechanical Stoker and Self-Cleaning Bars,and a corresponding number of tests made with this apparatus,the construction of which is set forth as follows,and illustrated in Plate II.:—

I.—Description of the Henderson Mechanical Stoker.

The coals are thrown on to the fire by means of horizontal circular fans revolving in opposite directions towards the furnace. The fans are set in motion by frictional pulleys attached to the driving shaft running under the fan boxes,at the end of which is the belt-pulley. At the central driving shaft is a wheel,working into a worm-wheel B,attached to a vertical shaft on the top of which is another worm A,which drives the crushers above the fans. In front of these crushers there is a plate worked by a hand-screw from the outside for regulating the feed of fuel,and against which any large pieces of coal are broken to the proper size before going on to the fire. At the bottom of the vertical shaft is another worm C,and wheel for working the furnace bars,which rest on a rocker or cradle of very simple construction,by which means half the bars are moved up and down vertically,thus breaking up the clinker and keeping the fire open,while the other half of the bars travel backwards and forwards horizontally,taking with them the clinker and refuse from the coal to the back of the furnace,where they are deposited over the back-end of the fire-bars into the combustion chamber,and form a natural bridge. The clinker and refuse are taken out of this chamber,when cold,by opening a damper door at the back-end under the bars. The bars in each furnace can be thrown out of gear at will by means of a thumbscrew attached to the crank in front. By means of a clutch the bars can be disconnected entirely from the machine,and the bars only left working. The fire-doors are so constructed that hand-firing can be carried on when necessary,which is very useful in the case of anything going wrong with the machinery ; the fires are then still self-cleaned,while the boiler need not be laid off,nor the boiler power at all interfered with.

II—Increased Duty and Saving of Fuel.

On comparing the results of mechanical stoking with those of hand-firing when using the same kind of fuel,there is an increase of duty of 33.3 per cent.,with a diminution of cost of evaporation of 23 per cent. when small coal was used. When duff coal was used the duty was increased 35.9 per cent,by mechanical stoking,while the cost of evaporation was diminished 24.5 per cent.

Again,comparing hand-firing with small coal with mechanical stoking with duff coal,the duty is increased 23.2 per cent.,and the cost of evaporation is diminished 52.4 per cent.; the cost of fuel being 1s. 6d. per ton less.

Referance to page 63.

Table II.

See library for image of Table II.

Referance to page 64.

Table II.---Continued.

See library for image of Table II.

The cost of fuel per boiler per annum,based on these results,can now be calculated. The year may be assumed at 300 working days,which is a pretty close approximation to actual practice ; and the average evaporation under mechanical firing is taken as the basis:—

Fuel.	Annual cost of Fuel per Boiler. Hand-firing.	Annual cost of Fuel per Boiler. Mechanical Stoker.	Saving.
	£ s. d.	£ s. d.	£ s. d.
Small at 3s. 6d. per ton ...	360 3 2	277 8 5	82 14 9
Duff at 2s. 0d. per ton ...	245 16 0	185 13 1	60 2 11

The annual saving of fuel per boiler,when small coal is used,is thus £82 14s. 9d.,or about 90 per cent,per annum on the cost of the apparatus. If,however,hand-firing with small coal is compared with mechanical firing with duff coal,the saving is much greater,and amounts to £174 10s. 1d. per annum.

III.—Experiment with the Henderson Fire-bars,Hand-fired.

To determine in what degree each part of the mechanical stoker contributed to the remarkable increase of duty,a test was made on the Lancashire boiler with the Henderson movable bars only,the coal being stoked by hand. The results were as follow:—

Coal burnt (in 48 hours)	23,772 lbs.
Water evaporated	17,873 gallons.
Do. per hour	370 gallons.
Temperature of feed-water	132 degs.Fahr.
Water evaporated	176,313 lbs.
Apparent duty	7.42 lbs.
Corrected duty	8.22 lbs.
Do.	20 % increase.
Coal burnt per square foot of grate surface,per hour.	19.61 lbs.
Proportion of ashes	8.1 per cent.
Value of fuel	3s. 6d. per ton.
Cost of evaporating 1,000 gallons of water at 62 degs.Fahr.	2s. 1.4d.

It thus appears that the increase of duty due to the bars is 20 per cent,out of the 33.3 per cent,increase yielded by the whole apparatus. Accounting out of this 20 per cent,for the proportion gained by the diminution of ashes,the useful effect of the Henderson mechanical stoker and bars may be thus analysed:—

	Per Cent.
Diminution of ashes increases duty	6.0
Movable furnace bars	14.0
Effect of mechanical stoking	13.3

Total effect of the whole apparatus 33.3

III.—Experiments upon Egg-ended Boilers,Covered and Uncovered,with two Arrangements of Bridges and Flues,

and fitted with the Juckes FIre.

The next series of evaporative tests were made in a range of egg-ended boilers,worked with the Juckes Fire. The tests were made upon two of the boilers,viz.,No.5, 38 feet long by 6 feet diameter,and No.6, 28 feet long by 6 feet diameter.

In No.5 boiler the tests were made with the boiler covered and uncovered,and with a new arrangement of bridges and flues. In the No.6 boiler the tests were made with the boiler covered.

Referance to page 66

Table III.

See library for image of Table III.

As before stated,the working steam pressure was 35 lbs. per square inch,day and night. In every case but one the feed-water was maintained at a constant temperature of 210 degs.Fahr. by the use of the exhaust steam.

The proportion of ashes obtained in these tests was extraordinarily large,and the circumstance of so much of the fuel being unburnt accounts for the comparatively low rate of duty.

Table III. contains the whole of the tests made with the Juckes Fires on No.5 and No.6 boilers,with the results calculated from them.

Thus,the corrected duty is 4.85 lbs. for the long boiler,and 4.82 lbs,for the short boiler,a quite insignificant difference,the variation in the proportion of ashes being very small ; and it would appear that within certain limits the comparative length of a cylindrical boiler has no influence on its duty.

I.—Results of Old and New Arrangements of Bridges and Flues.

The No.5 boiler was tested first with the old arrangement of bridges and flues,and then with a new adaptation. These two arrangements are shown in Figs. 1, 2, 3, 4, 5, and 6, Plate III.

The effect of the new adaptation on the effective duty is easily shown. With the boiler uncovered,the respective corrected duties are—old plan, 4.64 lbs. ; new plan, 4.77 lbs. ; with the covered boiler, 4.85 lbs. and 4.90 lbs. respectively. At first sight the difference would seem to be insignificant. But when we take into account the differences in the respective proportions of ashes,and eliminate these factors,the theoretical duties will stand as follows:—Boiler uncovered,old plan,7.69 ; new plan, 8.62 ; increase, 12.6 per cent. Boiler covered,old plan, 7.06 ; new plan, 8.40. Increase,19.0 per cent.

The mean of these increments may,therefore,be taken as a fair representation of the improved useful effect by the adoption of the new flues and bridges,and the gain per cent,may be estimated at [(12.6 + 19.0) divided by 2 =] 15.8 per cent.

There is frequent occasion to take into account differences in the proportion of ashes,and to eliminate that varying factor in order to arrive at any trustworthy comparison.

In these cases a theoretical or adjusted duty is deduced from the corrected duty as follows:—

$$D' = \text{Adjusted or theoretical duty} = \frac{D}{100 - p}$$

In which D = Corrected duty,and p = Percentage of ashes.

II.—Results of Covered and Uncovered Boiler.

Table IV. contains the comparative results of a series of tests on No.5 boiler,covered and uncovered.

The boiler was,of course,only covered on the portion exposed above the masonry,not much more than one-third of the total surface. The gain from the use of this non-conducting covering is represented by an increase of 4.1 per cent,of the corrected duty. When,however,the proportion of ashes is taken into account,and the adjusted duties compared,the 4.1 per cent,completely disappears,and is replaced by a decrease of 73 per cent.,a result which is absurd.

This discordance may be accounted for by the fact that in the first two tests made on No.5 boiler the quantity of ashes had not been observed,and the quantity in No.3 test (31.3 per cent.) is assumed as the average of Nos. 1, 2, and 3,which assumption is very probably erroneous.

An endeavour must,therefore,be made to find some means of checking the accuracy of the comparisons,and fortunately such a method is available.

Referance to page 68

Table IV.

See library for image.

The researches of Dulong enable one to find the amount of heat given off from a surface at a higher temperature than the surrounding medium,when their respective temperatures are known. This is divided into heat lost by radiation and heat lost by contact of air.

For small differences of temperature between the radiating substance and the absorbent medium,the loss of heat by radiation is simply proportional to the difference in temperature,but at higher temperatures and for greater differences the loss of heat is much greater,following a complicated law represented by Dulong's equation:—

$$r = \frac{124.72 \times 1.0077\ t \times (1.0077T - 1)}{T}$$

when t = temperature (centigrade degrees) of absorbent, T = excess temperature of radiating body (centigrade degrees),

r = ratio of loss of heat under the given temperatures.

The loss of heat by radiation is also dependent on the nature of the radiating substance,different surfaces giving very different results. These have been determined by experiment for a great number of substances. R is the number of units of heat emitted per square foot per hour,for a difference in temperature of 1 deg. Fahr. The total loss of heat by radiation is,therefore, R x D x r, when D = difference in temperatures of radiant and absorbent.

The loss of heat by contact of air is independent of the nature of the substance,but the form of the body affects the result considerably. In the case of a horizontal cylinder,if A = loss in units per square foot of surface per hour,for a

difference of 1 deg. Fahr.,and r = radius of the cylinder in inches,

A = .421 + (.307divided by r).

The heat lost by air-contact increases more rapidly than the simple ratio of excess of temperature,and is found by the formula:—

$$r' = \frac{.552 \times t^{1.233}}{t}$$

when t = difference of temperatures (centigrade degrees), and r' = ratio of loss of heat with that difference.

The total loss of heat by air-contact is thus = A x D x r', when D = difference of temperatures between substance and air.

III.—Temperatures of Boiler and Covering.

The first series of temperature observations were taken to check the six tests

(uncovered and covered) of No. 5 boiler with the old bridges and flues,and averaged as follows:—

	Degs. Fahr.
Temperature—Uncovered boiler surface	275
„ Covered boiler surface	106
Temperature of air	73

Using the above formula the total loss of heat per square foot per hour is—

Units.

Uncovered boiler	414.00
Covered boiler	45.18

and multiplying by the respective superficies the total loss per hour is—

	Units.
Uncovered boiler	110,289.60
Covered boiler	13,192.56

Difference =	97,097.04.

For the whole 48 hours the heat loss would be—

97,097 x 48 = 4,660,658.88 units.

With a feed-water temperature of 210 degs. and steam pressure of 35 lbs.,the total heat of the steam (from 210 degs.) = 988.7 degs. Fahr.,and 4,660,658.88 divided by 988.7 = 4,715 lbs. of water evaporated,equivalent to loss of heat for 48 hours.

The water evaporated per 48 hours on the average of the three earlier tests in the

uncovered boilers,was ... ... =	64,731 lbs.
Add loss =	4,715 „

Then average water evaporation in covered boiler ... ... =	69,446 „

Coal consumption = 14,292 lbs.,and 69,446 divided by 14,292 = 4.86 lbs. deduced corrected duty for covered boiler,compared with 4.85 lbs. corrected duty for covered boiler observed,or 4.7 per cent,increase over corrected duty of uncovered boiler.

The next series of temperature observations were made to check the two tests (uncovered and covered) made on October 1st and November 7th,1888.

The average temperatures observed were:—

			Degs. Fahr.
Uncovered boiler—Temperature of surface ...	...		280
„ Temperature of air	...	...	54
Covered boiler—Temperature of surface	...	...	91
„ Temperature of air ...	...	...	48

Working from these figures as previously,the corrected duty in the uncovered boiler of 477 lbs. is increased to 4.90 lbs. in the covered boiler,or 2.7 per cent,increase.

Referring to Table IV.,the observed corrected duty shows an increase of 4.1 per cent,when the boiler is covered ; and checking the comparison by Dulong's method,the increase of duty is found to be 4.7 per cent,increase from one set of observations,compared with 2.7 per cent,with a second series ; making an average of 3.7 per cent,increase, which corresponds very nearly with the 4.1 per cent,increase observed.

This is,therefore,a satisfactory confirmation of the accuracy of the comparative tests,so far as the corrected duty is concerned,and,doubtless,had the proportion of ashes been observed in the first two tests,the comparison would have

remained unaffected as regards the theoretical duties.

IV.—Further Experiments upon an Egg-ended Boiler,with New Arrangement of Bridges and Flues,and Hand-Fired. (Plate III.)

Another series of tests was made with an egg-ended boiler 41 feet long by 6 feet diameter,with hand-firing,which had just been fitted with the new arrangement of bridges and flues. The results obtained (see Table V.) were remarkably good,the corrected duty on the average of three tests being 6.07 lbs. It will be noted that the proportion of ashes is much less than in the case of the Juckes Patent Fires,namely,17 per cent,as compared with over 30 per cent.

Comparing the respective averages of three tests with long boilers by handfiring and the Juckes Fires,the corrected duties for the Juckes Patent Fires is 4.85 lbs.,with 31.3 per cent,of ash,and for hand-firing 6.07 lbs.,with 17.0 per cent,of ash.

Calculating the respective theoretical duties they come out : Juckes Patent Fires,7.06 lbs.; hand-firing, 7.31 lbs.; and thus the patent fires seem to show positively worse results than hand-firing. It must be remembered,however,that the hand-firing tests were made with the new arrangement of bridges and flues which,as shown previously,are equal to a gain of 15.8 per cent. Deducting this proportion from the hand-firing figures, the comparative theoretical duties with old flues and

Referance to page 71

Table V.

See library for image of Table V.

bridges are : Juckes Fires 7.06 lbs.; hand-firing, 6.31; an apparent advantage of 11.9 per cent,in favour of the Juckes Fires.

It may,therefore,be concluded that the use of the Juckes Fires affords a theoretical increase of duty of about 12 per cent.,which in practice is more than counter-balanced by the increase in the proportion of unburnt fuel.

V.—Experiments Upon a Lancashire Boiler,as to the Effect of Boiler Scale upon the Duty.

The next series of observations made referred to the effect of scale in a boiler in diminishing the duty of the fuel.

No.21 Lancashire boiler was selected for making the comparison. Like the others in the range it was 28 feet long by 7 feet 6 inches diameter. The inside was cleaned as perfectly as possible before the first 48 hours' test was made,after which the boiler was under steam about seven weeks. By this time a scale of .0625 inch in thickness had accumulated in the boiler,and the second 48 hours' test was made. Table VI. shows the comparative results of the two tests.

Referance to page 72

Table VI.

See library for image of Table VI.

This comparison has been complicated by the variation in the amount of ashes.

The dirty boiler shows a falling off in corrected duty of 8.5 per cent.,but when the respective proportions of ash are taken into account the difference is reduced to 1.5 per cent.,which is all that can be attributed to the action of one-sixteenth of an inch of boiler scale.

VI.— Experiments upon a Lancashire Boiler,with Ordinary and Checker Fire-Brick Bridges.

A further series of tests were made on No.23 Lancashire boiler to determine the effect of checker fire-brick work in the place of bridges. Two experimental arrangements of brickwork were made as shown in Figs.2 and 3, Plate 1.

A 48 hours' test with hand-firing,and the ordinary bridge was made on the No.23 boiler,beginning May 1st,1889,after which the arrangements in Figs.2 and 3 were successively tested with the results contained in Table VII.

The fixing of the No.1 bridge,Fig.2,diminished the evaporation by 60 gallons an hour,but the saving in fuel was more than proportionate. The adjusted duties are 9.35 lbs. with the ordinary bridge,or 9.82 lbs. with the No.1 new bridge,an increase of 5 per cent. At the same time,desirable as the 5 per cent,increase in duty might be,an accompanying disadvantage was the fall in evaporative power of the boiler from 347 gallons per hour to 287 gallons per hour,a loss of 17.3 per cent.

The arrangement in Fig.3 was then designed with the object of securing the 5 per cent,increase of duty,while avoiding any marked loss in evaporative power. The comparison of the tests then made shows that the theoretical duties are 9.35 lbs. in the old bridge,and 9.83 lbs. in the No,2 new bridge,the increase of duty being

Referance to page 73

Table VII.

See library for image of Table VII.

Note.—Fire-grate surface in No. 23 boiler = 33 square feet.

5.1 per cent.,while the evaporation of 347 gallons per hour was diminished merely to 333 gallons per hour,or only 4 per cent.   But for the fact that in the test with No. 2 new bridge,the fuel left 19.3 per cent,of ash as compared with 16.9 per cent.,probably even this small decrease of evaporation would not have occurred.

It may,therefore,be taken for granted that an arrangement of bridges similar to that in Fig. 3 with Lancashire boilers will increase their duties 5 per cent,without materially affecting their evaporative power.

VII.—Experiments upon a Lancashire Boiler,with Narrow and Wide Spaces between the Fire-Bars.

Owing to the employment of a dirtier coal than that in use when the mechanical stokers were first adopted,it was found that the work got out of each boiler was decreased by this change of fuel. It was determined to increase the air spaces between the fire-bars,and they were enlarged from .25 inch to .5 inch wide,the effect of which was to increase the fire-bar air space from 3.2 to 6.4 square feet per boiler.

The results of the experiments with this modification are contained in Table VIII.

It will be observed that the effect of changing from the clean to the dirty coal (8.7 per cent,ash to 22.2 per cent.) was to diminish the evaporative efficiency of the boiler from 405 to 366 gallons of water per hour,or from 64.8 H.P. to 58.6 H.P., while the air spaces between the fire-bars remained unchanged. The effect of increasing the air space was to restore,and rather more than restore,the evaporative efficiency which rose to 411.5 gallons,or 65.8 H.P. Nevertheless,the actual economy was less than with the other tests,as may be seen by comparing the respective duties.

Referance to page 74

Table VIII.

See library for image of Table VIII.

The dirty coal used in the latter portion of the experiments was analysed by Mr.J.Pattinson,as under:—

Carbon	66.87
Hydrogen	4.07
Oxygen	5.03
Nitrogen	1.32
Sulphur	2.93
Ash	17.28
Water	2.50

	100.00

Coke	66.30
Volatile matters	33.70

VIII.---Analyses of Flue Gases.

During the progress of the following test,samples of the flue gases were taken for analysis from the end of the boiler

flue just before it debouches into the main flue,by Professor Bedson:---

Test made 3rd July,1890.

No 21 Lancashire Boiler,fitted with the Henderson Mechanical

Stoker,and fired with Rough Small Coal

Duration of test	5 hours.
Coal burnt	3,024 lbs.
Water evaporated...	2,120 gals.
Do. per hour	424 gals.
Temp. of feed-water (average)	105 degs. Fahr.
Water evaporated	21,051lbs.
Apparant duty	6.96 lbs.
Corrected duty	7.89 lbs.
Coal burnt per square foot of fire-grate surface per hour	23.95 lbs.
Proportion of ashes	25.9 per cent.
Theoretical or adjusted duty	10.64 lbs

The writers are indebted to Professor Bedson for the following analyses of the flue gases taken from the end of the

flue in No.21 Lancashire boiler,fired by the Henderson Patent Mechanical Stoker. These samples were taken on the 3rd and 11th July:---

3rd July,1890.

Temperature at point whence flue gases were extracted,520 degs. Fahr.

Designation of Sample	A.	B.	C.	D.
When drawn off.	12.30-12.44 p.m.	12.50-1.5 p.m.	2.55-3.7 p.m.	3.18-3.32 p.m.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.

Carbon dioxide	11.27	10.58	8.29	7.91
Carbon monoxide	...	...	...	...
Combustible gas	...	...	...	...
Oxygen	7.17	8.20	10.93	11.47
Nitrogen	81.56	81.22	80.78	80.62
Total	100.00	100.00	100.00	100.00

11th July,1890.

Designation of Sample.	A.one.	B.one.	C.one	D.one	E.one.
When drawn off.	3.20-3.38 p.m.	3.45-4.0 p.m.	4.50-5.5 p.m.	5.18-5.35 p.m.	5.40-5.50 p.m.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Carbon dioxide ...	5.79	6.44	6.30	8.09	5.67
Carbon monoxide	...	...	...	...	...
Combustible gas	...	...	...	...	...
Oxygen	13.92	12.99	13.06	11.12	13.54
Nitrogen	80.29	80.57	80.64	80.79	80.79
Total ...	100.00	100.00	100.00	100.00	100.00
Temp.by pyrometer degs. Fahr.	440	440	420	440	440

It will be noted that the carbon dioxide is lower in proportion on the 11th July than on the 3rd,and the oxygen correspondingly in excess. The temperatures in the flues were also less,and point to a greater quantity of air passing. On both occasions carbon monoxide and other combustible gases were absent,and the combustion of the boilers is practically perfect.

IX.—Pyrometer Observations.

A series of pyrometer observations were made in the flues with a Hopkinson pyrometer,giving the following results:—

Lancashire Boiler Range—

	Degs. Fahr.
End of flue.—Hand-fired boiler	490
„ Mechanical stoking	400

Egg-Ended Boilers—Juckes Fires—

End of flue,No. 5 boiler,38 feet long by 6 feet diameter	875 and 865
,, No. 6 „ 28 „ 6 „ ...	940

Egg-Ended Boilers.—Hand-Fired—

End of flue,boiler,41 feet long by 6 feet diameter	780

Another series of observations were made in connection with a Twibell's economizer,which is fixed in the main flue of the Lancashire boiler range,with the following results:—

Degs. Fahr.

Temperature in flue.—Entrance to economizer	500
,, „ Exit from „	232
Temperature of feed water in pond	68
„ „ after passing economizer	148

In this case the feed pump (8 inches by 12 inches) was going 9 strokes per minute,and theoretically pumping 2.18 gallons per stroke.

A similar series of observations gave:—	Degs. Fahr.
Temperature in flue.—Entrance to economizer	485
„ „ Exit from „	244
Temperature of feed-water in pond	68
„ „ economizer	141

With the feed pump going 10 strokes per minute.

Many other most interesting experiments might be suggested in connection with boiler firing,but the writers think that enough has been described for a paper of reasonable length. In commending these ascertained results to the members of the Institution,they would,in conclusion,point out that the comparative tests have been taken under practical working conditions,and for sufficiently long periods of time to eliminate incidental errors,besides which all disturbing factors have been taken into consideration,and their effect discounted so as to arrive at a true comparison.

Mr.Steavenson said he had only one suggestion to make in regard to the paper,and that was that there should be a short synopsis or abstract prepared so as to summarise it.

The Chairman said they were all obliged to the authors of the paper for bringing this important matter before them,and also to Mr.Steavenson for reading it. Unless Mr.Bird had anything further to add,the paper would now be open for discussion.

Mr.Bird said he had nothing further to add. The manuscript which Mr.Steavenson had read was only compiled a few days ago,and the paper might,therefore,be considered as up to date.

Referance to following pages.

To illustrate Messrs.W.Armstrong jun. and W.J.Bird's paper on "The Economical Working of Steam Boilers at Collieries."

Vol I. Plate I. Fig.I. Wingate Grange Colliery General Plan Shewing position of Boilers.

Fig.2.&Fig.3. Checker Fire Brick Bridges for Tube Boilers.

See library for images.

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To illustrate Messrs.W.Armstrong jun. and W.J.Bird's paper on "The Economical Working of Steam Boilers at

Collieries."

Vol I. Plate II. Fig.I.&Fig.2. The Henderson Patent Mechanical Stoker and Self-Cleaning Furnace.

See library for images.

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To illustrate Messrs.W.Armstrong jun. and W.J.Bird's paper on "The Economical Working of Steam Boilers at

Collieries."

Vol I. Plate III. Old Arrangement of Boiler Seating. Fig.I. Side Elevation. Fig.2. Section at A B. Fig.3. Section at C D.

New Arrangement of Boiler Seating. Fig.4. Side Elevation. Fig.5. Section at A B. Fig.6. Section at C D.

See library for images.

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The Chairman knew that Mr.Bainbridge had had considerable experience with various systems of boilers,perhaps he would kindly make some remarks on the subject of the paper.

Mr.Bainbridge submitted that it seemed rather late in the day to read a paper specially referring to the scope for economy in the firing of cylindrical boilers,as these were now only used on a small scale ; probably nobody who had put boilers down during the last twenty years would have put down cylindrical boilers,and it was to these that the experiments applied. He would like to ask Mr.Bird,in regard to the cylindrical boilers,whether he found much difference in the pyrometer experiments after putting in the three bridges ; and also as to the effect of raising the bridge itself ?

It also seemed to him that the authors had not put enough stress on what appeared to be one of the most important points in the paper. In his (Mr.Bainbridge's) experience of mechanical firing,a class of coal was chiefly used containing some 15 per cent,of dirt ; some of the coal Mr.Bird mentioned exceeded that,and he thought the authors might have extended their remarks on the advantages of mechanical stoking where the coal produced so much cinder and ash.

With regard to the question of mechanical firing,too,it would have been interesting to learn not only the difference between hand-firing and the Henderson system,but also how the Henderson system compared with others. It was rather odd that while Messrs.Armstrong and Bird had hit upon the Henderson as being the best kind in the North of England,in Lancashire the Vickers was looked upon as the best,and in Yorkshire the Proctor. It would be interesting if experiments could be made to test relatively the merits of the three. He was led to believe from the description of the Henderson that it came under the same category as the Proctor. In the case of the Vickers stoker the coal was thrown close to the fire doors,and by becoming coked the tendency to smokelessness was much more marked than in

the Proctor and Henderson. The process mentioned in Figs.2 and 3,Plate I,of trying to improve the economy of Lancashire boilers was,of course,by no means a new idea ; the effect of No.2 process carried out the same idea as that of Mr.Gosling,an engineer who brought out an economizer some years ago,consisting of discs of fire-clay placed within the tube,of about half the diameter of the tube itself,but these fire-clay discs were so easily worn away that they were replaced by metal ones. The Gaslight and Coke Co. of London had a large number of boilers fitted with this process,effecting a saving of some 15 or 20 per cent. The pyrometer test at 490 degs. did not strike him as being quite satisfactory,as with a boiler thoroughly well arranged the temperature of the gases as they left the main flue should not exceed 350 to 400 degs. One mode of setting boilers had not been mentioned,viz.: making the outside flue larger in area,and raising the side flue curve of fire-brick slightly above the level of the water,the effect being a very

marked economy of fuel. It was difficult to discuss the large number of figures read ; but he gathered from the paper that the Juckes gave about the same result as hand-firing,and the Henderson mechanical stoker much better results.

Mr.A.L.Steavenson said his experience in testing boilers twenty years ago was with the Juckes fire-bars and with common hand-firing,and he thought the results were that,so far as economy went,there was very little in it,but there

was considerable saving in manual labour. The coals were teemed down a long spout,and the labour was reduced to almost nothing ; but the difference in evaporation was difficult to detect. He hoped Mr.Bird—who was about to take a distant flight—was only leaving them for a time ; but,he trusted,that while he was away he would not forget his friends here,but would send them any notes he could,and he (Mr.Steavenson) would only be too glad to read them for him.

The Chairman said he could speak to the merits of the Juckes bars in the reduced boiler repairs and saving of labour. With hand-firing,constantly opening the doors and exposing the front of the boilers to various temperatures were serious objections,which by the use of this system were much reduced,and further,there was entire prevention of the smoke which occurred with hand-firing. He instanced a colliery,where,owing to its being within the limits of a borough it became a difficulty to carry it on,but the adoption of the Juckes furnaces gave entire satisfaction to the authorities,and effected considerable economy. Where coals were cheap or of such a character as to be unsaleable,as was the case at many collieries with a portion of their output,he did not admit that the cylindrical boiler was out of date. Its low first cost and the facility for repairs were strong recommendations. The more costly the boiler,the more difficult and expensive are the repairs. It becomes a question of first outlay and of subsequent expense,as well as economy in fuel,in which latter respect the Lancashire boiler is no doubt an advance upon the cylindrical,but it must,he thought,give way to the type of tubular boilers,of which the Root boiler is an example,for efficiency and economy in evaporative power. He did not think the authors of the paper intended to recommend a similar boiler plant and the use of duff,or small or dirty coal,if they wanted the greatest efficiency,the results attained in pounds of water evaporated per pound of coal being so low ; but,in regard to the best utilisation of such fuel at a colliery where it is produced,the record of these experiments is extremely valuable.

