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NORTH OF ENGLAND INSTITUTE OF MINING ENGINEERS.

GENERAL MEETING, SATURDAY, SEPT. 3rd, 1864, IN THE ROOMS OF THE INSTITUTE, WESTGATE STREET, NEWCASTLE-UPON-TYNE.

T. E. FORSTER, Esq., Vice-President, in the Chair.

Mr. Howse having read the minutes of the Council, the following new members were elected, viz.:—Mr. Breckon, of Darlington; Mr. Thomas Lewis, of Mardy, near Aberdare; and Mr. L. Gott, of Brancepeth Colliery. Mr. Thomas Crawford, jun., of Lumley Park, was elected a graduate.

Mr. Boyd said, with respect to the proposed alteration of the rule relating to members who were in arrear with their subscriptions, he had sent six or seven notices to some of those members, and he was sorry to say without effect.

Mr. Daglish recommended that the next meeting be made special to consider the advisability of altering the rule relating to the number of the Council, as he wished to move a resolution, "That in future all Vice-Presidents on ceasing to fill that office shall become members of the Council."

A discussion then took place on the desirability of holding a general meeting in some eligible locality in the south-west of the country.

THE WASH OR DRIFT OF THE DURHAM COAL-FIELD.

The discussion of this subject was introduced by some additional remarks on the subject, which were forwarded by the President, and which were read to the meeting.

MR. WOOD'S OBSERVATIONS ON THE WASH THROUGH THE TEAM VALLEY.

The effect of the Wash through the county of Durham, as shown in the Paper by Messrs. Wood and Boyd, is a scooping out or denudation of the upper beds of the coal strata, especially of the Hutton-seam of coal, from a little west of the city of Durham to the river Tyne, near Redheugh, This is shown more particularly in Section No. 2, the Plan of the Wash being shown in No.1.

Taking the datum line of high water mark at Newcastle bridge at the present time, the section shows a denudation of the strata throughout the whole extent of the Team Valley, from Redheugh to beyond the city of Durham, at an almost uniform rate of inclination of 1 in 528, and to a depth below the present surface of the Team rivulet, of 150 feet below high water mark at Redheugh, and throughout the whole course of the rivers Team and Wear, varying only below the surface of those rivers of from 150 to 120 feet.

It will be seen, therefore, that the waters of the denudation or Wash, could not have had their exit by the rivers Tyne or Wear at the existing level of these rivers, inasmuch as the lowest level of the bottom of the Wash is 150 feet below the high water line, or136 feet below the present low water level line of these rivers.

It is true, we may imagine an obstruction or dam in the gorge at Newcastle-upon-Tyne, and that the waters were pent up or raised to a height of 150 feet, forming a lake up the Dunston-haughs of that depth of water; the bottom level of such lake forming the bottom level of the Wash, and the surface of such lake would in such a case be represented by the present water-level line on the map of high water at Newcastle bridge.

But this would hardly be consistent with the circumstances exhibited by the facts, which seem to have taken place throughout the whole course of the Wash, from Durham to the Tyne, and which exhibit, throughout the whole course of the Wash, the action of water in violent motion, or of glacial action in a state of active operation; and scarcely are they consistent with the facts appertaining to that of the quiet action of water at the bottom of a lake 150 in depth.

We would, therefore, be rather led to infer that there has been a lowering of the level of the valley of the Team, or of the level of the base of the Wash; or a raising of the level of high water to a corresponding extent.

A change of level appears also to have taken place, connected with these operations, at other points of their course, the present level of the drainage of the river Wear is, as will be seen by the section,120 feet above the base of the denudation or Wash; the waters from the river Wear at that period, and under such circumstances, would find their way to the river Tyne, either into the supposed lake, or into an outlet 150 fifty feet below the present level of high water; but there being a solid rock obstruction at Chester bridge of upwards of 90 feet, the water from the Wear could not have found its way to Sunderland, unless the surface of such water was raised to more than90 feet above the bottom of the denudation or Wash, and therefore if we suppose the water from the Wear to have, at that time, found its way to Sunderland, that could only have taken place if the waters were raised above the level of such obstruction; which would rather favour the supposition of a lake in the Tyne extending up the Wear valley, beyond Chester bridge, and at or above the level of the obstruction at that place.

But then we see also that the course of the Wash has been departed from at Durham and other places, and that a new course has been, created by the present drainage of the Wear (see Section No. 6, also the windings of the river around the city of Durham, and the excavations of the new course through the solid rock in many parts of the new course) at a higher level than the ancient bed or Wash. All this must be taken into consideration in determining the question of a relative depression of strata, or rise of sea level. We have likewise the fact of the boulder clay deposit at Percy Main Engine Pit, being 183 feet below high water mark, miles below any supposed obstruction in the gorge at Newcastle.

Assuming the effect of the Wash to have been that of glacial action, we would be rather inclined to have attributed that effect to have arisen along a comparatively dry valley, and not covered by a lake, inasmuch as we find boulder clay deposits extending over numerous other parts of the county of Durham, as instanced by Mr. Howse, and we would be rather inclined to adopt the conclusion that all the deposits of boulder clay and their accompanying characteristics had been the effect of one common great cause, which could scarcely be a complete covering of the whole county by a lake, or by a quiet deposit of water.

As the Institute, as a body, possesses the means by collecting the sinkings through the clay of all the collieries in the two counties, I beg again to suggest that a committee be appointed, or that the Council

undertake the task of collecting a set of the sinkings through the clay of all the collieries; by which correct records could be obtained of the actual deposits of boulder and other clays, sand, etc., of the different collieries. And as the Ordnance Survey gives the levels, a very complete record could thus be made of the boulder clay deposits at the different localities.

Mr. ATKINSON wished to ask if any existing glaciers were known to have traversed any place having no greater descent than 1 in 500?

Mr. HOWSE said he could not tell.

Mr. ATKINSON—As to the raising of the level of the sea, as suggested in Mr. Wood's paper, he thought that if a hundred square miles of surface were suddenly raised in the German Ocean, the sea level would scarcely be affected by it. He thought it was not likely that any great change had taken place in the level of the sea.

Mr. BOYD was inclined to agree with Mr. Atkinson. The more probable suggestion was that a depression of surface had taken place after the denudation had been effected and filled up; or it might not be after the filling-up, but before the filling-up. The depression would make way for the next floods to fill-up with clay. This 150 feet of depression, he thought, could not be accounted for in any other way.

Mr. ATKINSON said, he thought it was a matter that was altogether left to the imagination of individuals. It was difficult to conceive such a hot climate as our fossils indicated, and afterwards a temperature below 32 ®, when at present we had a temperate climate. There were not only great discrepancies of temperature, but they were not accountable for by supposing a gradual change of temperature—at first hot, then intensely cold, and now temperate.

Mr. HOWSE said, that the same objection might be urged just as forcibly to Melville Island at the present day as to this country. There they had Coal-measures containing the same supposed tropical plants as were found in the Coal-measures here: in fact, Coal-measures were known to occur both within the arctic and the antarctic circles.

Mr. ATKINSON said, in the polar regions there was not a temperate climate. Had the transition been from hot to temperate and then to cold he could have imagined it probable to some extent.

Mr. HOWSE said, there was an immensely greater difference of time between the Coal-measures and the boulder day period than there was between the boulder clay period and the present.

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Mr. GREEN said, we may be getting a temperate climate a second time over.

Mr. HOWSE said, with regard to glaciers passing down a small slope, that he did not know if any one had measured their under-surface. The great Humboldt glacier discharges its ice by pushing it forward into a deep sea-channel. It is being gradually launched into deeper water, where it floats, and it must be pushed along a very slight incline. Mr. Atkinson would admit that if there was pressure enough, ice might be forced up a steep hill. We have now an elevation of nearly 3,000 feet above the sea level; and if you suppose an enormous accumulation of ice and snow over the whole country, what an immense pressure there would be downwards towards the sea-coast.

Mr. ATKINSON said, he thought it would be necessary for glacial action in our present temperature that we should have mountains 15,000 feet high.

Mr. HOWSE said, there was every proof of our climate not having been always the same.

Mr. ATKINSON said, Snowdon was not high enough to establish glacial action.

Mr. HOWSE-—If you had a more arctic climate in these latitudes it would soon establish glacial conditions.

Mr. ATKINSON was of opinion that the Gulf-stream was too slight a cause to account for such a change of climate as the theory involved.

Mr. HOWSE—If the Gulf-stream were diverted through the central parts of America, or to any other part of the Atlantic, we should soon feel the effects. The whole of the North Atlantic would soon be blocked up with solid ice, deported or brought down out of the Spitzbergen Seas. It was not a thing we might live to see, but we had strong proofs of our proximity to northern waters. Our marine fauna was chiefly of a boreal character, and this fauna formerly extended much further south. A prevalence of arctic currents acting continually would bring about a condition of things very much like what we see in Greenland at the present day. We have very good proof of the existence of arctic currents on our own coast in the east winds of the spring months.

Mr. ATKINSON said, when passing up a valley he had noticed great land-slips, sometimes to the extent of 50 to 100 yards. There might be a scrubbing action of this kind producing its effects. He was taking clay instead of ice. Suppose a large stone was imbedded in the clay, and it slipped along during the course of fifty yards.

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Mr. HOWSE—The ice holds the stone fast and carries it forward, passes it over a gravelly or rough surface, and the enormous pressure of ice above grinds it down till it assumes this polished appearance.

Mr. ATKINSON said, he only doubted the fact in this case. He thought land-slips might account for it.

Mr. HOWSE produced four specimens of stones which he said must have travelled from a distance of more than fifty miles; for there was no rock nearer *in situ* to which they belonged.

The CHAIRMAN remarked, that they might have been brought down by hand.

Mr. GREEN mentioned that a piece of coal, weighing about four hundredweights, was found one hundred and eighty feet deep in chalk, in cutting a tunnel in Kent.

The CHAIRMAN mentioned a very large stone which was to be seen in a cutting beside Prospect Hill, which he thought was worth going to see. He thought the suggestion of the President of getting an account of the sinkings was a good one.

The meeting then separated.

NORTH OF ENGLAND INSTITUTE OF MINING ENGINEERS.

GENERAL MEETING, THURSDAY, OCT. 6th, 1864, IN THE ROOMS OF THE INSTITUTE, WESTGATE STREET, NEWCASTLE-UPON-TYNE.

NICHOLAS WOOD, Esq., President of the Institute, in the Chair.

The following new members were elected, viz.:—Mr. Charles Maynard, of Blackfield and Inkermann Collieries, Tow Law, Darlington: and Mr. Frederick North, of Tipton, Staffordshire. Mr. John George Harrison, Chilton Offices, Ferryhill, was elected a graduate.

The meeting was then made special, in order to consider the propriety of altering the rule relating to the election of the Council, as proposed, by Mr. Daglish, namely, "That all Vice-Presidents on ceasing to fill that office shall become *ex-officio* members of the Council."

Mr. SOPWITH, in the absence of Mr. Daglish, said he would make that proposition.

Mr. LINDSAY WOOD seconded the motion.

Mr. MARLEY moved as an amendment, "That the Vice-Presidents who have and may become ineligible from having held office three years, shall be *ex-officio* members of the Council for the following year." His reason for wishing to limit the motion in this way was this: he believed, the object of Mr. Daglish was to meet the case of Mr. Potter, who had. retired from office in accordance with the rule which provides that Vice-Presidents shall not fill that office more than three years consecutively. As the rule stood they might lose the services of a good and active friend of the society; now he thought it, would meet the object and be much better to make the change applicable only to such as retired by virtue of the rule, and not to those who retired by the votes of the members. Thus,

instead of making them members of the Council for life, it gave members of the Institute an opportunity to reconsider their votes, because such parties would be eligible for any office next year.

Mr. DICKINSON seconded the amendment.

Mr. SOPWITH said, that he merely proposed Mr. Daglish's resolution in the absence of that gentleman, in order to raise the discussion, as he had not made up his mind to any plan. He thought if Mr. Daglish had been present he would have considered—at least he (Mr. Sopwith) did— that the modified plan of Mr. Marley might be a better mode of proceeding at present. If they adopted at once so large a measure as that involved in Mr. Daglish's motion, the Council would in time become a very numerous body, and be somewhat inconvenient in its working on that account. It might be distasteful afterwards to make a resolution turning people out. He would, therefore, give way to the proposition of Mr. Marley.

The amendment was then put and carried by show of hands

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PROPOSED RECORD OF SINKINGS AND BORINGS.

The PRESIDENT said, that at a previous meeting he took the liberty of suggesting the desirability of obtaining records of sinkings and borings down to the stone head, through the gravel and sand of the different collieries. He believed this proposal had the favourable approbation of most gentlemen connected with the Coal Trade, who, he had no doubt, were quite willing to furnish those details to the Institute. He begged leave to move that the Council be instructed to facilitate this object by obtaining the requisite documents from the different collieries. It would be a desirable thing connected with the paper on the Wash.

Mr. ATKINSON seconded the motion.

Mr. MARLEY wished to know if it was to apply to those collieries only which had a bearing, directly or indirectly, on the Wash ?

The President - No; the collieries generally throughout Durham and Northumberland.

The motion was carried by show of hands.

PROPOSAL FOR HOLDING LOCAL MEETING

Mr. MARLEY inquired whether any steps had been taken with regard to a visit to some part of part of England or Scotland next year. If anything of the kind was contemplated, the sooner it was put into some persons hands the better.

The PRESIDENT said, that a great many important things were to be considered in such a proposition—one was a question of finance. He would, therefore, move that the Council be directed to consider the question of holding a local meeting, and report to the next meeting of the Institute.—Agreed to.

DISCUSSION OF PAPERS.

The first paper which stood for discussion was that of Mr. I. Lowthian Bell, "On the Iron Manufacture connected with the Northumberland and Durham Coal-field." Mr. Bell not being present the discussion was postponed; and Mr. Marley suggested that before it was put down for discussion again it would be desirable to see if Mr. Bell would be able to attend the meeting.

The next was Mr. Sopwith's Paper, "On the Lead Mining Districts of the North of England."

Mr. SOPWITH said, on being applied to furnish a paper respecting the Lead Mining Districts of the North of England, he was aware that a great many communications were to be made relating to different parts of the district; and, therefore, he had endeavoured to make his description as brief as he could by condensing some of the principal points connected with the History of the Lead Mining Districts, and the chief improvements that had from time to time been brought about. The first point to which he would now draw the attention of the meeting was one relating to the geology of the district generally, and that was the limit to be assigned to Mountain-limestone, Millstone-grit, and the Coal-measures. With respect to Mountain-limestone, there was no doubt whatever that the Fell-top-limestone, though a thin bed, was true Mountain-limestone, both as regards its fossils and chemical composition. That bed was found capping the tops of the hills, and had generally been considered by those who coloured general geological maps as the boundary of the Mountain-limestone formation.

The PRESIDENT—Following the Millstone-grit ?

Mr. SOPWITH—Yes; but his opinion rather was that the beds which lie for a considerable distance below the Fell-top-limestone were altogether of a character much more assimilated to Millstone-grit and the Coal-measures than they were to the Lead-measures. For every purpose of practical utility he would say the bed of Limestone called the Little-limestone ought to be the boundary. From that bed downwards there were only a few fathoms to the Great-limestone, which had a thickness

of sixty feet—10 or 11 fathoms generally. The importance of this bed of Limestone was so great that more than three-fourths of the lead ore that had been wrought in some of the chief lead-mining districts in the North of England, had been got in those veins which traversed the Great-limestone. Below this we have several important beds of Limestone, and, both as regards the character of the country, the effect on vegetation, and the productiveness of mineral veins, he would say that the proper limit on a geological map should correspond with the Great-limestone and its accompanying bed of Little-limestone—rather than taking in a vast range of silicious and argillaceous beds which they must take in if they gave pre-eminence to the Fell-top-limestone as the boundary of the Mountain-limestone formation. [Mr. Sopwith here pointed out on a diagram the particular strata, and remarked that the strata between the Fell-top-limestone and the Millstone-grit coloured on geological maps as Mountain-limestone he would have coloured as Millstone-grit.] No doubt the Fell-top was really a piece of Mountain-limestone; but he would not consider the insertion of a small bed of Limestone as a reason for extending the Lead-measures to that point any more than the little beds of Coal which were to be seen mixed with true Mountain-limestone should be taken as the boundary of the Coal-measures. In the south-west of England and in Derbyshire the Mountain-limestone is found in large masses, but it gets separated into ribbons or bands of thin strata as it passes further to the north. This was a practical point of some importance, because wherever there was Great-limestone available the ground was valuable for lead-mining; but the insertion of the Fell-top-limestone as the limit gave an idea of strata having valuable Mountain limestone when it was not so.

Mr. MARLEY—That would apply more to a section than a ground plan.

Mr. SOPWITH—It applies only when the Fell-top-limestone is rising with the country more steeply than the surface.

Mr. ATKINSON—The Fell-top-limestone being taken as the top of the Mountain-limestone, all underneath it is coloured as being part and parcel of that formation.

Mr. MARLEY-—As the Fell-Top lies so many fathoms above the Little-limestone, more area would be occupied by the Little-limestone than the Fell-top.

The PRESIDENT said, he could hardly see why the Limestone and Mill-stone-grit below the Coal should be designated as a separate classification of

rocks. Really the Coal, the Millstone-grit, and the Mountain-limestone, were all conformable to each other, and belong to one class of stratified rocks, though probably formed at different periods. You have a mass of Coal strata, and this is followed by the Millstone-grit coming in below it. The Millstone-grit is nothing more than two thick beds of Sandstone more gritty than usual. They are devoid of minerals entirely, and they are of no value except as furnishing a particular kind of stone. He thought the classification proposed by Mr. Sopwith of separating the measures, not geologically but mechanically, and of making the Lead-mining strata commence at the Little-limestone, would be a better division than extending it to the Fell-top-limestone.

Mr. SOPWITH said, the only other point which might have been treated of more largely in this paper—but he had not wished to extend it too much—was what they were doing in the Blackett Level. This would, eventually, be of great length, and they were going on at several points with it. The first water-pressure engine used in the West Allendale Mines, at Coalcleugh, was Westgarth's, more than 100 years ago. At East Allendale they had got several adaptations of engines and machinery by Sir Wm. Armstrong, which formed a novel feature in lead-mining. Since these observations were written, some experiments had been made in boring Limestone by machinery. This subject was attracting attention. The machine had been made at the works of Sir Wm. Armstrong and Co.; Mr. Westmacott's attention having been given to it more especially, both in the adoption of certain principles and the arrangement of details. It might be interesting if he were to mention what was going on in the Blackett Level by the boring machine. Hand labour being very slow in this hard rock, Mr. Beaumont had been desirous of expediting its progress by machinery, and they were now apparently likely to achieve success. The principle which Mr. Westmacott had adopted in this machine was based on a close imitation of hand labour, that is—the jumper, instead of being propelled violently against the rock, was made to press steadily against it at the time the impact was given. The impact was given by a spring on the hammer, and a violent blow was given at the time the jumper was in contact with the rock. As soon as this was done, by an ingenious contrivance in the withdrawal of a small quantity of water, the apparatus is withdrawn one-eighth of an inch, quite sufficient to allow the *debris* to fall down, and also to allow the free motion of the jumper, which is made in due succession to turn round one-fourteenth; so that with fourteen blows there is one revolution

of the jumper. From 150 to 200 blows are given in a minute; 300 could be given if necessary. At this rate the jumper has at times gone steadily in two inches per minute, through the hardest Limestone, and as much as two-and-a-half inches have been accomplished. The holes bore best when they are horizontal. When slightly inclined downwards, the workmen were troubled with *debris*, but that was got out by a strong jet of water. The inclination of the machine at present admits of angles of considerable extent, not quite so great as they sometimes adopt when they used hand labour.

Mr. ATKINSON wished to ask if the engine was on wheels, and had they flexible tubes ?

Mr. SOPWITH said, they had short flexible tubes to carry the water front fixed pipes. A column of water acted from pressure above. A clamp is fixed up against the roof, and they could ship or unship it by liberating a portion of water under high pressure.

Mr. MARLEY asked what was the diameter of the hole ?

Mr. SOPWITH—One-and-a-quarter inch. He would add, that if any members of the Institute felt an interest in seeing the machine at work, when it was fairly perfected, it would give him much pleasure to show it. He had Mr. Beaumont's full permission to do so, for it was generally found that they learnt more than they could teach by having visits from scientific strangers. He should say that the visit should be deferred until after the present month, because they were now only beginning to get the machine into shape. The Gun Cotton Committee were coming down to try several experiments. A Government Commission had been appointed, of which he was a member, and they were to meet at Allenheads and make some experiments with the gun cotton in the following week. The holes made by hand labour were generally triangular.

Mr. MARLEY—Is it the Great-limestone where these borings are made?

Mr. SOPWITH—It is.

Mr. MARLEY wished to ask if it was a short drill and hammer ?

Mr. SOPWITH—A jumper about 40 inches long, and hammer driven by a spring.

Mr. MARLEY—In the Cleveland mines they never use a hammer. It is entirely by long jumper and by hand.

Mr. WILLIS—The triangular hole is generally better than the round one for the irregular masses in the main bed of the Cleveland mines.

Mr. MARLEY—-The difficulty is when you do not get a round hole you cannot use your powder in paper. We have been trying gun cotton, but

in consequence of not getting a round hole, we have to undo the gun cotton.

The PRESIDENT (to Mr. Sopwith)—Are you using gun cotton ?

Mr. SOPWITH—Yes, we have used it to some extent. I do not know that I have anything to add. I may mention among other experiments one, which is that of enlarging the end of the hole, making it in the shape of a trumpet. Mr. S. here explained that the cutting surface of the jumper formed the letter H. He also described an ingenious instrument, contrived by Mr. Westmacott, which was very useful in measuring enlarged holes. Two springs were made to move back and forward, so as to tell the diameter they had arrived at.

Mr. MARLEY—To what extent do you carry this chamber longitudinally?

Mr. SOPWITH—It varies from four to eight inches.

Mr. WILLIS—Is the H drill for manual labour or the machine?

Mr. SOPWITH—For the machine.

Mr. ATKINS—-Have you ever tried dry sand in lieu of stemming ?

Mr. SOPWITH—Not since I have been at Allenheads. It was tried more than twenty years ago, and was not preferred by the workmen.

Mr. ATKINSON said, he had a strong idea that loose dry sand (if the hole was a dip hole) would be as good as any stemming. Where gun cotton was used, it would prevent ignition. You do not require to stem or beat at all with dry sand.

The PRESIDENT said, the members of the Institute were very much obliged to Mr. Sopwith for his observations, and also to Mr. Beaumont for granting them leave to see the operations that were going on. He was sure they would be very interesting. They might so arrange the visit that they might all go at one time.

Mr. MARLEY said, that would probably be most convenient to Mr. Sopwith. He should be happy to make one of the number ; and if it was not considered too great a liberty, he would suggest that the discussion on this paper should not be considered as closed, so that if any point arose, Mr. Sopwith would allow it to be named.

The PRESIDENT said, there was one point about the cropping out of the coal westward.

Mr. MARLEY said, there were several instances to which Mr. Atkinson had called his attention.

Mr. SOPWITH said, they had the Fell-top-limestone near the surface or cropping out, and yet for several miles beyond there was no Limestone

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available for mining in the thick beds. He believed that as geology went on in different parts of the world, they would find that these clear and definite lines between different formations which satisfied the early geologists, would require modifications in almost every place.