Mr.Bird said Mr.Bainbridge's interesting remarks were prefaced by a statement that cylindrical boilers were practically out of date ; of course,he agreed with him in that. Colliery managers were not going to put down cylindrical boilers to any practical extent now ; but,as they were in when the experiments were made for the Lancashire boilers,it was very little extra trouble to include them. The pyrometer observations were very incomplete. The pyrometer was only procured during the last week or two,and there was no comparison of the temperature observations available between the old bridge and the new,the pyrometer being got after the new bridge was introduced. The abnormal quantity of ash shown in the experiments with the Juckes fires was due solely to the fact of so much coal going through unburnt,and not,so far as their observations showed,to any actual variation in the quantity of ash. The analysis of the fuel showed a proportion of ash of 17.25 per cent,in the rough small coal,and a little more in the duff coal, whereas the proportion of burnt ash in the experiment with the Juckes fires rose as high as 40 per cent. He quite agreed with Mr.Bainbridge that,in considering the question of mechanical firing,it would be interesting to have a series of comparative tests made with the different kinds of apparatus,under the same conditions ; but that was not available at Wingate Colliery,the Henderson being the only one on the premises,unless the Juckes apparatus could be considered a mechanical firer also. Practically,the Juckes firing seemed to give the same results as hand-firing on the boilers ; but had the firing been done with cleaner coal—with less ash—he believed the Juckes fires would have shown the full advantage of 12 per cent,which had been worked out theoretically in the paper ; and there was no doubt that the life of the boilers under the Juckes fires would be much longer than under hand-firing,for very obvious reasons.

Mr.Steavenson very truly pointed out that the advantage of the Juckes system over hand-firing was in the less labour required—a less number of firemen could attend to the same range of boilers. But when the percentage of ash or un-

burnt fuel increased to so great an extent,and rose to such figures as they found at Wingate,and where that ash had to be moved any considerable distance away,the increased labour in removing the ash neutralised the diminished labour in firing. As Mr.Cochrane said,even the Lancashire boiler,though giving a higher duty than

the cylindrical,was going out of date,and the Roots might be destined in the long run to supersede it. Yet before they reached that Utopian future they would,he thought,have to very considerably modify the quality of water used in colliery

boilers. Generally speaking,the experiments had been,as Mr.Cochrane remarked,for the practical adoption of inferior fuel and consequent very obvious economy. He was obliged for Mr.Steavenson's kind offer to read any memoranda he might send home from Persia,and he could only assure him that he would take advantage of it at the earliest opportunity.

The Chairman said they would accord a vote of thanks to Mr.Bird and Mr.Armstrong for their paper,which would be printed,and open for discussion at a future date. He thanked the members for their attendance ; he was sorry there

were so few present,but he supposed this was due to the lack of information as to the kind of meeting this was intended to be. They could only by large attendances make the meetings successful. Nottingham had been fixed for the next meeting,on the 24th and 25th of September,and they hoped to have such a programme for that meeting as would satisfy the most exacting of their members.

EDISON PHONOGRAPH.

Through the kindness of Mr.C.R.Johnstone of the Edison United Phonograph Company,the members were given a private representation of the many uses of the phonograph.

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Proceedings.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

ANNUAL GENERAL MEETING,

Held in the Wood Memorial Hall,Newcastle-upon-Tyne,

on Saturday,August 2nd,1890.

Mr.William Cochrane,Vice-President,in the Chair.

The Chairman said he was very sorry that the President still remained too unwell to attend this meeting. In a letter he had that morning received from Mr.Marley he was asked to express that gentleman's regret at being unable to attend on the occasion of his retiring from the chair,and to thank the members for the manner in which they had supported him in it ; when Mr.Marley was able to come among them again he would possibly address them further. In the meantime, they would all regret the illness which had prevented him from continuing the work which he had so earnestly and zealously done during the time he had been their President. They would all agree in expressing sympathy with Mr. Marley in his illness,and in hoping that he would soon be perfectly restored. It was a pleasure to hear from the Secretary that Mr.Marley (whom he had seen the previous day) was much better,and that there was a prospect of his resuming active work in a short time. With the indulgence of the meeting he (Mr.Cochrane) would do what he could

to conduct the business in the President's absence.

The minutes of the last meeting were read and confirmed.

The following gentlemen were declared elected in accordance with the rules of the Institute:—

Member—

Mr.J.K.M.Robertson,M.D.,F.G.S.,Mining Engineer,Linton,Mitson's Point Sydney.

Associates—

Mr.Edward Taylor Cheesman,Colliery Manager,Blaydon Main Colliery,Blaydon-on-Tyne.

Mr.Thomas Rontree,Colliery Manager,Harton Colliery,South Shields.

The following were nominated for election:—

Members—

Mr.George Bradford,Colliery Viewer,Witton Park,Darlington.

Mr.G.A.Mitcheson,Mining Engineer,Dresden,Longton,Staffordshire.

Mr.William Ryder Stobart,Mining Engineer,Etherley Lodge,Darlington.

Mr.Thomas Watson,Mining Engineer,Trimdon Colliery,Trimdon Grange.

Associate Member—

Mr.W.Cochran Carr,Coal Owner,Benwell Colliery,Newcastle-upon-Tyne.

Associate—

Mr.Thomas Clark,Under-Manager,Dipton Colliery,Lintz Green.

Student—

Mr.G.M.Andrews,Mining Student,Broomhill Colliery.

The Chairman then appointed Messrs.A.L.Steavenson, T.O.Robson, R.Thompson,and R.L.Weeks,to act as Scrutineers of the ballot papers for the election of officers for the ensuing year.

The Secretary read the annual report of the Council and Finance Committee,as follows:—

THE COUNCIL'S ANNUAL REPORT.

The past year has been an eventful one in the history of the Institute,inasmuch as it has been worked under a new set of rules,and for the first time in close connection with other Institutes of a kindred nature under the Federated Institution of Mining Engineers' scheme.

It is too soon yet to fully appreciate the results due to these changes,but so far as they can judge the Council see no reason to doubt the wisdom of the steps which led to them.

Fifty-two new members of all classes have joined the Institute since the last annual meeting,and 9 have resigned. During the same period there has been a loss by death of 13 members,including,the Council deeply regret to say, some of the best known names connected with mining,such as Mr.E.F.Boyd,Mr.W.Crawford,M.P.,Mr.R.Forster, Mr.T.G.Hurst,and Sir Warington W.Smyth.

With Volume XXXVIII. of the Transactions the Institute closes a publication the value of which—from a professional point of view—is now too well established to be dwelt upon. In place of these Transactions members are now receiving,without extra payment,the Proceedings of the Federated Institution of Mining Engineers—in other words,the papers and discussions of this Institute plus those of the Chesterfield,Midland, and South Staffordshire Institutes.

Certain special publications have been issued to your members,unconnected with the Proceedings of the Federated Institution of Mining Engineers,such as the "Borings and Sinkings,"now nearly completed,Abstracts of Foreign Papers,which it is intended to issue quarterly,and the reports of certain committees to be referred to presently,etc.

In September,a ten days'visit to the Belgian Coal-field and to the Paris Exhibition took place,and much kindness was experienced by the members at the hands of the Belgian coal owners and engineers. In January,the first General

Meeting of the Federated Institution brought a large number of members together at Sheffield,where they were extremely well received by the Mayor,Master Cutler,and by their brother engineers of the Midlands,many of whose works and collieries were inspected. The next meeting of the Federated Institution was held in London,in April,in the rooms of the Institution of Civil Engineers,and the Royal Mint and Thames Subway were visited. The third meeting was held in Edinburgh,where the Exhibition was the principal attraction.

The Fan Committee,in which the North of England Institute is united with the South Wales and Midland Institutes,has carried on its work regularly since the date of the last Annual Meeting,and its report is being prepared for the press.

The Explosives Committee has also been hard at work,preparing plans,estimates,etc.,and in connection with it,the translation of a valuable Report of a French Government Commission will be issued to the members in a few days.

The Council have pleasure in stating that the negotiations with the North-Eastern Railway,mentioned in their last report,have come to a satisfactory termination. The Company will provide an entrance in Orchard Street,and

a broad passage lined with glazed bricks adjoining the basement of the Wood Memorial Hall.

In conclusion,the Council feel that they are justified in congratulating the members upon the continued and increasing prosperity of the Institute.

FINANCE REPORT.

The income for the year 1889-90 amounted to £1,509 14s. 2d.,being a decrease on that for the previous year of £301 7s. 5d.

The expenditure was £1,433 19s. 2d.—£84 0s. 11d. less than that of the preceding year.

The total receipts for subscriptions and arrears were £1,209 5s. 8d.—£240 16s. 4d. less than last year ; this decrease being attributed in a large measure to the fact that fewer finance circulars have been issued to the members this year. The arrears of subscriptions now amount to £207 18s. 0d. as compared with £553 7s. 0d. at the end of last year,of which amount £246 15s. 0d. has been struck off as irrecoverable.

In the ordinary items of expenditure there is a decrease this year of £240 10s. 11d.,but against this must be placed the liability of £552 15s. 0d. in respect of subscriptions to the Federated Institution,of which,however,the sum of

£223 3s. 5d. appears in the balance sheet as expenses incurred and paid on behalf of that institution. The payment of one hundred guineas in connection with the meeting of the British Association also adds to the year's expenditure, which,however,still compares favourably with that of previous years.

Accounts.

Referance to page 85.

The Treasurer in Account with Subscriptions,1889-1890.

See library for image of above account.

Accounts.

Referance to page 86.

The Treasurer in Account with the North of England.

See library for image of above account.

Accounts.

Referance to page 87.

Institute of Mining and Mechanical Engineers.

See library for image of above account.

88

Accounts.

Referance to page 88.

General Statement,July 16th,1890.

See library for image of above account.

89

Proceedings.

The Chairman said that in the Finance Report and Statements—which were on the table and could be examined in detail by the members after the meeting—it was stated that the total income for the year was £300 less than that for 1889 ; this was largely accounted for in the matter of arrears of subscriptions,of which there were large collections in 1889. These arrears having been partly paid,and partly wiped off by the Arrears Committee,left very few arrears to collect during 1890,and whilst the total income from all sources for the year was not so great as it was for the previous year,the Institute was in as flourishing a condition financially as ever,and had,in fact,a net gain in its number of members to the extent of thirty. In this respect they would all agree with him in congratulating the Institute—as

the report said—upon its "continued and increasing prosperity." The Council of the Federated Institution was now considering the subject of the mode of printing the Proceedings,which they would all consider at present to be unsatisfactory. There were,as they knew,two forms of publications printed in different type,a selection being made by the Council of the Federated Institution of the papers to appear in each. In one of these the discussions were printed verbatim,and it was thought undesirable to spend so much money in publishing these discussions ; those of similar institutions were generally concentrated into the remarks of a speaker once on each subject,but in the Transactions of the Federated Institution they would sometimes see on one page many short remarks from one speaker. This was inconvenient and expensive to print ; so much so,that it was felt undesirable to print the discussions in full as at present. The subject was under consideration,and some proposals would,no doubt,be submitted to the members shortly when the Council had decided what was best to be done. The principal point to call attention to in the annual report of the Council was as to the number of meetings. He was one of the very few members who went to Edinburgh —only twenty-eight in all,and these were never all together at one time—and it seemed to him that the great machinery of the Federated Institution of Mining Engineers having been put into operation to obtain the attendance of twenty-eight members from all the institutes,at Edinburgh,where the Exhibition was expected in itself to be a great attraction,the result was extremely disappointing. The Council of the North of England Institute had thought it well to discuss this question,and to consider whether four meetings a year were more likely to succeed when the members of all the institutes—except of that which was located at the place of meeting—were called upon to leave their homes. He wrould be glad to hear the observations of the members on this or on other subjects of the reports ; and in order to put

the matter formally he proposed that the reports as presented be adopted.

Mr.Willis (H.M.Inspector of Mines) seconded the motion.

Mr.Simpson said he had not thought of the subject ; but if the meetings were not better attended than that at Edinburgh he was afraid that even four would be too many. He did not know whether it would be wise to come to any conclusion at present,or to wait and see the result of another year. He supposed it would have to be brought before the Council of the Federated Institution for further consideration.

The Chairman thought that the Council of the Federated Institution would have their revised rules ready by September ; they could then be discussed at the Nottingham meeting,which was fixed for the 24th and 25th of September.

Mr.Simpson suggested that it would not be proper for this meeting to come to any conclusion.

The Chairman—Except as a recommendation,which the Council of this Institute could bring before the Council of the Federated Institution,showing what the members of the North of England Institute thought desirable to be done.

Mr.Simpson---How would two meetings in the year do ?

The Chairman—The Council to-day thought two would be enough.

Mr.Willis thought four too many.

The Chairman—Shall the Council be instructed to represent to the Federated Institution that they consider two meetings in the year sufficient ?

Mr.Thos.Bell (H.M.Inspector of Mines) said he would propose that it be referred to the Council to take into consideration whether two meetings per annum would not be sufficient. The Chesterfield Institute met four times in the year,and the North of England Institute meetings had been reduced from monthly to bi-monthly. He was not sure whether they would not get better local attendances if even this were altered to quarterly meetings. He would at all events propose that the Federated Institution should only meet twice during the year. The question of the General Meetings of this Institute might be left for future consideration.

Mr.Simpson seconded the proposal to refer the question to the Council,with a recommendation that there be only two meetings each year.

The resolution was carried unanimously.

The Chairman called upon Professor Lebour to read Mr.Marley's paper "On the South Durham Salt-field."

Mr.Thos.Bell remarked that no abstract of the paper had been issued,neither were there printed copies of the paper on the table.

The Secretary replied that,although it might have been possible to prepare a short abstract the paper itself could not be printed for the meeting,as was done formerly,owing to the fact—before-mentioned—of the papers being referred to

committee,who had to decide in which type it should appear.

The Chairman said this was one of the inconveniences which had been felt,and he hoped the subject of the publications would be brought before the Council of the Federated Institution at an early date.

ON THE CLEVELAND AND SOUTH DURHAM SALT INDUSTRY.*

By John Marley.

In 1863,at the Newcastle-upon-Tyne meeting of the British Association,the writer read a short paper setting forth the then recent discovery at Middlesbrough,in Cleveland,of rock salt by Messrs.Bolckow & Vaughan,showing how they,in July,1859,in their search for fresh water for the use of their Middlesbrough iron works,had commenced the sinking of a shaft,which they sank to a depth of 178 feet into the New Red Sandstone. From the bottom of this they began,on December 31st,1861,a boring,18 inches in diameter,by one of Messrs.Mather & Platt's boring machines,their object still being fresh water,and after repeated warnings,both before and during their operations,that salt water was more likely to be got than fresh,they,at a depth of 1,206 feet,touched the top of the rock salt,proving it to be 100 feet thick (Section XVI.). The boring itself was stopped on or about September 10th,1863. This was the first public announcement of this great geological and commercial fact. To this 1863 paper,which contained a full description of the boring machine and a coloured section of the strata sunk and bored through,was attached an analysis of the lightest coloured sample of the rock salt,representing about one-half of the whole bed. It was then admitted to be impossible to attempt any predication of the area of the salt,but as bearing thereon,the extension of the South Durham Coal-field from Castle Eden and South Wingate,and the fact of the existence of the Lias and Oolitic formations south of Middlesbrough were mentioned. Besides the question of the area of the salt deposit,it was also admitted that it was speculative to attempt to estimate the great commercial results that were expected to the district of the Tyne and the district generally. A period of 26 years having elapsed since this discovery and since the last meeting of the British Association at Newcastle,during the first 11 years of which the matter lay dormant,South Durham has now become a salt-producing district of vast commercial importance.

The question of salt in this district cannot be said to be a recent one,as the Rev.George Young in 1828 in his Geology of the Yorkshire Coast mentioned the possibility of rock salt similar to that of Cheshire and Worcestershire being found in the vale of the Tees ; next,Mr.G.C.Greenwell in his Milling Engineering (1853),in mentioning the Red Sandstone in the north-east part of Yorkshire,said it was by no means improbable that beds of rock salt might be found.

The British Association made an excursion from Newcastle-upon-Tyne to Messrs.Bolckow & Vaughan's salt boring in 1863,and to Messrs.Bell Brothers' works at Port Clarence,from York in 1881. After 1863,the salt question practically lay untouched till 1874,speculation being deterred by the depth at which the rock salt lay and the heavy water-bearing strata to be passed through,involving large capital outlay for sinking,and having regard also to the unknown extent of the area of the deposit,and the consequent uncertainty of suitable return on the capital invested.

Messrs.Bell Brothers'experimental or trial boring in 1874 (Section XI.) having proved that the rock salt continued to the north of Messrs.Bolckow & Vaughan's first boring,they adopted the Continental plan of a fresh-water column balancing the brine column at a point within 200 feet of the surface,accompanied with ease of pumping,and thus became the pioneers of the manufacture of salt in the district.

Mr.Thomas Bell,of Messrs.Bell Brothers,had suggested,and the firm had considered the practicability of raising salt by means of the two columns of water,viz.,1,200 feet of fresh water to 1,000 feet of brine,and on further enquiry it was

* This paper was read before the British Association,at the Newcastle Meeting,in 1889.

found that the plan in question was already in operation near Nancy,in France,where its details were investigated by the heads of the firm and their staff. Afterwards,with the possibility of finding coal,Messrs.Bell Brothers continued the boring for 150 feet,and proved the existence of the Magnesian Limestone below the rock salt.

The writer does not consider it necessary to enter into the details of the respective borings for the rock salt nor of the various modes adopted in the preparing and obtaining of the brine,and of pumping the same to the surface,as these,as well as the modes of manufacture of the salt,have been treated of fully by other writers,to whom reference is made below according to date.

By Mr.W.H.Peacock,mining engineer,on the New Red Sandstone of Cleveland and the rock salt then discovered. This paper was read before the Cleveland Literary and Philosophical Society in 1869.

By Sir Lowthian Bell in 1881 in his paper for the British Association on the industries of Middlesbrough ; but more especially in his elaborate paper on the manufacture of this salt,which was read before the Institute of Civil Engineers in May,1887.

By the late Mr.Thomas Allison,of Guisbro',in April,1882,in his paper on the "Geology of Middlesbrough and the Surrounding District."

By Mr.T.Hugh Bell,in 1883,before the Cleveland Institute of Engineers,on these salt deposits and the mode of winning them.

By the said Mr.T.Hugh Bell,on these salt deposits,in September,1883,in his notes for the Iron and Steel Institute meeting at Middlesbrough.

By Mr.T.W.Stuart,on the Tees salt industry,in his paper read in October,1888,at the Durham College of Science,and published in the Journal of the Society of Chemical Industry for the same month. This paper treats fully of the American system of boring,and of all details connected with the salt.

By Mr.W.J.Bird on this salt bed and associated strata,read before the Manchester Geological Society in June,1888.

The writer therefore considers it would be a waste of time to repeat in detail that information which can be obtained by reference to these various papers,but wishes more especially,1st,to direct attention to the extreme north,west, south,and east points of the deposit proved,with the various thicknesses,viz.:—

The last boring (VI.) in a northerly direction in which rock salt is proved at Greatham (see Plate LIV.),which proved salt 82.75 feet thick at a depth of 971 feet 9 inches,there being no salt proved at borings I., II., III., IV., and V.,farther to the north.

By way of illustration of the form of this basin of salt as far as known,the Lackenby boring (XXI.) being the deepest, the bottom of the salt being 1,804 feet from the surface,and taking this as the datum-line (as the slight difference of surface-level is too trivial to be taken into account) ; the rise from XXI. (Plate LIV.) or Lackenby to VI. or Greatham,a distance of about 4 miles,is 832 feet 3 inches,XXI. being as yet the easternmost position of the salt proved.

Then the westernmost point is at Stone Marsh or XXIX. (Plate LIV.),a distance of about 4.5 miles,with salt of a thickness of 9 feet,and a rise of 1,011 feet from Lackenby.

From Lackenby (XXI.) to South Bank (XX.),a distance of about 1 mile,with salt 82.5 feet thick,and a rise of 151 feet

9 inches.

Next from XX. (Plate LIV.) or South Bank to XVIII. or North Ormsby,a distance of 2.5 miles,with salt 89.5 feet thick, and a rise of 216 feet 3 inches,as the southernmost point. This southernmost point XVIII. or North Ormsby,and the

easternmost point XXI. or Lackenby,are clearly not the termination of the salt basin in these directions.

The several papers from the respective authors,in describing the various geological features,have brought into view differences of opinion on the geological questions,and amongst others a paper on "The Durham Salt District,"in the North of England,by Edward Wilson,F.G.S.,and published in the Quarterly Journal of the Geological Society;*and since then another paper by Mr.Howse on these geological points,and read by him in 1888 before the Tyneside Naturalists' Field Club.

Having shown the position and form of the basin,the writer will now call attention to the boring at the westernmost point,viz.,XXIX. (Plate LIV.) or Stone Marsh,where only 9 feet of salt was proved,part of that being mixed with gypsum. This was abandoned after boring into Magnesian

Limestone to a depth of 178.25 feet,or a depth from surface of 1,000 feet,this boring being taken to prove the westernmost outcrop.

Next,attention is called to the Seaton Carew boring IV. (Plate LIV.),where it was proved that salt rock did not exist at the point expected,viz.,at a depth of 497 feet. But at 606 feet rock oil was found,and sulphurous water was met with, and at 1,153 feet a brine feeder was got. The salt bed being usually met with between the main beds of anhydrite,this boring was then continued through the Magnesian Limestone at 1,400 feet,proving 878 feet thickness of this rock ; and the boring has been continued to a total depth of 1,814 feet 6 inches,and Carboniferous strata proved below the Magnesian Limestone. These,with the 10 inches and 14 inches coal-seams,all form elements for consideration as to their exact geological position.

The next boring to which attention is called is at the point marked XXII.,near to the river Tees,where the Newcastle Chemical Co. only got either some few feet of salt,or as some say,none ; after proving 167 feet of Magnesian Limestone to a depth of 1,260 feet,this was abandoned,the position of the boring being almost in a direct line from Messrs.Bolckow & Vaughan's first boring,XVI.,where salt is of great thickness,and that at Stone Marsh,XXIX,where salt,only 9 feet thick,rendered the absence of salt at XXII. as being most probably due to an underground dislocation and not to an outcrop. Another boring (XXX.) made near Norton by the diamond drill,proved gypsum and anhydrite,but did not prove salt,and after going through the Magnesian Limestone at 760 feet 8 inches depth,the boring was stopped in sandstone and shale.

The production of salt for the years 1887, 1888, 1889, 1890, and 1891 was as follows:—

District.	1887.	1888.	1889	1890	1891
Salt from brine.					
England---	Tons.	Tons.	Tons.	Tons.	Tons.
Cheshire	1,619,452	1,624,243	1,342,896	1,440,088	1,335,821
Durham	119,477	173,160	191,647	199,971	200,507
Lancashire... ...	....	....	....	7,877	26,867
Staffordshire ...	5,810	5,810	6,450	7,135	6,098
Worcestershire ...	252,000	267,000	217,798	267,348	202,643
Yorkshire	16,790	17,900	26,500	35,700	50,042
Scotland	....	....	....	....	....

Ireland	....	....	....	....	....
Total	2,013,529	2,088,113	1,785,291	1,958,119	1,821,978
Rock Salt.					
England---Cheshire	150,267	182,804	141,063	159,088	184,284
Ireland	30,155	34,652	20,142	29,642	37,309
Gross Totals ...	2,193,951	2,305,569	1,946,496	2,146,849	2,043,571

* Vol.xliv.,1888,page 761.

The salt area proved can be safely taken at 20 square miles,and would produce,if only 90 feet of thickness be taken, 115,200,000 tons of salt per square mile,and as the works on the Tyne consumed about 1 acre per annum,if there be 20 square miles of salt area,there is a supply available for 12,800 years.

The questions of the form of cavities produced by the pumping of the brine,and of possible subsidence of the surface in the future,may be left untouched at present by the writer,but it may be mentioned that the abandonment of the artificial supply of water in the making of brine,and the adoption of self-contained springs may unintentionally be the means of avoiding legal questions as to damages,if any,and also of the pumping of brine from adjoining lands.

Attached are copies of borings. (See Appendices A and B.)

APPENDIX A.

Sections of Boreholes in South Durham and Cleveland.

I.—Diamond-boring at the Warren Cement Works, near Hartlepool, by Mr. John Vivian, 1888.

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
1	Sand	22	0	22	0
2	Soft mud and peat	8	0	30	0
3	Red clay	18	0	48	0
4	Red pinnel, with small cobbles ...	6	0	54	0
5	Dark pinnel and cobbles	18	0	72	0
6	Pinnel and cobbles	2	0	74	0
7	Dark pinnel and cobbles	19	0	93	0
8	Red clay	2	0	95	0
9	Soft limestone ...	1	0	96	0
10	Red clay	1	0	97	0
11	Hard rock	1	5	98	5
12	Anhydrite	265	7	364	0
13	Dark grey limestone	38	0	402	0

II.—Diamond-boring at Messrs. Smalley's, Pulp or Celulose Works, near West Hartlepool.

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
1	Depth of well ...	37	0	37	0
2	Dark brown pinnel	13	0	50	0
3	Yellow clay ...	3	0	53	0
4	Coarse soft limestone	4	0	57	0
5	White limestone	1	0	58	0
7	Yellowish-white limestone ...	9	0	86	0
8	White limestone ...	102	0	188	0
9	Dark brown limestone	4	0	192	0
10	Dark shaly lime-				

No.	Description of Strata.	Ft.	In.	Ft.	In.	No.	Description of Strata.	Ft.	In.	Ft.	In.
6	Coarse, porous, yellowish-white limestone ...	19	0	77	0		stone	33	0	225	0
						11	Yellow limestone ...	12	0	237	0

III.—Diamond-boring at the Cement Works, West Hartlepool, for Mr. Casebourne.

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.	No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
1	Well previously sunk	30	0	30	0	6	Red marl, with beds of red sandstone	27	0	164	0
2	Red sandstone ...	9	0	39	0	7	Red and grey sandstone, with beds of red marl	26	0	190	0
3	Red sandy marl ...	10	0	49	0	8	Red sandstone ...	25	0	215	0
4	Red sandstone, with beds of red marl	31	0	80	0	9	Red marl	35	0	250	0
5	Red sandstone and marl mixed ...	57	0	137	0						

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.	No.	Description of Strata.	Thickness of Strata. Ft.	in.	Depth from Surface. Ft.	in.
10	Red marl, with beds of sandstone ...	20	0	270	0	21	Red marl, with veins of gypsum and				

11 Red marl	38	0	308	0
12 Red marl,with thin beds of red sand-stone	32	0	340	0
13 Red marl	45	0	385	0
14 Redmarl,with veins of gypsum ...	95	0	480	0
15 Red marl,with veins of gypsum and blue joints ...	55	0	535	0
16 Red marl,with blue joints	4	2	539	2
17 Red marl,with veins of gypsum and blue spots ...	4	6	543	8
18 Redmarl,with veins of gypsum and blue joints ...	24	10	568	6
19 Redmarl,with veins of gypsum and red sandstone...	10	0	578	6
20 Strong marl,with thick veins of gypsum	21	6	600	0
blue joints ...	5	6	605	6
22 Anhydrite	4	0	609	6
23 Anhydrite, with veins of gypsum	12	0	621	6
24 Anhydrite	2	6	624	0
25 Blue marl	0	8	624	8
26 Red marl,with blue joints and veins of gypsum ...	27	10	652	6
27 Anhydrite	7	0	659	6
28 Anhydrite, with black joints, and veins of gypsum	11	0	670	6
29 Anhydrite, with black joints ...	16	0	686	6
30 Anhydrite, with spots of gypsum	18	6	705	0
31 Anhydrite, with gypsum	9	4	714	4
32 Anhydrite, mixed with limestone	15	8	730	0
33 Limestone, with gypsum	40	0	770	0

IV.—Diamond-boring near Seaton Carew,by Mr.John Vivian,for Mr.C.T.Caseboume,1887-1888.

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
1	Brown clay	6	0	6	0
2	Red clay	6	0	12	0
3	Red pinnel and cobbles	6	0	18	0
4	Soft red sandy marl	12	0	30	0
5	Red sandy marl...	3	0	33	0
6	Red and grey sandstone	7	0	40	0
7	Red marl	2	0	42	0
8	Grey sandstone...	5	0	47	0
9	Red marl, with beds of sandstone...	10	0	57	0
10	Red sandstone...	20	0	77	0
11	Grey sandstone...	2	0	79	0
12	Red sandstone ...	13	0	92	0
13	Grey sandstone...	1	0	93	0
14	Red sandy marl...	47	0	140	0
15	Red and grey sandstone	10	0	150	0
16	Red marl	15	0	165	0
17	Red marl, with beds of grey and red sandstone ...	8	0	173	0
18	Red marl, with blue				
20	Red marl,with beds of grey marl ...	33	0	265	0
21	Red marl, with blue joints	24	0	289	0
22	Red marl, with blue joints and veins of gypsum ...	171	0	460	0
23	Red marl, with veins of gypsum	7	5	467	5
24	Anhydrite	13	0	480	5
25	Blue marl, with veins of gypsum	3	0	483	5
26	Anhydrite	1	0	484	5
27	Red marl,with veins of gypsum (rotten marl)	10	0	494	5
28	Dark marl and gypsum mixed ...	2	7	497	0
29	Anhydrite, with black joints ...	25	0	522	0
30	Magnesian, limestone,with spots of gypsum	27	0	549	0
31	Light grey mag-				

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
	joints	35	0	208	0
19	Red marl, with blue joints and beds of grey sandstone	24	0	232	0
	nesian limestone, with spots and veins of gypsum	38	0	587	0

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
32	Dark grey limestone, with spots and veins of gypsum	16	0	603	0
33	Dark blue shale (with small feeder of rock oil and sulphur water) ...	3	0	606	0
34	Anhydrite, with beds of dark blue shale and gypsum ...	35	0	641	0
35	Light grey limestone and gypsum	7	0	648	0
36	Blue shale	2	0	650	0
62	Black shale ...	0	6	1,428	0
63	Dark grey shale ...	1	0	1,429	0
64	Dark grey sandstone	1	0	1,430	0
65	Grey sandstone, with black joints ...	30	0	1,460	0
66	Grey sandstone ...	10	0	1,470	0
67	Very course grey sandstone ...	15	0	1,485	0
68	Dark grey sandstone	0	6	1,485	6
69	Black shale ...	0	6	1,486	0
70	Red and grey sandstone	1	7	1,487	7
71	Black shale	12	4	1,499	11
72	Shaly sandstone ...	2	6	1,502	5

37 Light grey limestone	11	0	661	0
38 White limestone...	90	0	751	0
39 Hard white limestone, with gypsum	12	0	763	0
40 Dark grey limestone and anhydrite ...	20	0	783	0
41 Light grey limestone, with gypsum	18	0	801	0
42 Light grey limestone	29	0	830	0
43 Limestone and gypsum mixed ...	31	0	861	0
44 Grey limestone, with gypsum	11	0	872	0
45 Light grey limestone and gypsum	33	0	905	0
46 Light grey limestone	50	0	955	0
47 Light grey limestone, with spots of gypsum ...	45	0	1,000	0
48 White limestone...	107	0	1,107	0
49 Light grey limestone	23	0	1,130	0
50 Broken light grey limestone, and				

73 Black shale	10	0	1,512	5
74 Grey sandstone ...	4	0	1,516	5
75 Dark grey sandy shale	0	7	1,517	0
76 COAL	0	10	1,517	10
77 Dark brown fireclay	1	2	1,519	0
78 Black sandy shale...	2	8	1,521	8
79 Dark grey sandy shale	1	8	1,523	4
80 White sandstone...	26	8	1,550	0
81 Dark grey sandstone	5	0	1,555	0
82 Light grey sandstone	12	8	1,567	8
83 Dark Shaly sandstone, with coal joints	1	4	1,569	0
84 Black Shale ...	9	6	1,578	6
85 COAL	1	2	1,579	8
86 Dark black shale and fireclay ...	0	4	1,580	0
87 White and grey sandstone	6	0	1,586	0
88 Black shale ...	8	0	1,594	0
89 Fine grey sandstone	6	0	1,600	0
90 Dark grey sandstone	3	6	1,603	6
91 Black shale ...	7	0	1,610	6
92 Black shale, with beds of dark grey sandstone ...	6	6	1,617	0

brine spring ...	23	0	1,153	0
51 Light grey limestone	9	0	1,162	0
52 Light grey limestone, with spar cavities	9	0	1,171	0
53 Light grey limestone	7	0	1,178	0
54 White limestone...	82	0	1,260	0
55 Light grey limestone, with a little gypsum	23	0	1,283	0
56 Dark grey limestone, with gypsum ...	17	6	1,300	6
57 Dark grey limestone, with veins of gypsum ...	19	6	1,320	0
58 Dark limestone, with spots of gypsum	40	0	1,360	0
59 Dark grey limestone	40	0	1,400	0
60 Dark grey shaly sandstone ...	10	0	1,410	0
61 Red and grey shaly sandstone ...	17	6	1,427	6

93 Black shale ...	6	0	1,623	0
94 Black shale, with beds of grey sandstone	7	11	1,630	11
95 COAL and shale...	0	1	1,631	0
96 Dark brown fireclay	2	0	1,633	0
97 Dark grey sandstone	6	0	1,639	0
98 Dark shaly sandstone	5	0	1,644	0
99 Yellowish sandstone	8	9	1,652	9
100 Coarse, light grey sandstone ...	16	6	1,669	3
101 Hard yellowish sandstone, with lime veinule... ...	2	3	1,671	6
102 Coarse, light grey sandstone ...	3	6	1,675	0
103 Coarse grey sandstone	1	6	1,676	6
104 Dark grey shaly sandstone ...	1	6	1,678	0

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
105	Black shale ...	8	0	1,686	0
106	Dark grey sandy shale	3	0	1,689	0
107	Dark blue shale ...	7	0	1,696	0
108	Black shale ...	4	0	1,700	0
109	Dark brown shale.	3	0	1,703	0
110	Grey shaly sandstone	10	0	1,713	0
111	Coarse grey sandstone, with coal pipes	24	0	1,737	0
112	Dark grey shaly sandstone ...	5	0	1,742	0
113	Yellowish shaly sandstone ...	6	0	1,748	0
114	Dark shaly sandstone	8	0	1,756	0
115	Black shale ...	24	0	1,780	0
116	Grey sandstone with beds of black shale	10	0	1,790	0
117	Coarse grey sandstone, with black joints	10	0	1,800	0
118	Grey sandstone ...	14	6	1,814	6

V.—Boring at Oughton,near Hartlepool.

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
1	Soil	1	0	1	0
2	Gravel,with water	10	0	11	0
39	White post ...	6	0	274	8
40	Red Metal	12	0	286	8

3 Blue clay,very strong	54	0	65	0
4 Sand,with water ...	1	8	66	8
5 Blueclay,very strong	8	6	75	2
6 Red sand	3	6	78	8
7 Sandy clay	5	2	83	10
8 Red sand	8	2	92	0
9 Blue clay	3	10	95	10
10 Sandy clay	1	6	97	4
11 Sand,with water ...	0	8	98	0
12 Clay,very strong,				
with pebbles ...	21	0	119	0
13 Grey freestone tum-				
bler	2	0	121	0
14 Grey sand	4	2	125	2
15 Clay,very strong ...	1	9	126	11
16 Brown clay,very fine	9	1	136	0
17 Brown freestone ...	5	0	141	0
18 Grey metal	7	5	148	5
19 Brown post,with gul-				
4				
lets	3	0	151	5
20 Red freestone ...	2	10	154	3
21 White post,very				
strong	3	0	157	3
22 Red post	12	7	169	10
23 White post,very				
strong,with metal				
10				

41 White post girdle ...	0	6	287	2
42 Red freestone post	6	0	293	2
43 White post girdle ...	0	6	293	8
44 Red freestone post	17	2	310	10
45 Whin girdle	0	4	311	2
46 Red freestone post	17	2	328	4
47 Strong whin girdle	0	2	328	6
48 Red metal	2	0	330	6
49 Strong whin girdle	0	8	331	2
50 Red metal	3	0	334	2
51 Strong brown post,				
with metal part-				
ings	4	6	338	8
52 Red metal	6	0	344	8
53 Grey metal	3	6	348	2
54 Red freestone post	17	6	365	8
55 Red bastard whin	0	10	366	6
56 Red metal	0	2	366	8
57 Strong whin girdle	0	8	367	
58 Red metal	9	0	376	4
59 White post girdle ...	0	4	376	8
60 Red metal	13	8	390	4
61 White post girdle ...	0	2	390	6
62 Red and whitemetal	6	2	396	8
63 Red metal	1	6	398	2
64 White post girdle ...	0	8	398	

partings	5	4	175	2	65 White stone,like spar	0	4	399	2
24 Grey metal	1	2	176	4	66 Red metal	0	4	399	6
25 Red freestone ...	4	1	180	5	67 Bastard whin girdle	0	6	400	0
26 White post	3	2	183	7	68 Red metal	0	2	400	2
27 Red freestone ...	15	0	198	7	69 Bastard whin girdle	0	5	400	7
28 Post girdle	0	9	199	4	70 Red freestone post,				
29 Red freestone ...	22	10	222	2	with metal part-				
30 Blue metal	3	6	225	8	ings	3	6	404	1
31 Red freestone ...	11	0	236	8	71 Red metal	1	6	405	7
32 Blue metal	2	0	238	8	72 Red freestone post	2	7	408	2
33 Red freestone post	6	0	244	8	73 Red metal	0	4	408	6
34 White post girdle...	0	6	245	2	74 Brown freestone post	15	8	424	2
35 Blue metal	1	6	246	8	75 Red metal	0	8	424	10
36 Red freestone post	13	0	259	8	76 White post	1	1	425	11
37 White post girdle ...	0	6	260	2	77 Red metal	0	6	426	5
38 Red freestone post	8	6	268	8					

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
78	Brown freestone post	6	6	432	11
79	Red metal	0	6	433	5
80	White post	2	0	435	5
81	Red metal	0	4	435	9
82	Brown freestone post	2	0	437	9
83	Red metal, very strong	1	0	438	9
84	Soft red metal ...	1	2	439	11
85	Brown freestone post	3	10	443	9
86	Red metal	0	8	444	5
87	Brown freestone post	3	4	447	9
88	Strong red metal...	1	6	449	3
89	Soft red metal ...	0	6	449	9
90	Strong brown post, with a strong feeder of water	3	0	452	9
91	White post girdle...	0	2	452	11
92	Red metal	1	0	453	11
93	White post girdle...	0	10	454	9
94	Red metal and post girdle	14	4	469	1
95	Strong brown post	3	0	472	1
96	Red metal	0	4	472	5
97	COAL	0	4	472	9
98	Red metal	1	0	473	9
99	Strong red metal ...	6	0	479	9
100	Strong freestone post	6	6	486	3
101	Soft red metal ...	0	3	486	6
102	Brown whin	1	2	487	8
103	Brown freestone ...	0	10	488	6
104	Brown whin	5	4	493	10
105	Brown freestone ...	0	7	494	5
106	Brown whin	5	7	500	0
107	Whitestone,like spar	0	3	500	3
108	Brown freestone ...	2	9	503	0
109	Brown whin	2	6	505	6
110	Strong white post ...	4	0	509	6
111	Strong whin post ...	1	1	510	7
112	White whin	0	1	510	8
113	Strong whinstone ...	3	11	514	7
114	Strong grey stone...	0	6	515	1
115	Strong blue post ...	1	6	516	7
116	Blue metal	1	3	517	10
117	Brown stone	6	7	524	5

VI.—No. a Diamond-boring at Marsh House, near Greatham, by Mr. John Vivian, for Mr. C.T. Casebourne, 1887 (now Hartlepool Salt and Brine Co., Ltd.).

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
1	Soil	1	0	1	0
2	Red and blue clay	3	0	4	0
3	Tough red clay ...	26	0	30	0
4	Red sand	4	0	34	0
5	Red sand and clay	15	0	49	0
6	Fine gravel ...	1	0	50	0
7	Brown sandy pinnel	1	0	51	0
8	Brown pinnel and cobbles	14	0	65	0
9	Red sand	2	6	67	6
10	Hard round gravel	4	5	71	11
11	Red sandstone ...	300	7	372	6
12	Red sandstone, with beds of marl ...	77	0	449	6
13	Red sandstone ...	15	2	464	8
14	Red sandstone, with beds of marl ...	114	7	579	3
15	Red sandy marl ...	8	6	587	9
16	Red marl, with blue joints	8	6	596	3
17	Red sandy marl ...	21	3	617	6
18	Red marl	20	3	637	9
19	Red marl, with blue joints	21	8	659	5
20	Red marl, with veins of gypsum ...	18	8	678	1
21	Red marl, with veins of gypsum and blue joints ...	106	11	785	0
22	Red marl, with veins of gypsum and blue spots ...	68	2	853	2
23	Red marl, with veins of gypsum ...	9	10	863	0
24	Anhydrite	11	0	874	0
25	Red marl (rotten)	15	0	889	0
26	ROCK SALT ...	57	2	946	2
27	SALT and anhydrite mixed ...	14	3	960	5
28	ROCK SALT ...	11	4	971	9
29	Anhydrite	1	0	972	9

VII.—No.1 Diamond-boring on Gowpon Marsh,by Mr.John Vivian,for the Newcastle Chemical Works Co.,Ltd,1885 (now United Alkali Co.,Ltd.).

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.	No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
1	Blue clay	4	0	4	0	7	Clay	0	6	57	10
2	Dark muddy sand	2	0	6	0	8	Gravel	0	8	58	6
3	Blue sand clay ...	29	4	35	4	9	Red pinnel ...	3	0	61	6
4	Soft sand	9	0	44	4	10	Brown clay and cobbles ...	15	6	77	0
5	Sand and gravel	7	0	51	4						
6	Rough sand ...	6	0	57	4						

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.	No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
11	Brown pinnel and cobbles	8	0	85	0	32	Marly sandstone, with veins of gypsum	20	0	801	0
12	Hard bound gravel	2	0	87	0	33	Marly sandstone	16	0	817	0
13	Soft red sandstone	6	0	93	0	34	Red marl	23	0	840	0
14	Red sandstone ...	1	4	94	4	35	Red marly sand-				
15	Soft red sandstone	40	0	134	4						

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
16	Red sandstone ...	223	3	357	7
17	Soft marl	0	8	358	3
18	Red sandstone ...	30	0	388	3
19	Red sandstone, with marl beds ...	27	4	415	7
20	Red sandstone ...	207	11	623	6
21	Red marl	3	9	627	3
22	Red marl, with grey stripes	18	1	645	4
23	Red sandstone ...	13	0	658	4
24	Marly sandstone ...	35	2	693	6
25	Red sandy marl ...	13	0	706	6
26	Red sandstone ...	6	0	712	6
27	Red marl	17	0	729	6
28	Red sandstone, broken	20	6	750	0
29	Red marl	15	0	765	0
30	Red sandstone ...	9	0	774	0
31	Marly sandstone ...	7	0	781	0
	stone	46	0	886	0
36	Red marl, with veins of gypsum	10	0	896	0
37	Red marl	19	0	915	0
38	Marly sandstone, with veins of gypsum	11	0	926	0
39	Red marl, with veins of gypsum ...	134	0	1,060	0
40	Anhydrite	9	0	1,069	0
41	Red marl, containing a little salt...	19	6	1,088	6
42	Red marl	2	6	1,091	0
43	ROCK SALT ...	96	0	1,187	0
44	ROCK SALT and gypsum ...	4	0	1,191	0
45	ROCK SALT ...	16	9	1,207	0
46	White stone ...	3	9	1,211	6
47	Anhydrite	2	6	1,214	0

VIII.— No.2 Diamond-boring on Gowpon Marsh, by Mr. John Vivian, for the Newcastle Chemical Works Company, Limited, 1885 (now United Alkali Co., Ltd.).

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
1	Brown soil... ...	1	0	1	0
27	Red sandstone ...	12	0	690	0

2 Blue clay	1	6	2	6
3 Sand	2	6	5	0
4 Blue clay	4	0	9	0
5 Blue sandy clay...	35	0	44	0
6 Sand	10	0	54	0
7 Bound gravel ...	2	0	56	0
8 Sand and gravel...	4	0	60	0
9 Brown clay and cobbles	5	0	65	0
10 Pinnel and large pinnel cobbles ...	3	0	68	0
11 Sandy pinnel ...	2	0	70	0
12 Gravelly pinnel and cobbles... ...	7	9	77	9
13 Grey sandstone...	2	2	79	11
14 Red sandstone ...	400	1	480	0
15 Red sandstone,with marl beds ...	17	0	497	0
16 Red marl	2	0	499	0
17 Red sandstone ...	70	0	569	0
18 Red sandstone ...	11	0	580	0
19 Red marl	5	0	585	0
20 Red sandstone ...	27	0	612	0
21 Red marl	28	0	640	0
22 Red sandstone ...	16	0	656	0
23 Red sandstone,with marl beds ...	9	0	665	0
28 Broken red marl ...	10	0	700	0
29 Broken red sandstone	14	0	714	0
30 Broken red marl ...	8	6	722	6
31 Red marl	7	0	729	6
32 Red sandstone ...	22	0	751	6
33 Red marl	6	6	758	0
34 Red sandstone ...	3	0	761	0
35 Red marly sandstone	17	0	778	0
36 Red marl	28	0	806	0
37 Red sandy marl ...	27	0	833	0
38 Red sandy marl,with veins of gypsum	11	0	844	0
39 Red sandy marl ...	9	0	853	0
40 Red marl,with veins of gypsum ...	42	4	895	4
41 Red marl	13	8	909	0
42 Red marl,with veins of gypsum ...	15	0	924	0
43 Red marl	3	0	927	0
44 Red marl,with veins of gypsum ...	116	0	1,043	0
45 Red marl	13	0	1,056	0
46 Anhydrite	9	0	1,065	0
47 Dark marl	16	2	1,081	2
48 Red marl,containing				

24 Red sandstone ...	3	0	668	0	salt	6	4	1,087	6
25 Broken red marl...	5	0	673	0	49 ROCK SALT ...	115	4	1,202	10
26 Broken red sand-					50 White stone ...	7	11	1,210	9
stone	5	0	678	0	51 Anhydrite	1	3	1,212	0

IX.— No.3 Diamond-boring on Gowpon Marsh,by Mr.John Vivian,for the Newcastle Chemical Works Company,Limited,1885 (now United Alkali Company,Ltd.).

No. Description of Strata.	Thickness of Strata.		Depth from Surface.		No. Description of Strata.	Thickness of Strata.		Depth from Surface.	
	Ft.	In.	Ft.	In.		Ft.	In.	Ft.	In.
1 Soil	1	0	1	0	23 Red marl	4	0	587	0
2 Blue clay	1	6	2	6	24 Red sandstone ...	31	6	618	6
3 Sand	2	6	5	0	25 Red marl	16	0	634	6
4 Blue clay	38	0	43	0	26 Red sandstone,very				
5 Sand	9	0	52	0	much broken ...	58	6	693	0
6 Sand and gravel ...	4	0	56	0	27 Red sandstone ...	18	6	711	6
7 Brown sandy pinnel,					28 Red marl	13	0	724	6
with pinnel cob-					29 Red sandstone ...	23	6	748	0
bles	1	0	57	0	30 Red marl	9	0	757	0
8 Red clay and cob-					31 Red sandstone ...	12	0	769	0
bles	5	0	62	0	32 Red marl	24	0	793	0
9 Brown sandy clay,					33 Marly sandstone ...	20	0	813	0

with cobbles ...	12	0	74	0	34 Red marl	19	0	832	0
10 Red sandy pinnel	1	0	75	0	35 Red marl,with veins				
11 Soft red sandstone	3	6	78	6	of gypsum ...	226	0	1,058	0
12 Red sandstone ...	59	6	138	0	36 Anhydrite	9	9	1,067	9
13 Grey sandstone ...	4	6	142	6	37 Broken red marl,				
14 Red sandstone ...	148	6	291	0	very salty ...	8	0	1,075	9
15 Broken red marl ...	3	0	294	0	38 Red marl,containing				
16 Red sandstone ...	201	0	495	0	salt	13	9	1,089	6
17 Red marl	4	0	499	0	39 ROCK SALT ...	101	6	1,191	0
18 Red sandstone ...	30	0	529	0	40 Gypsum	1	6	1,192	6
19 Red marl	3	0	532	0	41 Anhydrite	1	0	1,193	6
20 Red sandstone ...	43	0	575	0	42 Gypsum, containing				
21 Red marl	3	0	578	0	salt	9	6	1,203	0
22 Red sandstone ...	5	0	583	0	43 Anhydrite	2	0	1,205	0

X. —No.4 Diamond-boring on Cowpon Marsh,by Mr.John Vivian,for the Newcastle Chemical Works Company,Limited,1885 (now United Alkali Company,Ltd.).

No. Description of Strata.	Thickness of Strata.		Depth from Surface.		No. Description of Strata.	Thickness of Strata.		Depth from Surface.	
	Ft.	In.	Ft.	In.		Ft.	In.	Ft.	In.
1 Soil	1	0	1	0	24 Red sandstone ...	22	6	610	6
2 Brown sandy clay ...	1	6	2	6	25 Red marly sand-				
3 Sand	2	9	5	3	stone	2	0	612	6
4 Blue clay	30	9	36	0	26 Red sandstone ...	9	0	621	6
5 Brown clay ...	4	0	40	0	27 Red marly sand-				
6 Sand	9	2	49	2	stone	10	6	632	0

7 Sand and gravel ...	0	4	49	6
8 Brown pinnel ...	18	6	68	0
9 Brown pinnel,with cobbles	10	8	78	8
10 Soft red sandstone	8	4	87	0
11 Red sandstone ...	50	0	137	0
12 Grey sandstone ...	4	0	141	0
13 Red sandstone ...	43	0	184	0
14 Red sandstone ...	283	6	467	6
15 Red marl	1	0	468	6
16 Red sandstone ...	8	3	476	9
17 Red sandstone,with beds of marl ...	21	9	498	6
18 Red marly sand-stone	3	6	502	0
19 Red sandstone ...	27	0	529	0
20 Red marly sand-stone	25	0	554	0
21 Red sandstone ...	28	6	582	6
22 Red marly sand-stone	1	6	584	0
23 Red marl	4	0	588	0
28 Red marl	1	6	633	6
29 Red marly sand-stone	38	0	671	6
30 Marl	3	0	674	6
31 Red sandstone ...	18	0	692	6
32 Red marly sand-stone	6	6	699	0
33 Red sandy marl ...	7	10	706	10
34 Red sandstone ...	7	0	713	10
35 Red marl	6	0	719	10
36 Red sandstone, with beds of marl ...	29	8	749	6
37 Red marl	7	0	756	6
38 Red sandstone and marl	21	6	778	0
39 Red sandy marl ...	32	6	810	6
40 Red marl	30	0	840	6
41 Red marl, with veins of gypsum ...	61	6	902	0
42 Red marl	18	8	920	8
43 Red marl	46	7	967	3
44 Not drawn	18	3	985	6

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
45	Red marl, with veins of gypsum ...	15	0	1,000	6
46	Red marl	9	0	1,009	6
47	Red marl, with vertical joints of gypsum, .5 in. thick	4	3	1,013	9
48	Red marl	17	3	1,031	0
49	Red marl, with veins of gypsum ...	15	0	1,046	0
50	Red marl, with gypsum	15	0	1,061	0
51	White stone ...	0	6	1,061	6
52	Hard white stone ...	8	6	1,070	0
53	Broken red marl, containing salt ...	6	4	1,076	4
54	Red marl, containing salt	12	6	1,088	10
55	Decayed brown marl	1	0	1,089	10
56	Decayed brown marl and rock salt ...	12	2	1,102	0
57	ROCK SALT ...	90	6	1,192	6
58	Gypsum and salt ...	5	6	1,198	0
59	Gypsum and salt ...	4	0	1,202	0
60	Gypsum and salt ...	7	0	1,209	0
61	Gypsum, containing a little salt ...	3	0	1,212	0
62	Anhydrite	2	0	1,214	0

XI.—No.1 Diamond-boring at Salt Holme Salt Works,near Port Clarence,for Messrs.Bell Brothers,Limited (now Salt Union,Ltd.).

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
1	Peat,earth and clay	8	0	8	0
32	Red marl	7	0	711	0

2 Blue clay	32	0	40	0
3 Brown and red boulder clay ...	56	0	96	0
4 Red sandstone ...	291	0	387	0
5 Grey sandstone ...	2	0	389	0
6 Red sandstone ...	57	0	446	0
7 Striped red and grey sandstone ...	2	0	448	0
8 Red sandstone ...	19	0	467	0
9 Grey sandstone ...	2	0	469	0
10 Red sandstone ...	9	0	478	0
11 Grey sandstone, with 6 inches of red marl... ...	5	6	483	6
12 Reddish grey sand-stone	3	6	487	0
13 Red marl, with white stripes ...	11	0	498	0
14 Red sandstone ...	38	0	536	0
15 Grey sandstone ...	4	0	540	0
16 Red sandstone ...	15	0	555	0
17 Grey sandstone ...	0	6	555	6
18 Red sandstone ...	12	6	568	0
19 Grey sandstone ...	7	0	575	0
20 Red marl, with white stripes ...	14	0	589	0
21 Red sandstone ...	18	0	607	0
33 Red sandstone ...	2	0	713	0
34 Red marl	15	0	728	0
35 Grey sandstone ...	2	0	730	0
36 Red sandstone ...	6	0	736	0
37 Red marl	5	0	741	0
38 Red sandstone ...	9	0	750	0
39 Red marl	1	0	751	0
40 Red sandstone ...	5	0	756	0
41Red marl, with 2 inches of grey sandy band ...	10	2	766	2
42 Red sandstone ...	7	10	774	0
43 Red marl	3	0	777	0
44 Red sandstone ...	13	0	790	0
45 Red marl	185	0	975	0
46 Hard red marl,with grey stripes and veins of gypsum	21	0	996	0
47 Hard red marl, with thicker vein of pure gypsum ...	6	6	1,002	6
48 Pure gypsum ...	1	6	1,004	0
49 Hard white stone...	8	6	1,012	6
50 Red sandy marl, rather hard ...	4	6	1,017	0
51 Red sandy marl, very soft ...	5	0	1,022	0

No.	Description of Strata.	Ft.	In.	Ft.	In.	No.	Description of Strata.	Ft.	In.	Ft.	In.
22	Red marl	8	0	615	0	52	Red sandy marl, hard, with vein of gypsum ...	4	0	1,026	0
23	Red sandstone ...	7	0	622	0	53	Red and dark brown marl	5	0	1,031	0
24	Red marl, with white stripes and 2 inches of grey sandy band ...	14	2	636	2	54	Red and dark brown marl, with salt ...	12	0	1,043	0
25	Red sandstone ...	3	10	640	0	55	ROCK SALT and red clay... ...	65	0	1,108	0
26	Red marl	3	0	643	0	56	ROCK SALT and gypsum... ...	12	0	1,120	0
27	Red sandstone ...	29	0	672	0						
28	Red marl	4	0	676	0						
29	Red sandstone ...	24	0	700	0						
30	Red marl	2	0	702	0						
31	Red sandstone ...	2	0	704	0						

XII.—Trial Diamond-boring on Salt Holme Farm,near Port Clarence,for Messrs. Bell Brothers,Limited,December 15,1874 (now Salt Union,Ltd.).