Mr. MARLEY—In reference to its being productive or unproductive, more than in its chemical formation.

Mr. SOPWITH—Better in every way.

Mr. MARLEY inquired what was the usual thickness of the Fell-top-Limestone ?

Mr, SOPWITH— About four or five feet.

Mr. ATKINSON said, whenever there was a want of conformability between two series of strata, there could not be a doubt as to the line of demarcation. In that case the line would not require any alteration.

The discussion was then adjourned.

The next paper for discussion was on the Magnesian-Limestone of Durham, by Mr. Daglish and Mr. G. B. Forster, but neither of these gentlemen being present, its discussion was adjourned.

The meeting was brought to a close by the reading of an interesting paper by Mr. Edward Hedley, of Derby, on "The Iron Mines and Iron Manufactures of Nova Scotia."

(Geological map of the province of Novia Scotia including the island of Cape Breton)

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THE IRON MINES AND IRON MANUFACTURE OF NOVA SCOTIA.

By EDWARD HEDLEY.

The province of Nova Scotia has, within the last few years, owed its importance and value to its convenient and commanding position as a naval and military station for the British forces on the western side of the Atlantic. Few inducements presented themselves in the province to tempt the emigrant to its shores, beyond commercial enterprise and agricultural pursuits, and these were necessarily limited by a scanty population and little exportation. The ports and towns along the shore formed centres of attraction, which slowly grew into importance, the fertile plains of the interior were cultivated by the agriculturalists, who, confining their labours to the open lands in the valleys along the banks of the rivers, left untouched and unexplored vast tracts of forest land. As the requirements of the community increased a system of roads was formed, and internal navigation to a limited extent established; and finally a railway, forming part of the Intercolonial Railway, was made, crossing the country from Halifax to Truro.

The minerals of Nova Scotia were originally reserved by the British Crown, placing them almost beyond the reach of private speculation. All the coal mines of Nova Scotia and-Cape Breton Island were leased to the General Mining Association, who have opened the principal coalfields, and are now working the coal extensively for exportation and steam shipping.

Within the last ten years the Imperial Government has evinced a more liberal spirit with, regard to. the mineral wealth of the province, and has empowered the Provincial Government to grant leases of unopened metalliferous mines to private speculators, and the power of control of all the coal-mines on the expiration of the lease to the General Mining Association.

Since then a spirit of mining enterprise has sprung up, a large amount of capital has been invested, and the mineral resources of the country more fully developed.

Considerable impetus has been given to commercial, manufacturing, and agricultural industries by the increasing demands of an augmenting population, and the connections established with the neighbouring provinces, the States, and the mother country.

Thus Nova Scotia has risen in importance and wealth, and having a population of superior intellectual and industrious people, she now holds an influential position with regard to the rest of our North American possessions.

Before entering upon the immediate subject of this paper it may not be irrelevant or uninteresting to notice, briefly, the general geological features and the other useful minerals of this colony.

The map, Plate I., shows the general geological character of the country as well as the various mines and quarries now opened and in operation. Commencing with the oldest formation, it will he seen that the southeast coast is bounded by a broad band of clay-slate, quartzite, gneiss and metamorphosed Lower-Silurian, with large masses of intrusive granite. It is in this part of the colony that the recent discovery of gold has been made, and in which several mines have been opened with varied success.

The gold is contained in a fine quartz, and is frequently visible in large quantities, yielding as much as 14 oz. of gold per ton of quartz; a recent trial of seventy-seven samples of quartz yielded nearly 3 oz. of gold per ton, which may be considered an average yield. At the Laidlaw gold mine, situated twelve miles north of Halifax, occurs some of the richest specimens of gold-bearing quartz, of any yet discovered in the province; the quartz is singularly deposited in cylindrical, parallel layers, resembling several pipes of large diameter laid side by side, continuing unbroken for several hundred yards. The quartz is cellular, the cells being filled with oxide of iron, and which frequently contains particles of gold visible. The only gold-washing ground is at Lunenburgh, where the sand from the sea-shore is washed, yielding large quantities of gold.

Although the gold mining of Nova Scotia has not yet proved a commercial success, much more important results may hereafter be obtained by an extensive system of explorations and working..

The Devonian formation occupies less extent of country than the metamorphic and Lower-Silurian, it is also associated with dykes or veins of granite, syenite and other igneous rocks. The Devonian formation consists of shaly, sandy and calcareous deposits, more or less hardened by

the action of heat, while other portions are very highly metamorphosed and of a slaty structure. As the extensive deposits of iron ore are in this formation, I will hereafter revert to a more particular description of it

The Carboniferous formation, consisting of the upper and lower Coal-measures, the Millstone-grit, and the Mountain-limestone, is of the enormous thickness of nearly two-and-a-half miles. It contains many valuable seams of coal and ironstone, and abounds in building stones, grindstones, gypsum, and limestone.

The following section shows the general sub-division of the Carboniferous formation in Nova Scotia :—

UPPER COAL-MEASURES.

Gray- and red-sandstones and shales, with beds of conglomerate, and a few thin beds of limestone and coal, the latter not workable 500 fathoms

LOWER COAL-MEASURES.

Gray- and dark-coloured sandstones and shales, with a few red and brown beds; valuable seams of coal and argillaceous ironstone; beds of bituminous limestone, and numerous fire clays 670 fathoms

MILLSTONE GRIT

Reddish and gray sandstones and shales	500 fathoms

MOUNTAIN LIMESTONE

Sandstones and conglomerates, with thick beds of limestones and gypsum, and thin beds of coal	500 fathoms
Total fathoms	2170

The coal-fields of Joggings, Springhill, and Pictou, in Nova Scotia, and those of Sydney in the island of Cape Breton, have for several years yielded large quantities of coal: limestone and gypsum have been extensively quarried from the Mountain-limestone for home consumption and exportation. In Nova Scotia, 115,000 chaldrons of coals are raised, and 80,000 tons of gypsum quarried, annually.

The New-red-sandstone of Prince Edward's Island and Nova Scotia represents the Trias formation; above this, there is a wide breach in the geological sequence, the Lias, Oolite, Wealden, Cretaceous formations, and the whole of the Tertiary, being absent.

Frequent discoveries of copper and copper-ore have been made in the Trap associated with the New-red-sandstone, and although attempts have been made to work it, it does not appear to have been remunerative.

IRON-ORES AND MINES.

The remarkable deposits of iron-ore, to which I will now call your attention, occur in the Devonian metamorphosed rocks. I will confine

my observations to those veins which came under my own inspection. These are situated at Londonderry on the Cobequid mountains, at Nictaux in Annapolis county, and near to Clementsport on the Annapolis basin: at the two latter places several veins have been worked, and at each of the places iron works established.

In the first place, I may observe that the term "vein" is here used to denominate deposits of ore which originally have been beds or seams; but the upheaval of the containing rocks has caused these seams to be nearly vertical, and the action of heat—particularly at Londonderry— has changed the character of the ore and the position of the seam to such an extent that it resembles more the true "vein" than a metamorphosed bed or seam.

The Londonderry Iron Mines and Works, are situated about nine miles north of the Cobequid Bay, on the Great Village River. The vein of ore has been traced for several miles across the country, its course is north 75 degrees west (magnetic), and it is contained in rocks of a hard grey quartzite and slates. The vein hades conformably to the stratification of the adjacent rocks, which is almost perpendicular, but with a slight underlie to the south. (See Plate II., Section No. 1.) I have previously stated that the metamorphic action on this bed or vein has been such as to efface its original character, and has likewise formed a variety of ores in it. This metamorphic action, with natural disturbances, has also, in several places entirely nipped out the ore; thus, at the first mines I visited, the vein presented the appearance of a vertical wedge, all the ore having been extracted down to the point where the walls met. Although the vein is traceable below this point, little ore has yet been discovered.

The vein here contained the harder and denser ores, viz., specular, red oxide, and hematite; small quantities of sulphate of barytes, and the mineral called "ankerite"—a carbonate of iron, lime, and magnesia. This latter is the most abundant material in the vein, and is invariably attached to the walls; it is usually of a white colour, but sometimes tinged red, the following is an analysis of each variety:—

	White ankerite.	Red ankerite
Peroxide of iron	-	33.0
Carbonate of lime	54.0	46.0
Carbonate of Iron	23.2	19.5
Carbonate of magnesia	22.0	0.8
Silicious matter	0.5	0.4
Total	99.7	99.7

(Plate II – section 1 and section 2)

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This ankerite is of no commercial value; the red variety might have been employed as a flux ore in the blast-furnace, but its extreme density renders it useless.

The red oxide iron-ore yielded by analysis:—

Peroxide of iron.	74.8
Oxide of manganese	2.2
Silica	2.2
Insoluble specular titaniferous ore	1.8
Calcareous matter and water	19.0
	100

52.38 per cent, metallic iron.

The mines on that part of the vein where these ores were worked have been abandoned, and other mines three miles further to the west on the same vein have been opened. Here the vein and its ores present quite a different character to those already described; the vein is thrown out of its course and divided into a number of large cavities in which the ore is deposited. The containing strata consist of friable slates, to all appearances belonging to the metamorphosed Devonian formation, in which the fossilliferous remains, if there were any, have been entirely destroyed.

The cavities or "pockets" of ore are of an irregular shape; they are several feet long, and from ten to sixty feet wide, varying in depth from five to twenty fathoms. he vein below and between the cavities, so far as it has been proved, contains very little ore. The walls of the cavities are covered with a layer of yellow ochre, from two to three feet thick; the ore filling the middle space. The chief yield of ore is an open hematite, with a covering of, and the insterstices filled with, brown oxide; large quantities of the ore have been reduced almost to a powder, hence the ore is found in large pieces bedded in the oxide and small ore. In working, the hematite is picked out, all the small being left, as it cannot be used in the blast furnace.

The ores in the vein and cavities have been got by open or quarry work to such depths as the nature of the adjoining strata would admit; below this the ores are worked by successive stages or steps, thirteen feet high, following each other, the sill timbers and flooring slabs of the first stage being left in and answering as the roof bars and slabs of the second stage.

At Nictaux, in Annapolis county, there are vast deposits of iron-ore in veins in the lower Devonian rocks, and in large masses as bog-ore in

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the New-red-sandstone; the latter ore yields a large per centage of iron, but has been found to contain so large an amount of phosphorus that it could no longer be used.

The first vein in the Devonian rock is a peroxide of iron in a regular stratum from six to eight feet thick, occurring in dark-coloured slates; it is almost perpendicular, and is interstratified with the adjoining slates. (See Plate II Section No. 2.) The ore is highly fossilliferous, hence it is called "shell-ore"; it has not been extensively worked, its quality being unfitted for the making of bar iron.

Analysis of "shell-ore," by Dr. J. C. Jackson, State Assayer, Boston, U.S.:—

	First Sample	Second Sample
	Per cent iron	Per cent iron
Peroxide of iron	70.20 = 50.3	64.4 = 45.1
Silica	14.40	19.20
Carbonate of lime	5.60	3.20
Carbonate of magnesia	2.80	1.20
Alumina	6.80	5.40

Manganese	0.40	4.40
Water	-	2.40
Total	100.20	100.20
Gain oxygen	0.20	0.20
	100	100

Half-a-mile south from the shell-ore vein there exists three veins of argillaceous magnetic ore. As the whole of the Devonian formation in this district is almost perpendicular, the horizontal distance of half-a-mile may represent that distance vertical when we speak of the deposition of the magnetic ore previous to that of the shell ore.

The magnetic ore veins are about one hundred yards apart and each of them is about six feet thick; lying conformable with the containing strata, which consists of hard dark slates. The ore is very similar in each of the veins: it is of a bluish grey colour, and highly magnetic. It contains 54.41 per cent of the metallic iron.

The iron ore veins of Clementsport are possibly a continuation of the Nictaux veins: their character and position in the slates being in many particulars identical. The same species of fossil shells are found at Clementsport as at Nictaux, although not in such abundance.

Proceeding south from Clementsport along the banks of the Moose river at two-and-a -half miles distant, we meet with the "Milberry Vein",

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Two feet six inches thick, it consists of a very friable though pure carbonate of iron. One mile further south over vertical strata is the "Milner Vein," also two feet six inches thick, of an impure argillaceous magnetic ore. Another mile further south is the "Potter Vein," ten feet wide, with a band of dark slate three feet thick in the middle. This is also an argillaceous magnetic ore very similar to the magnetic ore of Nictaux, with which it has probably been connected, the two districts being severed by the mass of granite forming the south mountains east of Annapolis.

All these veins have their strike and underlay conformable to the containing strata, which, as at Nictaux, consists of hard dark slates of the metamorphosed lower Devonian formation.

In considering the history of these veins of iron ore we must commence with the premise that they were all deposited in the same geological era. The position of the Londonderry vein in the Devonian strata carries out the inference; for if it be an aqueous deposit it must be identical in point of time with the deposition of the veins of Nictaux and Clementsport. That these latter veins are aqueous and contemporaneous deposits, there I can, I think, be no doubt.

In the shell-ore vein of Nictaux the deposit is little changed from that of a marine-formed seam. The fossil shells are remarkably perfect, being in a matrix of fine ferruginous sand. They are all marine, and quite distinct from the fossils of the Carboniferous period, being of the same genera and species as those of the Devonian rocks of Britain. I examined the magnetic-ore veins of Nictaux and Clementsport very carefully for any organic remains that they might contain. I could only find a few fossil shells, which were deeply embedded in the ore. These shells, although much distorted, were evidently of the same species as those found in the shell-ore: by this, and also the regular thickness and stratification of the magnetic-ore veins, I infer that they are also of aqueous origin, and have, subsequent to their formation, been subjected to great metamorphic action.

If we assume, then, that the Londonderry vein was originally a regular, aqueous deposit similar to the shell or magnetic-ore veins, it must have been broken up and contorted, the sides pressed together in one place, while large cavities were left in other places, into which the broken ore would be forced. The action of heat and heated water are probably the agents by which the various descriptions of iron ores and the other minerals in the vein have been formed.

Although there are several other known deposits of iron ore in Nova

Scotia besides those which I examined and have here spoken of, I am not aware that any of them have been worked. Extensive districts which are likely to contain iron ore have yet to be examined; when this is done, larger fields for operations, with superior advantages, will doubtless be discovered.

IRON MANUFACTURE.

The whole of the iron manufactured in Nova Scotia is "charcoal iron," that is, iron made entirely with charcoal fuel. The following are the works established, with their annual produce:—

Works	Properties	Annual Produce	
Londonderry	Acadian Charcoal Iron Co., Limited	1 furnace	1700 tons
Nictaux	Ditto	2 furnaces	----- tons
Clementsport	Private Company	1 furnace	1200 tons
Total			2900 tons

The Acadian Charcoal Iron Company have also a forge and rolling mill at Londonderry, by which they produce upwards of 1,000 tons of bars per annum.

The blast furnaces erected are capable of manufacturing nearly 6,000 tons of pig iron per annum. The limited demand for foundry iron in the provinces and the competition met with for that description of iron at home will only permit of the manufacture of the best iron for bars, etc.

At Nictaux and Clementsport the dense magnetic ores are calcined or roasted with wood and charcoal breeze before being thrown into the blast furnace—the carbonate of iron in its raw state being used with it. It is found that these ores thus treated yield 35 per cent, of metallic iron.

At the Londonderry works the ores are broken into small pieces, and, as far as is possible, each quality stacked separately ready for use in the blast furnace. The limestone, of which a small quantity is used as a flux, is found in the adjacent carboniferous formation, and it is quarried and broken up in the same way as the ore.

The immediate vicinity of the iron works, like other vast districts of Nova Scotia, are covered with a dense forest of hard wood, such as birch maple, beech, etc.; these are converted into charcoal in the forest near the spot where they are felled. The charring is done in open stacks, containing twenty and forty cords each; the wood is carefully piled into a circular stack about twelve feet high, with a chimney left down the centre, the outside is covered with charcoal breeze so as to render the stack as air-tight as possible. Fire is thrown down the chimney; the

(Plate III – Blast furnaces)

charring then commences in the centre, and proceeds towards the outside. One acre of forest land yields about twenty cords of wood suitable for fuel or converting into charcoal, and one cord of wood produces thirty-six bushels of charcoal. At the Woodstock Iron-works, in New Brunswick, all the wood is charred in close ovens; which is found not only to produce a harder and denser charcoal, but to be much more economical than open burning. The charcoal is stored near to the blast furnaces in large wooden sheds in order to preserve it from the wet as much as possible.

The construction and size of the blast furnaces will be best understood by a reference to the drawings (Plate III.). No. 1 furnace is one of the smaller, and No. 2 one of the larger furnaces used for smelting with charcoal. The waste gases from the blast furnaces are utilized by heating the blast before entering the furnace; an apparatus for this purpose is shown attached to No. 1 furnace.

In blowing a furnace in blast it requires 2000 bushels of charcoal to heat the furnace sufficiently for the introduction of the ore. The various descriptions of ore are put into the furnace in certain proportions when the separation can be effected. The open hematite and the oxides being easily fused, while the compact hematite and the specular ores are refractory.

Each charge of ore into the furnace weighs 5 cwts. 0 qr. 14 lbs., of charcoal 20 bushels, and of limestone 50 lbs. The charges of each of these materials are thrown into the furnace at intervals of ten minutes.

During a period of eight months the charges and produce of one blast furnace were as follow:—

Total number of charges 10,331

Charcoal used	211,066 bushels = 169 bushels per ton of Iron.
Iron ore.	2648 tons 5 cwt. 3 qtr.11 lbs. = 2 tons 2 cwt. 1 qtr. per ton of Iron.
Limestone.	234 tons 8 cwt 3 qtr. 14 lbs. equals 3 cwt. 2 qtr. 26 lbs. per ton of Iron .

Make of Iron . 1248 tons 3 cwt. 3 qtr one lbs.
Yield of Iron in the furnace, 47 per cent.

The pig iron has a regular and dark gray fracture, it has been extensively used for ordnance and other purposes where great strength and tenacity is required. An average of the analysis of eleven different samples of the pig iron gave the following result.

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	Per cent
Iron	93.7202
Carbon	3.1844
Silicon.	2.1320
Sulphur	0.0103
Manganese	0.6413
Phosphorus	0.2118
Total	99.9

The iron has been tested with the best English and Scotch samples, as to the transverse and tensile strength and the resistance to crushing, by which the quality of Nova Scotia charcoal iron is proved equal to the best home makes.

TABLE OF TRANSVERSE AND TENSILE STRENGTH AND RESISTANCE TO CRUSHING.

[Table omitted]

At the Londonderry works the pig iron is puddled entirely with wood, of which it requires $3^{1/4}$ cords to puddle one ton of bars; the loss in weight by the puddling is 7.75 per cent, on the pig iron used. The bars make a very hard and superior steel-iron, which is used largely in Sheffield for the finest edge tools; it has also been employed with success in the manufacturing of locomotive and railway wagon tyres, etc.

The only market at which the Nova Scotian iron can be advantageously disposed of is that of England, where a first-class charcoal iron is always in demand; the provincial requirements are, as yet, very inconsiderable, and the heavy duty on iron imported into the Northern States of America, and the blockade of the Southern States, effectually close those markets. Much may hereafter be expected from the increasing wants of the British North American Provinces, as the manufacturing and commercial indus-

tries are extended. This will doubtless be accelerated by the construction of the Intercolonial Railway, which will connect Canada, New Brunswick, and Nova Scotia, running from Halifax to Quebec.

Since writing the above paper, the Londonderry bar iron has been made into armour plate bolts, some of which have stood a tensile strain of 45 tons per square inch.

The steel converters of Pittsburgh, Pennsylvania, have recently commenced using Nova Scotian iron for the manufacture of side arms, etc.

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NORTH OF ENGLAND INSTITUTE OF MINING ENGINEERS.

GENERAL MEETING, SATURDAY, NOV. 5th, 1864, IN THE ROOMS OF THE INSTITUTE, WESTGATE STREET, NEWCASTLE-UPON-TYNE.

NICHOLAS WOOD, Esq., President of the Institute, in the Chair.

The minutes of the Council having been read, Mr.Thos. R. Gainsford, of Darnell Hill, near Sheffield, was elected a member of the Institute.

The PRESIDENT said, the Council had given instructions to issue a circular to procure an account of the borings and sinkings through the different deposits from the surface to the stone-head of the different collieries of Northumberland and Durham. When these were obtained, they must appoint a Committee to collate them and put them into some shape to be brought before the Institute. With respect to holding a local meeting, the Council proposed that the Saturday meeting of the Institute in February be made special for this particular purpose. It would require a good deal of arrangement before the proposed meeting could take place, but it would probably be held in July, 1865. There had been an application from only one district at present, but that was an important one—South Wales. Wherever it was held they should take care to make it a meeting worthy of the Institute. He proposed that a sub-committee be elected to-day to obtain information.

A sub-committee was then appointed, consisting of Messrs. S. C. Crone, J. Daglish, G. B. Forster, T. Douglas, and J. B. Simpson.

IRON MANUFACTURE.

The PRESIDENT said, the first paper on the list for discussion was Mr. Bell's paper on the Manufacture of Iron in connection with the Durham and Northumberland Coal-field and Yorkshire Iron Mines; the statistics contained in this paper were extremely valuable. The iron trade was a

little more prosperous now than it was at the time the paper was written. He did not know what impetus that circumstance had given to the manufacture of iron in this district, but he believed that several new furnaces had been erected, and some were yet in course of erection.

Mr. BELL said, about thirty new furnaces had been erected. There was no change in the manufacture since he wrote the paper. In one part of that paper allusion was made to the increased capacity of furnaces. That system had not been more extensively adopted than at the time the paper was written. Messrs. Bell Brothers were building two furnaces eighty feet high and twenty feet in diameter—somewhat larger than those of Mr. Vaughan, who led the way in the erection of furnaces of an unusual size.

The PRESIDENT—That looked as if the results were favourable.

Mr. BELL— In one part of the paper allusion was made to the deposit of magnetic ironstone in Rosedale; he did not know whether the President knew anything more on the nature and extent of that deposit.

The PRESIDENT said, no; but he understood they were still getting a large quantity of magnetic ore. How long it might continue was uncertain. He did not know whether the Northamptonshire ironstone was being extensively worked yet, or not.

Mr. BELL—In two places it had been worked. The same bed of ironstone has also been worked in Lincolnshire.

MAGNESIAN LIMESTONE.

The next paper for discussion was that on the Magnesian-limestone, by Messrs. Daglish and G. B. Forster.

The PRESIDENT said, the Magnesian-limestone, within the limits of the Durham Coal-field, rested on the Coal-measures, but there was considerable variation in different districts, in the depth from the Limestone to the different beds of coal; in the western district the Magnesian-limestone lies very near the coal beds of the lower series of the Coal-measures, but in the eastern district the Coal-measures thicken very much. At Monkwearmouth, where the coal strata are thickest, the Magnesian-limestone is about 200 fathoms above the Hutton-seam of coal, whereas, at the western extremity of the Magnesian-limestone escarpment, it does not lie above fifty or sixty fathoms above the Hutton-seam. Throughout the whole of the district, wherever the Magnesian-limestone approaches or rests upon the Coal-measures there occur beds of Red-sandstone.

Mr. G, B, FORSTER—And Yellow-sandstone.

The PRESIDENT—Inclining to red.

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Mr. G. B. FORSTER—You never find any Red-sandstone in this district between the Magnesian-limestone and the Coal-measures.

The PRESIDENT said, he had given an account of the Red-sandstone beds occurring over a district of several miles, where the Magnesian-beds rested upon the Coal-measures.

Mr. G. B. FORSTER—That was a distinct deposit. There was a deposit of yellow sand, which was supposed to be blown sand; then below that they found what they called red-beds, both sandstone and shale, extending below Coal-seams in some cases.

The PRESIDENT—But adhering to the question of Red-sandstone that lies parallel almost to the Magnesian-limestone; those red-beds occur at the top of the Coal-measures, whatever part of the Coal-measures that top may be.

Mr. G. B. FORSTER—Our theory is that the red-beds are part of the Coal-measures.

The PRESIDENT--Let us have the facts. You have Red-sandstone beds where the Coal-measures extend to 200 fathoms from the Hutton-seam at the top of the Coal-measures and near the Magnesian-limestone. You have no Red-sandstone between those red-beds and the Hutton-seam; then you go to where the Coal strata is only sixty fathoms above the Hutton-seam, and there you have similar Red-sandstone at the top of the coal beds, sixty fathoms above the Hutton-seam.

Mr. G. B. FORSTER—Not the same beds; that is just the point—you have red beds.

The PRESIDENT—You have no red-beds in any portion of the strata of the 150 fathoms. They lie unconformable to the seams of the Coal-measures.

Mr, G. B. FORSTER—You have red-beds, and wherever you pass the sand, and get into the Coal-measures you meet with reddened beds; but these reddened beds are not lying conformable to the Yellow-sand. We say these beds are portions of the Coal-measures coloured by filtration from the upper strata.

Mr. HOWSE said, there was one point he wished Mr. Forster would explain. In Vol. XIII., page 209, it is stated that, "On diagram No. 4 it will be observed that whilst at Monkwearmouth Pit the Coal-measure strata, intervening between the Magnesian-limestone and the Hutton-seam, is 1500 feet, at Seaham it is 1100 feet, and at Castle Eden only 400 feet. So that at Castle Eden, 1100 feet of Coal-measure strata have been denuded, and yet the Yellow-sandstone underlies the Limestone at each place." He wished to have a proof that 1100 feet of strata had been

denuded. And again, in what way had the Hutton-seam at this and (the northern) of the Coal-field been proved identical with that so-called at the southern extremity near Castle Eden.

Mr. G. B. FOSTER—It has been worked all the way through.

Mr. HOWSE—It is known that Yellow-sandstone occurs at the top of the Coal-measures at Tynemouth, and the same bed occurs at greater depths from the surface at Monkwearmouth, Seaton, etc. Did it not follow that the Coal-measures had been originally deposited on a basin-shaped surface? It was not necessary to bring in the aid of denudation to account for the present conditions of these strata. Monkwearmouth was the deepest depression of the Coal-basin, and the beds rise all round it. He did not wish to say that there had been no denudation in any part of this Coal-field prior to the deposition of the Magnesian-limestone. To the south of the Hett Whin Dyke, the strata had been much disturbed and locally denuded; but so far as this northern part of the Coal-field was concerned, there had been no denudation of the Coal-measures before the red-beds at Tynemouth and Cullercoats, had been deposited. Those red-beds at Tynemouth were perfectly conformable to the Coal-measures. It is difficult to prove the extension and the existence of the red-beds to the south of Ferry Hill.

Mr. G. B. FORSTER—In going to the south we do not find the Hutton-seam getting nearer to the Main, nor the Main to the Low-main seam. There we find the seams cropping out. That would not be so if Mr. Howse's theory was true.

Mr. HOWSE—Will Mr. Forster point out the High-main-seam in the Monkwearmouth Pit section, if it does not thin out ?

Mr. DAGLISH—It does not thin out. It is deteriorated in quality, and is called by another name.

Mr. G B. FORSTER--I can take you to a place where a seam is six feet thick, and at the distance of a mile-and-a-half you have no trace of it. The absence of the seam in one particular shaft is no proof of its having thinned out entirely.

Mr. HOWSE—-These coal seams, I think, have not been traced from one end of the Durham Coal-field to the other.

Mr. DAGLISH—Yes; the Low-main or Hutton-seam, all through.

Mr. HOWSE—This must be proved to the satisfaction of geologists. Let it be granted that the bed so-called at Castle Eden is the Hutton-seam, does it follow that where there are only 400 feet of Coal-measures above it, that the upper strata have been denuded?

Mr. G. B. FOSTER—Yes, because you have other seams in their proper

places. It proves they have not thinned out there. There is the same thickness of intervening strata between the seams. If they thinned out at the edges, you ought to have so many fathoms less thickness at Castle Eden than at Monkwearmouth.

Mr. HOWSE—These statements are made on the assumption that the Yellow-sand is conformable to the Magnesian-limestone, which is not the case.

The PRESIDENT—Let me understand. I see, by referring to the diagram, that the Yellow-sand lies under the Magnesian-limestone, and parallel to it. Is it conformable to the beds of Magnesian-limestone ?

Mr. DAGLISH—We say it is.

Mr. HOWSE—I am of opinion that the Yellow-sandstone is unconformable to the Marl-slate, which is the base of the Magnesian-limestone, and where it can be observed it is conformable to the Red-sandstone.

Mr. G. B. FORSTER—We say it is conformable; it is a question of fact.

The PRESIDENT—Do you consider the Yellow-sand as conformable to the Magnesian-limestone, and unconformable to the coal strata? Are there any beds in the Magnesian-limestone which you can identify as being conformable to the Yellow-sand?

Mr. G. B. FORSTER—Yes, the entire thickness,

Mr. HOWSE—In Seaton Pit section the thickness of the Yellow-sand on one side of the shaft is considerably less than it is on the other side of it.

Mr. DAGLISH—The Yellow-sand always lies in hills.

The PRESIDENT—You have thirty fathoms of Limestone at Monkwearmouth, and there is Yellow-sand at the bottom of it. You have 100 fathoms of Limestone at Castle Eden, and you have the Yellow-sand at the bottom of this thickness of Limestone, the same as where there is only thirty fathoms.

Mr. DAGLISH—We commence by doubting whether there are any beds in the Magnesian-limestone at all. We think it is stratigraphically homogeneous.

Mr. HOWSE—The Magnesian-limestone is acknowledged by geologists to be divisible into three groups of beds. The lower division of the Magnesian-limestone thickens towards the south-east of the county of Durham, that is, in the general direction of the dip of the strata.

Mr. G. B. FORSTER—You want to claim a thickening and thinning for the Coal-measures; but you will not allow us that for the Yellow-sand.

The PRESIDENT—We come back again to the Yellow-sand, and say it may be parallel to the mass of Magnesian-limestone, or it may not.

Mr. HOWSE—There is not a single pit-shaft in the county of Durham sunk through the whole of the beds of the Magnesian-limestone.

Mr. G. B. FORSTER—Where will you find the upper beds?

Mr, HOWSE—They are to be seen at Fulwell and Roker, and in small, isolated patches near the Black Halls, but generally the upper beds are denuded. No pit in this district has been sunk through all the beds of the Magnesian-limestone.

The PRESIDENT—If the Coal-measures are washed away, the Red-sandstone is still on the top.

Mr. HOWSE—You have only to examine the district near Elemore and Eppleton to see the irregular, upper surface of the Yellow-sandstone. It forms an irregular bed all along under the Limestone. It is conformable to the red beds at Claxheugh, which are conformable to the Coal-measures at Tynemouth and Cullercoats.

The PRESIDENT—I think those red beds extend for several miles, and the strata are conformable to the strata of the coal beds, but they are not conformable in position with the red beds. That is, you have red beds in one place where there are an hundred beds above a particular seam, and the same where there are only fifty fathoms above the same seam. Wherever the Coal-measures come in contact with the Magnesian beds you have red beds, these beds being conformable to each other, but the red-coloured beds not conformable.

Mr. HOWSE—I object also to the filtration theory. The Red-sandstone beds contain nodules of ruddle, and are charged with red oxide of iron. The colour is derived from the decomposition of the included particles of iron, and not from filtration. Wherever these beds can be examined their fossils are the same as those occurring in the Coal-measures.

Mr. DAGLISH—They are the Coal-measures.

Mr. FORSTER—I am glad to see Mr. Howse is a convert to our theory.

Mr. DAGLISH—They are not distinct measures.

Mr. HOWSE—In 1857, I classified them as Coal-measures.*

The PRESIDENT—Suppose at Castle Eden there is a certain thickness of Coal-measures, then we may suppose they were subjected to a denudation which washed away all those beds to a certain depth. On the surface of those Coal-measures so washed away there comes another deposit upon that surface, however uneven it is—a sand deposit upon such uneven surface, a yellow sand deposit, and upon the yellow sand deposit comes the Magnesian-limestone.

* See Annals of Natural History, 1857

Mr. Bell—You say as soon as the strata comes to the day, the bed is either normally red, or coloured red ?

The PRESIDENT—I say that after the coal beds are partly washed away, there is left at the top of the strata certain beds of coal, parallel to the other coal beds, but when they became exposed to filtration from the Limestone and sand, then they become red, and the redness is at the top of the coal strata wherever in the coal series that top is.

Mr. BELL—You suppose that when they were tilted up so as to form the upper surface at one time, some circumstance or another has reddened the up-tilted ends of these beds?

Mr. DAGLISH—That is what we hold.

The PRESIDENT—Taking any particular locality, you have the edges or top of the coal beds in that locality. You have no red beds below the top of the beds, but as each successive bed comes to the surface it becomes red. Below this redness there are no red beds at all in the lower strata.

Mr. DAGLISH—It becomes red first.

The PRESIDENT—In some districts of England there is a Red-sandstone occurring below this Yellow-sand, and in addition to it, very well defined.

Mr. G. B. FORSTER—What district?

The PRESIDENT—In a great many districts in England this red sand exists in great thickness underneath the Magnesian-limestone, and conformable to it. We have no Red-sandstone of this description in the Durham measures, conformable to the Limestone, and as a distinct and thick bed, unless the Yellow-sand is a representation of it. In several districts in the south they have a defined and thick bed of Red-sandstone which they call (I believe) Lower-new-red. This Red-sandstone is apt to be mistaken for the coloured red beds heretofore described.

Mr. BELL-—Mr. Howse has paid so much attention to this subject that he has very naturally passed into a kind of authority. It may be my fault in not understanding him when he says that there may have been no denudation at the point called Castle Eden. I have always been taught to understand that these beds of coal must have been at some time or another deposited in a perfectly horizontal plane. Therefore, if you can, as it has been stated you can, trace the Hutton-seam over a very extended area, it follows as a matter of course that at one time or other it must have been in a horizontal position. What may be stated of the Hutton-seam applies to every bed of coal and every bed of shale above it. Consequently, I do not see how Mr. Howse can escape from the inference

that a great deal of matter that once constituted a portion of these beds, has been removed from some cause or other. As it does not exist, I infer it must have been washed away.

Mr. HOWSE—Firstly, I do not admit that the coal beds have been deposited on a horizontal or perfectly level surface. I suppose the coal-measures have been deposited in a basin-shaped hollow; and next, I am only requiring the proof that there have been strata deposited at the south end of the Coal-field, and that these were afterwards denuded. .

Mr. DAGLISH—I do not see anything in the paper which implies that there has been denudation.

Mr. HOWSE—Allow me to read what I read before, page 209, Vol. XIII.

Mr, DAGLISH—That has nothing to do with the red beds.

Mr. G. B. FORSTER—-If we can prove that the beds were deposited horizontally, or comparatively so, then you will allow there has been denudation.

Mr. HOWSE—I should much like to see a section in which, any unconformability or proof of denudation occurs.

Mr. G. B. FORSTER—The Coal-measures were, I think, deposited comparatively horizontally. I can show you a seam of coal in the Low-main where the finest coal is found gradually passing into coarse coal, and then into shale; you cannot find the parting. This coal, in like manner with the shale, contains the remains of fishes which must have died above it. Does not that prove that it must have been deposited horizontally?

Mr. HOWSE—No. It proves only that there was a lake or standing water there.

Mr. G. B. FORSTER—If it had been a lake the bed would have been thicker in one part than in another.

The PRESIDENT said, if a special paper on this subject was brought before the meeting it would raise a discussion, and the question might be further gone into. The discussion was then adjourned.

The President called the attention of the meeting to the suggestion made by Mr. Sopwith at the last meeting, to alter the classification of a portion of Carboniferous-series. The discussion was adjourned, and Mr. Sopwith had sent a diagram showing his views on the subject. They could not go into this at present, and, therefore, they would adjourn this also till the next meeting. The Carboniferous-series was classified into Coal-measures, Millstone-grit, and Mountain-limestone. The Mountain-limestone occurs immediately underneath the Millstone-grit. Mr. Sopwith

thought it would be better if they took the Little-limestone instead of the Fell-top-limestone as the termination of the Millstone-grit, and the commencement of the Mountain-limestone series.

Mr. DAGLISH said, the uppermost bed of Limestone was the Fell-top, and at present that marked the difference between the two classes of rocks. This was a proposal to put the Fell-top-limestone, and other beds below it, into the Millstone-grit.

The PRESIDENT—Several hundred fathoms below the Fell-top there was no lead. Mr. Sopwith threw this out as a suggestion, and it was desirable to come to some decision upon it.

Mr. DAGLISH—In reference to the last paper, the red beds referred to in it are at present in the geological maps coloured as a distinct group of rocks, viz., the Lower-new-red-sandstone. According to your view, there should be no belt of red colouring intervening between the Magnesian-limestone and the Coal-measures.

The PRESIDENT—You can express no other opinion than that at the top of the denuded Coal-measures, there was underneath the Magnesian-limestone a reddening of beds, such reddening being parallel to the Magnesian-limestone, though the beds were not, but parallel to the Coal-measures.

Mr. DAGLISH—The geological map is coloured, not according to the colour of the rocks, but according to the geological character of the rocks. Greenhow's map is now being republished by the Geological Society which Mr. Sopwith was anxious to have correctly coloured. As it at present stands there is a belt that is called Lower-new-red-sandstone running parallel to the Magnesian-limestone.

The PRESIDENT said, when he first examined Greenhow's maps the whole of Berwick Red-sandstone beds were coloured as New-red-sandstone. They had a meeting at Killingworth during the Meeting of the British Association in 1838 at which Mr. Greenhow and other gentlemen were present. He (the President) said it was a Bed-sandstone at the bottom of the Carboniferous-rocks, and that was the reason for his taking a journey from the Tyne to the Tweed to prove it.* He thought he proved it to the entire satisfaction of every geologist. Mr. Greenhow subsequently changed his colours from New-red to Old-red.

Mr. DAGLISH—It is the same map. The question is must the colour be altered? Has it to be coloured as New-red-sandstone again?

** See Transactions of Natural History Society of Newcastle.*

The PRESIDENT—You have certainly the .Red-sandstone above the Magnesian-Limestone—that is, the Red-sandstone of the Tees district; and you have yellow sand below the Magnesian-limestone, which has been sometimes considered red, because it has been associated with the reddening of the Coal-measures, heretofore described. If the yellow sand was reddened instead of yellow, and formed a definite and solid bed, this red strata might represent that given in Greenhow's recent map.

Messrs. Richardson and Bunning's report on the experiments at H.M. Dockyard, Devonport, on the use of Hartley coal in steamships of war, was then announced, and it was suggested that it was desirable to address a special note to such of the members as were engineers, that they might attend the discussion.

The President announced that Mr. Sopwith's machine was not ready for the inspection of the members.

The meeting then separated.

NORTH OF ENGLAND INSTITUTE 0F MINING ENGINEERS.

GENERAL MEETING, THURSDAY, DEC. 1st, 1864, IN THE ROOMS OF THE INSTITUTE, WESTGATE STREET, NEWCASTLE-UPON-TYNE.

NICHOLAS WOOD, Esq., President of the Institute, in the Chair.

Mr. Matthew Parrington, of Normanby Mine, Middlesbrough, was elected a graduate.

The PRESIDENT said, it had originally been intended that the Sub-Committee which had been appointed to make arrangements for a special meeting of the Institute, in some distant locality, should have drawn up a report, to be submitted to this meeting. The Committee had not, however, obtained the information necessary to enable them to make a report to-day; and therefore, he presumed they would have to wait till a future meeting. The only localities from which an application had been made for holding such meeting were South Wales, represented by Mr. Basset, of Cardiff as Secretary of the Institution in that locality; and Manchester, as represented by Mr. Dickinson, Government Inspector. Some gentlemen thought it might be advisable to have a meeting in Wales, others thought that Manchester was a very important locality. Therefore, it was resolved that the Sub-Committee should communicate with both these localities, and endeavour to obtain all the information they could, and then report to the general meeting. There was also a paper "On the Minerals found in the Coal-measures of Northumberland

and Durham” which stood for discussion. Mr. Daglish, however, had written a letter to say that he was not able to be present. Therefore, he presumed the discussion would have to be postponed.

After the reading of the following papers—by Mr. D. P. Morison, "On the *Caisses de Prévoyance* of Belgium," and by Mr. Howse, "On the Boundary-line between the Millstone-grit and the Mountain-limestone of the North of England", the meeting separated.

FURTHER REMARKS on the CAISSES DE PRÉVOYANCE,

or

NATIONAL MINERS' RELIEF FUNDS OF BELGIUM.

By DAVID P. MORISON.

Having received the Annual Official Report of the transactions of the "*Caisses de Prévoyance*" of the province of Hainaut, Belgium, for the year 1863, I have briefly noted down the following particulars, which may prove interesting, as a sort of Appendix, to the short notice of these funds which I had the honour of bringing before the Institute some little time ago.

The general tone of this Report is not by any means so sanguine as that of its predecessors, and expresses fears that some material addition will have to be devised to the annual receipts of the fund, by one or other of the following methods. By an increased per centage on the wages of the subscribing workmen, by a reduction in the amounts paid as annuities, or by an arrangement through which the associated collieries would become liable, for part or all of the relief to sufferers from explosions of fire-damp in their respective mines.

(1) In 1863, 32 collieries and railways shared in the benefits of the fund, and paid in the aggregate contributions for the year	£10,341 14s 3d
One-half of which, as formerly, is a per centage of 3/4 % on the workmen's wages, and the other half a similar sum paid by the owners.	
(2) Contribution from the *Ministère des Travaux Publics*	£551 12 0
(3) Contribution from the Province	£93 12 0
(4) Contribution from the Society for the Encouragement of National Industry	£100 0 0
(5) Yearly Interest at $4^{1/2}$ % on Government Bonds	£1,494 0 0.
(6) Interests at 5 % on Provincial Bonds	£37 0 0
(7) Interests at 3 % *"Société Générale"*	£28 17 0
(8) Paid by the Governor of the Province	£42 10 0
	£12,689 5 3

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The payments were—

(1) Annuities for accidents from the 1st Jan, 1841, to Dec. 31, 1863 Inclusive-	£11,994 16 6	
(2) Annuities to old men incapable of work	£255 2 8	
Total	£12,249 19 2	
(3) Educational communal grants	£720 0 0	
(4) Expenses of management, &c	£283 0 10	
Total --		£13, 253 0 0
exceeding the receipts by		£563 14 9

which, deducted from the balance in hand at Dec 31, 1862 of	£33,648 8 5
leaves at 31st Dec., 1863	£33,084 13 8

The 32 associated concerns return £689,446 8s 10d. as having been paid during the year to 24,574 workmen for 7,462,853 days' works; being an increase over 1862 of 2,227 men , 659,119 days' works, and 52,468 15s. 3d wages; the average *per diem* for 1862 being 1s 10 47d, and for 1863 1s 10 17d.

In their Report, the Committee direct special attention to the fact, that the above daily averages are those of the whole of the workers in the mines, ranging from 4s. and 5s. (the hewers and other first-class workmen) down to 5d. and 7½ d. (the boys of 10 or 12).

At the 31 of Dec., 1863, 3,844 permanent and temporary annuities had been granted since the commencement of the fund in 1841, and at the above date 2004 of these were still in force.

The number of accidents (40) was less than in the preceding ,year (53); and the casualties from these accidents were also fewer. In 1862, 58 men and boys were killed and 21 seriously wounded; while in 1863, 29 only were killed and 13 incurably wounded. These 42 casualties may be thus classified :—

22 from falls of stone, coal, timber, &.
1 burnt by fire-damp,
4 falling down shafts.
1 from fall of iron tool.
2 by blasting.
5 run over or crushed by wagons.
3 from accidental falls,
1 crushed between cage and shaft.
3 from sundry causes.

Total 42

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Of the 32 branch funds, 2 balanced evenly the receipts and disbursements, 17 showed a deficit, and 12 a surplus. There were relieved by them aggregately *pro tempore* 9,891 workmen, in the following manner:—

In money	£4,872 2 9 = 8s 10 per man
In medicine	£465 3 6 = 0 11 1/4
In coal	£278 8 8 = 0 6 3/4p
In sundries	£515 3 4 = 1 0 1/2
Total	£5630 18 3 = 11 4 1/2

Annuities to widows, etc	£1,818 5 6 = 3 8
Total	£7,449 3 9 = 15 0 1/2
Medical staff, etc.	£2,914 11 6
Grand total	£10,363 15 3

The total receipts of the branch funds in 1863 were £9,945 3s. 10d. towards which the 24,574 workmen contributed an average of 8s 1 13d. per man; while the owners subscribed the deficit of pounds £418 11s. 5d, or 4.09d. per man.

I have thought it advisable thus to trace the progress of this fund, as its operations can never fail to interest and astonish us, so long as they continue so unparalleled in their extent; while they may, possibly, serve in the future to assist us in forming the groundwork of some similar institution for the relief and improvement of the British miner.

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ON THE BOUNDARY-LINE BETWEEN THE MILLSTONE GRIT AND MOUNTAIN-LIMESTONE OF THE NORTH OF ENGLAND.

BY RICHARD HOWSE.

At the September Meeting of this Institute a proposal was made by Mr. Sopwith, as an addition to his Paper on the Lead-mining District of the North of England, to separate the sandstones and shales lying between the two uppermost calcareous beds of the Mountain-limestone series, and locally known as the Fell-top and Little-limestone from that division of the Carboniferous rocks, and to place them with the Millstone-grit.

The beds intended to be thus transposed are the following (the whole section of the strata will be seen at page 187, Vol. XIII.):—

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[Table of strata omitted]

The aggregate thickness of the beds intended to be thus transposed amounts to about 340 feet vertical, of shales and sandstones, with some beds of impure limestone and ironstone. As this proposal cannot be adopted by those acquainted with the fossil contents of these beds and the general groups of the Carboniferous-rocks in other parts of this island, the members of this Institute will, I hope, allow me to state a few considerations that seem to make it desirable to retain the Fell-top-limestone as the line of division between the Millstone-grit and the Yoredale series of the Mountain-limestone.

It is generally acknowledged by persons at all conversant with the geology of the North of England, that by far too much importance and space is given on our geological maps to the Millstone-grit series. The tendency of all the careful observations of the present day is to contract the limits formerly allotted to the Millstone-grit. One circumstance which has tended, perhaps to mislead observers, is the manner in which small isolated patches of Millstone-grit are found capping the tops of the hills far to the west of the regular outcrop of these beds, and also its being brought in in unexpected localities by faults and anticlinal depressions. That it should now be augmented by an addition of more than 300 vertical feet of strata is a proposition not likely to be entertained by geologists, for the following reasons.