No.	Description of Strata.	Thickness of Strata.		Depth from Surface.		No.	Description of Strata.	Thickness of Strata.		Depth from Surface.	
		Ft.	In.	Ft.	In.			Ft.	In.	Ft.	In.
1	Soil	1	6	1	6	36	Red sand and marl	5	0	880	0
2	Clay	4	0	5	6	37	Red sandstone with				

3 Dark sand	7	6	13	0
4 Clean sand	26	0	39	0
5 Red clay	3	0	42	0
6 Sand and gravel ...	8	0	50	0
7 Boulder clay ...	27	0	77	0
8 Red marl	73	0	150	0
9 Red sandstone, with veins of marl ...	144	0	294	0
10 White sandstone...	1	3	295	3
11 Red sandstone, with veins of marl ...	153	9	449	0
12 Red sandstone ...	10	0	459	0
13 Soft marl	3	0	462	0
14 Red sandstone ...	6	0	468	0
15 Blue vein	0	10	468	10
16 Red sandstone ...	31	2	500	0
17 Red sandstone, with veins of marl ...	27	0	527	0
18 Soft marl	4	0	531	0
19 Red sandstone ...	29	0	560	0
20 Red sandstone, with veins of marl ...	49	0	609	0
21 Soft marl	6	0	615	0
22 Red sandstone, with veins of marl ...	31	0	646	0
23 Red sandstone ...	6	0	652	0
24 Marl, with blue				
0				
veins of marl ...	14	0	894	0
38 Strong marl, with veins of sandstone	6	0	900	0
39 Strong marl ...	23	0	923	0
40 Strong marl with veins of gypsum	7	0	930	0
41 Mixed marl and sandstone ...	27	0	957	0
42 Marly sandstone, with veins of gypsum	141	0	1,098	0
43 Gypsum	4	0	1,102	0
44 Hard white stone (yielding gypsum)	3	9	1,105	0
45 Gypsum	3	6	1,109	3
46 Marly sandstone, very salty ...	8	1	1,117	4
47 Sandstone and salt	10	3	1,127	7
48 Red rock, with 4 per cent. of salt, only 3 ft. of core, because fresh water was used	9	0	1,136	7
49 GOOD SALT ...	16	0	1,152	7
50 ROCK SALT ...	48	5	1,201	0
51ROCK SALT, with marl and gypsum	35	0	1,236	

veins of sand-					52 Soft shale and gyp-				
stone	17	0	669	0	sum	8	0	1,244	0
25 Red sandstone, with					53 Gypsum	13	0	1,257	0
veins of marl ...	66	0	735	0	54 Gypsum and lime-				
26 Blue vein	0	7	735	7	stone	12	0	1,269	0
27 Red sandstone, with					55 Magnesian limestone				
veins of marl ...	13	5	749	0	(carburetted hy-				
28 Strong marl ...	9	6	758	6	drogen gas was				
29 Red sandstone, with					liberated here)	45	0	1,314	0
veins of marl ...	26	6	785	0	56 Grey limestone ...	9	0	1,323	0
30 Blue vein	0	3	785	3	57 Grey limestone and				
31 Strong marl ...	6	3	791	6	gypsum	11	0	1,334	0
32 Red sandstone, with					58 Gypsum	2	0	1,336	0
veins of marl ...	30	6	822	0	59 Gypsum containing				
33 Strong red marl and					salt	1	0	1,337	0
sandstone ...	17	0	839	0	60 ROCK SALT ...	14	0	1,351	0
34 Red sandstone, with					61 Marl,containing salt	2	0	1,353	0
veins of marl ...	16	0	855	0	62 Marl, with gypsum	1	0	1,354	0
35 Strong marl ...	20	0	875	0	63 SALT, impure ...	1	0	1,355	0

XIII.— No.1 Boring at Clarence,for Messrs.Bell Brothers,Limited,1890.

No.	Description of Strata.	Thick-ness of Strata.	Depth from Surface.	No.	Description of Strata.	Thick-ness of Strata.	Depth from Surface.

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
1	Sandy clay ...	10	0	10	0
2	Sand	33	0	43	0
3	Sand and gravel ...	15	0	58	0
4	Sand	1	0	59	0
5	Gravel	5	0	64	0
6	Sand and gravel ...	3	0	67	0
7	Gravel and pinnel	25	0	92	0
8	Red sandstone ...	458	0	550	0
9	Sandy marl ...	62	0	612	0
10	Red sandstone ...	14	0	626	0
11	Sandy marl ...	4	0	630	0
12	Red sandstone ...	16	0	646	0

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
13	Sandy marl ...	26	0	672	0
14	Sandstone	46	0	718	0
15	Sandy marl ...	39	0	757	0
16	Marl	172	0	929	0
17	Hard white stone	5	0	934	0
18	Marl	34	0	968	0
19	Marl and gypsum	113	0	1,081	0
20	White stone ...	16	0	1,097	0
21	Marl, containing salt	15	0	1,112	0
22	SALT	88	0	1,200	0
23	SALT and marl ...	11	8	1,211	8
24	Blue shale and anhydrite ...	10	0	1,221	8

XIV.—No.3 Boring at Clarence,for Messrs.Bell Brothers,Limited,1890.

Thick- Depth Thick- Depth

No.	Description of Strata.	ness of Strata. Ft.	In.	from Surface. Ft.	In.	No.	Description of Strata.	ness of Strata. Ft.	In.	from Surface. Ft.	In.
1	Surface	89	0	89	0	19	Limestone	8	0	983	0
2	Marl	52	0	141	0	20	Marl	36	0	1,019	0
3	Sand and gravel ...	4	0	145	0	21	Very soft marl ...	9	0	1,028	0
4	Sandstone, with marl beds ...	99	0	244	0	22	Marl	11	0	1,039	0
5	Red sandstone ...	30	0	274	0	23	Marl, with a little gypsum	11	0	1,050	0
6	Sandy marl ...	13	0	287	0	24	Marl	9	0	1,059	0
7	Sandstone	82	0	369	0	25	Marl and gypsum	28	0	1,087	0
8	Marl and sand-stone	104	0	473	0	26	Marl	35	0	1,122	0
9	Sandy marl ...	31	0	504	0	27	Muddy marl	8	0	1,130	0
10	Sandstone	24	0	528	0	28	Marl	23	0	1,153	0
11	Sandy marl ...	27	0	555	0	29	Marl and gypsum	12	0	1,165	0
12	Marl	35	0	590	0	30	White stone ...	7	0	1,172	0
13	Marl and sandstone	79	0	669	0	31	White stone and marl	8	0	1,180	0
14	Marl	22	0	691	0	32	Marl	15	0	1,195	0
15	Sandstone and marl	21	0	712	0	33	SALT	93	0	1,288	0
16	Marl	13	0	725	0	34	SALT and bluish marl	3	0	1,291	0
17	Sandy marl ...	51	0	776	0	35	Anhydrite and marl	10	0	1,301	0
18	Marl	199	0	975	0						

XV.—No.5 Boring at Clarence,for Messrs.Bell Brothers,Limited,1892.

	Thick-ness of	Depth from		Thick-ness of	Depth from

No.	Description of Strata.	Strata. Ft.	In.	Surface. Ft.	In.
1	Surface	138	0	138	0
2	Red sandy marl ...	42	0	180	0
3	Red sandstone and a little marl ...	90	0	270	0
4	Red sandstone ...	232	0	502	0
5	Red sandstone and red marl	68	0	570	0
6	Red marl	13	0	583	0
7	Red sandstone, with streaks of marl ...	34	0	617	0
8	Red marl, with small streaks of sandstone ...	30	0	647	0
9	Red marl	27	0	674	0
10	Red marl, with streaks of sand-stone	28	0	702	0
11	Red marl	103	0	805	0
12	Red sandstone ...	20	0	825	0
13	Red marl	105	0	930	0
14	Red marl, with a little sandstone	22	0	952	0
15	Red marl	12	0	964	0
16	Red marl with veins of gypsum	75	0	1,039	0
17	Red marl	31	0	1,070	0
18	Red marl, with veins of gypsum	20	0	1,090	0
19	Red marl and much gypsum	27	0	1,117	0
20	Red marl	6	0	1,123	0
21	White stone ...	11	0	1,134	0
22	Red marl	3	0	1,137	0
23	Broken marl ...	15	0	1,152	0
24	Broken marl with salt	4	0	1,156	0
25	SALT	90	0	1,246	0
26	Anhydrite	5	0	1,251	0
27	SALT	12	0	1,263	0
28	Anhydrite	2	0	1,265	0

XVI.—Boring at Middlesbrough for Messrs. Bolckow and Vaughan, by Messrs. Mather and Platt, commenced on July 4, 1859, and completed on August 29, 1862 (now Cleveland Salt Co., Ltd.).

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
1	Made ground ...	11	0	11	0
2	Dry slime or river mud	8	0	19	0
3	Sand, with water ...	10	0	29	0
4	Hard dry clay ...	10	0	39	0
5	Red sand, with a little water ...	1	0	40	0
6	Loamy sand, with a little water ...	3	0	43	0
7	Hard dry clay ...	15	0	58	0
8	Rock, mixed with clay and water...	11	0	69	0
9	Rock, mixed with clay	1	0	70	0
10	Rock, mixed with gypsum... ...	6	0	76	0
11	Gypsum, with water	2	0	78	0
12	Red sandstone, with small veins of gypsum, & water	55	0	133	0
29	Red sandstone and clay	9	0	1,001	9
30	Sandstone with a vein of blue rock	49	4	1,051	1
31	Red and blue sandstone	1	5	1,052	6
32	Red sandstone ...	6	0	1,058	6
33	Red sandstone and thin veins of gypsum... ...		5	1,059	11
34	Red sandstone and thin veins of gypsum	39	8	1,099	7
35	Red sandstone, with blue clay and gypsum... ...	1	2	1,100	9
36	Red sandstone, with veins of gypsum	87	3	1,188	0
37	Gypsum	3	2	1,191	2
38	White stone ...	0	8	1,191	10

13 Rock gypsum ...	6	0	139	0	39 Limestone	2	8	1,194	6
14 Brown shale, with					40 Blue rock	0	2	1,194	8
water	1	0	140	0	41 Blue clay	0	2	1,194	10
15 Red sandstone ...	4	0	144	0	42 Hard blue and red				
16 Red sandstone, with					rock	0	10	1,195	8
small veins of					43 White stone ...	2	7	1,198	3
gypsum, & water	12	0	156	0	44 Dark red rock ...	1	2	1,199	5
17 Blue sandstone, with					45 Dark red rock,rather				
water at bottom	3	0	159	0	salt	6	7	1,206	0
18 Red sandstone, with					46 ROCK SALT,				
water	19	0	178	0	rather dark ...	12	7	1,218	7
Bottom of sink-					47 ROCK SALT,very				
ing, bored below.					dark	4	1	1,222	8
19 Red sandstone ...	437	4	615	4	48 ROCK SALT,very				
20 Red and white sand-					light	3	6	1,226	2
stone	1	6	616	10	49 ROCK SALT,				
21 Red sandstone ...	215	7	832	5	rather dark ...	27	4	1,253	6
22 Red sandstone and					50 ROCK SALT,very				
clay	1	0	833	5	light	43	6	1,297	0
23 Red sandstone ...	52	3	885	8	51 ROCK SALT,				
24 Red sandstone and					rather light ...	9	0	1,306	0
clay	9	0	894	8	52 Limestone ...	1	0	1,307	0

25	Red sandstone ...	66	5	961	1	53	Conglomerate, resembling limestone, and containing a large quantity of salt	6	4	1,313	4
26	Strong clay ...	2	9	963	10						
27	Red sandstone and clay	1	6	965	4						
28	Red sandstone ...	27	5	992	9						

XVII.— No.1 Boring at Middlesbrough for Messrs.Bolckow,Vaughan and Company, commenced to pump brine on August 17,1886 (now Cleveland Salt Co.,Ltd.).

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.	No.	Description of Strata.	Thickness Strata. Ft.	In.	Depth from Surface. Ft.	In.
1	Made ground ...	11	0	11	0	5	Red sandstone, with water	1	0	40	0
2	Dry slime	8	0	19	0	6	Sand or loam, with water	3	0	43	0
3	Sand, with water ...	10	0	29	0						
4	Hard dry clay ...	10	0	39	0						

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.	No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
7	Hard dry clay ...	13	0	56	0	43	Red marl	13	6	620	6
8	Mixed rock and					44	Soft red sandstone,				

clay, with water	11	0	67	0
9 Mixed rock and clay, dry ...	1	0	68	0
10 Mixed rock and clay and gypsum, dry	6	0	74	0
11 Shell of rock with water	2	0	76	0
12 Red and blue rock, with small veins of white gypsum, and water ...	55	0	131	0
13 White gypsum rock, dry	6	0	137	0
14 Brown shale, with water	1	0	138	0
15 Red sandstone ...	4	0	142	0
16 Red sandstone, with small veins of white gypsum ...	12	0	154	0
17 Blue post stone and water	3	0	157	0
18 Red sandstone, with water	19	0	176	0
19 Red sandstone ...	134	6	310	6
20 Marl	6	6	317	0
21 Sandstone and a little marl ...	3	0	320	0

with thin seams of marl	19	9	640	3
45 Hard red sandstone, with a little mica	28	3	668	6
46 Hard red sandstone and marl	29	0	697	6
47 Marl	14	6	712	0
48 Red sandstone ...	8	6	720	6
49 Hard red sandstone and marl	25	6	746	0
50 Red marl	15	9	761	9
51 Red sandstone and marl	9	3	771	0
52 Soft red sandstone	20	3	791	3
53 Soft red sandstone, with a little marl	5	6	796	9
54 Hard red sandstone, with marl partings	6	6	803	3
55 Hard red sandstone and marl	7	9	811	0
56 Soft red sandstone	4	6	815	6
57 Red marl	10	6	826	0
58 Hard red sandstone and marl	9	3	835	3
59 Red marl	11	3	846	6
60 Fine dark red sand-				

22 Soft red sandstone	35	0	355	0
23 Hard dark red sand-stone	9	0	364	0
24 Hard dark red sand-stone, a little softer	5	9	369	9
25 Red marl	3	3	373	0
26 Red sandstone, with thin layers of marl	7	0	380	0
27 Hard dark sand-stone, with a little mica ...	23	0	403	0
28 Dark red sandstone, with a little mica	9	3	412	3
29 Rough red sandstone	20	3	432	6
30 Rough red sand-stone, a little darker	9	6	442	0
31 Fine dark red sand-stone	7	0	449	0
32 Rough red sandstone	12	3	461	3
33 Red sandstone, with				
stone	12	6	859	0
61 Hard dark sand-stone, with marl partings	11	6	870	6
62 Marl and a little red sandstone ...	6	9	877	3
63 Dark red sandstone	9	3	886	6
64 Marl, with partings of sandstone ...	1	8	888	2
65 Red sandstone ...	7	10	896	0
66 Red sandstone, with marl partings ...	2	0	898	0
67 Red marl	21	6	919	6
68 Hard dark red sand-stone	4	6	924	0
69 Hard dark red sand-stone and marl...	5	6	929	6
70 Hard red sandstone	4	3	933	9
71 Red marl	21	9	955	6
72 Red sandstone, with veins of marl ...	9	9	965	3
73 Red sandstone ...	5	9	971	0

a little marl ...	19	3	480	6	74 Red marl	43	0	1,014	0
34 Red sandstone,with					75 Hard red sandstone,				
kernels of marl...	8	6	489	0	with thin layers				
35 Red sandstone, a					of marl	8	0	1,022	0
little harder ...	24	6	513	6	76 Red marl	4	0	1,026	0
36 Hard red sandstone	8	6	522	0	77 Hard red sandstone,				
37 Marl	12	6	534	6	with grey spots	2	6	1,028	6
38 Soft red sandstone	34	9	569	3	78 Hard sandstone and				
39 Red marl	9	3	578	6	red marl	11	3	1,039	9
40 Soft red sandstone	11	0	589	6	79 Red marl	7	9	1,047	6
41 Hard red sandstone	13	0	602	6	80 Hard red sandstone				
42 Soft red sandstone	4	6	607	0	and marl	15	0	1,062	6

No. Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.	No. Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
81 Redmarl	15	6	1,078	0	94 Band of blue rock ...	0	3	1,190	7
82 Hard red sandstone					95 Red and white rock	0	5	1,191	0

and marl ...	10	9	1,088	9
83 Red marl	5	9	1,094	6
84 Red marl, with thin seams of red sand-stone	20	6	1,115	0
85 Hard red marl, wi a little red sand-stone	9	0	1,124	0
86 Hard red sandstone and marl ...	8	0	1,132	0
87 Very hard red marl	4	6	1,136	6
88 Hard marl and sand-stone mixed ...	17	0	1,153	6
89 Hard marl	15	0	1,168	6
90 Very hard marl and sandstone ...	16	3	1,184	9
91 Magnesian limestone and gypsum rock	2	9	1,187	6
92 Magnesian limestone, much lighter ...	0	10	1,188	4
93 Magnesian limestone	2	0	1,190	4

96 Hard gypsum and lime	1	0	1,192	0
97 Red and white rock rather salt ...	14	0	1,206	0
98 Marl and rock salt	2	0	1,208	0
99 Hard marl, with blue spots, rather salt	5	0	1,213	0
100 Marl and dark col-oured rock salt ...	7	0	1,220	0
101 ROCK SALT ...	66	0	1,286	0
102 Hard red marl and salt	0	6	1,286	6
103 Very hard blue marl and salt... ...	1	0	1,287	6
104 SALT and a little red marl ...	7	3	1,294	9
105 Solid grey gyp-sum	0	6	1,295	3
106 SALT and gypsum	1	0	1,296	3
107 Solid gypsum ...	3	9	1,300	0

* Analysis of No.93:—Sulphate of lime 27,carbonate of lime 40.25,and carbonate of magnesia 32.75 per cent.

XVIII.—No.1 Boring,near North Ormesby Toll Bar,for the Owners of the Middlesbrough Estate,Limited,June,1887.

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
1	Brown clay ...	6	0	6	0
2	Brown clay and stone	24	0	30	0
3	Hard clay and cobbles... ...	4	0	34	0
4	Red and grey marl	5	0	39	0
5	Rotten grey marl...	1	0	40	0
6	Red marl... ...	2	6	42	6
7	Red and grey marl	1	0	43	6
8	Red marl, with veins of gypsum	5	0	48	6
9	Red and grey marl, very hard ...	1	0	49	6
10	Red marl, with veins of gypsum	0	6	50	0
11	Red marl... ...	1	7	51	7
12	Red and grey marl, very hard ...	1	6	53	1
13	Red and grey marl, with veins of gypsum... ...	4	11	58	0
14	Red and grey marl	1	0	59	0
18	Grey marl, with veins of gypsum	3	0	83	6
19	Red marl, with veins of gypsum	6	6	90	0
20	Grey marl with veins of gypsum	11	0	101	0
21	Red and grey marl, with veins of gypsum	8	0	109	0
22	Red marl, with veins of gypsum	5	0	114	0
23	Red and grey marl, with veins of gypsum	4	6	118	6
24	Red marl, with veins of gypsum	3	6	122	0
25	Grey marl, with veins of gypsum	1	0	123	0
26	Red marl, with veins of gypsum	14	0	137	0
27	Red and grey marl, with veins of gypsum	11	6	148	6

15 Grey marl, with veins of gypsum	7	6	66	6
16 Red and grey marl	2	0	68	6
17 Red marl, with veins of gypsum	12	0	80	6
28 Red marl, with veins of gypsum	12	0	160	6
29 Red and grey marl, with veins of gypsum	10	0	170	6

No. Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
30 Red marl, with veins of gypsum	5	0	175	6
31 Grey marl, with veins of gypsum	4	0	179	6
32 Red and grey marl	25	2	204	8
33 Red and grey marl, with veins of gypsum	21	4	226	0
34 Hard grey marl ...	3	0	229	0
35 Rotten red and grey marl ...	3	0	232	0
36 Red and grey marl, with veins of				
53 Red sandstone ...	147	0	749	0
54 Red marly sandstone	2	0	751	0
55 Red sandstone ...	131	10	882	10
56 Red marl	7	0	889	10
57 Red sandstone ...	57	4	947	2
58 Red sandstone, with small beds of marl	20	6	967	8
59 Red sandy marl ...	7	6	975	2
60 Red sandstone ...	38	10	1,014	0
61 Red marl	7	0	1,021	0
62 Red sandstone ...	1	9	1,022	9
63 Red marl	1	0	1,023	9

	gypsum	2	6	234	6
37	Rotten red and grey marl	1	0	235	6
38	Red and grey marl, with veins of gypsum	1	6	237	0
39	Red and grey marl	5	0	242	0
40	Blue marl	5	0	247	0
41	Red and grey marl, with veins of gypsum	2	0	249	0
42	Red and grey marl, with veins of gypsum, broken ...	2	0	251	0
43	Blue marl, with veins of gypsum	2	8	253	8
44	Gypsum	1	0	254	8
45	Grey marl, with veins of gypsum	5	10	260	6
46	Red marl	16	6	276	6
47	Red and grey sandstone	4	0	280	6
48	Red sandstone ...	267	6	548	0
49	Red sandstone, broken	41	0	589	0
50	Grey sandstone ...	2	0	591	0
51	Red sandstone ...	10	0	601	0

64	Red sandstone ...	4	0	1,027	9
65	Marl	0	9	1,028	6
66	Red sandstone ...	7	0	1,035	6
67	Red marl	1	6	1,037	0
68	Red sandstone ...	4	0	1,041	0
69	Red sandy marl ...	15	6	1,056	6
70	Red sandstone ...	17	6	1,074	0
71	Red sandy marl ...	8	1	1,082	1
72	Red marl	8	0	1,090	1
73	Red sandy marl ...	45	11	1,136	0
74	Red sandy marl, with veins of gypsum	12	1	1,148	1
75	Red sandy marl ...	10	3	1,158	4
76	Red marl	20	3	1,178	7
77	Red marl, with veins of gypsum ...	140	2	1,318	9
78	White stone, anhydrite	8	6	1,327	3
79	Red marl, very much broken ...	12	6	1,339	9
80	Marl, containing salt	1	2	1,340	11
81	ROCK SALT ...	79	1	1,420	0
82	Anhydrous gypsum ...	6	0	1,426	0
83	ROCK SALT ...	10	0	1,436	0
84	Anhydrous gypsum ...	4	0	1,440	0

52	Grey sandstone ...	1	0	602	0

XIX.—Diamond-boring at the Imperial Iron Works,Eston,by Mr.John Vivian,1887.

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
1	Slag...	13	6	13	6
2	Loamy clay ...	1	0	14	6
3	Blue clay	15	6	30	0
4	Sandy clay... ...	12	0	42	0
5	Fine red pinnel ...	6	0	48	0
6	Red pinnel... ...	1	0	49	0
7	Hard brown pinnel	5	6	54	6
8	Hard brown pinnel, with small cobbles	5	6	60	0
9	Brown pinnel ...	6	6	66	6
10	Red marl	6	6	73	0
11	Red and blue marl	33	4	106	4
12	Red and blue marl, with gypsum ...	38	4	144	8
13	Hard blue marl ...	51	5	196	1
14	Blue and red marl	14	3	210	4
15	Red and blue marl, with gypsum ...	6	0	216	4
16	Red and grey sand-stone and marl, mixed	311	6	527	10
17	Red and grey sand-stone	1	9	529	7
18	Red sandstone ...	139	9	669	4
19	Red sandstone,with marl joints ...	106	11	776	3
20	Red and grey sand-stone and marl, joints	94	6	870	9
21	Red sandstone,with marl joints ...	102	9	973	6
22	Red sandy marl ...	7	6	981	0

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
23	Red sandstone, with marl joints ...	65	8	1,046	8
24	Red sandstone, with beds of marl ...	57	7	1,104	3
25	Red marl, with blue spots	16	0	1,120	3
26	Red sandstone, with beds of marl ...	105	11	1,226	2
27	Red marl, with blue spots	13	0	1,239	2
28	Red sandstone, with marl beds ...	26	6	1,265	8
29	Red marl	12	3	1,277	11
30	Red sandstone, with marl beds ...	13	7	1,291	6
31	Red marl	21	0	1,312	6
32	Red sandy marl ...	11	0	1,323	6
37	Red marl, with blue spots and veins of gypsum	4	0	1,371	6
38	Red marl,with veins of gypsum ...	0	6	1,372	0
39	Red sandy marl, with veins of gypsum and blue spots	19	9	1,391	9
40	Red marl,with veins of gypsum and blue spots ...	83	3	1,475	0
41	Red marl,with veins of gypsum ...	61	9	1,536	9
42	Anhydrite	14	3	1,551	0
43	Red marl, with a				

No. Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.	No. Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
33 Red sandstone ...	7	0	1,330	6	little salt ...	11	4	1,562	4
34 Red sandy marl ...	3	0	1,333	6	44 Marl and salt ...	25	8	1,588	0
35 Red sandy marl,					45 ROCK SALT ...	48	0	1,636	0
with blue spots					46 Anhydrite	41	6	1,677	6
and gypsum joints	21	0	1,354	6	47 SALT and anhydrite,				
36 Red marl, with veins					honeycombed	12	9	1,690	3
of gypsum ...	13	0	1,367	6	48 Anhydrite	1	9	1,692	0

XX. — No.1 Diamond-boring (.875 inch hole) at South Bank Iron Works, Eston, by Mr John Vivian, for Messrs. Bolckow, Vaughan, and Company, Limited, 1885 (now Cleveland Salt Company, Limited).

No. Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.	No. Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
1 Made ground ...	6	0	6	0	17 Sandstone, with				
2 Sandy blue clay ...	10	0	16	0	thin beds of shale	11	0	505	0
3 Dark brown clay ...	7	0	23	0	18 Red sandstone ...	415	8	920	8
4 Soft red marl ...	2	0	25	0	19 Red sandstone, with				
5 Brown pinnel ...	1	0	26	0	thin beds of marl	39	0	959	8
6 Hard brown pinnel	15	0	41	0	20 Red sandy marl ...	8	6	968	2
7 Soft red marl ...	6	0	47	0	21 Red sandstone ...	29	0	997	2
8 Red marl	16	10	63	10	22 Red sandy marl ...	4	2	1,001	4

9	Red and blue marl, with veins of gypsum	7	0	70	10
10	Red and blue marl, with veins of gypsum	3	0	73	10
11	Red and blue marl with veins of gypsum	21	3	95	1
12	Red marl, with veins of gypsum	46	8	141	9
13	Red and blue marl, with veins of gypsum	15	3	157	0
14	Red and blue shale, with veins of gypsum	325	0	482	0
15	Blue shaly sandstone	2	0	484	0
16	Red sandstone, with thin beds of gypsum and shale ...	10	0	494	0
23	Red sandstone, with small beds of marl	46	0	1,047	4
24	Red marl	8	6	1,055	10
25	Red sandstone, with beds of marl ...	34	6	1,090	4
26	Red marl	17	8	1,108	0
27	Red sandstone, with veins of marl ...	18	0	1,126	0
28	Red sandstone, with beds of marl ...	120	7	1,246	7
29	Red marl, with beds of red sandstone	21	11	1,268	6
30	Red sandstone, with beds of marl ...	14	6	1,283	0
31	Red marl,with sandstone	4	6	1,287	6
32	Red marl	43	0	1,330	6
33	Red sandy marl, with veins of gypsum	6	0	1,336	6
34	Red sandy marl,with blue spots and veins of gypsum	36	6	1,373	0

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
35	Red sandy marl, with thin veins of gypsum	78	0	1,451	0
36	Red sandy marl, with veins of gypsum and blue spots	9	6	1,460	6
37	Red sandy marl, with veins of gypsum	10	0	1,470	6
38	Red sandy marl, with veins of gypsum and blue spots	60	6	1,531	0
39	Hard white stone, anhydrite ...	11	6	1,542	6
40	Red sandy marl, with salt ...	21	0	1,563	6
41	Red marl, with salt	6	3	1,569	9
42	ROCK SALT ...	81	0	1,650	9
43	Hard white stone, with salt ...	1	6	1,652	3
44	Hard white stone,	1	6	1,653	9
45	Hard stone and a little salt ...	18	0	1,671	9
46	Hard white stone, with a little salt in it	7	11.5	1,679	8.

XX1.—Diamond-boring (12-inch hole) on the Lackenby Foreshore Estate,by Messrs.Mather and Platt,1889.