In South Wales and Derbyshire, where the lower Carboniferous-rocks put on a more compact form, they consist of three divisions, viz., the Coal-measures, Millstone-grit, and Mountain-limestone; the two latter being represented by a single stratum each; and in correlating the Carboniferous-rocks of this district, with those of other localities to the south, it is important to enquire what portion of our series correspond to the bed of Mountain-limestone occurring in South Wales. The chief guides in this correlation are the beds of Encrinital-limestone found intercalated through the series, and the fossil remains distributed in them and the adjoining beds. Now, it is admitted, that the Fell-top-limestone is encrinital, containing, or rather being made up of the innumerable small joints and fragments of encrinites; and also, that many of the shales and sandstones occurring in that part of the series, between the Little-limestone and Fell-top, contain assemblages of marine fossil shells identical with those found in the lower part of the Limestone series. It is impossible, therefore, to alter the present allocation of these beds without doing considerable violence to the acknowledged principle of zoological classification.   And further, in placing these marine-formed

beds in the Millstone-grit series, among which traces of marine life are of rare occurrence; a more arbitrary and a less natural classification is introduced and adopted.

The same argument will be found to apply even more forcibly if we attempt to correlate the Carboniferous-limestone of Scotland with this district; for in Scotland where the limestones are feebly represented, and sandstones and shales abound, the upper portion of the Mountain-limestone is determined by two or three small beds of limestone which immediately underlie the sandstone representative of our Millstone-grit; and these limestones are laid down and coloured on the Geological Survey maps of Scotland as the equivalents of the Mountain-limestone of the South of England. It is impossible, therefore, for stratigraphical and palaeontological reasons to entertain this proposed change.

And practically such a change would be of very little utility. The strata of the lead-mining districts are so well known to most of the intelligent miners that the most productive veins and the treasures they have contained are now nearly exhausted, and this even before a correct geological section has been laid down, and certainly before a correct map has been constructed and coloured for their guidance. For do we not know that Alston Moor, the great centre of mining operations, and the former metropolis and nursery of mining adventurers and enterprise is nearly worked out, and that it is only in contiguous secluded districts to which the veins have been followed that mining speculations and exertions can be profitably carried on. To the North and to the South of the Tyne and Tees district the eagle-eyed miner has been unable to detect any lead-bearing veins worthy the labour of his hands; and the same beds of limestone as they stretch through Northumberland and Yorkshire, though often tried have never yet yielded, and probably never will yield up, treasures so abundantly as they have done in the Alston Moor district.

And further, the plan adopted by the geological surveyors of putting down the outcrop of all the important strata, especially of the beds of limestone, and also the occurrence of productive mineral veins wherever these are known to exist, leaves nothing further to be desired in a practical point of view; and we have seen that zoologically and stratigraphically the change proposed would be a change less correct and less philosophical.

[Plates IV etc , Elevation and Section of boiler and feed apparatus used at H. M. Dockyard Keyham for testing coals, and diagrams of experiments.]

Two Reports on THE EXPERIMENTS AT KEYHAM, on the use of MIXED HARTLEY & WELSH COALS IN MARINE BOILERS.

FIRST REPORT TO THE STEAM-COAL COLLIERIES ASSOCIATION.

Newcastle-upon-Tyne, 19th Sept., 1863

Gentlemen,

We have now the honour to present our First Report on the Experiments made at Keyham Factory.

1.—In accordance with your instructions, we went to Devonport towards the end of July, and placed ourselves in communication with Mr. Miller, the chief engineer of the Keyham Factory. We consider it fortunate for all the parties interested in this question, that the charge of these experiments has been confided to Mr. Miller, whose previous acquaintance with the subject so eminently qualifies him for such a post. During these experiments, we received every attention from this gentleman, and, in truth, from all the officials of the dockyard, whose only object appeared to be to conduct the inquiry in the fairest manner. We would also observe, that Mr. Tomlinson, the representative of the Welsh coalowners, was actuated by the same laudable spirit.

I.—DESCRIPTION OF BOILER.

2.—The boiler, according to Government formula, was about 20-horse power, two views of which are given. It was a type of the ordinary

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class used on board of Her Majesty's steamers, being somewhat smaller than any in actual service, but preserving their general-proportions. It was 8‘ 10”high, 7‘ 8” long, and 5’ wide; it contained two furnaces, each 1’ 9” wide, with bars 4’ long, and a large brick bridge at the back end. The bars were 1¼ “thick, of wrought iron, with ½" spaces, 10” below the top of furnace in front, and 18” behind. The bridge was 13”below, and 12”in front of the bottom bend of back tube plate; the combustion chamber was 14”deep, and the whole width of the tube plate, and contained 25 cubic feet above the bridge, with a ratio of one 1 79 cubic feet to 1 square foot of grate. There were 128 tubes, 2” outside diameter, with 324 square feet of heating surface. The total heating surface was 398 square feet; the grate surface, 14 square feet; the chimney was 19” diameter, and about 45’ high, with no feed heater attached.

The following table will show, at a glance, the main points of difference between this boiler and the one used at Elswick, in conducting the experiments at Newcastle:—

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[Table omitted]

3. - Comparing these boilers together, it will be seen, that while the Government one adheres, in its general proportions of flame chamber, grate etc to Admiralty formula, viz, 0.66 sq ft of grate to 16 sq ft of tube per horse power, it differs principally from the Elswick boiler in having 50 per cent less combustion chamber, and a very considerable decrease of heating surface compared with grate surface.

II - FEED APPARATUS.

4. - The feeding apparatus was extremely simple, and consisted of two tanks placed one above the other on the top of the boiler: there was

a pipe and valve for passing the water from the top into the bottom tank, and a valve for admitting the water from the bottom tank into the boiler. These valves were attached to the same spindle, and so placed that they could not both be open together. The top tank had a pipe and cock for filling it with water, which was worked by the stoker; also a waste pipe running up through the bottom, till within a few inches of the top, so that the water in the tank, when level with this pipe, weighed exactly 1000 lbs. There was a float attached to a catch and balance weight, which opened the communication between the top and bottom tanks, a few minutes after the former was filled; and afterwards emptied the bottom tank into the boiler, when the water was at the original level.

III—COALS.

5.—The Welsh coals, with which the experiments were made, consisted of four parcels, viz., Gellia Cadoxtan and Resolven, from the Swansea district, and Merthyr Dare and Wayne's Merthyr, from Cardiff.

6.—The coals from this district were called West Hartley, but they had evidently been long wrought, were very dull, and far from being well cleaned; in fact, they were by no means a fair sample of the steam coals generally supplied from your collieries.

7.—The absolute calorific power of these different coals was as follows:—

West Hartley	13.89
Gellia Cadoxtan	14.08
Resolven.	13.86
Merthyr Dare	14.85
Wayne's Merthyr	13.31

8.—When you compare these figures with the results given in the Third Report of the Elswick Experiments, you will find a striking difference. The average power of the four Welsh coals at Keyham, is 14.02; while that of the hand-picked Welsh coal at Elswick was 14.30. The case of the Hartley, however, is very different, for that used at Elswick had a power of 14.63; while the sample taken at Keyham, which was superior to the bulk, for the obvious reason that we could not apportion the impurities, had a power of only 13.89.

IV.—STOKING.

9.—The stoking of the coals was made by the usual Government stoker, George Weekes, who was a very intelligent workman, and had

had many years' experience in the use of Welsh coals on board ship, and at Keyham Factory. On the other hand, he had seldom used North Country coals, and yet, so easy is the management of these coals, he soon was quite equal to your own stoker, who was sent to Keyham to work the Hartley coals. The quantity of coals thrown on at each stoke, was two to three good shovels, or about 20 lbs.

10.—-The Welsh coals were thrown equally over the surface of the grate bars, and never disturbed. The Hartley coals were thrown in on the front, and afterwards pushed forward towards the far end of the furnace.

11.—The cinders were not used, which, we may remark, is a greater disadvantage in the case of the Hartley than in that of the Welsh, as regards the prevention of smoke.

V.—MODE OF CONDUCTING THE EXPERIMENTS.

12.—-The temperature of the water in the boiler being ascertained, that of the air and feed water was then taken, and the two latter were again observed during the day, and at the close of the experiment. The mean of these observations was used in making the subsequent calculations.

13.—The weight and time of each charge of coals and water were recorded, as well as each stoke of the right and left fires.

14.—After some preliminary trials, the colour of the smoke evolved was designated in the record of each experiment, according to the following scale:—

Very light smoke was recorded as			No. 1
Light	do.	do.	No. 2

Light brown	do.	do.	No. 3
Brown	do.	do.	No. 4
Black	do.	do.	No. 5
Very black	do.	do.	No. 6

15.—The record was divided into minutes, so that the character of the smoke could be traced throughout the entire duration of each trial.

16.—The grates were charged with wood and coals, and ignited, and the time occupied in raising steam was noted. The state of the furnace as to fuel, was carefully examined, and left in the same condition at the conclusion of each experiment.

17.—-The average duration of each experiment was about six hours ; and, varying with the circumstances, when the 11th or 12th tank was

run in, the coals left were weighed, or a small addition was made, in order to bring the fires to the same state as at starting.

18. —In some instances, the soot or small coal which had collected in the tubes and smoke chamber, was weighed, to assist us in forming an opinion as to the waste of heat.

VI—HARTLEY COAL EXPERIMENTS.

19.—In these trials, it was impossible to prevent the formation of some smoke when close doors were used, but even with this unsuitable form of fire door, the smoke evolved really bears a small per centage on the total possible quantity. The greatest number of marks which could be recorded against this coal is 1866, and the number actually observed, when Hartley was burnt, was 309, 214, 215 (see experiments Nos.3, 4 and 16), or only 13.2 per cent, on the average.

20.—When the perforated door was employed, the number recorded against Hartley coal was 29 (see experiment No. 17), proving the great value of a larger supply of air.

21.—In all these experiments, the stoker found it impossible to keep his back fire in a good condition, where the fuel burnt off much more rapidly than in the front. This rapid combustion of the coal near the fire bridge, partly arose from the powerful draught of the high chimney.

22.—Some experiments were made to remedy this objection, which, besides diminishing the evaporation of the water, increased the difficulty of preventing the formation of smoke.

23.—A damper was introduced into the chimney, and the length of the bars was diminished by covering the far end with two courses of fire bricks. A reference to experiments No. 22 gives us the following statement:—

	Lbs. of Water evaporated per lb. of Coal -
With ordinary bars and draught.	8.25
With damper and short bars	8.77

VII—KEYHAM AND ELSWICK EXPERIMENTS WITH HARTLEY COAL.

24.—At Elswick, the quantity of water evaporated was 9.58 lbs. per lb. of coal; but, as the cinders were all burnt in these experiments, an allowance must be made for this circumstance.

25.—The calorific powers of the Hartley cinders left in the Keyham experiments was 7.08. If a Dr. and Cr. account of the power of the Hartley coal is made, the following statement is obtained:—

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		Lbs. of Water which the Coal would evaporate.	
1358 lbs. coal x 13.89 calorific power		= 18,862	
Cr.			
Lbs. of water actually evaporated		= 12,678	
49lbs. of cinder x 7.08 calorific power		= 346	
Allow 1 1/2 lbs, of water for draught		= 2,037	
			= 15,061
	Loss of power		= 3,801

26.—The above statement being reduced to the lbs. of water evaporated from 212 degrees, by 1 lb. of coal, will be as follows:—

9.16 lbs. actually evaporated.

0.25 "	power left in cinders
1.50 "	allowed for draught.
2.098 "	loss.
13.98 lbs.	calorific power.

27.—The difference in the calorific power of the two parcels of coal being 0.74, and the disuse of the cinders at Keyham, sufficiently account for the difference in the results in the two series of experiments, without having recourse to the larger heating surface of the flame chamber of the Elswick boiler.

VIII—WELSH COAL EXPERIMENTS.

28.—The experiments with these coals, recorded in Nos. 1, 2, 5 and 6, do not invite many remarks. The average quantity of smoke made by each coal is stated below':—

Gellia Cadoxtan	40
Resolven	25
Wayne's Merthyr	43
Merthyr Dare	100

29.—The rate of evaporation is much below that of the Hartley, the quantity of water boiled off per hour, per square foot of grate surface, being as follows:—

	cubic feet
Gellia Cadoxtan	33.5
Resolven	30.46
Wayne's Merthyr	32.02
Merthyr Dare	34.18

30.—The evaporative power of these coals was superior to that of the Hartley, partly because the samples of these coals were, of their kind, of a better quality than the north country, and partly on account of the more rapid combustion of the latter coal.

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IX— COMPARISON OF KEYHAM AND ELSWICK EXPERIMENTS WITH WELSH COAL.

31.—It will be observed, that the evaporation of both the Hartley and Welsh coals at Devonport was below the Elswick results, which is partly explained by the larger heating surface, per square foot of grate, of the latter boiler. The evaporation of the Hartley fell at Devonport 0.52 lbs. more than the Welsh, which was owing to its very inferior quality, its actual calorific value, as ascertained by Wright's apparatus, being 0.67 less than that used at Elswick, while the average sample of Welsh at Devonport was only 0.25 less than that employed at Elswick, hence the balance against Hartley was 0.42 lbs.

32.—On comparing the results obtained in the two boilers, we find that at Elswick, the Welsh (Blaengwaen Merthyr) evaporated 10.16 without the heater, and at Devonport an average of four Welsh gave as follows:—

Cardiff Wayne's Merthyr		9.25
Cardiff Merthyr Dare		9.36
average	9.40	
Swansea Resolven		9.21
Swansea Gellia Cadoxtan		9.29
average	9.25	
Or an average of		9.35 lbs.

Or 0.81 of a pound below what was obtained at Elswick.

At Elswick, the Hartley, direct from colliery, evaporated 9.6 lbs. without heater; at Devonport, an average of three experiments gave 8.27, or 1.33 below the Elswick result.

The Hartley results were, therefore, compared with the Welsh, (1.33 0.81 =) 0.52 less than at Elswick, with a sample relatively 0.42 weaker.

X.—EXPERIMENTS WITH MIXED COALS.

33.—The various Welsh and Hartley coals were very roughly mixed, in different proportions, and stoked in a somewhat similar manner to that employed when the north country coal was used.

34.—-The rate of evaporation and the evaporative power were, generally, very nearly a mean of the two kinds of coal, according to the proportions used.

35.—*The most extraordinary fact, however, elicited by these experiments, was the almost smokeless character of the mixture.*

36.—When equal quantities of Hartley and Gellia Cadoxtan were used, as in No. 10 experiment, there was practically *no smoke*. The following figures give the numbers recorded against the separate coals and the mixture :—

Hartley... ...... average 246

Gellia Cadoxtan average 40

Mixture of the two average 1

37. -The ease with which the mixture is managed in the furnace, and the diminished attention required from the stoker, are also points of great practical importance in the use of fuel on board ship, and there cannot be a doubt, that stokers generally will give a decided preference to the mixture.

38.—Without assuming that no other explanation can be given of this valuable fact, we incline to the opinion, that the dry Welsh coal assists in keeping open the bituminous Hartley coal, and thus facilitates the passage and more perfect mixture of the air and fuel, upon which the prevention of the formation of smoke, in a great measure, depends.

39.—This inexpensive plan for preventing smoke, and combining the advantages peculiar to each coal, can also be adopted everywhere, without incurring any expense in the form of apparatus, doors, or grates.

40.—The mixing of the coals can be very easily managed during the coaling of the vessel; the coal hulk can be laden fore and aft with the two coals, and when the steamer comes alongside to receive her fuel, two gangs of men can carry, the first a sack of Hartley, and the second another of Welsh, which are emptied alternately into the bunkers. This mixing, with a turn or two of the shovel before stoking, is quite sufficient for the purpose.

XI.—PRACTICE IN THE FRENCH NAVY.

41.—We are fortunate in being able to quote from a letter, the statement of the engineer of the "Prince Jerome," as to the practice adopted on board that steamer, viz, :—

For ordinary steaming 1/3 Newcastle coal, and 2/3 Cardiff.

For high speed 1/2 ditto, and 1/2 ditto.

For greatest speed All Newcastle.

42.—We also have a letter from Admiral Paris, of the Imperial French Navy, dated "Brest, 6th Sept., 1863," in which this gentleman says:—"When using foreign coals for trials at measured miles, or elsewhere, we used half Newcastle and half Cardiff, as the best mixture for our grates and boilers."

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XII—WEATHERING OF COAL.

43.—After each experiment, the tubes and smoke chamber were examined and cleaned. When Hartley coal was used, the deposit was chiefly soot, but with Welsh coal it consisted of minute particles of a material having the appearance of coal.

44.—The composition of these two deposits is as follows :—

		Welsh.
Carbon		36.28
Hydrogen		0.41
Oxide of iron, etc.		16.01
Copper, present in the form of sulphide and sulphate		6.21
Insoluble matters		23.88
Sulphur, present as sulphide and sulphate		3.45
Oxygen and loss		13.76
total	100	

		Hartley
Carbon	42.79	
Hydrogen	0.85	
Ashes	43.86	
Oxygen and loss	12.05	
total	100	

45.—It is obvious from the analysis, that the deposit from the Welsh coals arises from the sudden disintegration of this description of coal, under the influence of a high temperature.

46.—This disintegration is analogous to that which takes place when Welsh coals are stored in warm climates, and so seriously diminishes the value of this coal for distant stations, where stocks of coal must be kept.

47.—The loss of coal, from this cause, is well known to naval officers, some of whom have informed us, that hundreds of tons are continually thrown overboard as perfectly useless.

48.—This circumstance is thus adverted to in a circular of Messrs. Nixon, Taylor, and Cory, who state, that at the present time a large proportion of the mixed coal, shipped at Cardiff, is from the "Six Feet Coal Seam". This coal they say "contains large quantities of iron pyrites (sulphuret of iron) completely imbedded and blended with the coal in such a manner that it cannot be removed where it is disseminated, as it forms one of the constituents of that portion of the seam called coarse coal, the action of which, on the boiler and fire bars, is most destructive: one or two pieces will destroy the bars on which they are thrown."

49.—The peculiar and intimate manner in which this sulphuret of iron is disseminated, as Messrs. Nixon. Taylor, and Cory say, through the coal, explains the character of the disintegration of Welsh coal.

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50.—The iron pyrites rapidly absorbs oxygen from the air, increases in volume, and thus reduces the coal to a state of fine powder.

51.—The sudden action of a high heat on the iron pyrites is similar in its effects, and accounts for the showers of fine coal which often descend on the decks of steamers using Welsh coal.

52.—Another important fact connected with the use of the mixed coals is, that the small coal above-mentioned can all be worked up by admixture with Hartley coal, without producing smoke.

XII.—RATING OF STOKERS.

53.—The value of an engine of 100 horse-power may be taken at £5,000 and the consumption of fuel to keep this machinery at work for twenty days per month, and ten months per annum, will be 2,400 tons, which may be safely valued at £2400, or nearly 50 per cent, on the cost of the engine.

52.—The large quantity of this valuable material, thus consumed, and the necessity of having competent men as stokers, fully justifies the step recently taken to rate them as petty officers, and to give them a higher standing in the navy.

We have the honour to remain,

Gentlemen,

Your obedient Servants,

THOMAS RICHARDSON,

THEO. WOOD BUNNING.

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General Summary of Results.

[Table omitted]

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SECOND REPORT.

Newcastle-on-Tyne, November, 1863.

Gentlemen,

Having finished the Second Series of Experiments at Keyham, we have the honour to report the results which were obtained.

1.—We commenced these experiments on the 28th September last, and we avail ourselves of this opportunity to repeat what we stated in our former Report, that Mr. Miller, and all the officers of the factory, afforded us every facility to conduct them in a manner calculated to elicit the truth.

I.—APPARATUS.

2.—We have already described the boiler employed in these experiments, and having obtained drawings of the feed apparatus and fire doors, we are in a position to give the details of these parts of the apparatus at greater length than in our First Report.

3.—The door was of a very simple construction, and is shown in a drawing. It will he seen that the baffle plate (with as many 7-16 holes as practicable) alone is perforated, and the door intact, the air coming up through the bottom space between the door and the baffle plate.

4.—The water measured out in the top tank was weighed, and found to contain exactly 1000 lbs. at the height of the waste water pipe; and it will be seen, by reference to the drawing, that by no possible chance could more or less water be conveyed to the boiler each time the valve was opened, which was done by self-acting machinery.

5.—The mode of shortening the furnace, by the thickening of the brick bridge by adding to it in front, is indicated in the drawing. A better result would have been obtained, could a new bridge have been constructed, and a space left between it and the back of the boiler to form a combustion chamber; but we could not wait until this alteration was made.

II—THE COALS.

6.—The Welsh coal employed was a mixture of Nixon's Navigation,

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Powell's Dufferin, and Davis's Abercwomboy, in equal quantities, sent direct by the coalowners from Cardiff to Keyham.

7.—The Hartley coals consisted of two parcels of Davidson's West Hartley, sent by the northern coalowners, and a cargo of Hastings' Hartley, supplied by the Government contractor.

8.—The absolute calorific power of these different parcels of coals was as follows:-

Davidson's Hartley, No. 1	14.01
Do. No. 2	14.05
Hastings' Hartley	14.16

Welsh Mixture	14.19

III—MODE OF CONDUCTING THE EXPERIMENTS.

9.—The plan pursued in this series of experiments did not differ from that we explained in the First Report, and it will be noticed in the abstract, that the quantity of coal thrown on the grates at each stoke was nearly 20 lbs.—a fact to which we wish to call attention, as it has been said that the prevention of smoke was due to the moderate character of the stoking. In many instances, when using Hartley coal, the furnace was filled with fuel up to the arch.

IV.—SMOKE.

10.—The character and quantity of smoke produced was recorded each minute, as on the previous occasion; but in order to convey a better idea of what is meant by the figures 1 to 6, we now give a shaded diagram, with the corresponding figures, representing each kind of smoke.

11.—In this series, the quantity of smoke recorded is generally greater than with previous experiments, but this arose entirely from the character of the weather. During the previous experiments, the weather was very fine—a clear blue sky, with scarcely a cloud during the whole day. On the present occasion, we rarely had a fair day; the air was generally loaded with moisture, with dense masses of clouds. In estimating the character of the smoke, its intensity was thus apparently increased by the white background of clouds and the foggy state of the atmosphere.

12.—The practically smokeless character of the mixture of Welsh and Hartley coal, and of Hartley coal itself, when burnt with perforated doors, even under such unfavourable circumstances, is shown by the following table, which contains the average number of smoke marks per hour recorded against the coals under different conditions:—

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	closed doors	perforated doors
Hartley	48.6	7.7
Welsh	4.3	0.3
Half Hartley and half Welsh	3.5	2.6

In recording the smoke, the dark puffs evolved at each stoke with the Welsh were not noticed, as they did not continue throughout the first minute after stoking.

V.—HARTLEY COAL EXPERIMENTS.

13.—In all the experiments with these coals, we found on this, as on the previous occasion, that it was impossible to maintain a good back fire with the long grate bars, and as the results obtained under these circumstances do not really illustrate the power and speed of these coals we will not discuss the experiments made with the long bars.