Thick- Depth Thick- Depth

No.	Description of Strata.	ness of Strata. Ft. In.	from Surface. Ft. In.	No.	Description of Strata.	ness of Strata. Ft. In.	from Surface. Ft. In.
1	Clay and gravel ...	13 0	13 0	9	Red marl	217 0	597 0
2	Hard red clay and a little gypsum ...	11 8	24 8	10	Red sandstone ...	598 0	1,195 0
3	Red marl and thin rock ...	62 4	87 0	11	Red marl	77 0	1,272 0
4	Red marl and bed of blue marl ...	159 8	246 8	12	Red marl and sand-stone beds ...	371 0	1,643 0
5	Bed of hard rock ...	8 4	255 0	13	Hard white rock ...	20 0	1,663 0
6	Blue and red marl ...	88 0	343 0	14	Honeycomb marl ...	9 0	1,672 0
7	Dark red marl and blue stone ...	30 0	373 0	15	SALT and marl, mixed	13 0	1,685 0
8	Hard blue stone ...	7 0	380 0	16	ROCK SALT, clean	119 0	1,804 0
				17	White rock ...	2 0	1,806 0

XXII.—No.1 Diamond-boring at Port Clarence,by Mr.John Vivian,for Messrs. C.Allhusen and Sons.

No.	Description of Strata.	Thick-ness of Strata. Ft. In.	Depth from Surface. Ft. In.	No.	Description of Strata.	Thick-ness of Strata. Ft. In.	Depth from Surface. Ft. In.
1	Peat and muddy sand	10 0	10 0	17	Red and grey sandy shale, with gyp-sum	29 0	173 0
2	Dark muddy sand	6 0	16 0	18	Grey sandy shale,		
3	Dark sand	4 0	20 0				

4 Sand and gravel ...	4	0	24	0
5 Dark sandy clay ...	4	0	28	0
6 Sandy clay ...	17	0	45	0
7 Running sand ...	35	0	80	0
8 Sand and gravel ...	4	0	84	0
9 Hard bound gravel	3	0	87	0
10 Strong red pinnel ...	7	0	94	0
11 Grey sandy clay ...	1	0	95	0
12 Red pinnel ...	4	0	99	0
13 Red and blue shale	17	0	116	0
14 Red sandy shale, with gypsum ...	18	0	134	0
15 Red and grey sandy shale,with gypsum	3	6	137	6
16 Grey sandy shale, with gypsum ...	6	6	144	0

with gypsum ...	4	6	177	6
19 Red and grey sandy shale, with gypsum	3	0	180	6
20 Red shale	17	0	197	6
21Red and grey sandy shale	12	3	209	9
22 Soft red sandstone	119	6	329	3
23 Red sandstone ...	193	9	523	0
24 Red shale	5	6	528	6
25 Red sandstone ...	33	0	561	6
26 Red shale,with beds of sandstone ...	5	0	566	6
27 Red sandstone ...	41	0	607	6
28 Strong red shale ...	1	6	609	0
29 Red sandstone ...	4	0	613	0

No. Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.	No. Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
30 Strong red shale ...	5	0	618	0	55 Hard grey stone, with thin veins of				
31 Red sandstone ...	34	0	652	0					

32 Strong red shale ...	1	0	653	0
33 Red sandstone ...	1	0	654	0
34 Strong red shale ...	11	0	665	0
35 Red shale,with beds of sandstone ...	8	0	673	0
36 Red sandstone ...	17	0	690	0
37 Red sandstone, with beds of shale ...	61	0	751	0
38 Strong red shale ...	8	6	759	6
39 Red sandstone ...	29	6	789	0
40 Red shale	9	6	798	6
41 Red sandstone and shale	19	6	818	0
42 Strong red shale ...	10	0	828	0
43 Strong red shale, with light blue spots	6	6	834	6
44 Red sandstone,with light blue spots	5	0	839	6
45 Red shaly sand- stone	16	6	856	0
46 Red sandy shale ...	9	0	865	0
47 Red sandy shale, with, light blue spots	17	0	882	0
48 Red sandstone,with red shale beds...	22	0	904	0

gypsum	14	0	1,067	6
56 Hard grey stone ...	10	0	1,077	6
57 Hard grey stone, with gypsum ...	6	6	1,084	0
58 Grey stone, with veins and spots of gypsum	9	0	1,093	0
59 Magnesium limestone and gypsum	4	0	1,097	0
60 Magnesium limestone	28	0	1,125	0
61 Magnesium limestone, with gypsum ...	3	0	1,128	0
62 Magnesium limestone	33	0	1,161	0
63 Anhydrite	5	0	1,166	0
64 White gypsum ...	13	6	1,179	6
65 White rock	11	0	1,190	6
66 Magnesium lime- stone	22	6	1,213	0
67 Magnesium lime- stone,with veins of gypsum ...	6	0	1,219	0
68 Magnesium lime- stone	11	0	1,230	0
69 Anhydrite	3	0	1,233	0
70 Dark grey lime- stone, with gyp- sum and black				

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
49	Red shale, with veins of gypsum	18	0	922	0
50	Red shale, with beds of sandstone ...	46	0	968	0
51	Red shale, with small blue joints and veins of gypsum	60	6	1,028	6
52	Red sandstone with veins of gypsum	12	0	1,040	6
53	Red and grey shale and gypsum mixed	12	0	1,052	6
54	Gypsum	1	0	1,053	6
	joints	7	0	1,240	0
71	Dark grey limestone	5	0	1,245	0
72	Anhydrite	1	0	1,246	0
73	Limestone, with gypsum	3	0	1,249	0
74	Dark grey limestone, with gypsum and black joints	5	0	1,254	0
75	Dark grey limestone	4	0	1,258	0
76	Magnesium limestone and gypsum	2	0	1,260	0

XXIII. —No.1(or Eastern) Boring at Haverton Hill,for the South Durham Salt Company,Limited (now Salt Union,Limited).

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
1	Soil	1	0	1	0
2	Yellow clay ...	3	0	4	0
3	Blue clay	35	3	39	3
4	Brown sand ...	0	9	40	0
5	Tough brown pinnel	12	0	52	0
9	Gravel and pinnel mixed	1	5	62	9
10	Red sandstone ...	31	9	94	6
11	Grey sandstone ...	1	0	95	6
12	Red sandstone ...	35	6	131	0

6	Blue pinnel ...	3	10	55	10	13	Red marl	1	0	132	0
7	Brown sandy pinnel	2	8	58	6	14	Red sandstone ...	45	0	177	0
8	Hard bound gravel, with pinnel ...	2	10	61	4	15	Red and grey sandstone	10	0	187	0

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.	No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
16	Red sandstone ...	13	0	200	0	45	Red marl, strong...	2	0	651	7
17	Red and grey sandstone	18	6	218	6	46	Strong marl, with gypsum	8	3	659	10
18	Red sandstone ...	21	0	239	6	47	Strong marl ...	14	8	674	6
19	Red marl	2	6	242	0	48	Red sandy marl ...	22	10	697	4
20	Red sandstone ...	28	6	270	6	49	Red marl,with long vein of gypsum...	9	8	707	0
21	Red sandstone,with marl joints ...	25	7	296	1	50	Red sandy marl ...	9	1	716	1
22	Red sandstone ..	25	7	321	8	51	Red marl with gypsum joints ...	13	6	729	7
23	Red marl	1	6	323	2	52	Red sandy marl ...	3	0	732	7
24	Red sandstone,very jointy	8	6	331	8	53	Red marl,with veins of gypsum ...	4	4	736	11
25	Red sandstone ...	37	0	368	8	54	Red marl	6	0	742	11
26	Red marl	4	0	372	8	55	Red marl, with				
27	Red sandstone,										

	jointy	40	5	413	1
28	Red marl	12	0	425	1
29	Red sandstone,with marl joints ...	11	6	436	7
30	Red sandstone...	8	5	445	0
31	Red sandstone,with marl joints ...	21	9	466	9
32	Red sandstone...	22	5	489	2
33	Red sandstone,with marl joints ...	11	0	500	2
34	Red marl	8	0	508	2
35	Red sandstone...	33	5	541	7
36	Red marl	5	0	546	7
37	Red sandstone...	19	8	566	3
38	Red sandy marl...	22	4	588	7
39	Red marl	8	3	596	10
40	Sandstone... ...	2	0	598	10
41	Sandy marl ...	3	9	602	7
42	Red sandy marl...	27	4	629	11
43	Red sandstone ...	5	0	634	11
44	Red marl	14	8	649	7
	large veins of gypsum	24	6	767	5
56	Red sandy marl, with gypsum joints	22	11	790	4
57	Red marl,with gyp-sum	56	5	846	9
58	Anhydrite	9	6	856	3
59	Red marl,contain-ing a little salt ...	11	1	867	4
60	Dark red marl,con-taining salt ...	3	0	870	4
61	SALT	86	6	956	10
62	SALT and gypsum mixed	10	10	967	8
63	Gypsum,containing salt	1	0	968	8
64	Gypsum	5	0	973	8
65	SALT	8	10	982	6
66	SALT and gypsum	16	8	999	2
67	Anhydrite	7	2	1,006	4

XXIV.— No.4 (or Western) Boring at Haverton Hill,for the South Durham Salt Company,Limited (now Salt Union,Limited).

No.	Description of Strata.	Thick-ness of Strata.	Depth from Surface.	No.	Description of Strata.	Thick-ness of Strata.	Depth from Surface.

No.	Description of Strata	Ft.	In.	Ft.	In.
1	Soil	1	0	1	0
2	Yellow clay ...	4	0	5	0
3	Brown clay ...	10	0	15	0
4	Brown clay and cobbles	17	0	32	0
5	Brown sand and clay	3	1	35	1
6	Loamy sand ...	12	5	47	6
7	Brown pinnel ...	15	0	62	6
8	Yellow sandy clay	1	9	64	3
9	Brown pinnel ...	4	9	69	0
10	Red sandstone ...	160	6	229	6
11	Red marl	4	0	233	6
12	Red sandstone...	79	0	312	6
13	Red marl	4	8	317	2
14	Red sandstone ...	34	0	351	2
15	Red marl	9	6	360	8
16	Red sandstone ...	79	10	440	6
17	Red marl	1	0	441	6
18	Red sandstone ...	70	6	512	0
19	Red sandy marl ...	64	6	576	6
20	Red marl	72	10	649	4
21	Red marl,with veins of gypsum ...	140	6	789	10
22	Anhydrite	6	0	795	10
23	Salty marl	14	0	809	10
24	Red salty marl ...	3	0	812	10
25	ROCK SALT ...	104	6	917	4
26	Gypsum	7	6	924	10

XXV.—Diamond-boring at Westfeld,Haverton Hill,by Mr.John Vivian,for Mr. George Dyson,May 30 to November 21,1885. (Now Westfield,Durham, Salt Company,Limited).

No.	Description of Strata.	Thickness of Strata.		Depth from Surface.		No.	Description of Strata.	Thickness of Strata.		Depth from Surface.	
		Ft.	In.	Ft.	In.			Ft.	In.	Ft.	In.

1 Soil	1	0	1	0
2 Yellow clay ...	2	0	3	0
3 Brown clay ...	8	6	11	6
4 Sand	2	0	13	6
5 Hard red clay and cobbles	6	6	20	0
6 Sand	0	6	20	6
7 Tough brown pinnel	8	6	29	0
8 Sand	2	6	31	6
9 Red clay	1	3	32	9
10 Sand	11	3	44	0
11 Brown sandy clay...	1	0	45	0
12 Brown pinnel ...	3	0	48	0
13 Tough brown pinnel	9	0	57	0
14 Rough sand and fine gravel	3	6	60	6
15 Bound gravel ...	0	6	61	0
16 Hard bound gravel	3	8	64	8
17 Red sandstone ...	8	8	73	4
18 Red sandstone ...	30	5	103	9
19 Red sandstone,with veins of spar ...	15	9	119	6
20 White sandstone ...	5	0	124	6
21 Red sandstone ...	69	11	194	5
22 Red sandstone ...	35	7	230	0
23 Soft red marl ...	8	0	238	0
24 Red sandstone ...	24	6	262	6

35 Red marl	8	6	488	6
36 Red sandstone ...	5	0	493	6
37 Red sandstone ...	15	6	509	0
38 Red marl	21	6	530	6
39 Sandy marl ...	8	6	539	0
40 Red marl	18	6	557	6
41 Sandy marl, with veins of gypsum	18	0	575	6
42 Red marl	10	0	585	6
43 Red marl,with veins of gypsum ...	25	0	610	6
44 Red marl	19	0	629	6
45 Red marl	8	0	637	6
46 Red marl,with veins of gypsum ...	10	6	648	0
47 Red marl,with veins of gypsum ...	73	6	721	6
48 Red marl, with veins of gypsum	52	6	774	0
49 Anhydrite	5	6	779	6
50 Red marl, rather salty	3	0	782	6
51 Red salty marl ...	11	0	793	6
52 Red marl, containing salt	2	6	796	0
53 ROCK SALT ...	15	8	811	8
54 ROCK SALT ...	0	9	812	5

25 Red sandstone ...	54	0	316	6	55 ROCK SALT ...	24	6	836	11
26 Red marl	4	0	320	6	56 ROCK SALT ...	53	10	890	9
27 Red sandstone ...	11	6	332	0	57 ROCK SALT,				
28 Red sandstone ...	23	9	355	9	mixed with gyp-				
29 Sandy marl ...	8	0	363	9	sum	6	0	896	9
30 Red marl	10	3	374	0	58 Gypsum and salt ...	0	6	897	3
31 Red sandstone ...	20	0	394	0	59 Gypsum and salt ...	2	0	899	3
32 Red sandstone ...	59	9	453	9	60 Gypsum,containing				
33 Red marl	3	0	456	9	a little salt ...	8	11	908	2
34 Red sandstone ...	23	3	480	0	61 Anhydrite	1	0	909	2

XXVI.—Boring at Sandfield,Haverton Hill,1886.

No. Description of Strata.	Thick-ness of Strata. Ft.	In.	Depth from Surface. Ft.	In.	No. Description of Strata.	Thick-ness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
1Soil	1	6	1	6	14 Red sandstone, with				
2 Strong red clay ...	4	6	6	0	beds of marl ...	7	8	461	10
3 Brown sand ...	30	4	36	4	15 Red marl	4	0	465	10
4 Dark sand	11	1	47	5	16 Red sandy marl ...	2	0	467	10
5 Brown clay ...	3	4	50	9	17 Red sandstone ...	20	2	488	0
6 Brown pinnel and					18 Red marl	20	4	508	4
					19 Red sandstone ...	17	8	526	0
cobbles	19	7	70	4	20 Red marl	15	6	541	6
7 Red sandstone ...	145	8	216	0	21 Red sandy marl ...	7	9	549	3
8 Red marl	2	0	218	0	22 Red sandstone ...	6	7	555	10
9 Red sandstone ...	82	0	300	0	23 Red marl	29	3	585	1

No. Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.	No. Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
10 Red marl	3	0	303	0	24 Red marl, with gypsum joints ...	8	6	593	7
11 Red sandstone ...	38	7	341	7	25 Red sandy marl ...	52	11	646	6
12 Red marl	10	5	352	0					
13 Red sandstone ...	102	2	454	2					

No. Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.	No. Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
26 Strong red marl, with veins of gypsum	38	9	685	3	32 ROCK SALT ...	80	10	877	10
27 Red marl... ...	1	0	686	3	33 Anhydrite and rock salt	1	6	879	4
28 Red marl,with veins of gypsum ...	84	3	770	6	34 ROCK SALT ...	1	0	880	4
29 Anhydrite... ...	9	6	780	0	35 Anhydrite and salt	4	2	884	6
30 Red marl, salty ...	12	0	792	0	36 Anhydrite, containing a little salt	9	9	894	3
31 Decayed brown marl, containing salt...	5	0	797	0	37 ROCK SALT ...	6	0	900	3
					38 Anhydrite... ...	0	9	901	0

XXVII.—No.1 Diamond-boring at Haverton Hill,for Messrs.G.Tennant and Partners,Limited (now United Alkali Company,Limited).

	Thickness of	Depth from		Thickness of	Depth from

No.	Description of Strata.	Strata. Ft.	Strata. In.	Surface. Ft.	Surface. In.	No.	Description of Strata.	Strata. Ft.	Strata. In.	Surface. Ft.	Surface. In.
1	Soil	1	6	1	6	27	Red marl	6	6	596	11
2	Red sandy soil ...	5	6	7	0	28	Red stone and beds of marl	18	9	615	8
3	Stiff dark muddy clay	10	0	17	0	29	Red marl	19	0	634	8
4	Stiff red clay ...	17	0	34	0	30	Red stone and beds of marl	12	10	647	6
5	Red clay and cobbles	3	0	37	0	31	Red stone	3	0	650	6
6	Dark sand... ...	0	9	37	9	32	Red marl, with blue joints	18	0	668	6
7	Brown sand ...	16	7	54	4	33	Red sandstone ...	5	0	673	6
8	Brown sand, very fine	5	2	59	6	34	Red sandy marl ...	20	6	694	0
9	Brown sandy pinnel and gravel ...	4	6	64	0	35	Red marl,with veins of gypsum ...	84	0	778	0
10	Brown sandy clay and cobbles ...	7	0	71	0	36	Red marl,with blue joints and veins of gypsum ...	74	0	852	0
11	Cobbly pinnel ...	9	0	80	0	37	Red marl,with gyp-sum	42	6	894	6
12	Sand and gravel...	3	3	83	3	38	Red marl	0	9	895	3
13	Red sandstone ...	93	5	176	8	39	Anhydrite	9	0	904	3
14	Grey sandstone...	8	0	184	8	40	Red marl,with salt	1	0	905	3
15	Red sandstone ...	164	7	349	3	41	Red marl,with veins of salt	23	4	928	7
16	Red marl... ...	3	0	352	3	42	ROCK SALT ...	72	11	1,001	6
17	Red sandstone ...	66	8	418	11	43	Hard stone... ...	3	2	1,004	8
18	Grey stone ...	3	6	422	5						
19	Red marl... ...	3	0	425	5						
20	Red sandstone ...	37	0	462	5						
21	Red marl... ...	16	9	479	2						

No.	Description of Strata	Thickness of Strata Ft.	In.	Depth from Surface Ft.	In.
22	Red sandstone...	73	3	552	5
23	Red sandy marl...	9	3	561	8
24	Red sandstone ...	24	0	585	8
25	Red sandy marl...	2	9	588	5
26	Red sandstone ...	2	0	590	5
44	Hard stone, with salt	2	8	1,007	4
45	ROCK SALT and gypsum	6	0	1,013	4
46	Hard blue stone...	0	10	1,014	2

XXVIII.—No.8a Boring,by the American system,at Haverton Hill,for the United Alkali Company,Limited (Messrs.G.Allhusen & Sons),completed November 18,1891.

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In
1	Ordinary surface-soil, etc. ...	5	0	5	0
2	Blue clay	30	0	35	0
3	Sand and clay ...	15	0	50	0
4	Sand and gravel ...	15	0	65	0
5	Gravel	5	0	70	0
6	Soft sandstone ...	5	0	75	0
7	Red sandstone ...	325	0	400	0
8	Red marl	332	0	732	0
9	Anhydrite	9	0	741	0
10	Rotten marl, containing salt ...	25	0	766	0
11	ROCK SALT ...	42	0	808	0
12	Light grey limestone	93	0	901	0
13	Dark grey limestone	18	0	919	0
14	Light grey limestone	313	0	1,232	0

Thick- Depth Thick- Depth

No.	Description of Strata.	ness of Strata. Ft.	In.	from Surface. Ft.	In.
15	Dark grey limestone	42	0	1,274	0
16	Black and red shale	41	0	1,315	0
17	Sand and water, gas bubbles... ...	48	0	1,363	0
18	Black and red shale	6	0	1,369	0
19	Grey limestone ...	20	0	1,389	0
20	Shale	18	0	1,407	0
21	Sticky substance, like fireclay ...	17	0	1,424	0
22	Dark limestone ...	8	0	1,432	0
23	Sand	9	0	1,441	0
24	Sand and limestone	18	0	1,459	0
25	Sand	20	0	1,479	0
26	Shale and fireclay...	20	0	1,499	0
27	Fireclay	36	0	1,535	0
28	Shale	9	0	1,544	0
29	Grey limestone ...	35	0	1,579	0
30	Black shale ...	18	0	1,597	0
31	Sandstone... ...	7	0	1,604	0
32	Sandstone and shale	11	0	1,615	0
33	Limestone and shale	8	0	1,623	0
34	Sandstone... ...	30	0	1,653	0
35	Limestone... ...	11	0	1,664	0
36	Light grey sand-				

No.	Description of Strata.	ness of Strata. Ft.	In.	from Surface. Ft.	In.
45	Black shale and sand	13	0	1,862	0
46	Shale	53	0	1,915	0
47	Grey limestone ...	12	0	1,927	0
48	Grey limestone, with a little shale ...	12	0	1,939	0
49	Grey sandstone ...	5	0	1,944	0
50	Shale and a little sand	6	0	1,950	0
51	COAL and a little gas	2	0	1,952	0
52	Limestone	6	0	1,958	0
53	Sandstone	14	0	1,972	0
54	Sandy shale and a little gas* ...	2	0	1,974	0
55	Hard shale	3	0	1,977	0
56	Hard black shale ...	9	0	1,986	0
57	Grey sandstone ...	2	0	1,988	0
58	Black shale... ...	2	0	1,990	0
59	Grey micaceous sand- sandstone... ...	8	0	1,998	0
60	Black shale	11	0	2,009	0
61	Limestone	26	0	2,035	0
62	Grey micaceous sand- stone	7	6	2,042	6
63	Grey micaceous sand-				

No.	Description of Strata	Thickness Ft.	In.	Depth Ft.	In.
	stone	9	0	1,673	0
37	Dark sandstone and shale	21	0	1,694	0
38	Shale	44	0	1,738	0
39	Black shale ...	16	0	1,754	0
40	Black shale ...	24	0	1,778	0
41	Limestone... ...	16	0	1,794	0
42	Grey sandstone ...	19	0	1,813	0
43	Sandstone, mixed with shale ...	20	0	1,833	0
44	Fine sand, with water	16	0	1,849	0
	stone, with veins of shale	32	0	2,074	6
64	Hard black shale, with veins of sandstone	6	0	2,080	6
65	Micaceous sandstone	9	0	2,089	6
66	Hard shale	3	0	2,092	6
67	Micaceous sandstone	8	0	2,100	6
68	Hard grey shale ...	3	6	2,104	0
69	Hard black shale ...	48	6	2,152	6
70	Dark sandy shale ...	3	6	2,156	0
71	In hard black shale...	17	0	2,173	0

XXIX.—Boring at Stone Marsh or Sweethill,near Haverton Hill,1886.

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
1	Soil	1	0	1	0
2	Yellow clay	1	0	2	0
3	Red clay	16	6	18	6
4	Brown pinnel ...	24	6	43	0
5	Red sandy pinnel ...	1	0	44	0
6	Blue and sandy clay	10	0	54	0
7	Red clay	8	0	62	0
8	Sand and gravel ...	1	0	63	0
9	Gravel	2	0	65	0
18	Bound gravel ...	6	6	100	6
19	Fine gravel ...	4	3	104	9
20	Red sandstone ...	179	3	284	0
21	Red marl	2	9	286	9
22	Red sandstone ...	20	3	307	0
23	Sandy marl... ...	6	0	313	0
24	Red marl	7	0	320	0
25	Red sandstone ...	78	0	398	0
26	Red sandy marl ...	21	0	419	0

10 Gravel and cobbles	2	6	67	6
11 Sand and gravel ...	3	6	71	0
12 Sand	2	0	73	0
13 Gravel and cobbles	2	0	75	0
14 Bound gravel and pinnel	5	0	80	0
15 Pinnel and gravel ...	4	6	84	6
16 Clayey sand ...	7	0	91	6
17 Pinnel and gravel ...	2	6	94	0
27 Red marl	3	0	422	0
28 Red sandstone ...	31	6	453	6
29 Red marl	6	6	460	0
30 Red sandstone,with marl beds ...	15	3	475	3
31 Red marl, with red sandstone beds...	11	6	486	9
32 Red marl, with blue joints	7	3	494	0

* Continued from this point by the diamond drill,August 25,1891.

No. Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
33 Red sandstone, with marl beds ...	14	3	508	3
34 Red sandstone ...	4	0	512	3
35 Red marl	14	9	527	0
36 Red marl, with red sandstone ...	3	3	530	3
37 Red marl	18	6	548	9
55 Magnesium limestone, with gypsum joints	12	6	842	0
56 Magnesium limestone	26	9	868	9
57 Magnesium limestone, with gypsum veins	17	7	886	4
58 Hard blue stone with veins of gyp-				

38 Red marl, with blue joints	41	6	590	3
39 Red sandstone ...	2	0	592	3
40 Red marl, with blue joints	9	6	601	9
41 Red marl, with blue joints and veins of gypsum ...	62	3	664	0
42 Red marl	15	0	679	0
43 Red marl,with veins of gypsum ...	61	0	740	0
44 Red marl	8	6	748	6
45 Red marl, with veins of gypsum	7	6	756	0
46 Anhydrite	9	0	765	0
47 Decayed red marl, containing salt...	10	3	775	3
48 Red salty marl ...	1	9	777	0
49 Anhydrite	7	0	784	0
50 SALT and gypsum	9	0	793	0
51 Anhydrite	7	0	800	0
52 Anhydrite, with black joints ...	14	3	814	3
53 Anhydrite ...	7	6	821	9
54 Magnesian lime-stone	7	9	829	6
sum	5	8	892	0
59 Red and blue marl, with gypsum ...	1	8	893	8
60 Hard blue and red stone	0	8	894	4
61 Anhydrite	3	8	898	0
62 Red marl, with an-hydrite and gyp-sum	2	10	900	10
63 Anhyydrite, with red marl and gypsum veins	15	11	915	11
64 Anhydrite, and mag-nesian limestone	14	8	931	5
65 Magnesium limestone, with gypsum veins and blue shale joints	11	11	943	4
66 Anhydrite	3	4	946	8
67 Magnesium limestone with gypsum veins	9	0	955	8
68 Anhydrite	4	0	959	8
69 Anhydrite, with spots of gypsum ...	9	1	968	9
70 Magnesium limestone with gypsum veins	31	3	1,000	0

XXX.—No.1 Diamond-boring on the White House Estate, near Norton, by Mr. John Vivian, 1889.

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
1	Brown sandy clay	8	0	8	0
2	Blue clay	7	0	15	0
3	Red clay	10	0	25	0
4	Stiff brown clay ...	21	0	46	0
5	Muddy sand ...	2	0	48	0
6	Brown sandy clay	2	0	50	0
7	Grey pinnel, with stones	2	0	52	0
8	Stiff brown clay, with stones ...	2	0	54	0
9	Stiff brown clay ...	14	0	68	0
10	Sand	1	0	69	0
11	Sandy clay ...	1	0	70	0
12	Strong brown pinnel	7	0	77	0
13	Strong brown clay	1	0	78	0
14	Strong pinnel, with cobbles... ...	6	0	84	0
15	Brown pinnel ...	1	0	85	0
16	Sand	0	6	85	6
17	Dark gravelly pinnel	2	0	87	6
18	Grey pinnel, with cobbles	2	0	89	6
19	Brown pinnel ...	2	10	92	4
20	Sandstone	0	4	92	8
21	Dark brown pinnel	13	4	106	0
22	Dark red pinnel, with sandstone cobbles	1	6	107	6
23	Grey pinnel ...	7	0	114	6
24	Dark red pinnel ...	0	6	115	0
25	Red sandstone ...	19	0	134	0
26	Red sandy marl ...	9	0	143	0
27	Red marl	1	7	144	7
28	Red sandstone ...	9	4	153	11
29	Red sandy marl ...	2	0	155	11
30	Red sandstone ...	4	2	160	1
31	Red marl	22	0	182	1
32	Red sandstone ...	7	8	189	9
33	Red marl	21	7	211	4
34	Red marl, with blue joints	13	8	225	0

Cleveland and South Durham Salt Industry.