14.—The bars were afterwards shortened one foot, by building a brick wall from the bottom of the ash pit up to the level of the old fire bridge.

15.—When this modification was tried on the previous occasion, the wall was formed of loose bricks built upon the grate bars, which, of course, admitted a considerable quantity of air, but in this instance the bricks were laid in mortar, so that no air was admitted at the back of the fire. This difference, trifling as it may appear, fully accounts for the great improvement which was noticed in all the subsequent experiments.

16.—The following table illustrates the effect of shortening the bars, when burning Hartley coal with perforated doors:—

Hartley Coal

Davidson	
Lbs of water evaporated per lb of Coal with long bars:	8.54
Lbs of water evaporated per lb of Coal with short bars;	10.71
Cubic feet of water evaporated per hour long bars:	33.5
Cubic feet of water evaporated per hour short bars:	43.0
Hastings	
Lbs of water evaporated per lb of Coal with long bars:	8.66
Lbs of water evaporated per lb of Coal with short bars;	10.13
Cubic feet of water evaporated per hour long bars:	34.4
Cubic feet of water evaporated per hour short bars:	44.6

17.—The effect of thus shortening the bars, was therefore, not merely to develop the power of the coal, but to increase the work of the boiler, while the grate bars were not injured in the least degree.

18.—If we compare the above results with the two best experiments made at Elswick, for speed and power, under the inspection of Messrs. Miller and Taplin, it will be found that the Keyham results are superior, taking these two elements into account.

Elswick—Water passing through the heater. Lbs of water evaporated per lb of Coal	10.99	
Elswick—Water passing through the heater. Cubic ft of Water per square foot of Grate		3.6
Elswick—Without heater. Lbs of water evaporated per lb of Coal	9.09	
Elswick—Without heater. Cubic ft of Water per square foot of Grate		4.8
Keyham Without heater. Lbs of water evaporated per lb of Coal	10.71	
Keyham Without heater. Cubic ft of Water per square foot of Grate		4.1

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19.—The idea that the Elswick boiler was specially built to prove the value of Hartley coal, although sanctioned by the observation of even such a gentleman as Mr. Taplin,* is, therefore, at once proved to be totally without the least foundation. These Keyham experiments demonstrate that the Hartley coal is truly such as its most ardent supporters have always asserted.

VI.—WELSH COAL EXPERIMENTS.

20.—The experiments made with this coal under the ordinary conditions, with long bars and half-inch spaces, furnished the following results:—

Lbs of water evaporated per lb of coal	9.81
Cubic feet of water evaporated per square foot of grate	2.4

21.—When the fires were urged to the utmost extent, under the direction of Mr. Tomlinson, the results were as follow: —

Lbs. of water evaporated per lb of coal	10.0
Cubic feet of water evaporated per square foot of grate	2.82

22.—In the latter case, however, it was found that the grate bars bad been burnt away to a far greater extent, in two experiments, than during all the previous trials. The waste actually amounted to one-eighth of an inch; or, in other words, hard firing with 28 cwts. of these coals had consumed 11 per cent of the grate bars.

23.—When the same coal was tried with short bars, the improvement was striking, but not to the same extent as with the Hartley coal, while the grate bars were not injured.

The difference in the three sets of experiments is shown in the following table:—

Long bars, ordinary stoking - Lbs of water evaporated per lb of coal	9.81
Long bars, ordinary stoking - Cubic feet of water evaporated per square foot of grate	2.40
Long bars, hard firing - Lbs. of water evaporated per lb of coal	10.0
Long bars, hard firing - Cubic feet of water evaporated per square foot of grate	2.82
Short bars, ordinary stoking - Lbs. of water evaporated per lb of coal	10.14
Short bars, ordinary stoking - Cubic feet of water evaporated per square foot of grate	3.67

*In comparing the drawings of the two boilers, there is a striking dissimilarity in design. That at Newcastle was obviously made specially for experimental trials of a peculiar coal. Its proportions favour, in a remarkable manner, the combustion of bituminous coal. Still I believe it to be undeniable, that the large amount of success at Newcastle, resulting from the practical experiments on Newcastle coal, is greatly attributable to the spacious heat chamber above referred to, judging from the above proceedings, as reported herein on the other side, taking into consideration, the advantages the new experimental boiler at Newcastle had over its competitor at Cardiff, differing in form and dimensions from those in ordinary use in Her Majesty's service, and this (apparently) designedly done to accomplish one object, namely, a successful competition.

24.—The advantages, therefore, of using short bars are not confined to Hartley coal, while the benefit to the service is even greater, when the limited space in the stoke hole and the increased power of the boiler are considered.

VII—EXPERIMENTS WITH MIXED COALS.

25.—The remarks in our former Report, on the use of mixed Hartley and Welsh coal, are quite as applicable to the experiments just concluded.

Having regard to the weather, the absence of smoke was as marked a characteristic as before, and fully justifies the language of Mr. Tomlinson, that this mixture was practically a "smokeless fuel."

26.—If we take an average of the smoke marks during the experiments with each kind of coals and the mixture of half Hartley and half Welsh, we get the following figures :—

Welsh.	Close doors	26
	Perforated doors	2
Hartley	Close Doors	258
	Perforated doors	42
Mixture	Close Doors	23
	Perforated doors	12

27.—A similar result was obtained when short grate bars were employed.

	Smoke marks.
Welsh	12
Hartley	24
Mixture	12

As we have already remarked that the puffs of smoke, at each stoke with the Welsh coals, are not recorded, but when the Welsh is mixed with Hartley coals, there are no puffs to record.

28.—The facility of stoking the mixed coals was even more marked in the present experiments; so much so, indeed, that Weekes, the stoker, often expressed his preference for the mixture, saying he could work his fires as he liked, and that it made no difference how he threw his coals on the grates.

29.—The speed and power of the mixed coals are shown in the following table :—

Mixture of Coals

Half Hartley and half Welsh, close doors - Longs bars

Lbs. of water evaporated per lb. of Coal	9.45

cubic feet of water evaporated per sq. foot of Grate	2.42

Half Hartley and half Welsh, close doors - Short bars

Lbs. of water evaporated per lb. of Coal	9.93
cubic feet of water evaporated per sq. foot of Grate	3.45

Half Hartley and half Welsh, perforated doors - Longs bars

Lbs. of water evaporated per lb. of Coal	9.55
cubic feet of water evaporated per sq. foot of Grate	2.73

Half Hartley and half Welsh, perforated doors - Short bars

Lbs. of water evaporated per lb. of Coal	10.45
cubic feet of water evaporated per sq. foot of Grate	3.70

The mixed fuel, when used with short bars and perforated doors, is,

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therefore, superior to the Welsh coals, however used, under the most favourable conditions.

VII.—EXPERIMENT WITH SMALL COAL.

30.—In order to test the power of Hartley coals to the utmost, the following experiment was made. The Welsh coals were screened through, a fine sieve, so that nothing but the very smallest coal passed through, yielding a mass of what is termed dust on board ship, and which is always thrown overboard as perfectly useless. This powder was too small to burn; alone on the grates, and was mixed with its own weight of ordinary Hartley coal. The results were as follow:—

	Mixture	Welsh Round
Lbs. of water evaporated per lb. of coal	9.93	10.14
Cubic feet of water evaporated per square foot of grate	3.45	3.67
Smoke marks	10	12

The experiment was made with close doors and short bars, and, as the result shows, the mixture was little inferior to large Welsh coals.

IX—STOWAGE OF COALS.

31.—The trials made at Keyham having proved the value of mixing Hartley and Welsh coals, we made some experiments on the stowage of mixtures of these coals,

32.—A. large box was prepared, and filled with the coals and mixtures, which were carefully weighed, and we found that the same space contained of,

1. Welsh coal, round 5 Cwts		
2. Hartley coal, round 5 Cwts		
3. Hartley round	2 Cwts 3 qrs	
Welsh broken for use 2 Cwts 3 qrs		
Total weight	5 cwts 2 qrs	10 p.c. saving in stowage
4. Hartley round	2 Cwts 3 qrs 21 lbs	
Welsh beans	2 Cwts 3 qrs 21 lbs	
Total weight	5 Cwts 3 qrs 14 lbs	17 p.c. saving in stowage
5. Hartley round.	3 Cwts 1 qrs	
Welsh dust	3 Cwts 1 qrs	
Total weight	6 Cwts 2 qrs	30 p.c. saving in stowage

33.—It is well known that the Welsh coal, when kept in store, undergoes a rapid disintegration, and produces a large quantity of beans and small, and our experiments having proved that the mixture of these different kinds of Welsh coal with Hartley, yields a fuel of great power and speed, the mixture acquires additional value from the circumstance that it occupies less bulk than either of the coals.

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X.-DURABILITY OF HARTLEY COAL.

34.-This invaluable property of a steam coal has been proved incidentally, in this and the former series of experiments, in the case of the Hartley coal.

35.—The first series of experiments were made upon a Hartley coal from a colliery adjoining the Hastings Hartley, and which we have good reasons for believing was actually four years old.

36.—This coal, after being so long exposed to the weather, when examined for its calorific power and tried at Keyham, gave the following results:—

Calorific power	12.59 at 100 degs
Evaporative ditto	8.31 at 100 degs

37.—The Hastings Hartley, from the adjoining colliery and fresh worked, furnished the following results :—

Calorific power	12.83 at 100 degs
Evaporative ditto	8.66 at 100 degs

38.—The difference between the calorific and evaporative power in the two coals was, therefore—

West Hartley Main	4.28
Hastings Hartley	4.17

or, in other words, the long exposure and hardship to which the former had been subjected, had not injured its power as a steam coal.

39.—This fact, thus incidentally elicited, strikingly illustrates the durability of the Hartley coal, and proves its vast superiority over the Welsh for use in distant stations.

XI.—RESULTS OF THE EXPERIMENTS.

40.—These experiments demonstrate the superiority of the Hartley coal in all the points which distinguish a steam fuel-—in power, speed, action on the grate bars, and durability.

41.—It is also remarkable in rendering the useless small Welsh coal practically available on board ship.

42.—Lastly, it produces, when mixed with Welsh coal, large and small, a smokeless fuel, and more easily managed by the stoker than either coal separately used in the furnace.

43.—Taking the best experiments with each coal, the Hartley is superior to the Welsh in

Power	5 $^{3/4}$ percent
Speed	13 $^{1/4}$ percent

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while, as regards speed, the best experiment made with Welsh coal was at the expense of the grate bars.

44.—The mixture of Welsh and Hartley was equal in speed with the Welsh when urged as before, but 3 per cent superior in power to the Welsh.

We have the honour to remain,

Gentlemen,

Your obedient Servants,

THOMAS RICHARDSON,

THEO. WOOD BURNING.

[Tables and results of experiments]

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NORTH OF ENGLAND INSTITUTE of MINING ENGINEERS.

GENERAL MEETING, SATURDAY, FEB. 4, 1865, IN THE ROOMS OF THE INSTITUTE, WESTGATE STREET, NEWCASTLE-UPON-TYNE.

NICHOLAS WOOD, ESQ., PRESIDENT OF THE INSTITUTE, IN THE CHAIR.

The Secretary having read the minutes of the Council, the following gentlemen were elected members of the Institute, viz.:—Mr. Robert Mitchison, jun., Kibblesworth Colliery, Gateshead; Mr. James Varley, Waterloo Foundry, St. Helen's, Lancashire; Mr. Frank Wardell, Hetton Colliery, Fence Houses; and Mr. John G. Weeks, Ryton. Mr. George Ridley, of Cowpen Colliery, Blyth, was elected a graduate.

The PRESIDENT said, he supposed they were all agreed as to the propriety of holding a meeting of the Institute in some other locality than Newcastle. Two invitations had been received—one from South Wales, and the other from Manchester. Both parties seemed desirous that a meeting of the Institute should be held at their respective localities. He was happy to find that the Institute had acquired a standing in the profession, and that an opinion was entertained in both those districts that a meeting would be of some utility. He hoped such would be found to be the case. There could be no doubt that South Wales was a very proper locality for holding such a meeting. It was varied in its character, and extremely interesting in locality; probably it was a newer locality in mining operations generally than Manchester. South Wales was later in the field of improvements than Manchester. Therefore, if the Institute was of any use in disseminating information, it might be considered that South Wales was the right place to go to. But the same might be said, in a great measure, with regard to Manchester. The mines there were very deep, and they would probably

see a greater quantity of machinery there, and some of them would, no doubt, receive instruction by the study of such works. There were also some other matters which he thought would show that Manchester would be a proper place for the meeting. They would get more accommodation at Manchester than they could have in South Wales. There were several scientific societies there, with rooms very well adapted for their meeting; and there was another matter in favour of Manchester that could scarcely be overlooked. They had been very much pressed by Mr. Dickinson, who was a member of some of those societies to which he had referred. Mr. Dickinson had been associated with a gentleman, a resident in this locality, Mr. Atkinson, with whom he had been employed by the Government to investigate the system of ventilation practised on the Continent, and they had, in furtherance of that object, visited a great many of the mining districts in Belgium and other localities in France and on the Continent. They had, he believed, been particularly investigating the mode of ventilating by machinery in contrast with the furnace ventilation of our country, which inquiry they had pursued to a very considerable extent, and he believed they had got a great deal of valuable information. If the meeting was held in Manchester, he hoped those gentlemen would avail themselves of the opportunity, and furnish the Institute with a paper on the subject. They would, no doubt, supply an extremely valuable mass of information. He knew that such a mode of proceeding would meet with the approbation of the Government for he had had some communication himself with Sir George Grey on the subject, and Sir George expressed himself anxious that all the information possessed by the inspectors should be communicated to the trade at large, so they might, he thought, rely on the whole of the information that had been furnished to the Government, with respect to ventilation, being brought before them. He anticipated that they would find no difficulty in adopting that course. If so, Manchester probably would be a more proper place than South Wales for the discussion of this subject. It would be extremely important to have the subject thoroughly discussed in the presence of those gentlemen, who, he had no doubt, would give them all the information in their power. They would also have the opportunity of discussing with the Manchester gentlemen the whole question with respect to furnace ventilation practised in their deep pits. He assumed that the members of the Institute generally (if he might judge from past experience) would be disposed to give the preference to

furnace ventilation; but he believed that extremely important results and information on machine ventilation would be laid before them. He ought, probably, to say, with respect to this part of the subject, that South Wales had stepped forward in a great respect in reference to engine or mechanical ventilation, and that might weigh in favour of their going to that locality. However, he hoped that, in the event of their meeting in Manchester, it would not prevent the South Wales gentlemen from giving them all the information they had respecting their machines, some of which, he believed, were extremely efficient With these observations he would bring before them a proposition that they should select Manchester as their place of meeting.

A resolution to this effect was carried by show of hands.

NOVA SCOTIA IRON MINES.

Mr. Hedley's paper, "On the Iron Mines of Nova Scotia," stood for discussion. Mr. Hedley was not present, but a letter had been received from him, requesting that the discussion of his paper might be delayed till the meeting in March. The discussion was accordingly postponed.

BELGIAN MINING FUND.

Mr. Morison's paper, "On the Belgian Mining Fund," stood next for discussion.

Mr. Morison said, he thought it was a subject which, if properly gone into by some of the mining engineers of this district, might be productive of good results. The Miners' Relief Fund now in operation in the neighbourhood, he understood, had been of practical utility, and he thought many of the principles of the Belgian institution might be grafted upon it with considerable advantage.

The PRESIDENT said, that the one great feature of importance attached to the Mining Fund in Belgium, which the fund here did not possess, was its connection with the Government of the country; It was, therefore, a recognized fund, subscribed to largely and patronized by the Government of the country. We had no such fund here. The Mining Fund in this country and district were local funds—there was no General Relief Fund, certainly none in any way patronized by the Government. Therefore, we were rather in a different state, and could not furnish the statistics of so extensive a fund as that of Belgium. However, he had no doubt that the gentlemen patronizing the funds of these districts would avail themselves of the information to be obtained

from Mr Morison's paper. Then, in addition to this, they had in the Belgian Fund the result of several years' working, which was extremely important. The funds in England, he believed, were looked upon with some degree of suspicion with respect to their durability. A great many of them were very flourishing in the first instance; but afterwards when the subscriptions of members fell off, for want of new members it was found to operate on the permanency of the fund. Therefore, the experience of this fund was very valuable, as showing that a fund could be supported permanently.

BOUNDARY BETWEEN THE MILLSTONE-GRIT AND MOUNTAIN-LIMESTONE.

Mr. Howse's paper, "On the Boundary between the Millstone-grit and Mountain-limestone" was next discussed.

The PRESIDENT said, that Mr. Sopwith, who was certainly an important personage in this discussion, was unwell, and though in the town, he was unable to attend the present meeting. They had, of course, read Mr. Sopwith's paper, and Mr. Howse's observations upon it. The present classification, you are aware, divides the Carboniferous-rocks into the Coal-measures, then the Millstone-grit, and next the Mountain-limestone. The Coal-measures extended down to the Millstone-grit, the Millstone-grit down to the first bed of Limestone, and then below the first bed or Fell-top-limestone inclusive occurs the Mountain-limestone, which is generally considered the lowest portion of the series. Mr. Sopwith proposed that the Millstone-grit formation should be considered as including the first and second bed of Limestone, viz., the Fell-top and the Little-limestone. The first bed of limestone was called the Fell-top-limestone, as it generally cropped out on the top of the fells; and Mr. Sopwith proposed that there should be one group from the top of the Millstone-grit down to the Little-limestone. Mr. Howse, on the contrary, did not wish to make any change, and he gave his reasons for it. He (the President) would be glad to hear the observations of any gentlemen on one side or the other. He supposed that the subject had been so put before them by Mr. Sopwith, that the Institute being a body of some weight, any decision come to by them would be of some importance. The question was whether they should give any opinion at all or not.

Mr. T. E. FORSTER said, they had better let them stand on their own merits.

Mr. TONE said, they were not called on to decide the question, they could not alter the natural position of the grit or the Limestone, and he did not think it was desirable they should give any opinion. .

Mr. HOWSE said, the matter was already decided so far as geologists were concerned. The Government Maps of Scotland had already settled this beyond doubt. If they altered the present arrangement they must alter those maps, which had been carefully prepared by the Government Surveyors lately, and published by the Ordnance Survey.

Mr. G. B. FOSTER—If they are wrong they will have to be altered.

Mr. HOWSE—The line of separation between the Millstone-grit and Mountain-limestone is based on palaeontological and mineralogical characteristics, but depending almost entirely on the fossils. There is no unconformability between these divisions. Though artificial, it is a very convenient arrangement.

Mr. BOYD said, it seemed very reasonable to continue the division as it had been between the Millstone-grit and the Mountain-limestone. In the one they had a certain class of deposits marine, and in the other the deposit contained only land-plants. If geologists had thought this a sufficient reason for the division, that Institute should hesitate before giving an opinion to the contrary.

The PRESIDENT said, he should hesitate to make any change from the present mode of classification. It had acquired so much stability, and was sanctioned by such high authorities, that they would be extremely bold if they were to propose any change. At the same time, he thought, it was only due to Mr. Sopwith that he should have an opportunity of explaining his reasons for proposing such a change. He would, therefore, suggest that the discussion should be postponed.

The discussion was postponed accordingly.

LIGHTING MINES BY ELECTRICITY

The President introduced M. Dumar, who had invented a mode of lighting mines by electricity. M. Dumar had been at his house, and he had sent his man down the pits to show the lamp to his (the President's) workmen. When the Davy-lamp was put beside M. Dumar's lamp, the Davy quite superseded it. But M. Dumar very properly said he did not wish to supersede the use of the Davy. What he aspired to was to have a lamp to use in cases where you could not use the Davy-lamp.

Mr. Easton said, a phosphoric light was not new. He had heard of a stale fish having been used for the same purpose.

The PRESIDENT said, M. Dumar would attend at any time, or send his man down a pit with any gentleman who wished to examine it.

M. Dumar then retired. The following is a written description supplied by him of his invention:—

[TRANSLATION.]

Newcastle-on-Tyne, February 3rd 1865.

TO THE MEMBERS OF THE NEWCASTLE INSTITUTE OF MINING ENGINEERS.

Gentlemen,—Among you there are many gentlemen who know the danger a miner must encounter when he is deprived of light, or when explosive gas is sufficiently abundant to render the means of illumination you employ ineffective.

The Apparatus which I present to your notice is intended to furnish light in all difficult cases, where lights by combustion becomes dangerous.

I should be very happy to learn that from the experiments my foreman, "Badin", has made before you, or some of you, that you could assure me that I have attained a desired object, and succeeded in finding a safeguard for the lives of so many men.

I have named the apparatus a Phosphorescent Light, as it gives a cold light, like the glow worm, which light suggested to me the first idea.

The means of producing light to which I had recourse is an electric current in a very rarefied gas, and *for the first time*, I might almost affirm with certainty has "Geislers" tube been used as a useful light to guide men in obscurity.

The apparatus is quite portable, and may at the same time as giving light be used for firing blasts at a considerable distance.

The entire cost of keeping the apparatus in working order is one penny per ten working hours, and it may be taken to pieces as easily as any other lamp.

I would repeat, Gentlemen, that I should esteem myself most happy if that, during my short stay here in England, I have been able to give you an exact idea of the usefulness of this apparatus, for the exceptional circumstances which are to be met with in mines.

I am Gentlemen,

Your most obedient Servant,

ALPHONSE DUMAR.

Mr. W. Cochrane read a description of a "Ventilating Machine at Elswick Colliery;" after which

Mr. T. W. Embleton read a paper "On the Patent Hydraulic Coal-Cutting Machine". He said, he had not entered into the question of cost supposing it to be against the Rules of the Institute, but if not he would do so on a future occasion.

The PRESIDENT said, certainly. That was a most important question.

The meeting then broke up.

DESCRIPTION OF GUIBAL'S VENTILATOR, AT ELSWICK COLLIERY.

By WILLIAM COCHRANE.

The ventilation of mines by machinery, though it has been at various times brought before this Institute, and its advantages pointed out in special cases, has not received the full consideration which its importance warrants; and practically the adoption of machinery in this country, instead of the generally adopted furnace system, has made very little progress. The attention of mining engineers has lately been more particularly drawn to this subject, and if a system can be established which will produce the large volumes of air required in the most extensive mines with greater economy and safer action than the furnace, doubtless it will have a claim of preference, for the position of the furnace in the mine itself, the liability to communicate fire to the coal seam or to portions of the shaft, and the most objectionable use of a furnace upcast shaft for the conveyance of either coals or men, also the damage to materials in the shaft, the necessity of slackening the furnace for examination of the drifts, often when by atmospheric variation a contrary step should be adopted for the ventilation of the mine, and, lastly, the waste of fuel—these are objections so serious as must induce the more extended adoption of machinery at the surface, when its merits are as well known in this country as they are abroad. Besides, thinner sections of coal seams are being rapidly brought into operation, and the furnace will be found incompetent to yield the power requisite for satisfactory ventilation, as the cost of providing spacious air-courses becomes too great for the economical working of the seams. In consequence of the much higher resistances with which machine ventilators can cope, and in the case of well constructed fans acting by exhaustion the large volumes of air that

can be put into circulation, the latter seem best qualified to overcome the difficulties mentioned. It is proposed, in this paper, to describe such a fan-ventilating machine, recently erected at the Elswick Colliery near this town, which fulfils many of the desirable conditions, and the results obtained from experiments thereon will serve for comparison with other systems of ventilation, while they will, it is hoped, provoke discussion on the general subject. An accurate comparison of the furnace with the various mechanical ventilators is in the hands of some of our Government Inspectors for investigation, and it would be well if the results they establish could be early published.