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
35	Red marl	41	0	266	0
36	Red marl, with veins of gypsum ...	8	3	274	3
37	Red marl	10	0	284	3
38	Red marl, with veins of gypsum ...	12	5	296	8
39	Red marl	22	2	318	10
40	Red marl, with veins of gypsum ...	77	2	396	0
41	Anhydrite	10	0	406	0
42	Red marl, with veins of gypsum ...	17	2	423	2
43	Anhydrite	17	9	440	11
44	Gypsum	3	0	443	11
45	Magnesian limestone, with veins of gypsum ...	13	8	457	7
46	Magnesian limestone	55	4	512	11
47	Blue shale, with				

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
73	Magnesium limestone, broken	49	10	742	11
74	Grey gritstone ...	4	9	747	8
75	Grey sandstone ...	1	0	748	8
76	Magnesium limestone broken	6	0	754	8
77	Limestone	6	0	760	8
78	Dark blue shale ...	5	2	765	10
79	Light grey sandstone	8	2	774	0
80	Dark sandy shale ...	6	0	780	0
81	Light grey sandstone	7	3	787	3
82	Dark sandy shale ...	9	9	797	0
83	Dark shale	16	5	813	5
84	White sandstone ...	4	0	817	5
85	Light grey sandstone	7	2	824	7
86	Course light grey				

	veins of gypsum	11	11	524	10
48	Dark limestone and gypsum	1	0	525	10
49	Blue shale and gypsum	3	0	528	10
50	Anhydrite	4	0	532	10
51	Red and blue shale, with veins of gypsum	5	0	537	10
52	Anhydrite	1	0	538	10
53	Red and blue shale	2	7	541	5
54	Anhydrite, limestone, and red shale mixed ...	2	9	544	2
55	Anhydrite, with brown shale joints	21	5	565	7
56	Anhydrite	10	0	575	7
57	Anhydrite, with black shale joints	2	5	578	0
58	Magnesian limestone	13	11	591	11
59	Anhydrite, with veins of gypsum	7	0	598	11
60	Anhydrite	14	3	613	2
61	Anhydrite, containing gypsum ...	15	10	629	0
62	Blue marl	8	0	637	0
63	Anhydrite, with				

	stone	3	11	828	6
87	Dark shale... ...	2	0	830	6
88	Black shale, with bands and balls of ironstone ...	23	7	854	1
89	Black shale, with balls of ironstone	8	3	862	4
90	Black shale ...	10	8	873	0
91	Black shale, with veins of gypsum	4	0	877	0
92	Dark grey limestone	3	7	890	7
93	Black shale... ...	13	6	894	1
94	Grey limestone ...	5	11	900	0
95	Dark limestone ...	5	11	905	11
96	Dark limestone, very jointy	6	8	912	7
97	Dark limestone ...	3	0	915	7
98	Dark grey sandy shale	10	0	925	7
99	Black shale ...	16	9	942	4
100	Grey sandstone ...	3	0	945	4
101	Black shale ...	7	6	952	10
102	Grey sandstone ...	3	0	955	10
103	Black shale ...	8	0	963	10
104	Dark grey sandstone with black				

	gypsum	1	6	638	6		joints	0	6	964	4
64	Red marl, with					105	Dark grey sand-				
	veins of gypsum	7	7	646	1		stone and black				
65	Anhydrite, with						shale mixed ...	13	0	977	4
	gypsum	2	0	648	1	106	Coarse light grey				
66	Red marl,with gyp-						sandstone ...	18	0	995	4
	sum	11	8	659	9	107	Dark grey sandy				
67	Red and blue marl,						shale	2	8	998	0
	with gypsum ...	8	6	668	3	108	Black shale, with				
68	Anhydrite, contain-						iron nodules ...	3	4	1,001	4
	ing spar	2	2	670	5	109	Dark grey sandy				
69	Magnesian limestone,						shale	1	3	1,002	7
	containing spar...	8	10	679	3	110	Black shale, with				
70	Red and blue marl	4	3	683	6		iron nodules ...	5	3	1,007	10
71	Red sandy gritstone	3	4	686	10	111	Dark grey sandy				
72	Red and blue marl	6	3	693	1		shale	3	0	1,010	10

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.	No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	n.
112	Black shale, with					117	Dark grey sandy				
	dark limestone balls	16	0	1,026	10		shale, with veins				

113 Grey limestone ...	10	4	1,037	2
114 Black shale ...	1	1	1,038	3
115 Blue shale	5	8	1,043	11
116 Grey sandy shale ...	7	6	1,051	5
of spar	18	0	1,069	5
118 Dark grey sandy shale	9	0	1,078	5
119 Black shale ...	1	1	1,079	6

XXXI.—Boring at Kirklevington,about 2 miles south and east from Yarm,for Lord Falkland,commenced in 1856,and continued during 1857 and 1858.

No. Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
1 Reddish clay ...	27	0	27	0
2 Fine sand	7	0	34	0
3 Coarse sand ...	4	0	38	0
4 Fine sand	10	0	48	0
5 Reddish clay ...	51	0	99	0
6 Yellow sandstone...	0	8	99	8
7 White sandstone, hard	0	9	100	5
8 Sand and gravel ...	4	0	104	5
9 White sandstone ...	1	6	105	11
16 Sand and gravel ...	3	3	109	2
11 Light bluish sandstone	119	10	229	0
12 White sandstone, extra hard ...	0	11	229	11
37 Magnesium limestone	6	0	548	2
38 Fake and clay ...	2	3	550	5
39 Magnesium limestone	1	6	551	11
40 Red fake and clay ...	5	1	557	0
41Red sandstone, hard	9	1	566	1
42 Red sandstone, in bed	4	9	570	10
43 Light red sandstone, hard	4	0	574	10
44 Red sandstone, very hard	1	4	576	2
45 Red sandstone, and beds of fake ...	6	4.5	582	6.5
46 Red shale, with beds of red sand-				

13 Light fireclay ...	1	5	231	4
14 Light fake* and fire-clay	2	6	233	10
15 Red sandstone in bed	204	3	438	1
16 Red fake and blae	1	0	439	1
17 Red sandstone, hard	1	1	440	2
18 Red sandstone,softer	18	0	458	2
19 Red fake and blae	0	3	458	5
20 Red sandstone, extra hard	2	3	460	8
21 Red fake	7	3	467	11
22 Red sandstone, extra hard	2	6	470	5
23 Red fake	7	8	478	1
24 Red sandstone ...	4	0	482	1
25 Red fake	4	8	486	9
26 Red sandstone ...	2	1	488	10
27 Red fake and clay	2	8	491	6
28 Red sandstone ...	3	9	495	3
29 Red clay	0	7	495	10
30 Light red sandstone	1	9	497	7
31 Red sandstone, in bed	13	9	511	4
32 Red sandstone, in bed	3	0	514	4
33 Magnesian limestone	6	9	521	1
stone and threads of grey metal stone	16	2.5	598	9
47 Grey pyritic sand-stone	1	0	599	9
48 Red shale, with beds of hard red sand-stone	24	3	624	0
49 Gypsum, called chalk or pipe clay by the workmen	0	9	624	9
50 Red shaly sandstone	6	9	631	6
51 Red sandstone, with a shaly appear-ance	20	6	652	0
52 Red shaly-looking sandstone, con-taining some gyp-sum	20	0	672	0
53 Red sandstone, nearly uniform in appearance,with a great quantity of carbonate of lime and white masses of gypsum	17	6	689	6
54 Red sandstone,with a shaly appear-				

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.	No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
34	Red fake	3	0	524	1		ance, with gypsum	6	0	695	6
35	Red fake and clay...	8	8	532	9	55	Red shaly sandstone,				
36	Red fireclay ...	9	5	542	2		with gypsum ...	14	6	710	0

* "Fake" is a Scotch term for shale, and "Blae" for white post or sandstone. This boring was made by Glasgow men, hence the use of these terms.

XXXII. No.2 Boring from the bottom of a well at Eston Low Farm, and about 1300 yards south of Eston Junction, for Messrs. Smith and Oakey.

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.	No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
1	Well	25	0	25	0	14	Grey gypsum, mixed				
2	Shale	3	0	28	0		with white gyp-				
3	Soft dark grey shale,						sum	0	4	116	3
	with water ...	2	6	30	6	15	Red gypsum, mixed				
4	Grey shale... ...	16	6	47	0		with white gyp-				
5	Blue shale... ...	4	0	51	0		sum	1	0	117	3
6	Blue shale... ...	18	0	69	0	16	White gypsum, a				
7	Blue shale... ...	7	0	76	0		little mixed ...	1	0	118	3
8	Dark grey shale ...	20	0	96	0	17	Red gypsum, mixed				
9	Light shale... ...	14	8	110	8		with white gyp-				

10	Dark red shale ...	0	11	111	7		sum	2	6	120	9
11	Red gypsum ...	2	0	113	7	18	Solid white gypsum	0	6	121	3
12	Grey gypsum, mixed with white gypsum	1	8	115	3	19	Red gypsum, with much white gypsum	0	8	121	11
13	Red gypsum, mixed with white gypsum	0	8	115	11	20	White gypsum ...	6	6	128	5

XXXIII.—Boring on West Coatham Farm,Kirkleatham Estate,near Redcar,for Messrs.W.Bullen and Partners. (Long. 1° 5' 28" W., lat. 54* 36' 31" N.)

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.	No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
1	Clay	6	0	6	0	13	Red and white mottled, white and blue mottled post	12	0	186	0
2	Blue shale, with dogger band ...	75	0	81	0	14	Dark blue shale, with whin girdles	19	0	205	0
3	Nodular band ...	1	6	82	6	15	White shale! ...	18	0	223	0
4	Blue shale	1	8	84	2	16	Red marl, mixed with gypsum ...	86	0	309	0
5	Nodular band ...	2	0	86	2	17	Strong band ...	0	2	309	2
6	Blue shale	6	4	92	6	18	Red marl	23	0	332	2
7	Nodular band ...	1	6	94	0						
8	Blue shale	21	0	115	0						
9	Bastard grey post ...	5	0	120	0						
10	Blue shale, with hard band ...	33	0	153	0						

11	Dark shale, with sulphur and hard band	12	0	165	0	19	Strong band ...	0	3	332 5
						20	Strong red marl ...	7	0	339 5
						21	White gypsum ...	1	4	340 9
12	White and grey post, with water* ...	9	0	174	0	22	Red marl	0	9	341 6

XXXIV.—Boring on West Coatham Farm,Kirkleatham Estate,near Redcar, for Mr.Slate. (Long. 1° 5' 28" W., lat. 54° 36' 45" N.)

No.	Description of Strata.	Thickness of Strata.		Depth from Surface.		No.	Description of Strata.	Thickness of Strata.		Depth from Surface.	
		Ft.	In.	Ft.	In.			Ft.	In.	Ft.	In.
1	Soil	0	6	0	6	6	Soft slaty metal ...	4	0	22	4
2	Clay	6	0	6	6	7	Hard grey post ...	0	4	22	8
3	Cashy partings, sulphurous	0	4	6	10	8	Soft slaty metal ...	9	0	31	8
						9	Hard grey post ...	0	8	32	4
4	Blue post and whin, with white metal partings and salt water	1	6	8	4	10	Soft light grey post	12	0	44	4
						11	Blue slaty metal ...	3	6	47	10
						12	COAL	0	10	48	8
5	Blue,grey,and blac metal, with slaty white girdles, without water...	10	0	18	4	13	Dark blue metal, coaly and slaty	12	0	60	8
						14	JET	0	1	60	9
						15	White post and blue metal... ...	3	0	63	9

* A feeder of salt water was met with in the stone which proved to be local,and was supposed to be the same salt water or brine spring found in sinking Slate's Pit.

! Bottom of the Lower Lias shale and top of the New Red Sandstone.

Cleveland and South Durham Salt Industry.

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
16	Dark blue metal ...	6	0	69	9
17	Dark blue metal, coaly	2	6	72	3
18	Grey metal, with white and grey post	3	0	75	3
19	Blue metal... ...	3	6	78	9
20	Hard band, coaly ...	0	4	79	1
21	Fireclay	3	0	82	1
22	Blue metal... ...	4	8	86	9
23	Strong white post	0	6	87	3
24	Dark metal stone and ironstone ...	0	2	87	5
25	Strong post and ironstone	0	11	88	4
26	Slaty metal, with Coal	1	2	89	6
27	COAL	1	3	90	9
33	White post and grey metal	2	0	115	0
34	Strong brown and white post and metal	1	3	116	3
35	Strong white and grey post ...	0	10	117	1
36	Blue metal with white post towards top ...	3	0	120	1
37	Blue metal, with white post and mica	1	10	121	11
38	Blue metal and metal stone	3	6	125	5
39	Grey metal and hard girdles	3	3	128	8
40	Brown & grey metal,				

	Ft.	In.	Ft.	In.		Ft.	In.	Ft.	In.
28 Clay	0	9	91	6	metal stone, white				
29 Blue metal... ...	10	6	102	0	post and whin				
30 Dark blue slaty metal	6	6	108	6	girdles	1	6	130	2
31 Grey metal, and					41 Blue metal and metal				
white post ...	2	6	111	0	stone	3	0	133	2
32 Grey metal... ...	2	0	113	0	42 Blue metal... ...	2	6	135	8

XXXV.—No.1 Diamond-boring on the Elstob Estate, for the Earl of Eldon, commenced on May 29, 1873, and stopped on March 4, 1874.

No. Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.	No. Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
1 Lime and sand ...	3	0	3	0	30 Hard limestone ...	4	0	382	0
2 Sand, clay, and gravel	31	0	34	0	31 Strong dark shale ...	17	0	399	0
3 Quicksand	29	0	63	0	32 Sandstone and shale	11	0	410	0
4 Boulder clay and					33 Hard sandstone ...	1	0	411	0
stones	18	0	81	0	34 Hard shale and				
5 Sand	2	0	83	0	spar	2	0	413	0
6 Quicksand... ...	6	0	89	0	35 Strong dark shale ...	5	0	418	0
7 Boulder clay ...	2	0	91	0	36 Strong dark shale				
8 Sandy clay... ...	4	0	95	0	full of spar ...	7	0	425	0
9 Quicksand... ...	8	0	103	0	37 Strong shale ...	8	0	433	0
10 Boulder clay ...	43	6	146	6	38 Soft shale and fire-				
11 Soft magnesian lime-					clay	2	0	435	0
stone	134	6	281	0	39 Hard red sandstone	6	0	441	0
12 Hard limestone ...	19	0	300	0	40 Soft dark shale and				

13 Sandstone and lime-stone	4	0	304	0
14 Grey limestone ...	5	0	309	0
15 Fireclay	2	0	311	0
16 Grey limestone ...	1	0	312	0
17 Light blue limestone	3	0	315	0
18 Red shaly limestone	7	0	322	0
19 Shaly limestone ...	1	0	323	0
20 Hard limestone ...	19	0	342	0
21 Red sandstone ...	5	0	347	0
22 Red sandstone and shale	5	0	352	0
23 White sandstone...	8	0	360	0
24 Soft dark shale ...	6	0	366	0
25 Sandstone and spar	5	0	371	0
26 Soft dark shale ...	2	4	373	4
27 Sandstone and spar	2	8	376	0
28 Soft dark shale ...	1	0	377	0
29 Fireclay	1	0	378	0
sandstone ...	12	0	453	0
41 Soft dark shale ...	1	0	454	0
42 Strong sandstone...	3	0	457	0
43 Hard purple sand-stone	7	0	464	0
44 Soft sandstone,with shale bands ...	54	0	518	0
45 Hard blue limestone	44	0	562	0
46 Sandstone, with bands of shale...	102	0	664	0
47 Dark shale and spar	42	0	706	0
48 Light blue limestone	16	0	722	0
49 White sandstone ...	25	0	747	0
50 Soft dark shale ...	2	0	749	0
51 COAL, soft ...	0	3	749	3
52 Sandstone, with bands of shale...	139	9	889	0
53 Light blue limestone	1	0	890	0
54 Hard limestone ...	2	10	892	10

Cleveland and South Durham Salt Industry.

Report on Elstob Boring.

The result of the experiment by boring at Elstob,to a depth approaching 900 feet,is to establish—

	Ft.	In.
First, an unusual thickness of Pleistocene deposits (boulder clay) ...	146	6
Secondly, the absence of all Triassic (New Red) deposits		
Thirdly, a considerable thickness of Magnesian Limestone	195	6
Fourthly, a considerable thickness of Permian (red or purple sandstone and shale) strata	122	0
Making of this upper series	464	0
Then follows a quite different group of strata, consisting of white and grey sandstones, grey and dark shales, and blue or blueish limestones, altogether at the date reported	428	10

In this series,which in a large sense is Carboniferous,three limestone beds occur,

at intervals,from the top to No.2, 54 feet ; between No.1 and No.2, 144 feet ;

between No.2 and No.3, 167 feet ; and below the second is a bed of coal enclosed

in shale.

Surface.	Thickness Ft.	In.
Pleistocene---		
Boulder clay	146	6
Permian---		
Magnesium Limestone... ...	195	6

Red (purple) sandstone and shale

Carboniferous System below Millstone Grit (Yoredale Rocks)---

Carboniferous System below Millstone Grit (Yoredale Rocks)---	122	0
White sandstone and shale	54	0
1. Blue limestone...	44	0
Grey sandstone and shale	144	0
11.Blue limestone...	16	0
Sandstone...	25	0
Shale enclosing coal ...	4	0
Sandstone and shale... ...	138	0

111.Blue limestone... ... ... not penetrated

Fig 1.

This coal is said to be about 3 inches thick,and to be enclosed in shale about 3 feet 9 inches thick.

On considering Fig.1 with attention,and examining the specimens of limestone from the three beds named,I arrive at the conclusion that the whole series of strata,penetrated to about 430 feet below the Permian (red and purple) sandstones and shales,belong to the Yoredale Rocks (upper part of the Mountain Limestone

series). The composition of the limestones,taken by themselves,would be quite enough to prove their affinity to some part of the Mountain Limestone series ; and the succession of the beds,well considered in relation to the well-known sections in the mining dales lying to the westward (Weardale,Tynedale,Teesdale, etc.),leads to the probability that they belong to the Yoredale series,above the thick Scar limestones.

Adopting this conclusion as positive,I have to advise,in this first report,that the boring operations be discontinued at Elstob. By continuing the process,similar strata,and among them thin coal-seams would be found ; but in this part of the Carboniferous range the limestone seams,as they may be termed,have no practical value,though farther to the north they are worked to profit.

What is already proved is of great importance in regard to any further steps which may be advisable,on which I shall be prepared to report after seeing selections from the other cores brought up in the boring,and considering the plans

and other means of judging which you will be able to supply.

John Phillips,

April 4,1874.
Oxford.

To John Johnson,Esq.,

Newcastle-upon-Tyne.

XXXVI.— No.2 Diamond-boring on the White House Estate,near Norton.

No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.	No.	Description of Strata.	Thickness of Strata. Ft.	In.	Depth from Surface. Ft.	In.
1	Soil	1	0	1	0	28	Red sandy sandstone	21	3	291	6
2	Red sandy clay ...	4	0	5	0	29	Red marl,with gypsum and blue joints	1	7	293	1
3	Blue clay	15	2	20	2	30	Red marl,with blue joints and gypsum	6	0	299	1
4	Sand	1	4	21	6						
5	Sand and gravel ...	1	6	23	0						
6	Sand	5	1	28	1						
7	Red clay	15	5	43	6						
8	Dark brown sandy										

clay	30	3	73	9
9 Soft brown clay, mixed with sand	4	0	77	9
10 Brown pinnel ...	16	1	93	10
11 Red loamy sand ...	4	0	97	10
12 Brown pinnel ...	5	10	103	8
13 Grey sandstone ...	0	3	103	11
14 Brown pinnel ...	10	11	114	10
15 Grey loamy sand ...	2	0	116	10
16 Dark brown pinnel	2	11	119	9
17 Dark brown pinnel and cobbles ...	14	9	134	6
18 Red sandstone ...	24	8	159	2
19 Red marl	1	0	160	2
20 Red sandstone ...	23	10	184	0
21 Red marl	14	7	198	7
22 Red sandstone ...	9	2	207	9
23 Red marl	7	0	214	9
24 Red sandstone ...	3	6	218	3
25 Red sandy marl ...	40	0	258	3
26 Red sandstone ...	5	6	263	9
27 Red sandy marl ...	6	6	270	3
31 Red marl, with veins of gypsum	13	8	312	9
32 Red marl,with blue joints and gypsum	11	0	323	9
33 Red marl, with veins of gypsum	49	5	373	2
34 Red marl,with blue joints	11	0	384	2
35 Red marl,with blue spots	17	1	401	3
36 Red sandy marl ...	10	7	411	10
37 Red marl, with veins of gypsum	6	0	417	10
38 Anhydrite	6	3	424	1
39 Red marl,with blue spots and gypsum	3	0	427	1
40 Red marl,with gypsum (compact)...	16	8	443	9
41 Anhydrite	20	6	464	3
42 Magnesian limestone	55	9	520	0

122

Referance to followring pages 122, 123, 124.

On page 122   APPENDIX B.---Abstracts of sections of Boreholes and Brine-wells in Cleveland and South Durham.

See library for image.

123

On page 123 APPENDIX B.---Abstracts of Sections of Boreholes and Brine-wells in Cleveland and South Durham.---

Continued.

See library for image.

124

On page 124 APPENDIX B.---Abstracts of Sections of Boreholes and Brine-wells in Cleveland and South Durham.---

Continued.

See library for image.

Referance to followring pages.

To illustrate Mr John Marley's Paper on "The Cleveland & South Durham Salt Industry".

Vol.1 Plate LIV.

Also Vol. XXXIX Plate XXV.

See library for image.

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To illustrate Mr John Marley's Paper on "The Cleveland & South Durham Salt Industry".

Vol.1 Plate LV.

Also Vol. XXXIX. Plate XXVI.

See library for image.

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The Chairman invited comments on the paper,which,however,would be open again for discussion.

Mr.Thos.Bell suggested that when the paper was again discussed an enlarged map should be hung on the wall showing the position of the various boreholes,together with a section showing the position of the different beds bored through. A paper by Mr.T.W.Stuart had been alluded to,and he thought if that gentlemen could be induced either to read that paper or give them some extracts to accompany this one,the different boring-machines being treated of,it would be very interesting ; if,however,these machines were mentioned,care should be taken to omit none.

There was a dispute among geologists in the district as to whether the Red Sandstone underlaid the Lias.

Prof.Lebour—There is no reason to think it does not.

Mr.Thos.Bell.—Could it be proved? He had had some discussion at a meeting of the Manchester Geological Society on the point ; they said it was so,but he had given them some notes on the Lackenby Hole to show that it did not. It might ; but had any gentleman ever met with a case where it overlapped? The object,however,of his rising was not to ask these questions so much as to propose a vote of thanks to Mr.Marley for his paper.

Mr.J.B.Simpson said he had much pleasure in seconding the vote of thanks to Mr.Marley. The paper was a very interesting one,and when it was in the hands of the members they would be better able to consider the points upon which they now required more definite information.

Prof.Lebour,in answer to Mr.Bell,said that with regard to the red beds beneath the Lias,unless they actually bored beneath the Lias he did not think they could absolutely prove it,but there was no reason to doubt that the red beds continued in that direction,though one could not tell. That red beds occur in other districts was of course well known. In the Bristol district,for instance,the Lias was to be seen above and the red beds below. That the red beds fell out somewhere to the south there was no doubt ; the probability was that the Lias rested on some of the older beds,but he did not see how it could be proved in the North of England except by boring. It was not to be supposed that where they had a considerable thickness of these beds of red sandstone there would be a thinning out immediately.

The Chairman said they would all agree in passing this vote of thanks. They would also ask Professor Lebour—even if Mr.Marley was not able to attend to it—to make some arrangements for a plan and sections in a conspicuous form for the next meeting,something like Mr.Simpson's well known coal sections.

The Chairman said he would not offer any further observations—-rather reserving till the adjourned discussion anything he might have to say ; but he would allude to the extensive discoveries in recent times of valuable salt-beds in other districts than the Tees—among which was that on the West coast near Fleetwood,where,at 100 yards depth,the top of a salt-bed was reached,which had been sunk through and proved to be 100 yards thick. This would be likely to prove a strong competitor with this district.

The vote of thanks was carried with acclamation.

ELECTION OF OFFICERS.

The Scrutineers submitted the list of officers for the ensuing year as follows:—

President.

Wm.Cochrane,Esq.,Grainger Street West,Newcastle-upon-Tyne.

Vice-Presidents.

William Armstrong,Sen.,Esq.,Pelaw House,Chester-le-Street.

T.J.Bewick,Esq.,Suffolk House, Laurence Pountney Hill,London, E.C.

Wm.Lishman,Esq.,Bunker Hill,Fence Houses.

G.May,Esq.,Harton Colliery,South Shields.

J.B.Simpson,Esq.,Hedgefield House, Blaydon-upon-Tyne.

James Willis,Esq.,14,Portland Terrace, Newcastle-upon-Tyne.

Council,

Henry Armstrong,Esq.,Chester-le-Street.

Wm.Armstrong,Jun.,Esq.,Wingate, Co.Durham.

T.W.Asquith,Esq.,Harperley,Lintz Green,Newcastle-upon-Tyne.

Emerson Bainbridge,Esq.,Nunnery Colliery Offices,Sheffield.

T.W.Benson,Esq.,11,Newgate Street, Newcastle-upon-Tyne.

R.F.Boyd,Esq.,Houghton-le-Spring, Fence Houses,Co.Durham.

M.Walton Brown,Esq.,3,Summerhill Terrace,Newcastle-upon-Tyne.

Sir B.C.Browne,Westacres,Benwell, Newcastle-upon-Tyne.

T.E.Forster,Esq.,North Jesmond, Newcastle-upon-Tyne.

T.Heppell,Esq.,Leafield House,Birtley, Chester-le-Street.

H.Lawrence,Esq.,Grange Iron Works, Durham.

Prof.J.H.Merivale,2,Victoria Villas, Newcastle-upon-Tyne.

M.W.Parrington,Esq.,Wearmouth Colliery,Sunderland.

A. M.Potter,Esq.,Shire Moor Colliery, Earsdon,Newcastle-upon-Tyne.

T.H.M.Stratton,Esq.,Cramlington House,Northumberland.

J.G.Weeks,Esq.,Bedlington,R.S.O., Northumberland.

R.L.Weeks,Esq.,Willington,Co. Durham.

W.O.Wood,Esq.,South Hetton,Sun-derland.

Mr.A.L.Steavenson said he had much pleasure in congratulating their new President ; he hoped he might have many years of health and strength to enjoy a successful presidentship.

Mr.Cochrane said he felt very proud of the honour which the members had done him,and he assured them that he would do his best to add to the success of the Institute. He felt a little nervous about taking the presidency under any circumstances,and it looked as if he were afraid of the position when he told them that he was going away for a time ; he hoped,however,when he came back that he would have good health to enable him to devote his energies to their interests. The Institute would not suffer by his absence,for he knew he could rely on the band of Past-Presidents who were ready to support him,and without whose assistance and that of the Council he could not undertake the work. He felt certain that under the circumstances,and knowing that he had gone away for his health's sake,they would conduct the affairs of the Institute,in his absence,as well,and perhaps better,than he could have done. He thanked them cordially.

Mr.J.B.Simpson said there was one duty they must not overlook. There was an old proverb that it was better to be off with the old love before they were on with the new ; and they ought not to part to-day without emphasizing their thanks

to Mr.Marley for the manner in which he had conducted the affairs of the Institute

for the past two years,their sympathy with him in his illness,and the hope that he might be soon recovered and able to come amongst them again. They all knew that Mr.Marley had thrown his whole heart into the work of the Mining Institute,and they ought therefore to convey to him in some manner their appreciation of the very able manner in which he had conducted their proceedings.

Mr.Cochrane could only say that taking the chair after Mr.Marley was one of the serious things he had to face. Mr. Marley had unreservedly devoted his time and attention to the interests of the Institute,lie had done all that a President could be expected to do,and he thought the members would admit that the Institute had prospered in consequence. He would be happy to convey to Mr.Marley personally and by letter the kind expressions to which Mr.Simpson had given utterance,and the manner in which these had been received. He was very pleased to second Mr.Simpson's motion.

The vote of thanks to the retiring President was heartily adopted.

Mr.Jas.Willis proposed a vote of thanks to the Scrutineers. The task of these gentlemen was an unwelcome one, and occupied considerable time which they might have spent much more pleasurably in listening to the interesting papers and discussions.

Mr.Simpson seconded the proposal,which was unanimously approved.

LECTURE THEATRE.