The ventilator is upon the principle of an exhausting fan. It consists of eight vanes, each of which is formed of $1^{1/4}$ inch oak cleading, secured by bolts to a pair of bars and angle irons, which are bolted to two cast iron octagonal bosses keyed on the main shaft. These bars being carried past the boss and interlaced, as shown in the accompanying drawing, form a very firm structure, at the same time simple and inexpensive, admitting of a speed of as much as one hundred and fifty or 2 hundred revolutions per minute, without any danger. This is an important improvement in construction, as it will be seen from Mr. Atkinson's paper upon the Elsecar Fan (Vol. XI. of Proceedings) that its construction rendered a higher speed than sixty revolutions per minute dangerous.

The outside diameter of the vanes is twenty-three feet, the width six feet six and three-quarter inches, and each vane extends about eight feet into the interior of the fan, being inclined at an angle of sixty-seven and a half degrees to a radial line through the apex of the octagonal boss.

The main shaft is driven by a vertical direct-acting engine, with cylinder $23^{5/8}$ inches internal diameter, and 19 **eleven-sixteenth** inches stroke, worked at high pressure.

A wall is built on each side of the fan, giving about one inch clearance to the side of the vanes. Outside of one wall the engine is fixed, and in the other an inlet orifice of proper size is left (in the Elswick arrangement it is ten feet diameter), such inlet being connected with the upcast shaft. An arch is carried over the fan, giving about two inches clearance to the vanes, and in continuation of this arch an invert to a point about one-eighth of the circumference below the centre line, at which point the two-inch clearance is increased gradually, expanding the lower curve of the casing till it ends in the sloping side of a chimney formed between the continuation of the side walls of the fan-erection, as

(Plates)

shown on the Plate. A sliding shutter is fitted into cast iron grooved rails for about one-fifth of the circumference, which enables the concentric circle of the top arch to be completed nearly round the fan—that is, giving the two-inch clearance to the vanes. This shutter is worked by a chain passing over sheaves at the top of the chimney and to the outside. For convenience, a manhole-door is left at the foot of the sloping side of the chimney.

The fan being set in motion, the air is drawn through the inlet from the mine, and discharged below the shutter into the chimney, from the top of which it is seen to issue at no great velocity.

This system, called from the inventor the "Guibal Ventilator," possesses the following important advantages over other machine ventilators :—

1st. —It is of very simple construction, at the same time very firm, and capable of high speed, as well as of constant working without great wear and tear.

2nd —The theory and practice of exhausting fans having hitherto been, that there should exist a free discharge all round the circumference, this is the first application to mining ventilation of an exhausting fan which is covered in as described, and in the complete arrangement of which are found the requisite correctives of such a covering, which, without them, would still offer only a very ineffective machine. By the covering the opposing action of winds is prevented, which is a serious check to fans discharging all round the periphery; but the object of chief importance is to prevent the communication of motion by the revolving vanes to the surrounding exterior air, and the formation of currents, which, in an open-running fan, creep along the sides and vanes from the exterior air to supply the partial vacuum caused in the interior by the revolution of the fan. As the demonstration of these facts was well seen in an open-running fan at the Tursdale Colliery, county of Durham, it will be perhaps better to refer to it. A sensible diminution of the ventilating current was perceived with a wind from the N. or S., the direction in which the fan discharged; in one instance, with a high South wind, reducing the air-current one-third of its usual quantity with a calm atmosphere. The air-currents from the exterior at all times could be distinctly seen entering the fan by the drawing in with them of the exhaust steam, which was at that time allowed to discharge from the fan engine at the level of the top of the fan. In consequence of Guibal's system being thoroughly and satisfactorily tested in Belgium, it was resolved to adopt

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the covering and chimney to the Tursdale fan, which was done, but only temporarily in wood the joints being made as nearly airtight as possible in the covering, but not in the chimney. The improvement will be seen on comparing the following results :—

Open running – May, 1862 - revs per min	50
Open running – May, 1862 – cubic ft. air per minute	22,170
Open running – May, 1862 - water gauge	0.55
Open running – May, 1862 - Steam pressure at cylinder	25lbs.
Open running – May, 1862 - Coal consumed in 24 hours	5 tons
Covered in – Oct., 1862 - revs per minute	50
Covered in- Oct., 1862 – cubic ft. air per minute	32,930.
Covered in- Oct., 1862 - water gauge	0.90
Covered in- Oct., 1862 - Steam pressure at cylinder	25 lbs.
Covered in- Oct., 1862 - Coal consumed in 24 hours`	4 tons

while the power utilized was found to be increased from 12,69 per cent, when open running, to 26.3 per cent when adapted as above described. The useful effect, though much improved, is still far short of what it should be; but it is thought that the construction of the fan is not good, the vanes being too numerous, and not sufficiently extended towards the centre, allowing them to slide through the air without throwing it off at the circumference.

Thus a heavy loss by the entry of exterior air into the open running fan is evident On the other hand, with the casing and other appliances of the Guibal system, the space outside the vanes, that is between their extremities and the inside of the casing, presents an aid to the ventilating power, instead of a source of loss. Contrary to what might be expected, and contrary to theory (for the air is thrown off the extremities of the vanes against the casing), a partial vacuum is found in this space, the amount of which, at various speeds, will be seen from the annexed tabulated results of experiments. But the covering in of the fan alone would produce the following disadvantages:—it would check the free discharge of the air, and would communicate to it a high velocity— hence the adaptation of the other parts, viz.:-

3rd. —-The shutter and chimney, which are the other new elements in this system, and which are claimed by M. Guibal as essential requirements of a perfect ventilating machine. By means of the shutter enlarging or diminishing the outlet, the volume of air drawn by the fan can be so regulated as to suit the special requirements of the mine, and produce the greatest economical effect. By no known theory can the quantity of air be determined which such a ventilating machine will draw from any particular mine; hence the necessity of experimental trials to determine the best size of outlet and the easy means employed for this purpose. If the outlet be too large, air will be drawn back into the fan, as is the case with open running fans, and in this also if the shutter is imperfectly adjusted. If the outlet be too small, the air cannot get quickly enough

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away. In either case, economical effect is lost; and as the circumstances of a mine are never long the same, it seems evident that a machine incapable of such an adjustment must be defective.

The following experiment upon the Elswick Fan to fix the position of the shutter shows the results above mentioned :

Calling the lowest position of the shutter zero, and the highest 1, the intermediate positions will be expressed fractionally—

a Revs per minute 55 Water gauge near Inlet 1.150

Position of shutter 1. Steam pressure 32 lbs. constant and valve not altered

b Revs per minute 60 Water gauge near Inlet 0.350

Position of shutter 0 Steam pressure 32 lbs. and valve not altered

c Revs per minute 55 Water gauge near Inlet 0.800

Position of shutter ½ Steam pressure 32 lbs. constant and valve not altered

d Revs per minute 52 Water gauge near Inlet 1.040

Position of shutter ¾ Steam pressure 32 lbs. constant and valve not altered

e Revs per minute 55 Water gauge near Inlet 1.100

Position of shutter ¾ Steam increased in pressure to get 55 revolutions

f Revs per minute 52 Water gauge near Inlet 1,085

Position of shutter 7/8 Steam increased in pressure to get55 revolutions

g Revs per minute 55 Water gauge near Inlet 1.180

Position of shutter 7/8 Steam increased in pressure to get 55 revolutions

The position of 7/8 was fixed as the best for these conditions.

The chimney contributes also greatly to the useful effect, being shaped for this special object—the sectional area increasing upwards. This enables the air which is discharged under the shutter at a high velocity to expand, and, spending its force in the chimney, to pass out at a very low velocity, thus benefitting the ventilating power to the extent of this difference. It is true that the high velocity of discharge absorbs a corresponding amount of the power applied to the fan, but the attainment of the partial vacuum in the interior of the fan, due to the centrifugal force of the vanes in the first instance, must impart to the discharged air their velocity, and it is to restore some portion of this power and make it useful for the ventilating effect that the chimney is arranged. From the following table of results the depression of the water gauge will be noticed in the positions, Nos. 3, 4, 6, 7 the three first being fixed into the space between the vanes and interior of the casing, No. 7 being near the foot of the chimney.

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(table of results)

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DIAGRAMS SHOWING POSITION OF WATER-GAUGES REFERED TO IN THE TABLE.

DIAGRAM HERE

It should be mentioned that the diagrams taken from the steam cylinder indicate an imperfect adjustment of the slide valve, which will be corrected for future experiments and will give a higher economy of the whole power employed. In this instance also the indicator had been so arranged as to interfere with the free discharge of any water accumulating in the cylinder, and this proved to be a considerable inconvenience consequent on the stoppages which frequently took place. So that the fairest comparison will be the column of useful effect calculated from the power transmitted to the fan. On a careful comparison of the diagrams, it is also found that those taken on the upper side of the piston show a lower average pressure expended in the cylinder than

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those on the under side; this will be due partially to the unbalanced weight of piston rod, etc; they were mostly taken on the under side only; so that it is expected when the next experiments are made, still better results will be obtained. It will be seen that the position of the shutter was not fixed for the best effect in each case; time would not admit of this.

It is especially worthy of notice that the water gauge indicated at the inlet is greater than the theoretical result obtained by calculation, every adjustment being correct; so that if 'h' be the height of water gauge, and h^1 the height computed, as due to the velocity of the extremity of the vanes, then

$h \div h^1$ is always greater than 1

and this result is different to that obtained from any other machine ventilator,

$h \div h^1$ in other cases is greater than 1 rarely = 0.75.

The cause of this is assignable to the prevention of the return of air currents into the fan, and the utilization of a part of the power carried off by the discharged air.

In the Elswick experiments the value of h^1 being computed from the formula

$h^1 = v^2 \div 2g \times 12 \div 815$ inches of water column,

where v = velocity of the extremity of the vanes in feet per second, the following results arise, though the shutter was not varied in each case, as it ought to be, to produce the best results :—

No. revolutions per minute 40

Indicated water gauge (h) – 0.600 Theoretical water gauge h^1 0.530 $h \div h^1$ – 1.13

No. revolutions per minute fifty.

Indicated water gauge (h)-0.925 Theoretical water gauge h^1 - 0.830 $h \div h^1$ -1.11

No. revolutions per minute 60

Indicated water gauge (h)- 1.300 Theoretical water gauge h^1 - 1.191 $h \div h^1$ 1.09

No. revolutions per minute 70

Indicated water gauge (h)- 1.875 Theoretical water gauge h^1 1.625 $h \div h^1$ 1.15

The relation h divided by h-one is generally 1.25, and it has been proved by M. Guibal as great as 1.60 in the case of a small volume of air, and the shutter nearly at its lowest. The value of h divided by h^1 if calculated from observations taken in various positions of the shutter, no alterations being made in the pressure of steam nor in the opening of the regulator valve, and multiplied by the number, of revolutions in each case, say R by $h \div h^1$ is an indication of the best position of the shutter when such product gives the highest result, for it shows that the minimum resistance is offered to the fan at the same time that a maximum water gauge is obtained.

It is upon this principle that the position of the shutter can be experimentally tried, for the production of the best economical effect.

The consumption of coals at one boiler, arranged to work this fan, was for twenty-four hours taken over a fortnight, 2 tons 16 cwts., the average speed of the fan being forty revolutions per minute, day and night. This is found to yield sufficient air for the present workings, the quantity passing through the mine being nearly 40,000 cubic feet per minute. The indicated steam pressure at the boiler is 35 lbs., to the square inch, the water gauge at bank near the inlet is decimal seven inches, and underground 0.70 inches (at higher speeds there is a greater depression at bank than underground), the seam being very low, the return air-courses are of small area, and the upcast is an 11-feet diameter shaft, used for ventilation only. No engineman is required, one of the firemen being instructed to attend to the requisite oiling of the bearings. In some cases the pumping engine-man might take the engine in charge; the simple arrangement of all the parts offers the least possible risk of any of them getting out of order.

In order to test the capabilities of the ventilator, the experiments above tabulated were made, and it will be seen, from the calculated useful effect, how much superior are the results obtained to those of previous machines of the fan type.

The cost of a fan and engine similar to those at Elswick, is about £400, manufactured in Belgium, including patent royalty; the additional cost of erection (bricks costing 25s. per thousand) was £240, including a connecting drift to the upcast.

There remain yet many interesting and important experiments to be made with this ventilator, but it has been thought advisable to bring the subject before you without further delay, as though the results are somewhat anomalous and require further investigation for accurate analysis, still the generally satisfactory working of the ventilator is clearly established. It is only fair to add that the fan was constructed specially for the circulation of 50,000 cubic feet of air per minute, with a water gauge of 1.5 inches, which it was guaranteed to yield at 60 revolutions. No. 9 experiment, therefore, with a useful effect of 52.40 per cent of the whole power applied, and of 67.56 per cent, of the power transmitted to the fan, is the nearest to the conditions for which this machine was proportioned.

(Figures of hydraulic coal cutting machine)

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On a PATENT SELF-ACTING HYDRAULIC COAL-CUTTING MACHINE, IN USE AT KIPPAX COLLIERY, NEAR LEEDS.

By T. W. EMBLETON.

It is admitted by all mining engineers that any mechanical power that can be applied to take the place of manual labour in working coal, or in bringing the coal from the working places, or any improved method of raising it up the shaft, is at the present time a desideratum. We, therefore, propose to bring before the notice of the members of this Institution a hydraulic machine for hewing coal, which is now regularly at work in the Kippax Colliery, near Leeds. It has been in successful operation there for some months, and has been inspected by many members of this Institution. This machine is intended to take the place of manual labour in "nicking" or kirving", or, as it is called in Yorkshire, "baring" the coal. The seam of coal worked at Kippax Colliery is the well-known Haigh Moor.

Its depth from the surface is 120 yards, and its section is as follows:—

Coal	3 feet 8 inches
Band of hard shale, with, pyrites	0 foot 2 inches
Coal	0 foot 8 inches
Total thickness	5 foot 6 inches

The roof is soft shale, containing thin beds of coal. It is to be noticed here, that in the Kippax and surrounding districts this coal is worked in its entire thickness, the band of shale having thinned out to two inches, as above-mentioned; but at Horbury, three miles west of Wakefield, the Haigh Moor is worked in two distinct beds, the upper and lower divisions being at that place twelve or thirteen yards apart.

The "band" at Kippax is the only part of the seam that is removed by this self-acting coal-cutting machine (it is the usual place in which the coal is bared by hand labour), and therefore no portion of the seam is made into small coal by the action of the machine.

The direction of the workings is towards the rise of the coal, or "north end," as it is locally called.

While the machine proceeds with the "baring," completing the work at once going over it, square pieces of wood and wedges are inserted loosely into the baring, at intervals of four or five feet, to keep the coal in position till the colliers come to remove it. This slight support, however, does not prevent the coal so "bared" from detaching itself from the "unbared" part of the bed. The line of fracture is a few-inches beyond the extremity or back of the " baring," and is in one even straight line.

The quantity of coal obtained for every yard of face is two tons, and the yield of small coal produced by breaking up the detached coal and the bottom coal is about eight per cent.

The lower division of the coal is blasted with gunpowder in the usual way.

Water is the medium employed to actuate this coal-cutting machine, and water being for all practical purposes incompressible, its full power, diminished only by the friction of its passage through the pipes, can, therefore, be transmitted and applied at any distance from its source.

This self-acting machine consists of a hydraulic reciprocating engine, having a cylinder of four-and-a-half inches diameter and eighteen inches stroke, working horizontally, or at any angle to suit the inclination of the coal, or at any required height above the floor. The piston-rod is a hollow trunk or ram, into which is fitted a cutter-bar easily removed, carrying three or more cutting-tools. The cutting-tools can be adjusted so as to enter the coal at any angle with the line of the face. The position of the cutting-tools will be most readily understood by reference to the accompanying plate, fig.6. Although the length of the stroke of each of the cutting-tools is eighteen inches, the practical cutting length of the stroke into the coal is about sixteen inches, and, consequently, the three cutters jointly give a total depth of four feet at each stroke. The cutting-cylinder has a valve-motion, which is entirely self-acting; and the length of stroke of the tools can be varied, or any number of strokes can be given at any part of the entire length of the stroke. The cutting-action of the tools being a steady push or thrust without any percussion, it is neces-

sary that the machine should be firmly held upon the rails during the cutting-stroke, and be released so as to traverse forward at the end of the return- or back-stroke, and this rigid fixing of the machine upon the rails is effected by means of a vertical self-acting "holder-on," which is a prolongation of the piston-rod of another cylinder, mounted upon and becoming part of the machine itself.

The piston of this cylinder is actuated by means of the same self-acting valve-motion as that of the cutting-cylinder, and the "holder-on" is retained in its "dead-fast" position by means of a small keep-valve, which retains the water during the cutting-stroke. At the return- or back-stroke the valve-motion opens the keep-valve and releases the water, thus enabling the "holder-on" to descend and to slacken its pressure against the roof, and thus the machine is free to traverse upon the rails the requisite distance for the next cut. This traversing or progressive motion is also self-acting. For this purpose a chain is made fast ahead, close upon the floor, and passes over a grooved pulley on the machine, which gets the necessary bite upon the chain. This pulley makes part of a revolution, to suit any length of traverse, at the moment when the cutter-bar is completing its back-stroke.

The amount of "feed" or distance of cut is easily adjusted, and the self-acting traversing power is sufficient to move the machine upon "skids", where they are found to be more convenient than wheels.

Unless the cutting-tools complete a full stroke, the traverse-motion does not come into operation, but the tool will continue to cut in the same place until the full stroke is completed, and then only will the traverse-motion come into action; thus the back of the baring is always parallel with the rail upon which the machine travels, thereby causing the coal to break off in one uniform line.

The cutting-tools are of a form easy of construction, and are very strong, and capable of penetrating the hardest material with little risk of breaking. The cutting-edge is nearly a quarter of an inch thick, and any or all of the cutters can be removed and replaced in a few moments. They are easily sharpened on an ordinary grindstone. The cutting-tool (Plate LXXII, fig. 9) which is now shown, has been used for baring fifteen yards of face without sharpening.

The machine can be adapted to any gauge in use for the roads of the mine, and is easily moved from place to place on its four wheels. The supplementary wheels at each end are used only when in operation, in order to secure a greater base.

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The water pressure by which the machine is actuated is produced, in this instance, by an engine placed at the bottom of the shaft.

The cylinder of this engine is fourteen inches diameter; stroke, two feet three inches. Attached to the engine are two double-action pumps of four and a half inches diameter, and twelve inches stroke. These are capable of maintaining a pressure of 350 lbs. per inch.

When the machine is not working, the engine regulates its own speed accordingly, and is further used for forcing water out of the mine to the surface. Where convenient, the water pressure may be obtained from any pumping engine on the mine, by connecting the supply pipes with the ordinary pumps, thus obviating any special outlay of capital for the moving power. The machine when working makes twenty-five strokes per minute, and uses forty gallons of water.

The water is conveyed from the engine to the machine chiefly by two-inch wrought iron pipes, the remainder being one and a half inch bore. The total length of these pipes is about 600 yards.

To allow the machine to traverse on the rails, it is connected to the one-and-a-half-inch pipes by means of an india-rubber tube of the same diameter. This tube will bear a pressure of 500 hundred lbs. per square inch. The wrought-iron pipes are the ordinary butt-welded steam tubes, tested to a pressure of 500 lbs. per square inch. They are used in preference to cast iron pipes, because they occupy little space, are easily screwed together and bent, and will accommodate themselves readily to the varying floor of the mine, with no risk of breakage or leakage.

The exhausted or waste water is conveyed away from the machine by two-and-a-half-inch india-rubber hose, and by two-inch ordinary gas-tubes, to the place whence it was forced, and thus a very small quantity of water is required to work the machine, viz., as much as is necessary to fill the circuit of the pipes. The water may be used over and over again as in the ordinary hydraulic press.

The pressure at the engine is eighty lbs. in excess of that at the machine when working at twenty strokes per minute. Whenever the cutting-tools meet with any extra resistance, the retarded speed allows this pressure to equalize itself, and thus overcome any obstacle.

The amount of pressure used for working the machine varies from 150 lbs. to 300 lbs. per inch, according to the hardness of the material to be cut

The average rate of cutting during several trials is about ten yards on the face per hour, and the maximum rate under favourable conditions is thirteen yards.

The baring at Kippax Colliery is made in a thin band of shale mixed with pyrites, which is exceedingly hard. The cutters on the machine are arranged at such a relative distance on the bar as to cut three feet three inches deep instead of four feet, this having been found, from the nature of the roof, the most suitable distance in working this particular mine. The height or width of the groove or "baring" is three and a quarter inches in front, and two and a half inches at the back.

The ram and cylinder are fitted with hydraulic leathers, as in the well-known Bramah press, and they are easy of access for renewal.

From this description it will be seen that the machine is perfectly self-acting in all its operations, fixing itself " dead-last" between roof and floor when the cutting-tools are penetrating the coal, and releasing itself during the return-stroke, and at its completion traversing on the rails the requisite distance for the next cutting-stroke.

There is no percussive action either against the roof or against the coal, but simply concentrated pressure. Irregularities or breaks in the roof do not affect the action of the " holder-on", for they can easily be bridged over, or the head will stride them. During the working of the machine there is little noise, and the cutting action being slow, there is no dust, neither is there any violent wear and tear. For the same reason, when cutting pyrites the tools throw out no sparks, and this, we think, is a decided advantage in a fiery mine; while the absence of noise enables the workman who attends the machine to detect any movement either of the coal or of the roof.

It may not be out of place here to state, that there is hardly any limit to the pressure of the hydraulic power as applied in this machine.

The limit would appear to be what the flexible pipes will bear, and we understand that they can be made to sustain a pressure of 1000 lbs. per inch; and as water is practically incompressible, the length of the pipes necessary to reach to the most distant part of a mine need be no hindrance to the application of the machine.

In the works at Kippax the hydraulic pressure from these pipes is used to work a double-action pump in the dip workings, and it is equally applicable to actuate a rotative water-engine for hauling or other purposes.

The results of a few trials of the machine, of which we have taken notes, are appended.

On the 16th November,1864, the machine was at work, including ail stoppages, for four hours fifty minutes, and during that tame bared sixty-eight feet on the face to a depth of three feet three inches. This

is equal to 16 $^{1/3}$ feet per hour. The stoppages amounted to one hour fourteen minutes. Taking the time actually employed (two hours fifty-six minutes), the extent of face hared per hour is twenty-three feet.

On 30th November, 1864, the machine began to work at 12:21, and in thirty minutes the distance completed was fifteen feet; and in the next half hour, thirteen feet four inches; and in the third half hour, fifteen feet, being an average of 28.10 feet per hour.

On the 15th December, 1864, in seventy-four minutes thirty-six feet were completed, being after the rate of twenty-nine feet per hour.

On the 24th January, 1865, in eighty-two minutes the distance was thirty feet, equal to twenty-two feet per hour. In this trial, owing to a fall of the roof, the stoppage amounted to thirty-six minutes. The time actually employed was forty-six minutes, being at the rate of thirty-nine feet per hour.