The President said that before closing the meeting he would call the attention of the members to the arrangements in connexion with the lecture theatre. They could now see from the window the white glazed bricks of the passage which

enclosed the new ground they held from the railway company. The only drawback to this acquisition was that it would be dark when the railway company's buildings were completed. The only natural light they would have in the lecture

theatre would be from the end windows. The question of lighting by electricity or some other mode would,however, come before the Council in due course. He would also like to call attention to an adjoining room,in which the whole of their stock of Proceedings had been very conveniently arranged by Mr.Gosman. Although the stock had been put there at some little cost,he thought they would all agree that the manner in which it was now stored was very efficient,and they could obtain information at any moment as to the volumes in hand.

Mr.Bell asked if the Council had agreed to the railway company closing the side windows?

The President explained that the Institute never had any right of light in that direction ; they had always paid an acknowledgment of 5s. a year for it,and now that the railway company had purchased the adjoining property they had

power to build close to the windows.

The President announced that the next meeting of the Federated Institution would take place at Nottingham,on the 24th and 25th of September,when he hoped many members from the North of England would attend. There would be every inducement,for the colliery owners there were taking the matter up strenuously. He was sorry he would not be there himself ; but he hoped the meeting would be—as it promised to be—a success,and that the members would enjoy it thoroughly.

The meeting then concluded.

Barometer,Thermometer,Etc.,Readings,1889.

APPENDICES.

I.—Barometer,Thermometer,Etc.,Headings for the Year 1889.

By M.Walton Brown.

The barometer,thermometer,etc.,readings have been supplied by permission of the authorities of the Glasgow and Kew Observatories,and give some idea of the variations of temperature and of atmospheric pressure in the intervening districts in which the mining operations of this country are chiefly carried on.

The barometer at Kew is 34 feet,and at Glasgow is 180 feet,above sea-level. The barometer readings at Glasgow have been reduced to 32 feet above sea-level by the addition of .150 inch to each reading,and the barometer readings at both Observatories are reduced to 32 degs.Fahr.

The fatal explosions in collieries are obtained from the annual reports of H.M.Inspectors of Mines,and are printed upon the diagrams recording the Meteorological Observations.

Referance to page 129

Barometer,Thermometer,etc.,readings,1889.

for January,1889.at Kew. and Glasgow.

for Febuary,1889.at Kew. and Glasgow.

see library for image.

130

Referance to page 130

Barometer,Thermometer,etc.,readings,1889.

for March,1889. at Kew. and Glasgow.

for April,1889. at Kew. and Glasgow.

see library for image.

131

Referance to page 131

Barometer,Thermometer,etc.,readings,1889.

for May,1889. at Kew. and Glasgow.

for June,1889. at Kew and Glasgow.

see library for image.

132

Referance to page 132

Barometer,Thermometer,etc.,readings,1889.

for July,1889. at Kew and Glasgow.

for August,1889 at Kew and Glasgow.

see library for image.

133

Referance to page 133

Barometer,Thermometer,etc.,readings,1889.

for September,1889. at Kew and Glasgow.

for October,1889. at Kew and Glasgow.

see library for image.

134

Referance to page 134

Barometer,Thermometer,etc.,readings,1889.

for November,1889. at Kew and Glasgow.

for December,1889 at Kew and Glasgow.

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Referance to following pages.

Diagram shewing the height of the Barometer,the Maxima & Minima temperatures & the direction of the

wind at the Observatories of Kew & Glasgow together with the explosions of firedamp in England & Scotland.

Appendix Vol. I. Plate I.

also Appendix Vol. XXXIX. Plate I.

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Diagram shewing the height of the Barometer,the Maxima & Minima temperatures & the direction of the

wind at the Observatories of Kew & Glasgow together with the explosions of firedamp in England & Scotland.

Appendix Vol.I. Plate II.

also Appendix Vol XXXIX. Plate II.

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Diagram shewing the height of the Barometer,the Maxima & Minima temperatures & the direction of the

wind at the Observatories of Kew & Glasgow together with the explosions of firedamp in England & Scotland.

Appendix Vol.I. Plate III.

also Appendix Vol.XXXIX. Plate III.

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Diagram shewing the height of the Barometer,the Maxima & Minima temperatures & the direction of the

wind at the Observatories of Kew & Glasgow together with the explosions of firedamp in England & Scotland.

Appendix Vol.I. Plate IV.

also Appendix Vol.XXXIV. Plate IV.

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III.—NOTES OF PAPERS ON THE WORKING OF MINES,METALLURGY, ETC.,FROM THE TRANSACTIONS OF FOREIGN SOCIETIES AND FOREIGN PUBLICATIONS.

A HAND DIAMOND ROCK-BORING MACHINE.

Schwedische Diamantbohrmaschine fur Handbetrieb des "Svenska Diamantberg-borrnings-Aktiebolag" in Stockholm. By E.Gad. Berg- und Huetten-maennische Zeitung, Vol. xlviii., pp. 451-454. One figure.

Mr.A.Craelius has recently invented a hand boring machine formed on the model of the American power drills, except as regards the advance motion,and its weight reduced to about 14 cwt.,including 164 feet of bore-rods, force-pump and accessories. The boring crown is 1.38 inches outside and .94 inch inside diameter,giving a core of from .865 to .905 inch. Eight diamonds of .75 to .8 carats are fitted into it in the usual manner. The core-tube, screwed on to the diamond crown,is 3 feet 3 inches long. The bore-rods are made of 4 feet 11 inches lengths of iron pipes of 1.30 inches outer and .98 inch inner diameter. A force-pump supplies water to the boring crown through an india-rubber tube at the rate of 1.10 gallons per minute. The boring spindle,into which the bore-rod fitted,is rotated with wheel gearing by handles,the iron stand resembling that of a hand winch in size and appearance. By hand the new machine can be driven at about 60 or 70 revolutions per minute against the 200 to 400 obtainable by power. The advance motion is obtained by a weighted lever,and the power is doubled by a pulley,a rope being led from the end of the lever over a pulley on the bore-rod to an eye on the iron frame. For shallow depths three workmen are required,and for deeper holes five workmen,in addition to a skilled foreman. The greatest speed attained with the new machine is 34 feet in 24 hours. The work becomes difficult and costly as the depth increases. With workmen's wages at Is. 6d. per shift,the cost varies from 40s. to 50s. per fathom. The system is considered suitable for borings up to about 38 fathoms in any desired direction either in the mine or from the surface. A. R. L.

THE CONDITIONS OF FORMATION OF LIGNITE.

Alte Funde auf der Saalburg und die Lignitbildung. Von F.Seeland. Oesterr-Zeitschr.f. Berg- u. Huttenwesen,1891,Vol.xxxix.,p.247.

The author has examined oak timber found in the remains of the Roman castellum of Saalburg,built on the Eastern Taunus in 17 b.c.,destroyed in 282 a.d. This timber was used as lining for wells or cisterns (? for the baths) which were sunk about 30 feet below ground,and was thus long subjected to moderate pressure at the ordinary earth temperature. It is now mostly converted into a sort of lignite comparable with that of Koflach. O.S.E.

THE ORIGIN OF COAL.

Des diverses theories emises sur le mode de formation de la houille et d'une conclusion que l'on peut en tirer. By A.Cocheteux. Annales de la Soc.Geol. de Belgique,1885-86,Vol.xiii.,Bulletin, pp. clxix-clxxiii.

After a brief recapitulation of the various theories extant on the formation of coal,the author enumerates his own conclusions with regard to the Belgian coalfield,as follows:—

1.—The Carboniferous Limestone is a deep sea formation.

2.—The soil of Belgium was slowly rising during the deposition of the Lower Coal-measures,and of equivalent strata without coal.

3.—During the deposition of the Belgian coal-seams,the land slowly subsided again. The dunes heaped up by the wind had formed a salt-lake,in which the sediment,brought down by the streams from the Ardenne and Brabant hills was deposited ; the continual flow of fresh water sweetened the lake,and made the growth of vegetation possible ; then the set broke in again,and the preceding series of events was repeated many times over.

4.—A second time the land rose during the Upper Coal-measure and Permian age.

The author maintains that the above statements have been confirmed by his own observations in the collieries ; and he intends to embody his theory in a more detailed work.
O.S.E.

THE COAL DEPOSITS IN THE INDWE BASIN AND STORMBERG

RANGE OF MOUNTAINS [CAPE OF GOOD HOPE].

Report by W.Galloway,and presented to the Legislature of the Colony.52 pages

and 5 Plates.

This report on the Indwe coal-mines gives details as to the area of the deposit,quality of the coal,best means of working,and estimated value to the colony.

M.W.B.

THE ADAMS BEE-HIVE OVEN.

Coke-burning Simplified. By Frank M. McKelvey The Colliery Engineer,

(Scranton,U.S.A.),1890,Vol. x., p.130-131,and three figures.

The ordinary bee-hive oven is fitted with a portable oven bottom,worked by an hydraulic ram,and removable with its contents from the oven upon a four-wheeled carriage.

The movable bottom of the oven is built up of wrought-iron,of circular shape. The oven is built of the same diameter as an ordinary oven,but of greater height,to the extent of 3 feet,and is fitted with a door whose width is equal to the diameter of the oven.

The hydraulic ram is placed in the centre of the oven,and has a stroke of 3 feet.

The oven bottom is placed upon a small carriage,and pushed along a track until it is in the oven and directly over the hydraulic ram. The ram is then raised until the oven bottom presses against a shoulder built around the oven. When the bottom is in position,supports are dropped to keep it secure. The ram is withdrawn,the carriage removed from the oven,and the doors closed.

The oven is then charged and burnt off in the ordinary way.

In withdrawing the coke,the doors are opened,the carriage run under the oven bottom,the ram raised until the supports are withdrawn,and the oven bottom and coke is then lowered on to the carriage,which is run out of the oven. The coke is watered,and a chain placed round in it,and the mass dragged off the oven bottom.

M.W.B.

THE ADAMS IMPROVED BEE-HIVE COKE-OVEN.

By John Fulton. The Colliery Engineer,1890,Vol.xi., pp.8 and 9,and

three figures.

An Adams oven has been erected by the Cambria Iron Company,near Dunbar,and its produce is of good quality.

A charge of 6.25 tons of coal produced 4 tons of coke,and the Adams oven was drawn 3.5 times per week ; it was drawn easily in .15 hour at a net cost of 3.12d. per ton ; while the ordinary oven,with the same load of coal and produce of coke is drawn 3 times per week,was drawn in 3 hours at a cost of 10.44d. per ton.

The cost of a battery of 100 ovens of the ordinary bee-hive oven,producing 60,000 tons of coke per annum,may be calculated as under:—

100 ovens ... ... each £50 ...	£5,000			

Annual charges—				
Interest at 10 per cent.	£500	=	2.00d. per ton.	
Repairs and renewals,each £2 ...	200	=	.80d.	„
Loading ovens...	240	=	.96d.	„
Levelling	480	=	1.92d.	„
Drawing,60,000 tons...	2,610	=	10.44d.	„
	-----------		------------	

Total	£4,030	= 16.12d.	„
	-----------	------------	

The same quantity of coke would be produced by 85 Adams ovens,the cost of which would be:—

85 ovens ... ... each £100 ... £8,500

Annual charges—

Interest at 10 per cent.	£850	= 3.40d.	per ton.
Repairs and renewals,each £3 ...	255	= 1.02d.	„
Loading ovens...	255	= 1.02d.	„
Levelling	510	= 2.04d.	,,
Drawing,60,000 tons...	780	= 3.12d.	„
	-----------	------------	
Total	£2,650	= 10.60d.	„
	-----------	------------	

M.W.B.

COPPER MINING IN SPAIN (HUELVA).

L'Industrie du Cuivre dans la Region d'Huelva (Rio-Tinto,San Domingos,etc.).

By L.De Launay.Annales des Mines,1889,Ser.8,Vol.xvi,,pp.427--516,

and Plates X.,XL,XII.

The copper industry has existed many years at Huelva,on the south frontiers of Spain and Portugal,and the names of Rio-Tinto,Tharsis,etc.,are become world renowned. These mines are very interesting owing to their antiquity,the nature of their outcrops,the mode of working by quarry systems,the ingenious methods employed in the economical extraction of the copper from so poor a mineral,etc.and these details are all exhaustively described in this memoir.

M.W.B.

A CYLINDRICAL DAM.

Note sur la Plate-cuve du Puits No.1 des Mines de Sel et Salines de Saint-Nicholas-Varangeville. Bulletin de la Societe de L'Industrie Minerale,Third Series, Vol.i.,1887,pp.1268--70. Plate 27,Figs. 4--9.

Owing to subsidences of the old workings in the vicinity of the No.1pit,in the eleventh bed of rock salt,at a depth of 525 feet,an influx of brine was found in the roof of the old workings at a depth of 275 feet in the fourth bed.

These feeders,small at first,quickly increased and threatened to flood not only the old workings but also the new workings,recently commenced around No.2 pit,sunk about 1,050 feet to the east of No.1pit,the two pits being connected by a level in the eleventh bed.

The company therefore decided to fix in the No.1pit,between the level of the workings of the eleventh bed and that of the workings in the fourth bed,a dam to keep back the water of the old pits,as well as the feeders leaking from the

tubbing above the fourth seam.

The figures show the position and details of the dam,which consists of 35 segments of metal weighing about 59 tons.

The shaft was filled below the level of the thill of the sixth bed of salt at a depth of 370 feet. A timber scaffold was laid at this point,covered by about 11 feet of concrete,and the centres for the dam were placed above the concrete.

The dam is in the form of a cylindrical arch,with a radius of about 12 feet,the chord or width being 14.5 feet,and the length 17.5 feet. It consists of seven sections,each containing five hollow cast-iron blocks,or voussoirs,the faces of whose joints

are planed,and before being bolted together are brushed over with a thin coating of mastic and linseed oil. The four surfaces,between the four abutments of the arch,in the sixth bed of salt were covered with sheets of india-rubber. The centres were removed before the central key block was placed in position and wedged with copper.

The dam was covered with a bed of quick setting cement about 2.5 feet thick. The concrete was applied in thin beds of 1 to 2 yards area,about 3 inches thick in the middle and thinned towards the edges. Very little water was used with the cement applied to the sides of the pit in the rock salt,with which it united very fairly. The concrete was formed of one part of washed river sand and one part of Vassy cement,of which 17 tons were used.

The concrete is covered with about 33 feet of good clay,carefully pugged with saturated brine.

The sides of the pit were carefully dressed by the pick in order to remove any rock loosened by contact with air or water.

The work cost about £2,200.
M.W.B.

PERMEABILITY OF CEMENTS.

Results of Experiments made to determine the Permeability of Cements and Cement

Mortars. By G.W.Hyde and W.J.Smith,condensed by L.M.Haupt.

Journal of the Franklin Institute,1889,Vol 128,pp.199--207. One figure.

The specimens,3 inches thick,were tested by means of four pipes,3 inches in diameter,joined to a 3-inches pipe,through which the pressure was communicated from a hand-pump,and maintained throughout the series at 75, 100,and 200 pounds per square inch respectively for three hours.

The experiments embraced six series,and the discharge of water through the samples was as follows:—

Samples.	No. of Samples.	Pressure per Square Inch.		
		75 lbs.	100 lbs.	200 lbs.
		Water passed per Square Inch per 24 Hours.		

		Max.	Min.	Max.	Min.	Max.	Min.
		Quarts.	Quarts.	Quarts.	Quarts.	Quarts.	Quarts.
Neat cement,after setting 7 days ...	5	.091	---	.092	.006	.267	.040
Do. do. 28 do.	1	----	.034	----	.052	----	.158
Cement mortar, 1 to 1,after setting 7 days	3	12.397	1.503	17.096	2.336	36.207	6.323
Cement mortar, 1 to 2,after setting 7 days	5	42.546	2.107	52.554	3.310	101.268	10.508
Cement mortar, 1 to 1,after setting 28 days	3	1.704	.328	2.482	.551	4.471	1.413
Cement mortar, 1 to 2,after setting 28 days	5	34.006	1.941	13.815	3.012	31.482	6.616

M.W.B.

GRISOUTITE.

Experiences faites sur la Grisoutite,les 25 April et 23 Mai,1889,au Charbonnage des Produits,a Flenu. By E.Larmoyeux. Revue Universelle des Mines. 1889,Vol.viii,,pp.239--255,and Plate 11.

The experiments were made in an old boiler about 48 feet long and 59 inches diameter,and .39 inch thick.

It was closed at one end with masonry containing the cannon,27.5 inches long and 15.75 inches diameter,the shot-hole being 2.125 inches diameter and 19.75 inches long. The boiler was fitted with 14 windows,6 of which

were closed with glass .75 inch thick. There were 3 valves,near the closed end of the boiler.

A meter was used to measure the gas. 7.71 grains detonators (triple) and 15.43 grains detonators (quintuple) were used on the first and second days' trials respectively.

A coil,heated by steam,was placed in the closed end of the boiler.

Coal-dust was spread upon a plank placed 6 inches below the orifice of the shot holes,so that the gases of the explosive should be thrown upon the dust.

In 11 experiments the end of the boiler was open,but in the remainder an iron ring |__| was riveted to a wing in the boiler,to which a sheet of waxed paper could be attached by means of an india-rubber band,during each experiment. By this means a closed space of about 280 cubic feet was formed,fitted with 6 windows closed with thick glass. The gas was introduced by an iron pipe into the bottom of the boiler,near the cannon,and was mixed with the air by means of an iron plate,swung to and fro,by an external lever. The valves rested upon india-rubber seats. All joints were carefully luted with thin clay. The glass windows were replaced by waxed paper on the second day.

It is with great difficulty that the gas was introduced without escape,and that a mixture of exact composition was obtained.

The explosions increased in violence as the proportion of coal-gas was increased,and for the same proportion,as the temperature increased. Explosions of gas are produced with 10 per cent.mixtures.

A short interval separated the appearance of flame at the end of the tube and that of the fumes and dust.

The results of the experiments may be tabulated as under:—

Percentage of Coal-gas.

Name of Explosive. ---

	Stemmed with Coal-dust.				Stemmed with Clay.			
	0	6	10	12	0	6	10	15
Compressed powder...	I2	---	---	---	---	I	I2	---
Gelatine-dynamite ...	I	---	---	---	---	---	I	---
Blasting gelatine ...	---	---	I	---	---	---	---	---
Forcite	I3	I	I	---	N	---	N3	I!
Grisoutite	N4*	N	N2	N2	---	---	N	N!

I signifies ignition,and N non-ignition of the explosive mixtures,the small figures 2,3,4 indicating the number of experiments. *Crusts of coke found in the boiler. Coal-dust was placed in the boiler,in all the experiments except the two marked !.

It will be seen that all the explosives stemmed with coal-dust,gas being absent,produced flame except grisoutite. Forcite,stemmed with clay,gas being absent,did not produce flame.

In experiments with explosives care should be taken to distinguish the flame of the explosive,of the coal-gas,and of the coal-dust,which occur in rapid succession.

In all the experiments the mechanical effects produced by the explosive with coal-dust were very little more than when stemmed with clay,and much less than produced by the explosive with coal-gas.

It is not surprising that coal,a combustible,should ignite in prolonged contact with the very hot gases produced by the detonation of an explosive and make a slight addition to the mechanical effects owing to the heat developed during its

combustion.

The non-explosibility of coal-dust seems demonstrated by the appearance of flames exempt from sparks at the end of the tube followed by black clouds of smoke and dust ; without dust they were accompanied by flame. M.W.B.

THE CHALON-GUERIN GELATINIZED WATER-STEMMING.

Grisoutite et l'Eau gelatinisee. By Messrs.V.Watteyne and E.Larmoyeux.

Revue Universelle des Mines,1889,Vol.viii.,pp.256--269.

Messrs.Chalon and Guerin use water in a gelatinous form,in small cylinders.

These cylinders contain 98 per cent,of water and 2 per cent,of gelatinous matter procured from seaweed.

It is placed at the end of a shot-hole somewhat larger in diameter than the cartridges,which are pushed in with the beater,so as to penetrate into and be surrounded by the gelatinous matter. One or more pieces of the gelatinized stemming is then pushed in,and the operation completed with clay stemming.

Trials have been made with this stemming in the mine and in the dark,and it may be presumed that the absence of the slightest glimmer would allow of the statement being made that no explosion would occur in the presence of an explosive mixture.

The following table contains the results of various trials:—

Explosive used.		Length of Clay Stemming.	Length of Glimmer or Flame observed.							
			Weight in Ounces of Gelatinized Stemming.							
Name.	Weight.		Nil.	8.4	11.3	14.1	16.9	19.0	21.1	29.6
	Ounces.	Inches.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.
Grisoutite... ...	6.6	12 to 20	20	---	---	---	---	---	---	---
	10.1	12 to 20	40	---	---	---	---	---	---	---
	12.7	8	---	---	---	---	---	?	---	---

	13.1	12 to 20	40	---	---	---	---	---	---	---
	16.4	8	26	---	---	---	---	---	---	---
	19.7	16 to 20	24	---	---	---	---	---	6	Nil.
	19.8	8	26	---	---	---	---	---	---	---
Forcite	6.3	8	---	---	---	---	---	26	---	---
	9.5	8	---	---	---	26	---	---	---	---
Blasting-gelatine	5.3	3	---	120	---	---	---	---	---	---
	6.0	12 to 20	---	40	40	40	---	---	---	---
	8.2	30	120	---	---	---	---	---	---	---
	9.0	8	---	---	---	---	26	26	---	---
	10.6	16 to 20	---	---	---	---	---	---	?	---

It is evident that impressions are subject to errors,which may be reduced by the number of witnesses.

The table shows that actual safety is not secured under any of the conditions given ; with one exception,glimmers of light were seen in all the experiments.

Grisoutite has about one-third of the power of blasting-gelatine or forcite.

It will be seen that grisoutite alone is similar to forcite or blasting-gelatine,with the gelatinized stemming in point of safety.

Although the Chalon-Guerin stemming is not difficult to use,it is more difficult than grisoutite.

The cost of a charge of grisoutite is a little more than a charge of blasting-gelatine or other explosive,with the addition of the safety stemming.

The gelatinous matter costs 5s. 6d. per pound,and boiled with fifty times its weight of water cools into a gelatinous mass,which is easily cast into little cylinders of suitable dimensions.

A charge of 10.5 ounces of blasting-gelatine requires 18 ounces of Chalon-Guerin stemming,hence—

Blasting-gelatine ...	10.5 ounces	at 1s. 3d.	per pound	= 9.84d.
Stemming	18 „	at 1.5d.	„	= 1.68d.

		Total		11.52d.
				-----------

20 ounces of grisoutite would be required,costing,at 1s. per pound,Is. 4d.,or a difference of 4.5d. in favour of the Chalon-Guerin stemming.

The writers suggest that instantaneous dry plates should be used. The camera being turned towards the orifice of the shot-hole,the cover would be removed as soon as all lights had been removed. The shot would be fired,and the glimmer would be faithfully recorded on the plates. The records would be fixed and could be reproduced to any extent,and the copies could be compared and discussed at leisure.

M.W.B.

DYNAMITE AND GRISOUTITE.

Note sur de Nouvelles Experiences faites sur la Grisoutite. By E.Braive.

Revue Universelle des Mines,etc.,1889,Vol.v.,pp.67--86.

The following experiments have been made at Schlebeisch,with grisoutite,with the apparatus as described in

Vol.xxxviii.,Abstracts,p.26,of the Transactions of the North of England Institute of Mining and Mechanical Engineers:—

1,2,3.—Experiments were made in the absence of gas and dust. Dynamite (2.65 ounces),gelatine dynamite

(2.65 ounces),and grisoutite (7.95 ounces) were fired. In the first and second explosions flames were distinctly seen. No flame was seen with grisoutite,only a white cloud and water vapour.

4.—Dynamite : two cartridges (5.30 ounces) ; dry and finely screened coal-dust from Agrappe (4.41 pounds),no gas. Result,flames without explosion.

5.—Dynamite : 2.65 ounces enclosed in 4.41 pounds of coal-dust from Agrappe ; 8 per cent,of gas ; temperature, 73 degs.Fahr. Result,explosion of gas rather than coal-dust.

6.—Dynamite : 5.30 ounces with 4.41 pounds of dust from a New-Iserlohn ; 8 per cent. of gas ; temperature,86 degs.Fahr. Result,much more violent explosion ; flames 13 feet high.

7.—Grisoutite : 8.82 ounces with about 4.41 pounds of the same dust as used in No.6 ; 8 per cent. of gas ; temperature,86 degs.Fahr. Result,neither flame nor explosion.

8.—Dynamite : 5.30 ounces ; 4.41 pounds of dust from Boule ; 12 per cent. of gas ; temperature,86 degs.Fahr. Result,very violent explosion,flames many feet high and burning for some seconds at the orifice of the cylinder ; many buttons and crusts of coke in the interior of the apparatus.

9.---Grisoutite : 8.82 ounces ; 12 per cent. of gas ; temperature,84 degs.Fahr ; coal-dust from Boule. Result,neither flame nor explosion.

10.—Dynamite : 8.82 ounces ; 4 per cent. of gas ; Boule dust ; temperature,86 degs.Fahr. Result, long flames, heavy explosion.

11.—Grisoutite : 8.82 ounces ; 16 per cent. of gas ; Boule dust ; temperature,86 degs.Fahr. Result,no explosion and no flame.

12.—Dynamite : 5.30 ounces ; 12 per cent. of gas ; Agrappe dust ; temperature,84 degs.Fahr. Result,very sharp explosion,very high flames,the sheet-iron cylinder destroyed.

13.—Grisoutite : 8.82 ounces ; 12 per cent. of gas ; Agrappe dust ; temperature,93 degs.Fahr. Result,explosion.

14.—Grisoutite : 8.82 ounces ; 12 per cent. of gas ; Agrappe dust ; temperature,86 degs.Fahr. Result, neither flame nor explosion.

15.—Grisoutite : same conditions as the preceding,with similar result.

16.—Grisoutite : the same.

17.—Grisoutite : same conditions, except temperature,95 degs.Fahr. Result,explosion.

18.—Grisoutite : 8.82 ounces ; 4.41 pounds of Agrappe dust ; temperature,95 degs.Fahr. A stemming of about 4.8 inches of crystallized salt was placed above the cartridge in the hole,and the dust was spread in the ordinary manner. Result,neither flame nor explosion.

19.—Grisoutite : same conditions as above,with same result.

20.—Grisoutite : modified with extra salt ; 7.05 ounces ; Agrappe dust ; 12 per cent. of gas ; temperature,95 degs. Fahr. Result,neither flame nor explosion.

21.—Grisoutite : with extra salt ; same conditions as above,with same result.

22.—Grisoutite : the same.

Grisoutite has been tried in the mine for blasting coal and stone. It is very suitable for coal,as it does not break it small,and is similar,if not superior,to powder in its effects. In ordinary stone,grisoutite has sufficient effect in a hole

.90 inch diameter. Its power is said to be double that of compressed powder.

M.W.B.

NOTES ON PETRAGITE.

Mitteilungen uber den neuen Sprengstoff "Petragit." By Dr.Muck. Gluckauf.

1889,Vol.xxv.,pp. 433---435.

The new explosive,petragite,is prepared as follows:—A quantity of specially prepared molasses is nitrified by the admixture of sulphuric and nitric acids in the same proportions as are used in the preparation of nitro-glycerine. The nitrated

molasses are then washed,first in cold and then in warm water (with a little ammonia) to remove any free acid. The water is easily poured off and a quantity of wood-dust or powdered wood added,containing 52 per cent,of nitre. This

mixture,when thoroughly dried,is petragite,containing equal quantities of nitrated oil of molasses and wood-dust.

The following advantages are claimed for petragite as compared with dynamite:—

(1) it does not freeze ; (2) its production is absolutely safe ; (3) it is cheaper and equally effective ; and (4) it is unaffected by concussions or by contact between metals.

Compared with roburite and other explosives free from nitro-glycerine (1) it is much cheaper ; (2) it keeps better, being free from hygroscopic substances ; and (3) it is more homogeneous,containing only one kind of solid matter.

It is found in practice to act with good effect in coal and rock,exploding with less shock than dynamite,and with a quieter action,more like gunpowder. No appearance of flame was noticed after the shots were fired,and the gases given off were non-injurious.
A. N.

THE BOILERS EXPLOSION AT FRIEDENSHUTTE.

Une Explosion de 22 Chaudieres a Vapeur aux hauts Fourneaux de Friedenshutte

(Haute-Silesie.) By — Olroy. 1889,Series 8,Vol.xv.,pp.5---60 and Plate V.