It must be borne in mind that these trials are the results of the first machine. The principal working parts in the subsequent machines are made of steel, and the cylinders lined with brass. The " holder-on " is made to descend by water pressure as well as by gravity, so as to enable the machine to work freely in dip workings under back-pressure. Besides the quicker descent of the "holder-on", the area of the main cylinder is slightly increased, so as to accelerate the back- or return-stroke of the cutting-tools, from which it is fair to infer that a greater length of face per hour will be accomplished to any required depth at once going over.

STATEMENT OF THE COST OF WORKING THE COAL-CUTTING MACHINE AS COMPARED WITH HAND LABOUR IN THE HAIGH MOOR COAL, AT KIPPAX COLLIERY.

Feb 10

Distance Bared on Face in Feet	111
Time of Trial in Hours	11½
Feet bared on Face per Hour	9.65
Wages Paid at Each Trial	28s. 9d.
Capital per Day	5s. 6 ½d.
By Machine per Yard of Face	11 d.
By Machine per Ton	5 1/2 d.
Hand Labour per Ton	8d.

Feb 14

Distance Bared on Face in Feet	105
Time of Trial in Hours	15
Feet bared on Face per Hour	7
Wages Paid at Each Trial	25s. 11d.
Capital per Day	5s. 6 ½d.
By Machine per Yard of Face	10 ¾ d.
By Machine per Ton	5 3/8 d.
Hand Labour per Ton	8d.

Feb 16

Distance Bared on Face in Feet	42Forty-two
Time of Trial in Hours	3
Feet bared on Face per Hour	14
Wages Paid at Each Trial	6s. 5d.
Capital per Day	5s. 6 ½d.
By Machine per Yard of Face	10 ¼ d.
By Machine per Ton	5 $^{1/8}$ d.
Hand Labour per Ton	8 d.

Feb 17

Distance Bared on Face in Feet	111
Time of Trial in Hours	8
Feet bared on Face per Hour	13.87
Wages Paid at Each Trial	18s. 8d.
Capital per Day	5s. 6 ½d.
By Machine per Yard of Face	7s. ¾ d.
By Machine per Ton	3 $^{7/8}$ d.
Hand Labour per Ton	8d.

Feb 22

Distance Bared on Face in Feet	117
Time of Trial in Hours	11 ½
Feet bared on Face per Hour	10.17
Wages Paid at Each Trial	22s. 8d.
Capital per Day	5s. 6 ½d.
By Machine per Yard of Face	8 ½ d.
By Machine per Ton	4 ¼ d.
Hand Labour per Ton	8d.

During these trials the machine was much out of order, the baring excessively hard, and the faces short.

The sum under the head of capital is thus obtained -—Cost of engine for working the machine, the machine itself, boiler, pipes, and all other expenses, £600. The engine is capable of actuating two machines.

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Allowed 20 per cent, for interest and wear and tear, £120,

This on 250 working days is	9s. 7d.
Slack (unsaleable)	1s.

Oil, tallow, etc.	6d.
Total divided by 2	11s. 1d.
	5s. 6 ½d.

This is assumed as a constant sum in each trial.

The produce of slack, taken from the coals sent out of the pit, and got by manual labour, in January and February last (a portion of slack being left below), is 18.3 per cent.

The produce of slack from the quantity of coal bared by the machine is 8 per cent., and all is sent out of the pit.

The difference in price between coals and slack is 4s. a ton.

Hence 18.3 – 8 = 10.3 x 4s. = 41.2 ÷100 = 4.94d. per ton.

The quantity of slack left underground is18.75 per cent, when the coal is bared by hand, and is altogether lost.

Average price of all kinds of coal and slack sold is	5s. 6d.
If the 18.75 were sent to the surface the cost would be	3s.
Loss per ton	2s. 6d.

Hence 18.75 x 2s. 6d. = 46.10 ½ ÷100 = 5.62d. per ton.

Therefore, supposing that there is no actual saving in baring the coal by the machine, there is in this instance a saving of 10.58d. per ton in the produce alone.

Any coal can be worked "end" by the machine instead of board.

At Kippax the quantity of slack produced, when the coal was worked "board," was 33 per cent; now, when it is worked "end", 18.3 per cent on the coal sent out.

NORTH OF ENGLAND INSTITUTE OF MINING ENGINEERS.

GENERAL MEETING. THURSDAY. MARCH 2, 1865, IN THE ROOMS OF THE INSTITUTE, WESTGATE STREET, NEWCASTLE-UPON-TYNE.

JOHN B. SIMPSON, Esq., in the Chair.

The following new members were elected, viz.:—Mr. Thos. Gilchrist, Newbottle Colliery, Fence Houses; Mr. John Lancaster, jun., Hunwick, etc., Collieries, Bishop Auckland; Mr. Henry Aiken, Falkirk, North Britain; Mr. J. J. Horsfall, Fairbottom Colliery, Ashton-under-Lyne; Mr. Henry Richardson, Backworth Colliery, Newcastle; and Mr. Robert Miller, Outwood, Wakefield, Yorkshire.

Some conversation took place relative to the proposed meeting in Manchester, letters on the subject having been received from Mr. Andrew Knowles, President of the Manchester Geological Society, and Mr. Dickinson, Government Inspector of Mines.

Mr. GREENWELL said, they should communicate with the Lancashire and Cheshire Coal Trade Association, the committee of which would hold a meeting next week, at which he expected to be present.

Mr. BERKLEY moved, that the proposed meeting be held in Manchester in the early part of July next, subject to the approval of the Lancashire and Cheshire Coal Trade Association; and that the Secretary be instructed to send particulars of the proceedings at the Birmingham meeting to the President of the Association.

Mr. SOUTHERN seconded the motion, which was carried unanimously.

THE IRON MINES AND MANUFACTURES OF NOVA SCOTIA.

Mr. Hedley's paper on the Coal-field of Nova Scotia stood for discussion, but the author was not present'

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Mr. GREENWELL said, there was nothing to discuss in a paper of this kind: there was no theory brought forward.

Mr. BERKLEY begged to move that the discussion be passed over, but that it may, by the desire of any member, be renewed at a future meeting, when Mr. Hedley is present.

Mr. GREENWELL seconded the motion, which was carried by show of hands.

Mr. Howse's paper on the Boundary between the Millstone-grit and Mountain-limestone stood next. It was remarked that, as other gentlemen interested in the discussion were absent, it had better be postponed.

This was agreed to.

Mr. GREENWELL read a paper " On the Rating of Coal Mines."

Mr. RAMSAY—You separate houses, coke ovens, and everything else.

Mr. GREENWELL said, he wished to lay down a principle. You are holding and occupying the fixed plant in a colliery, in the same way as you are holding and occupying a house. It matters not what trade you carry on in the house; and it matters not what profit you make in the colliery. The profit is not rateable at all.

Mr. GREEN—You take a tonnage rate.

Mr. GREENWELL said, he would rate every colliery. The reason he would put it in this form was that it worked hand-in-hand with the statute.

The CHAIRMAN said, that generally a colliery was in different townships, and the rate must be proportioned to each.

Mr. GREENWELL said, the first thing was to discuss the general principle. The rate was a rate of occupation. Where the colliery plant was situated, there the rate ought to be paid.

Mr. HAGGIE said, that would be awkward for parishes.

Mr. GREEN said, the difficulty would be obviated by all the parishes being thrown into a union.

Mr. GREENWELL said, he was not certain whether coke-ovens were rateable at all or not. He thought the cost of repairs would come to more than the rent, and therefore they would not be rateable. If the repairs came to the full amount of the rent, they could claim the amount as a set-off for rateable purposes.

Thanks having been voted to Mr. Greenwell for his valuable paper, the proceedings terminated.

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ON THE RATING OF COAL MINES.

By G. C. GREENWELL, F.G.S.

The principle of rating coal mines is contained in the Parochial Assessment Act, 6 and 7 Wm. IV., c. 96. It is there enacted that no rate for the relief of the poor should be of any force which should not be made upon an estimate of the *net annual value* of the property rated, that is to say, of the rent at which the same might reasonably be expected to let *from year to year*, free of all usual tenants' rates and taxes, and tithe-commutation rent-charge if any, and deducting therefrom the probable annual average cost of the repairs, insurance, and other expenses necessary to maintain it in a state to command such rent.

Such is the principle as laid down by the statute, but such certainly is not that upon which coal-mines are ordinarily rated.

Coal mines are usually rated in proportion to the amount paid to the proprietor as the purchase of the coal *in situ*. This clearly is not what is meant by the statute, for the rent of anything let from year to year, implies that the thing let continues from year to year, and requires repairs, insurance, and other expenses to maintain it in a state to command the rent.

It is also universally admitted that stock-in-trade is not rateable, and it is clear that immediately the coal has been severed from the freehold it has become stock-in-trade. It is not paid for to the landlord until so severed, and the payment is therefore a simple working charge incident to the production of a marketable article, as money paid to a landed proprietor for a tree is a charge incident to the production of those articles into which the tree may be manufactured.

Upon the principle laid down by the statute, the machinery of a mine is not rateable, because no amount of repairs, etc, would maintain it in

the same state from year to year: and the repairs added to the depreciation would, in most cases, exceed the amount which might be paid as a rent for such machinery.

Practically, the rent at which a coal mine should be let to a tenant from year to year, would be the rent that he would give to the landlord for such fixtures as the previous tenant could not remove.

He could not thus become tenant of the machinery at all—he would have to purchase it, and he could only do this in the event of the previous tenant being willing to sell.

It has been proposed* that "the annual value of a colliery, therefore, must mainly depend upon the produce of the mine, and the cost of production with the use of the machinery and other appurtenances belonging to it. The clear annual proceeds, arising from the sale of the coals, must first be ascertained, after deducting all the current costs of working and management, all usual tenants' rates and taxes, the probable average cost of the repairs, insurance, and other expenses incident to the mine, the machinery, works, ways, staiths, buildings, and other property of the colliery. In districts where the mineral is subject to tithe, the tithe-commutation rent-charge should be deducted. It may then be inquired, what would be the amount of reasonable rent which a yearly tenant should pay for the whole colliery, in order to secure to him a proper profit and remuneration for his risk and undertaking, and under the assumption that the mine will continue to be worked in a regular and workmanlike manner. The amount of this rent will be the proper source of the rate."

This mode of assessment would have the simple effect of converting a poors' rate into an income-tax, and would place colliery property in an unfair position with regard to every other manufacturing property in the kingdom. It would be as consistent as to rate a bank, a cotton mill, or an iron foundry, in proportion to the amount of business done and profits realized.

It is besides laid down ** that "a fictitious value which a mine acquires from peculiar circumstances, must not be mistaken for the probable amount of rent for which the mine would let to a bona fide company."

In the present state of the law, however, coal-mines are rateable: the principle has, as before stated, been clearly laid down, and my object

*Bainbridge, Law of Mines and Minerals, 2nd Ed., p. 459.
**Rogers, Law of Mines, Minerals and Quarries, p. 523.

in this paper is to attempt so to apply it as practically to meet every case, and to avoid the anomalies to which its general interpretation has hitherto given rise.

It is submitted that a mine should be viewed in the same light as a house or a factory, and that, as in the case quoted by Mr. Rogers, all peculiar circumstances should be completely discarded.

It is therefore suggested, that the rateable value of a colliery should be based on such rent as would be given to a landlord for the immoveable plant necessary, on the average of the whole kingdom to produce the quantity of coal worked at any given colliery. It appears from Mr. Hunt's statistics that the average production is about 30,000 tons per colliery per annum. I assume for the sake of argument, that the average depth of the colliery is 120 fathoms, and that the average cost of shafts, engine-houses, and other unmoveable plant necessary to produce 30,000 tons per annum is £10,000.

House property usually produces 6 per cent., and I therefore propose 6 per cent, to be applied in this case for assessment, which would produce £600 per annum. Still applying the custom of rating houses to collieries, I would make a reduction, say, of one-sixth for repairs, &c., thus making the rateable value of collieries £500 per annum for every 30,000 tons of coal raised.

Thus, a colliery producing150,000 tons per annum would be rated at £ 2,500; and one producing 300,000 tons at £5000.

The foregoing proposal I submit to the North of England Institute of Mining Engineers with great deference: none know better than they the difficulties that now exist in getting rating matters arranged. I have endeavoured to suggest a plan which I think easy of general application, and at the same time consistent with the Parochial Assessment Act, and calculated to avoid what has been, and, as at present conducted, will always be a fruitful source of litigation and annoyance.

NORTH OF ENGLAND INSTITUTE OF MINING ENGINEERS.

GENERAL MEETING, SATURDAY, APRIL 1, 1865, IN THE ROOMS OF THE INSTITUTE, WESTGATE STREET, NEWCASTLE-UPON-TYNE.

EDWARD F. BOYD, Esq., in the Chair.

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

An application from Mr. Embleton, for the republication of his paper, was then brought before the meeting. The Secretary stated that Mr. Embleton's request had been granted, on condition that he would pursue the invariable rule adopted in these matters. This was also confirmed.

The following gentlemen were unanimously elected members of the Institute :—Mr. John Oliver, Victoria Colliery, Coventry; Mr. Stuart C. Wardle, Townley Colliery, Blaydon-on-Tyne; and Mr. John Darlington, of the firm of Phillips and Darlington, Moorgate Street Chambers, London.

The CHAIRMAN said, the next matter was the consideration of the paper read by Mr. Cochrane, at the February meeting, viz., the "Description of M. Guibal's Ventilator at Elswick Colliery."

After a few remarks from Mr. Atkinson on the subject, the meeting broke up.

NORTH OF ENGLAND INSTITUTE of MINING ENGINEERS.

GENERAL MEETING, THURSDAY, MAY 4, 1865, IN THE ROOMS OF THE INSTITUTE, WESTGATE STREET, NEWCASTLE-UPON-TYNE.

GEO. W. SOUTHERN, ESQ., IN THE CHAIR.

The Secretary having read the minutes of the Council, and a letter from Mr. Embleton, expressing his regret at not being able to attend, and Mr. Greenwell also being absent, the meeting adjourned, there being no business of any kind before them.

NORTH OF ENGLAND INSTITUTE of MINING ENGINEERS.

GENERAL MEETING, SATURDAY, JUNE 3, 1865, IN THE ROOMS OP THE INSTITUTE, WESTGATE STREET, NEWCASTLE-UPON-TYNE.

NICHOLAS WOOD, Esq., President of the Institute, in the Chair.

The SECRETARY (Mr. Doubleday) having read the minutes of the Council,

The PRESIDENT called attention to a programme which had been drawn up with reference to the Manchester Meeting. He believed that on a former occasion a committee was appointed to make arrangements, and this had been productive of very considerable benefit. He thought that in this case they could not do better than follow the example of the Birmingham Meeting, he would therefore simply move that a committee be appointed to cooperate with the committee which was already appointed in Manchester with reference to the arrangements which had to be made for the meeting in July.

The motion was agreed to, and the following gentlemen were appointed to form the committee, with power to add to their number, viz.:—Messrs. John Daglish, Lindsay Wood, T. Douglas, W. Cochrane, and E. Boyd.

On the motion of the PRESIDENT, the resolution of the Council of 25th March, fixing the days of meeting for the 11th, 12th, 13th and 14th July, was confirmed.

COAL-CUTTING MACHINE AND RATING OF COAL-MINES.

The paper of Mr. Embleton on the "Patent Hydraulic Coal-Cutting Machine," in use at Kippax Colliery, stood for discussion, but that

gentleman not being present the meeting took up the paper of Mr. G. C. Greenwell, on the "Rating of Coal-Mines."

Mr. GREENWELL said, he had only one remark to make, and that was in illustration or corroboration of the view taken in the paper, namely, that when the coal had been sold by the landlord to a purchaser, it was a creation of a new capital capable of being invested, and producing a rent which then became rateable. Now if, in the first instance, they rated the freehold, this property would be rated twice over. A remark had been made to him to this effect:—"Don't you think that difference of situation may make a thing more valuable?" His reply was, "Yes, more valuable as a saleable article.”

Mr. MARLEY said, he agreed very nearly in the remarks of Mr. Greenwell, but he wished him more clearly to define the difference between moveable and immoveable "plant." Further he might go on to illustrate Mr. Greenwell's remarks. A rent was usually reserved on coal; and it became the lessees and the lessors—the lessors particularly to consider if they were to have a continuation of the income tax—how far they should modify their leases so as to make it a bona-fide sale, the purchase money to be paid by instalments. He believed that in every case it was a sale, and as now it was an assessment of income tax on the instalments of the purchase money. He knew one case where it was so put in a legal document as to avoid coming in the shape or appearance of rent. The money was paid by instalments, and though the instalments varied by the tonnage, it was still a sale. He would avoid the income tax on the whole of them. It was a payment of purchase money by instalments.

Mr. GREENWELL said, the distinction he drew was this:—what he called immoveable "plant" was what, at the termination of his lease, a lessee could not take away, such as shafts, engine-houses, and other buildings which would remain the landlord's property, and he could let to an incoming tenant, Moveable "plant" was everything which a lessee could take away.

Mr. BOYD said, with regard to the income tax, Mr. Marley would have some difficulty in establishing his proposition to get rid of it. Assuming that the payment per ton was a payment of instalments, yet if a lessee was receiving newly-created capital, the annual sum would certainly seem to be rateable to the income tax.

Mr. MARLEY said, he did not mean to say that no amount or sum by way of rent was not liable to the income tax; but he said that the tonnage rent should not be the rent on which the income tax was rated. But that the proposed principle, which was arrived at in Mr. Greenwell's paper, in rating a colliery should be the same for the assessing of the income tax. He agreed with Mr. Greenwell as to the definition of moveable and immoveable "plant." Mr. Greenwell said, what would the landlord get for the colliery that was left? It would be a little uncertain as to what the landlord would get. It would depend somewhat upon whether the colliery had a deep shaft or a shallow one; and it would vary with the position of the articles which he had to sell.

Mr. GREENWELL said, the lessor having sunk the shaft, asks a rent from the new lessee. If it came to the question of income tax, he quite agreed with Mr. Marley. He thought that an income tax on the thing to be sold, ought to be fairly levied.

Mr. BOYD said, if this subject was discussed any further, it would be desirable that Mr. Taylor should be present, that he might give them an account of the mode of rating at Ryhope Colliery.

The PRESIDENT suggested, that they should postpone the discussion, and that Mr. Taylor might be asked to furnish them with all the papers.

Mr. BOYD said, if any steps could be taken by which they could improve the condition of the rating of collieries, he did not believe that any remarks would be of greater weight than those coming from the members of this Institute.

Mr. MARLEY said, if there was any intention to get information from Mr. Taylor on the rating question, he would move that the discussion be adjourned.

The PRESIDENT said, this was a very important discussion. It was a subject which he had had before him on another occasion when he had presided. He referred to the meeting of Associated Coalowners of Great Britain. This was one of the subjects that had been repeatedly before them. The result of those discussions was anything but satisfactory. He did not know that they could throw much more light upon it. Coal-owners from different districts had given their opinions as to the mode of rating, but as he had said, the result of the discussions was not very satisfactory. He very much regretted that it was not in his power to take part in the discussion on this occasion, which he was very anxious to do. It was known to them all that he had not attended these meetings lately; and he was sorry to say that the cause of his not attending was want of health. The same cause had disabled him from taking part in

this discussion to-day. He trusted that the discussion might not end at this meeting. There would be other meetings, when he hoped he would be in better health, and better able to take part in the discussion. He was not sure that the state of his health might not operate in preventing his attending the meeting at Manchester. He should very much regret if he was prevented from presiding on that occasion; but, looking at the state of his health during the past month or so, he could not be certain that he would be able to attend. He regretted it very much. Nothing would induce him to forego attendance on that occasion except sheer necessity. He thought it was desirable if they could look about for some gentleman, in case he was not able to attend. He should like the Institute to be supported on that occasion, and he knew that there were gentlemen connected with the Institute who were able, and he believed, willing, to undertake the task, if he should not be present. It should be some gentleman who had the confidence of the Institute. He should certainly, if able, make a point of attending, but he thought it due to the meeting to make these remarks.

Mr. E. POTTER said, he only expressed the sentiments of the members present, who had heard the statement of the President as to the state of his health. They all hoped that he would soon be in good health again; and that he would be able to preside at Manchester. There was another subject which had occupied the attention of the members for some time, and that was, to place some memorial of their President in that room, where he had on so many occasions illustrated the various subjects which had come before the Institute for their discussion. He was only sorry that Mr. Southern was not here to open the subject, for they were indebted to him for having originated the idea. The proposal was that a portrait, which might now be seen in the gallery of Mr. Turner, and which had been inspected by many members, should be hung up in that room. All would agree that it was a very good likeness, and would help to perpetuate the memory of their President.

Mr. BOYD supported the proposition. He thought it was a fitting compliment to pay to their President. Those who had seen the portrait would agree with him, that it was not only a very good likeness, but a handsome work of art.

The PRESIDENT said, he scarcely knew what to say except that he was greatly obliged to them. He felt very much the compliment they proposed to pay him. He thought he had done to the best of his ability what he considered to be a duty to the profession. If his labours had

been productive of any good, he was fully repaid by their kindness. At the same time he could not object to any memento that should serve as it were to keep alive the sort of feeling that ought to pervade the members of the Institute where any member had done his duty. He was obliged for the suggestion made, and no doubt it would be well considered before it was carried into effect. Anything that could tend to perpetuate the labours of that body could only be for the general good.

NOMINATION OF OFFICERS.

Mr. MARLEY said, to-day was the day for nominating the officers for the ensuing year, and some of the members then handed in papers of nominations.

COAL-CUTTING MACHINES.

Mr. DOUGLAS said, with regard to the question of coal-cutting machines, it would be interesting to hear from persons who had had opportunities of judging, their opinion of the merits of these machines. Mr. Lindsay Wood had read a paper on Firth's machine, and he had tried one at Hetton. He had also seen the Kippax machine, and he would, perhaps, be prepared to say how far one was superior to the other in his judgment. There were at present three kinds of machines in operation. The Kippax machine acted on the slotting principle, those such as Firth's on the pick principle, while Harrison's machine, recently introduced into the Bishop's Close Colliery, had a rotary motion. He trusted this very important question would be fully gone into at the Manchester meeting.

The PRESIDENT said, it was a subject which he would not like to have passed over in an imperfect manner.

Mr. COCHRANE said, it would no doubt be discussed at the Manchester meeting, and they might leave it till then.

Mr. MARLEY said, they would still have to discuss the question here. For if true that they would only have two hours in the whole four days for the reading of papers, they could not have many papers read or discussed at Manchester. They might leave it till the annual meeting, when it would make a good subject for discussion.

Mr. LINDSAY WOOD said, he had been in communication with Mr. Dyson, for the trial of his patent. Firth's machine was the only one which had been tried at Hetton as yet. When both had been tried, he would be able to make a comparison of their respective merits.

The meeting then broke up.

NORTH OF ENGLAND INSTITUTE OF MINING ENGINEERS.

SPECIAL MEETING AT MANCHESTER, JULY 11th, 1865.

The formal business of the meeting was opened on Tuesday morning, July 11th, in the Lecture Theatre of the Royal Institution, Mosley Street, Manchester.