This accident has been already described in the Transactions of the North of England Institute of Mining and Mechanical Engineers,Vol.xxxviii.,Abstracts,p.25. Full details are given of the accident.

The Silesian Boiler Inspection Association state that the bad quality of the plates of the twenty oldest boilers,which singularly facilitated the rents from rivet to rivet,was the preponderating cause of the extent of the disaster. Such defective material was wholly unsuitable for a batttery of boilers working twenty-four hours daily for many years. They think that boilers Nos.4 and 15 were destroyed by steam pressure,that No.6 failed under the effects of an explosion of flue gases and steam pressure,and that the remainder have been thrown and displaced by the external action of the explosion of flue gases and by lateral shocks from the adjacent boilers.

The Silesian Branch of the German Society of Engineers attribute the explosion to the bad quality of the plates,and consider that the determinate cause was want of water.

The German Society of Metallurgists consider that one of the boilers may have exploded first owing to the bad rivets,plates,want of water,etc.,and to have caused the destruction of the others in succession by the fracture of the main steam-pipe. They declare that the explosion should not be attributed to the flue gases.

The General Committee of the Prussian Boiler Inspection Associations are of opinion that by an unhappy combination of circumstances an explosive mixture of flue gases and air was formed in the flues and became suddenly ignited. The explosion of gases produced local fractures,etc.,in the boilers,which (owing to their length,their mode of construction,and the bad quality of the plates) were readily extended,and finally the boilers themselves exploded.

Mr.Olroy is of opinion that the catastrophe must not be attributed to external action upon the boilers,that is by the explosion of a mixture of flue gases and air accumulated in the flues. It was probably due to the bad condition of the boilers,constructed of inferior plates and want of proper repairs,and the explosion of one boiler would successively cause the destruction or displacement of all the others,owing to lateral shocks and the sharp fall of pressure in their interior.

M.W.B.

THE VERPILLEUX COLLIERY EXPLOSION (ST.ETIENNE).

Le Catastrophe du Puits Verpilleux,a Saint-Etienne. Le Genie Civil,1889,

Vol.xv.,pp.219,325.

L'Explosion de Grisou du Puits Verpilleux. By A.Evrard. Le Genie Civil,

Vol.xv.,pp.264---268,and three figures.

No.13 Seam,15 feet thick,was being worked at a depth of about 1,300 feet by longwall in two sections of about

7.5 feet,the goaf being carefully packed with material sent down from bank as required.

The explosion occurred about 11.50 a.m. on July 3,1889,in either No.5 or 6 district at the face. The flames,hot gases,irrespirable gases,and air driven by the expansion had extended in three principal directions—to the downcast pit and to the two upcast pits. Fires were found at several points.

Charred coal and crusts of coke were found on the timber in Nos.5 and 6 districts,and attained a maximum,at a certain radius beyond which it gradually decreased in all directions.

Notwithstanding the fact that the Jabin Pit explosion of some years ago was and is attributed to coal-dust,the cause of this explosion is attributed to fire-damp. It is thought that the gas came off very rapidly,and fouled a large and rapid

current of air. This sudden issue is attributed to a slipping of the rocks and coal on a line of fault.

An earthquake occurred at 3 a.m. of the same day near the colliery and in the Pyrenees,and may have caused the slip.

It is difficult to define the mode of ignition,but it could not be an opened lamp as they are locked electrically. Matches had been found on workmen before the accident,and it is suggested that some may have fired spontaneously or from a blow. All the Marsaut lamps were found to be perfect after the accident. It is not considered probable that the gas was ignited from the spark of a pick.

M.W.B.

THE CARBONIFEROUS CONGLOMERATE OF MONS.

Le poudingue houiller (2eme notice). By J.Faly. Annales de la Soc.Geoloq. de Belgique,1885---86,Vol.xiii. Memoires,pp.183---196.

A detailed account is given of the occurrence of a Lower Carboniferous conglomerate in the Mons coal-field. Above this conglomerate there are 600 to 700 feet feet of beds (sandstones and shales) either barren of coal or containing only unworkable seams,and above these again are the Coal-measures proper.

O.S.E.

NOTES ON THE TOPOGRAPHY AND GEOLOGY OF THE CERRO DE PASCO,PERU.

By A.D. Hodges,Jun.,M.E.,Boston,Mass. Transactions of the American Institute of Mining Engineers,1887---88,Vol. xvi.,pp.729---752. Three maps and one section.

A description of the geology,topography,climate,and industrial resources of the region.

The mining district of Peru is described as a belt of mountainous country running nearly the entire length of the Republic. It comprises the two ranges of the Andes,and the high table-lands between them.

To the east of this belt are the plains and valleys of the Amazon and its tributaries ; to the west a narrow strip of coast from 20 to 50 miles broad. In this latter district are found salt,petroleum,enormous quantities of nitrate of soda, silver in a few localities,copper,and other minerals.

The mining belt has an average elevation of 15,000 to 16,000 feet. It contains valuable mineral deposits in all parts. Gold,silver,quicksilver,lead,and copper are found ; salt and coal occur in many places ; iron is also said to exist.

The Cerro de Pasco—the portion of the district specially described in the paper—lies to the north of Lake Junin or Chinchaicocha. This latter lies in a plateau encircled by the Cordilleras of the Andes,which unite to form the Knot of Pasco (Nudo de Pasco).

At the extreme north of the plateau an irregular circle of hills forms the basin of the Cerro. It is a series of small terraced plains,with a low central ridge,on which the town and the greater number of the mines are located. This central

ridge is about 1.5 miles long,.75 mile broad,and is the "Cerro de Pasco."

The town is situated on the backbone and eastern slope of the ridge,while a series of immense quarries,or open cuts,called Tagos,or Tagos abiertos,occupy the western slope.

Mines have been worked over all parts of the ridge ; many of the openings of the same occur in the yards and streets of the town.

The altitude of the town is some 14,000 feet above the sea ; the population is from 7,000 to 8,000.

A railway running to Sachafamilia,7 miles distant,connects the mines with various amalgamating works to the south.

The social accommodations and mining appliances are described as rough and primitive for the most part.

Mining operations carried on unsystematically for 250 years have resulted in the formation of the immense open cuts or tajos by the caving of the mines. These passing into and through the town limits have destroyed many buildings and threaten others.

As to the climate of the Cerro,its reputed terrible nature is said to be unfounded. No extremes of heat or cold occur,and from August,1886,to March,1887,the temperature ranged from 28 degs. to 64 degs.Fahr. Lowest point

recorded 10 degs.Fahr. during night.

July,August,and September are the coldest,and from December to March the warmest months. Hailstorms,snow, and rain are liable to occur any time,and especially during certain seasons. It is exceptional,however,to have more than 2 inches of snow on the ground,or more than a mere skin of ice on the pools,and both disappear quickly under the sun.

Rains are prevalent from November to March.

The air is tonic and bracing,but owing to its thinness new-comers are subject to shortness of breath. There is very little wind.

Finally,it is concluded that the climate of Cerro is unusually wholesome for those with proper conveniences of life, but is trying to some constitutions.

At distances of from 8 to 10 miles,in almost any direction,a soft and pleasant climate can be reached by descending one of the steep ravines.

The climate is too cold for agricultural crops,but plenty of grass for sheep and cattle is produced.

The estimated grinding capacity of all the amalgamating works (haciendos) in the vicinity of the Cerro is 185,000 tons yearly. Many of these,however,are seldom or never used,and some are falling into ruins.

The rocks of the mining belt are of Jurassic and Cretaceous age.

In and around the basin of the Cerro,limestone conglomerates,limestones,andesites,slates,sandstones,and the argentiferous formation are found.

The limestone conglomerate caps the hills forming the western boundary of the basin ; the limestones form the hills on the north and east,and partly on south. Veins,some of which have been worked,occur in the limestone.

Next the limestones come nearly vertical slates,and then eruptive masses and dykes of andesite containing fragments of sedimentary rocks. These latter are frequently much altered in the neighbourhood of the igneous rocks.

The argentiferous formation occurs between the limestones on the east and the andesite on the west. It forms the surface of the central ridge on which the town is built. The same has long been a geological puzzle. For convenience it is divided into (1) surface deposits,or ground above the water-level ; and (2) deep deposits,or ground below the same.

(1) Consists of a highly metamorphosed and greatly oxidized material of constantly varying structure,colour,and composition. Over a large portion of the town ridge it is a hard,compact,reddish or brownish,and very quartzose cap of varying thickness.

Below this the formation is softer and more decomposed ; sometimes of fragments of all sizes,loose or cemented together.

It is of all degrees of hardness and structure : earthy masses,soft clays,sugary sands,hard grey quartzite,porous matter like scoria,and rotten slate occur in a confused mixture. The smaller fragments are often arranged so as to present a slaty appearance. It is always very siliceous,and everywhere contains at least traces of silver.

Decomposition does not always proceed gradually from the surface downwards ; very hard and very soft rocks often adjoin.

In some parts the silver is uniformly distributed,and in others in pockets. The metal is rarely visible,even with a glass,and when it is it occurs in native scales associated with quartz.

The following is an analysis of the surface ore;—

	Per Cent.
Silica...	72.00
Alumina	6.50
Iron peroxide	13.50
Iron protoxide	0.50
Iron sulphide	2.00
Lead carbonate	1.25
Lime (and magnesia) carbonate	1.50
Manganese peroxide	0.55
Zinc (combination undetermined) ...	0.40
Copper	0.05
Arsenic	trace
Antimony	0.25
Sulphur	0.30
Silver	from traces upwards.

Below the water-level the rocks are very much less altered,but still metamorphosed to a considerable extent. Sulphides of silver,copper,and iron are common to both divisions and to the veins in the limestone.

The following is an analysis of a hard pyritic ore from the deeper deposits :—

	Per Cent.
Silica,etc	40.05
Iron...	26.63
Copper	2.73
Nickel	trace
Silver	0.13
Sulphur	26.55
Antimony	2.40
Arsenic	trace
Moisture	0.95
	99.44

Gold occurs in the merest traces,and thallium has been detected in the bullion.

The argentiferous deposit is considered to be in part metamorphosed sandstone,and in part altered clay slate and limestone. The original strata having been repeatedly tilted and altered by ejections of siliceous and metalliferous matter from below accompanying the eruptions of andesite have produced the existing formation. G.W.B.

NOTES ON THE GEOLOGY OF THE DE KAAP TRANSVAAL GOLD-FIELDS.

By W.H.FURLONGS. The Engineering and Mining Journal (New York),1890, Vol.xlix.,pp.287-291. One figure and one plan.

This paper contains a geological description ot the district as a whole.

White or light red granite covers an extensive area,and is sometimes found decomposed to considerable depths. Taking the large granite area upon the south-eastern edge of which Barberton is built,as a centre,the auriferous deposits are found on three sides among the hills. The rocks of these hills are highly inclined,with a strike tangential to the edge of the granite basin,and dipping away from it at angles varying from 60 degs. to 90 degs.

The northern hills are composed of a narrow belt of schistose rocks ; on the west those rocks are true schists, talcose,hornblendic,and chloritic ; on the east they are argillaceous,and become true shales ; on the south are,as a whole,shales,usually argillaceous,and sometimes hornblendic and chloritic.

Beds of sandstone and conglomerate are found on the south side.

Dioritic dykes are found,frequently decomposed into an unctuous red clay at the surface.

A most remarkable feature is the absence of lime and the large preponderance of silica,generally as quartz,found in and among the shales and schists,and penetrating the crevices,cracks,and pores of the eruptive rocks.

Many of these quartz deposits are auriferous,of irregular and roughly lenticular shape,found laying at intervals along the axis of their strike.

The other deposits of auriferous quartz take the form of veins,which extend for considerable distances along the line of strike.

Both these deposits are found continuous for the limited depths attained up to the present time. The associated minerals are all sulphides,and consist usually of pyrite or pyrrhotite,rarely of chalcopyrite and arsenopyrite. Galenite has been found in a few places,and sphalerite never.

These sulphides often contain 5 ounces of gold per ton ; 30 to 50 ounces are not uncommon,and 760 ounces have been found in one sample.

Many argillaceous beds contain payable amounts of gold ; the beds of conglomerate are frequently impregnated with pyrite,and with gold up to one ounce per ton.
M.W.B.

THE GOLD-MINES OF OURO PRETO (BRAZIL).

Ouro Preto et les mines d'Or (Bresil).By Paul Ferrand.Le Genie Civil,

1890,Vol.xvi.,pp.285-288,303,304,325-327,338-340,355-357,374-376,

389-390,421-423,and 22 figures ; Vol.xvii.,pp.8-10,21-23.

Historical.—In 1572 the existence of gold was rumoured in Ouro Preto,and proof was found in 1693. Mines were opened in various parts of the district. The miners,chiefly slaves,increased to 80,000 about 1750,but decreased to 6,000 in 1820. Their objection to mining,the heavy imposts and taxes,gradually reduced the mining to its minimum.

At present only six companies are working : Saint John del Rey Mining Co. (Morro Velho and Cuiaba mines),

Santa Barbara Mining Co. (Pari mines),Pitangui Mining Co.,Dom Pedro North del Rey Mining Co. (Machine),

Ouro Preto Mining Co. (Passagem,Raposos,Espirito Santo,and Borges mines),and Society des Mines d'Or de Faria.

Geology.—The rocks are distinguished in order of superposition as under:—

I.—Gneiss,mica-schists.

II.—Micaceous schists,schistose quartzites,argillaceous schists,"itabirites."

III.—Compact quartzites,sandstones.

The itabirites are a mixture of schistose quartz and specular iron ore.

The gold ores are found in veins and alluvial deposits.

The veins are either quartz with auriferous pyrites,or auriferous quartz. The pyrites veins are only found in the lower rocks,following the lines of stratification forming bed veins. The quartz veins are found at various horizons in the rocks. In the argillaceous schists a series of parallel veins are usually found,and the schists are impregnated with gold for limited distances.

In the friable itabirites,jacotingas,which are traversed by quartz veins,there are impregnations of gold to such distances that they are frequently taken for distinct deposits from the veins with which they are intimately connected.

The alluvial deposits are found in the valleys,and were formerly extensively worked.

Mining.—The methods and tools used in the working of the alluvium deposits of the river beds,edges,and surface deposits,and friable and decomposed rocks,are fully described and illustrated. M.W.B.

GOLD-WASHING AND DREDGING IN NEW ZEALAND.

Engineering and Mining Journal,1890,Vol.I.,p.510.

Between the rocky bluffs,on the west and south coasts of the Middle Island,are low beaches consisting of the disintegrated bluff,the nearer the bluff the coarser the material,and on the west coast this is mixed with a quantity of drift wood.

The gold is found in layers of black titanic iron sand,inclining from the sea at an angle of 30 degs.,or varying according to the depth of the wave that caused withdrawal of the lighter sand.

Numbers of men (hutters) are employed on these beaches (beach-combing). A high wind causes the sea to make a high beach of sand and stone,and succeeding tides gradually wash down the lighter particles,leaving the gold or part of it mixed with the heavier sand.

The beach-comber uses a box about 4 feet long and 2 feet wide,with an amalgamated copper plate at one end,and a trough,4 feet by 2 feet by 2 feet,with handles

at one end and a barrow wheel at the other. He wheels his plant from patch to patch,and ascertains the payable ground with a long-handled shovel.

The trough is placed at right angles to the box,with the copper plate resting on the edge of the trough,and the box is inclined to the trough at an angle of 1 in 6. Another box,holding about 3 cubic feet of sand,is placed at the upper end, forming a hopper wherein the material is to be treated. The trough is half-filled with sea water,then the water is lifted from the trough to the hopper,and carries back part of the wash in its descent. When all the wash is out of the hopper the tailings are shovelled out of the trough,and the operation renewed. A large proportion of the gold is thus saved on a flat 2 feet square.

Dredging was introduced in the year 1887 by Mr.B.Smith. He used a Ball centrifugal pump,three-bladed,20 inches diameter,with suction end enlarged to double area. This was placed on a pontoon 10 feet by 30 feet,and 3.5 feet deep. The pump was driven by a compound engine with two cylinders,5 inches and 9 inches diameter and 14 inches stroke. A vertical boiler was used,5 feet by 2.5 feet,with twelve 3-inches tubes. The pontoon was fitted with a crane, fitted with a Wild grab,to lift large stones and drift wood.

Mr.Wellman uses a centrifugal pump,and does not enlarge the suction end,but places a loose sleeve outside the suction,with an opening equal to the area of the suction between the pipes. This machine is doing very good work.

The beachers usually have a lagoon or creek in close proximity to the beach,where the dredgers get water ; in other cases the water is led into ditches.

Bucket and ladder dredges have been tried,without financial success,on beaches.

In rivers,buckets and ladders have been more successful,being driven by side wheels,by the river current,thus saving fuel and attendance.

The deposits have a short existence although some have yielded prodigiously for a few months. M.W.B.

THE AMBER INDUSTRY IN EAST PRUSSIA.

Bernstein und Bernstein-Gewinnung. Dr.Richard Klebs. Zur Guten Stunde,

Vol.v.,No.19.

At the beginning of the Eocene period thick forests of a gigantic species of fir tree,the Pinites succinifer,covered the north-east provinces of Germany and the southern bed of the Baltic,then dry. Their rosin has been preserved in the form of amber in a stratum of so-called "blue earth,"consisting of the soil in which the forest grew,mixed with the detritus of the succeeding glacial period. At a some what later epoch similar trees grew here and there in the forests, which produced the brown coal-seams,and in these latter also amber occurs in small quantities. The peninsula of Samland,near Konigsberg,was a part of the Tertiary or Eocene formation which escaped the devastation of the glacial epoch,and is the home of amber. The erosive action of the waters of the Baltic has partly laid bare the blue earth,and the coast between Danzig and Memel has been for centuries the seat of the amber industry.

In times past amber was fished from the sea. Its specific gravity being small,lumps of it,entangled in floating seaweed,were washed on shore by the north and north-west storms,and the right of fishing for it with a kind of shrimping net from boats was let to the different villages on the coast.

About twenty years ago the Konigsberg firm of Messrs.Stantien & Becker,in whose hands almost the whole industry now lies,successfully employed divers to search the sea-bed further from the shore. The principal seats of these operations were the villages of Bruesterort and Palmnicken,the blue earth near the latter places forming a bank 16.5 feet thick,in about 8 fathoms of water,and at from half a mile to a mile from the shore. After a time the loose pieces of amber were nearly all gathered and the diving was discontinued,but the same firm continued to win amber from the sea-bed in the Kurische Haff,and at a place further north,near the village of Schwarzort,by dredging. The bottom of the Haff was dredged to a depth of about 33 feet,at first with good results,but here also the supply in time became exhausted.

In 1872,Messrs.Stantien & Becker began mining operations at Palmnicken,and were the first in successfully working the blue earth underground. Previously attempted sinkings had been frustrated by the large quantities of water met with in the overlying strata of sand and glacial debris.

At an earlier date the blue earth was reached by quarrying,and the 22 fathoms of overlying strata were,at great expense,dug out and thrown into the sea. One of these quarries was now turned to good account. A drift was cut in the blue earth to a point below the intended shaft,and the water met with in sinking was let off downwards,through it,and into the quarry,to be there pumped out. On the shaft being finished,and the water in the sand stratum dammed back, the drift became unnecessary and was closed. The mine was then worked in the ordinary manner,and it now has passages of a total length of some 150 miles. In the year 1890 it employed 1,550 workmen and 100 officials,with engines of 1,300 horse-power,using about 1,200 tons of coal. The annual output was 117,000 cubic yards of blue earth,yielding 200 tons of amber,worth about £90,000.

The blue earth is mined and sent to bank very much as coal is worked. The larger pieces of amber are picked out at the face and collected in bags,at bank the earth is teemed into a large tank and softened with jets of water,and the mass thus dissolved is run off in long perforated troughs. The sandy earth falls through the holes in the trough and the lighter amber remains on the surface and is picked out with spoon-shaped nets.

The amber collected from the troughs and at the face is put into revolving barrels and washed with water and sand until its coating of earth is removed. It is then sent to the sorting hall in Konigsberg,and,according to size,shape, quality,etc.,is divided for the market into nearly 100 different varieties,the shades of colouring being very varied,and variously appreciated in different countries. In general,the flat pieces are manufactured into articles for smoking,the round pieces into beads and other ornaments,and the smaller pieces are used for the preparation of varnish. In the year 1890 these three classes of manufactured articles represented values of about £108,000,£7,750,and £9,500 respectively.

A.R.L.

FIRELESS MINE LOCOMOTIVE.

Sur l'Application de la Locomotive a vapeur sans Foyer au Transport des Wagons

dans l'lnterieur des Mines de Charbon. By Camille Rolland. Revue

Universelle des mines,etc.,1889,Vol.viii.,pp.229-238,and Plate 10.

The locomotive consists of a receiver containing water heated to 400 degs.Fahr.,corresponding to a pressure of about 16 atmospheres ; the heating of the water being affected by steam from boilers upon the surface. The receiver has a capacity of about 20 cubic feet,which allows of a journey of 2 to 2.5 miles. The sides frames are ---! shaped iron plates,fitted with round buffer end plates.

There are two pairs of driving wheels,which are coupled together and to the crank shaft. There are two cylinders placed between the ---! frames,and vertically over the internal cranked shaft. The driver's cab is convenient.

It is 6 horse-power at a speed of 400 feet per minute,that of a horse being from 150 to 200 feet per minute.

It weighs about 6,500 lbs.,in working condition. All the mechanism can be readily examined and repaired,being placed externally. It is not more than 32.25 inches wide,for a 24-inches gauge,and the length about 10 feet. The exhaust is made at either end,at the will of the driver.

From 50 to 60 lbs.of steam are exhausted per mile,and aids in laying dust.

The heat given off is less than that of the equivalent (6) number of horses and drivers which it can replace.

In case of derailment,owing to its lightness,one man with proper tools can replace it.

The cylinders are 4.5 inches diameter,and 7 inches stroke. The wheels are 17.75 inches diameter,and the axles 39.5 inches apart. The maximum pressure of steam is 100 lbs.per square inch,and a maximum pressure of 1,660 lbs.upon each piston.

The first cost of a plant for a length of 1,970 feet at a depth of 1,970 feet is:—

Two locomotives,one in reserve	£350 0 0
Boiler with 350 square feet of heating surface and fittings ...	83 0 0
Pipes,2 inches diameter,for 1,970 feet	75 0 0
Covering of pipes	75 0 0
Water-pipe	42 0 0
Contingencies	25 0 0

	£650 0 0

The cost of transport for 1,970 feet will be:—

Two enginemen at 2s. 11d. for 300 days	£87 10 0
Coal	21 0 0
Oil,etc...	6 10 0
Maintenance and repairs	25 0 0
Interest and redemption of capital,10 per cent.	65 0 0
	£205 0 0

The same work by horses would cost:—

Feeding six horses,repairs to harness,redemption,365 days at 2s. 6d.	£273 15 0
Five drivers,300 days at 1s. 8d.	125 0 0
Two horse-keepers,365 days at 1s. 8d.	60 16 8
	£459 11 8

The saving being about £40 per animal replaced.

For a distance of 3,280 feet,requiring 10 horses,the cost would be:—

Ten horses,365 days at 2s. 6d.	£456 5 0
Eight drivers,300 days at 1s. 8d.	200 0 0
Two horse-keepers,365 days at 2s. 1d.	76 0 10
	£732 5 10

The two locomotives being still sufficient for the work,and allowing that the cost may be £220,there is a saving of at least £50 per horse replaced.

M.W.B.

TRANSMISSION OF POWER THROUGH A BOREHOLE.

By Wm.Hall. The Colliery Engineer (U.S.),1889,Vol.ix.,p.173.

The north slope in the Spring Hill Colliery (Nova Scotia) will ultimately be driven for a distance of 2,050 feet,dipping about 18 inches per yard ; at present it has been driven about 800 feet.

A borehole 4 inches in diameter has been put down from the surface to a depth of about 600 feet,cutting the line of the north slope,at about 1,300 feet from the top. An engine and boiler are placed near the hole,and a rope is taken down the borehole,which will be used to haul the coals from the dip in extending the north slope,in advance,for a further distance of 750 feet. The coals from these workings is conveyed temporarily to the surface,through a level drift to the west slope (at the aforenamed depth of 600 feet),through which it is hoisted to the surface.

M.W.B.

IRON IN MEXICO.

By Richard E.Chism. The Engineering and Mining Journal (New York),

Vol.xlvi.,1888,pp.391-392.

The total production of iron in Mexico may be estimated as under:—

	Tons.
Durango	7,200
Hidalgo	5,000
Jalisco	600
Oaxaca	450
Guerrero	200

Other provinces	100

	13,550

About 4,500 tons are sold as castings and the remainder is wrought into bars for smiths'use.

The most important deposit of ore is the "Iron Mountain,"near the city of Durango. It is an immense hill,1 mile long, .334 mile wide,and rising at the highest points to 450 or 650 feet above the surrounding plain. The ore in situ is estimated at 250,000,000 tons,and is all oxides,yielding about 50 per cent,of iron in the blast furnace,and is reasonably free from phosphorus and sulphur,

The next deposit of ore in importance is that of Zimapan,in the state of Hidalgo. These ores are chiefly magnetic oxides,with 30 to 80 per cent. of iron,and very low in sulphur and phosphorus. There are six blast furnaces,four of which are in operation. The ore is worked open-cast at a cost of about 2s. per ton.

In the state of Jalisco,the chief ores found are haematites,with an average of 65 per cent. of iron. There are two blast furnaces. The fuel used is charcoal,costing about 20s. per ton ; mining costs from 2s. to 3s. per ton.

In the state of Oaxaca extensive deposits of haematite and magnetite are worked in several places.

Other deposits of ore are found,of haematite near Salome Botello Station,on the National Railroad,about 80 miles south of Laredo,in Texas ; near Monclova,on the International Railroad,about 50 miles west of the last-mentioned deposit ; in the cantons of Matamoros,Galeana,and Jimenez,in Chihuahua ; in the district of Leon,in the state of Guanajuato ; and near the city of Culiacan,in the state of Sinaloa. M.W.B.

RULES FOR VALUATION OF IRON ORES.

By S.B.Patterson. Engineering and Mining Journal (New York),1889,Vol. xlviii.,p.201.

Rules for determining the relative values of iron ores containing the ordinary constituents:—

1.—Metallic Iron.—

(a) Base,less than 40 per cent,per unit iron.

40 per cent,to 44 per cent.,inclusive,add .25 cent per unit.						
45	„	49	„	,,	.5	,,
50	„	54	„	„	.75	,,
55	,,	59	,,	,,	1.00	,,
60	„	64	„	„	1.25 cents per unit.	
65	„	and upwards,add 1.5 cents per unit.				

No fractions of 1 per cent. to be counted.

(b) Taking unroasted magnetites as 100 ; calculate red haematites as 110 ; and brown haematites as 115.

2.—Phosphorus.—Deduct for passing Bessemer limit 25 cents per ton,and 1 cent per ton additional for every one-hundredth of 1 per cent.

3.—Sulphur.—Deduct 1 cent for every 2 one-hundredths of 1 per cent.

4.—Silica.—Offset by bases in following ratio:—

Lime.—1 per cent. offsets 1 per cent. silica.

Magnesia.—1 per cent. offsets 1.5 per cent. silica.

For excess of silica above bases,as above calculated,deduct 5 cents for every 1 per cent.

5.—Alumina.—In doubt as to its position.

6.—Fine Ore.—Proportion of fine ore to coarse ore has,in some cases,a bearing on the relative values.

M.W.B.

LATERAL EFFECTS OF FALLS IN MINES.

La Propogation laterale des Mouvements d'Effondrement dans les Mines. By —

Villot. Annales des Mines,1889,Series 8,Vol.xvi.,pp. 421-426,and

Figure 3,Plate X.

In this case,heavy falls,produced by the robbing and removal of pillars 33 feet square,in a 7-foot seam of coal,lying at a depth of 1,060 feet,were felt,and damage caused to houses,etc.,in villages situated at distances of 2,600 yards,3,500 yards,4,000 yards,and 7,900 yards,situated on coal-measures. No effects were produced

at distances of 3,000 yards and 3,700 where the villages were situated on older rocks forming the margins of the coal-field or basin.
M.W.B.