J. T. WOODHOUSE, Esq., in the absence, from illness, of Nicholas Wood, Esq., the President, occupied the chair, and in his opening- remarks said:—It is not customary, gentlemen, at meetings of this important character, for the Chairman to bring himself very prominently forward in the first instance. The Chairman is generally noticed later on in the day; but in this particular case I, perhaps, may be pardoned if I ask your permission to say one or two words for myself, and to explain to you the great difficulty that I am now labouring under, in consequence of having been most unexpectedly called to fill this chair. It was only yesterday, at the hour of one in the afternoon, that I received this letter from the Council of the Institute, which, if I am not taking up too much of your time, I will read. [The Chairman then read the letter from Mr. Doubleday to himself, enclosing a resolution from the Council, to the effect that Mr. Wood being unfortunately unable to attend the meeting, Mr. Woodhouse was the most proper person to undertake the duties of Chairman at the meeting.] The Chairman, in continuation, said—Irrespective of a request of that sort, I should certainly have attended this meeting; but I regret very much indeed that some person, or one of the Vice-Presidents, much more competent than myself, was not appointed to take the chair. And I regret it very much indeed, because, as some of you are aware, I am not resident in the North of England. I am what you may call a southern man; but I have the honour to be a member and one of the Council of the Institute whose Vice-Presidents are Mr. Armstrong, Mr. J. Taylor, and Mr. Thomas

E. Forster. I had an assurance from Mr. Thomas E. Forster that he would be here to-day, and I deeply regret that it is not so, for I do feel that this Institution ought to be represented to-day, and throughout the whole of these proceedings, by a man from the North of England. However, it is not so. It appears that those gentlemen are " rather backward at coming forward," as the saying is, and sooner than leave the ship to go to wreck, I myself will take, as far as I can, the conduct of the business of this meeting. The fact is this: I shall throw myself upon the meeting —not in a physical point of view, because there would be a little injury to somebody—but I shall throw myself entirely upon your generosity. Be so good as to cheer me up in the usual way, by calling " hear, hear," whenever I appear to be sticking fast, and I have no doubt we shall pull through. I will now take a brief notice, if you will permit me, of regret at the absence of our excellent President, Mr. Wood. I have had the honour to know Mr. Wood a great many years, and to sum up in a few words that which many of you feel quite as warmly towards him as I do—to know Mr. Wood is to love him. I think of all the scientific men I have ever met, there is no man who combines so much the thorough English gentlemen with the practical qualities of the man of science, as Mr. Wood. His uniform urbanity, his kindness, and his attention to details of every kind, enlist our sympathies towards him, and we cannot but feel a deep regret at his absence. I cannot but think that his absence will throw a deep shade over this meeting. But it is caused by illness, not, I trust, of a kind permanently to weaken his health. I am informed by a gentleman from the North of England, who well knows Mr. Wood, that he fully intended, notwithstanding his ill-health, to come here and take part in these proceedings, and that it was only at the urgent remonstrances of his medical advisers that he stayed away. I believe there will be an expression of sympathy with Mr. Wood passed on some day during the present meeting. There is a great deal before us to do. There are members to be elected, there are papers to be read, and there are many hospitable dinners also to encounter. I have moved about a good deal amongst one sort of society or other, but, speaking as a member of the Northern Institute, I have never seen an instance where a society has been so warmly and hospitably received, and such a programme set before them, as the gentlemen of the South Lancashire and Cheshire Coal Association have set forth for our entertainment now. It would take up too much time to go through the whole programme, and, if all be well, I may have another opportunity, perhaps to-morrow, or

the next day, if you will permit me, to go through the pleasures which are prepared for us. I will content myself at present with the business of to-day. [The Chairman then gave an outline of the proceedings for the day.] He continued:—First of all, there is a list of new members who will be elected to-day, or considered to be elected, the names having been suspended in the usual way at Newcastle, and they are *de-facto* members. Next, new members will be elected by the proposal of any three members. These will enjoy the privileges of membership pending their election one month hence; and I sincerely hope they will take a long part in the present discussions. The following gentlemen are proposed for election as members:—Thos. Greener, Etherley Colliery, Darlington ; Herbert Fletcher, Clifton Colliery, Manchester; Kay Knowles, Pendlebury, Manchester; Joseph Cooksey, West Bromwich, Staffordshire; J. H. Cooksey, West Bromwich, Staffordshire; R. M. Knowles, Eagley Bank, Bolton; Elias Doming, 41, John Dalton Street, Manchester; Clegg Livesey, Bradford Colliery, Manchester; Edward Burns, 14, Pimblett Street, Cheetham, Manchester; Joshua Lancaster, Kirkless Hall Colliery, Wigan; Samuel Lancaster, Kirkless Hall Colliery, Wigan; Hugh McDonald, Standish and Shevington Canal Co., Wigan; T. W. Hilton, Haigh, Wigan; William Evans, Ruabon Iron Works, Ruabon; Robert Southern, Coxhoe Colliery, Ferryhhill; Charles S. Homer, Chaterley, Tunstall; Wm. Lowe, jun., Wrexham; Thos. S. Hindhaugh, Newbury, near Bath; James Campbell, Staveley Works, Chesterfield; George Hales, Broncoed, Mold; Wm. Bryham, jun., Ince Hall, Wigan; P. Higson, jun., Brookland, Swinton, Manchester. This, gentlemen, as regards the proposal of new members. It is one of the advantages of this Institution, that if we can only secure plenty of practical talent, we shall get men who are taking an interest in the development of science as applied to our particular vocation in life. The Chairman concluded by calling attention to the papers to be read that morning.

The following papers were read and discussed, viz.:—-

No. 1.—" On some of the Leading Features of the Lancashire Coal-field," by Joseph Dickinson.—Mr. Dickinson presented a printed copy of the paper referred to therein.

No. 2—"On Direct-Acting, Pumping, and Winding Engines," by John Knowles.—Discussion adjourned to Thursday morning. Mr. Knowles was requested to supply further details for the table of results.

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No. 3. —" On an Improved Plan for Drawing Coals," by Robert Aytoun.* Mr. Aytoun not being present, this paper was not discussed.

No. 4. —" On Safety-Cages," by J. Marley.

After the discussions, votes of thanks were passed to the authors of the papers.

The meeting was then adjourned for an excursion to Messrs. Knowles' collieries.

July 12th. —The business of the meeting to-day consisted in an excursion to the London and North-Western Railway Company's workshops at Crewe, and the Kirkless Hall Coal and Iron Company's works.

July 13th. —The meeting at the Royal Institution was resumed this morning, at ten o'clock, J. T. Woodhouse again presiding.

The CHAIRMAN, in opening the business, said, gentlemen, it will be in your recollection, that at the opening of these proceedings, I told you that there was a list of members, who had been duly proposed at Newcastle, which by some mistake had been left behind. I have the names of the gentlemen before me, and their formal election now, therefore, rests with you:—J. H. Hedley, Geo. Oliver, R. L. Booth. Astley Thompson, T. M. Bunning, Becket S. Chadbourn, and Benjamin Biram. If it is your opinion that the election of these gentlemen be confirmed, say " aye"; to the contrary, "no."

The list was unanimously adopted.

The CHAIRMAN then read a second list of gentlemen proposed at the present meeting, and who would enjoy the privileges of membership at once, on being nominated. They were nominated accordingly, and the intimation was made that their names would be suspended in the council room at Newcastle, for one month, in the usual way. They are as follow:—S. Firth, Manchester; Thos. Shortreed, Manchester; John Thompson, Field House, Hoole, Chester; E. Mammet, C.E., Barnsley, Yorkshire; J. Howard, Blackwell; John Marshall, Smithfold Colliery, Little Halton, near Bolton; James Stott, Basford Hall, Stoke on-Trent; Henry Ashworth, The Oaks, near Bolton; John C. Sutcliffe, North Gawber Colliery, Barnsley.

The CHAIRMAN then said, he was requested to inform them that the

•As this paper has already been published in the " Colliery Guardian," July 8th, the Council consider it advisable not to reprint it in the Transactions of the Institute.-ED

proprietors of the following mines had very kindly intimated their pleasure to throw open their mines to the inspection of the members:—The British Salt Company's Works, Northwich; Messrs. Thompson and Son's Rock-and-White Salt Works, Northwich; and the Marston Salt Works, near Northwich. These, therefore, must be considered as part of the programme of the day.

The adjourned discussion on Mr. Knowles' paper was resumed, and Mr. Maddison's communication in connection with it read.

Mr. Gilroy's paper, "On Coal Washing Machinery," was read and discussed.

Messrs. Greenwell and Berkley's paper, "On Tail Ropes," was read and discussed.

Votes of thanks to the authors were proposed and carried unanimously, and it being now 12 o'clock,

The CHAIRMAN called their attention to the excursion to Oldham, fixed for 12.30. He was willing to go on with the present discussion, which was a very important one, but it was necessary to settle their arrangements at once. He wished, however, to take that opportunity— as he could not be present on the following day—to say something in respect to the gentleman who sat on his left—Mr. William Cochrane. He was now addressing especially the members of the Institute. Mr. Cochrane, in consequence of the absence of the Local Secretary, Mr. Doubleday, had taken the onerous and troublesome duties of arranging that meeting, and of assisting him (the Chairman) in carrying it out, and without him he could have done nothing. With that patience and perseverance which characterised him in every walk of life, he had really conducted the whole of the business. He, therefore, begged to move "that the thanks of this meeting be presented to Mr. William Cochrane, who has so ably discharged the duties, not only of honorary but acting Secretary to the Institute during the visit of its members to this district."

Mr. LANCASTER had great pleasure in seconding the motion. He thought Mr. Cochrane was entitled to their warmest thanks for the labour he had performed; and he thought they ought not to separate without showing their appreciation of his services in that capacity. Reverting to tail ropes, he said the subject was so important that it ought not to be slurred over. It was worthy of future discussion, especially if they took the opportunity in the meantime of looking at the chains Mr. Dickinson had been so kind as to mention, and to thoroughly examine them.

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Mr. T. E. FORSTER—I would propose that a Committee be appointed to examine into the merits of the chain and tail rope systems.

The CHAIRMAN here put the rote of thanks to the Secretary, which was carried by acclamation.

The SECRETARY, in reply, said, you have taken me so much by surprise by the kind manner in which you have proposed this vote of thanks that I am scarcely able to give utterance to my feelings on the occasion. I am sure that had it not been for the valuable assistance I obtained from the committee in Newcastle, from Mr. Peace, and from the committee in Manchester, the few services I should have been able to render for the furtherance of the objects of this meeting would have been very insufficient. I have been assisted most warmly by everybody with whom I have come in contact; and although the programme, which had been prepared by our Manchester friends, was so full as to leave almost nothing for us in Newcastle to suggest, still I found the utmost willingness to accede to all the wishes of the Northern Committee, and to carry out whatever we were anxious should be done at the Institute. Speaking for the committee, of which I have the honour of being the Secretary, we are grateful for the assurance that you now give us, that what we have done has contributed at all to the success of the meeting. In their name, as well as my own, I beg to thank you most sincerely for the thanks you have now voted to me.

A conversation as to the subsequent proceedings here ensued, after which,

Mr. T. E. FORSTER again proposed the appointment of a committee to enquire into the relative merits of endless chains and tail ropes.

Mr. HEWLETT seconded the motion.

The time having now expired, the members hastily left the room in order to meet the special train which was to convey them to Oldham.

July 14th.—The business was resumed this day, Mr. T. E. Forster, Vice-President, in the chair.

The CHAIRMAN called on the Secretary (Mr. Cochrane,) to read a letter which had been received from Mr. Woodhouse, regretting that he was unable to remain in town to preside over to-day's meeting.

The Secretary read the letter.

The CHAIRMAN—-The next thing, gentlemen, is that if there are any new members to be nominated, I shall be glad to have their names. No nominations were made.

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The SECRETARY—Gentlemen, I have been asked this morning to bring before your notice the following proposition:—"That the thanks of the Institute be given to the Royal Institution, for the gratuitous use of the Lecture and Council Rooms for their meetings; and that the Secretary (T. W. Doubleday) communicate the same to the Institution."The handsome and liberal manner in which we have been met throughout our visit by our friends in Manchester, has been highly gratifying; and, in this particular instance, it has been of great use to us to have such splendid rooms for our meetings. I have great pleasure in proposing that this resolution be carried.

The resolution was put to the meeting and carried unanimously.

The CHAIRMAN—The next thing is, gentlemen, to propose a vote of thanks to the Local Secretary, Mr. Peace. I am sure you will all agree with me that he has been most assiduous and attentive to his duties here. And he has given them all gratuitously. I beg to move—"That the thanks of the Institute, and of the members who have attended the meetings, be tendered to Mr. Peace, for his valuable and gratuitous services on behalf of the Institute."

The resolution was carried unanimously.

The CHAIRMAN said, the motion, with reference to the appointment of a Committee on Tail Ropes, had not been exactly settled at the previous meeting; and the proposal required to be ratified now. He thought it would be a most valuable thing if they could get information upon this point; and he had put down a great many names upon the list he had to propose as a Committee. Still, he did not think the Committee could go into the question as was desirable, unless the Institute would enable them, by some grant or vote of money, to employ a person to get up all the statistical accounts for them. The names were as follows:—Messrs. Lancaster, Hewlett, T. W. Embleton, J. Daglish, G. Gilroy, A. Potter, W. Armstrong, G. C. Greenwell, J. Marley, R. F. Matthews, J. Stott, J. Knowles, W. Cochrane, L. Wood, G. B. Forster, with power to add to their number. Three to be a quorum.

Mr. DICKINSON thought that if they could get either Mr. James Stott or Mr. Waddington to give them a paper, setting forth the merits of the endless chain, they could in that way put their views forward forcibly. But the formation of a committee, if there was to be any opinion expressed, would lead to an expression of such an opinion as was held by the majority, which would be in favour either of tail ropes or endless chains.

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The CHAIRMAN thought otherwise. He thought these gentlemen would act impartially, and he had that amount of confidence in them that he believed they would not, for the sake of showing favour to either the one or the other, give an opinion which they did not really believe.

Mr. DICKINSON—You would never be able to get that committee together.

The CHAIRMAN—That is the main thing. I think the Institute should appoint a person to go into the different districts and get up statistical accounts, to enable the committee to form an opinion.

The SECRETARY said, the Institute would be very glad indeed to have papers from the gentlemen named by Mr. Dickinson; and, indeed, he thought Mr. Stott had already almost promised a paper on the subject.

Mr. DICKINSON remarked that, as they had Mr. Greenwell's paper on one side, they would, if they could get such a paper as he had suggested, have both sides of the question before them.

The SECRETARY thought it would be better to have two or three papers on different subjects, or different parts of the subject.

Mr. DICKINSON had seen the difficulty of getting such a committee together. Practically the members could not be got together.

The CHAIRMAN—Especially in such a large district as this enquiry would include.

Mr. DICKINSON thought it would be well if Mr. Waddington would give them a paper, as no man knew the merits of the system better, because he had nearly forty miles of endless chain at work.

The SECRETARY—Do you wish to propose that the committee be not appointed?

Mr. DICKINSON—I think the papers would serve the same object in a better way.

Mr. MARLEY was of opinion, that irrespective of the question whether the general meeting should appoint a committee, it would be very important if the gentlemen who had been named would send papers. It would facilitate the work of a committee, if such should be appointed. As a member of the Council, he should be very glad to have them, and if those gentlemen would read papers, they would then have a full opportunity not only of stating their own views, and supporting them individually, but also of giving, in connection with the subject, a large number of facts; and the committee would then have the papers before them. He should support the idea, if the gentlemen would be kind enough to consent.

Mr. DICKINSON—Well, have both the committee and the papers.

Mr. MARLEY—I should prefer both.

The SECRETARY said, one use of the committee would be that they would decide upon some particular form of comparison, to supply to gentlemen who were acquainted with one or other of the two sides of the question, so as to enable them to state the results uniformly. Without such an arrangement, gentlemen who took the trouble to get up statistics would not have them in a regularly tabulated form.

The CHAIRMAN thought the papers very desirable, but that still great benefit would result from the appointment of a committee.

Mr. LANDALE asked whether the committee was not too large to be workable?

The CHAIRMAN—We must make a regulation that three shall be a quorum.

Mr. DICKINSON—I think you have only one representative of the endless chain.

The SECRETARY—-Pray name one or two others. We could not think of another.

A MEMBER—Will not Mr. Dickinson act upon it himself ?

Mr. DICKINSON—No; I would rather not act upon any committee.

The CHAIRMAN—Put Mr. Waddington on the committee.

Mr. DICKINSON—He is not a member of the Institute.

The CHAIRMAN—Then he ought to be.

Mr. DICKINSON—Yes, he should. Suppose you make him one now.

The CHAIRMAN then called upon

Mr. EMBLETON, who said—Since I read my paper at Newcastle I do not think there are any additional facts to be added to what I then gave, except the further trial of the Coal Cutting Machine (Garrett, Marshall, and Co.'s). I find it has been working, since that paper was read, from 1st of March this year up to the present time, the 6th of July; and I have here the performances during that time. It is a continuous performance, day by day, with certain interruptions for repairs and things of that kind, or when it was not necessary to work it. Without further detail I will just state these few facts. The average rate of baring the coal, during the period I have stated, is 8 1/10 feet per hour. The cost of that is 4 2/10 d. per ton. The average depth was three feet six inches—it varied from three feet nine inches to three feet three inches. The greatest distance which has been cut in one day during the above period was on the 16th of May, when 153 feet were cut in eight hours, being at the

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rate of nineteen feet per hour. That includes the stoppages ; but if you take the actual time the machine was working, which was five hours, that gives thirty feet per hour. The minimum amount of work in one day was on the 13th of June, when eight yards were cut in eight hours, being at the rate of three feet per hour. The time given here includes stoppages of every description. The machine was set to work for a few hours in order that a visitor might see it and examine it; but I have calculated the rate as for eight hours. So that I have stated this, I think, rather to the disadvantage of the machine than otherwise. I should not wish to give an impression that the machine can do more work than it has performed. We have made the trial for four months under every variety of circumstances, and the actual work performed, and the amount of time occupied, and cost incurred, is here stated [in the paper]. There is another thing I should wish to explain to the members of the Institute, I have been asked several times whether I have any interest in this machine, I can only say I have no more interest in it than our worthy Vice-President. These are the results obtained and they can be tested.

The CHAIRMAN—Can you give us the cost?

Mr. EMBLETON—I have stated that it was 4 $^{2/10}$ d. per ton.

The CHAIRMAN—Could you give the quantity of work done in any given time?

Mr. EMBLETON—I have the quantity done each day, the average being 8 $^{1/10}$ feet per hour.

The CHAIRMAN—But could you give us the quantity in ton?

Mr. EMBLETON—The number of tons is just double the number of yards. The coal yields two tons to the-yard of face bared in 3 feet 6 inches.

The CHAIRMAN—I think you did give us the per centage of round and small?

Mr. EMBLETON—I believe I did, in my former paper; but unfortunately I have not got it with me; and I am not aware how far this statement agrees with or differs from those made in that paper.

Mr. Cooper thought the saving of slack was 8 or 10 per cent.

Mr. WARRINGTON said, it was 10 per cent.

Mr. EMBLETON said, that unfortunately he had been unable to find a copy of his paper, read at Newcastle.

Mr. MARLEY—There were two or three printed copies here yesterday.

Mr. EMBLETON—Yes, I brought one with me; but it has not the calculations.

Mr. WARRINGTON—The quantity of slack was stated to be 8 per cent, by machine holing, and 18 per cent, by hand holing.

Mr. EMBLETON—Yes, I believe it was; but the8 per cent, was the total quantity of slack from the entire seam, and the 18 per cent, plus 18.75 left below = 36.75 the proportion of slack in hand-holing.

Mr. WARRINGTON—Yes.

Mr. ....I think the production of slack is in proportion to the height of the seam. If it be a nine feet seam, the per centage of slack will be less, the circumstances being the same. The height of the seam in which we have been working is five feet six inches- and I found that 20 per cent, was obtained. The per centage ought to be the same if the hardness of the coal and the height of the seam are the same. Your seam being higher, a reduced per centage of slack on account of the extra height of the seam is obtained, and not on account of the motion or variation of the machine. Your holing was three inches?

Mr. WARRINGTON—Three and a-quarter inches.

Mr. EMBLETON said, they had two seams of coal at Kippax, and the holing was made between them in the band.

Mr. LINDSAY WOOD observed, that if the seam was a certain height it was immaterial where the holing was made, in the centre or at the top or at the bottom; they still got about three inches of it made into slack. If he understood aright the amount of slack mentioned was the proportion obtained out of the whole thickness of the seam.

Mr. WARRINGTON—The saving would only arise out of the upper bed.

Mr. LINDSAY WOOD—You said out of the whole thickness of the seam.

Mr. WARRINGTON—The per centage is taken out of the whole in stating the average of slack, but the saving of slack would arise altogether out of the upper bed because the machine could not save out of the lower.

Mr. LINDSAY WOOD—No; but it saves out of the whole thickness.

Mr. WARRINGTON—That is, if the two seams are taken out together.

Mr. DAGLISH—Still it is taken out of the whole.

Mr. LINDSAY WOOD—And you hole in the same place by band or by machine ?

Mr. WARRINGTON—Yes.

Mr. L. WOOD—I did not hear the question, but I apprehend the answer as to the per centage of small, would have to be made upon a

calculation as between the machine and hand labour at each separate colliery. You cannot compare the different modes in two different places, it must be between hand holing and machine holing in the same seam.

Mr. DAGLISH thought they got a greater per centage of slack by hand holing, and was in favour of the machine.

Mr. EMBLETON thought Mr. Marley was right in saying that there was no saving of slack in the lower part of the seam at Kippax, by baring with the machine. At Newcastle he had given them a section of the seam. The band lay about three feet eight inches from the roof, and the holing whether by hand or machine was made in that, the machine cut out the band and left the coal above and below. In hand holing the lower part of the upper division was removed to bare the proper distance, and the slack was made by this operation, but the same quantity of slack was made in the lower part of the seam, whether the baring was made by hand or machine. He quite agreed with the observation that the experiments only applied to this particular seam. The proportion of slack had been correctly made. He had gone through the calculations, which had been made from the books, and if they were correct they showed exactly the amount of saving to be effected. If they went to the Hutton seam at Hetton they might have greater or less saving, according to the constitution of the seam. If they had a seam with a band of clay in the middle, they would have less small coal than in an undivided seam. The whole of the baring in an undivided seam would be sent out as small coal; whereas, in this instance the clay was removed completely. If they took a hard seam he did not know what effect would be produced. But the whole depth of the baring would be slack, and that would be in proportion to the thickness of the seam. In a six feet seam, if the holing were made at the bottom, a three and a quarter inch baring would he required, a three feet seam would require the same, and a two feet seam the same. These experiments were stated as the result of a trial at one colliery only. Unfortunately I am not able to say what results would be produced by a trial at any other colliery,

Mr. WARRINGTON—If the holing was to be made at the bottom was not necessary to touch the coal, because it might be made in the stone below.

Mr. DAGLISH—That depends upon the nature of the stone.

Mr. MARLEY—In your colliery the proportion of small was eighteen per cent.

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Mr. EMBLETON— 36.75 per cent.

Mr. L. WOOD—Was the holing made in the bottom stone by your machine ?

Mr. WARRINGTON—The machine can he raised to any required height, or set to any required horizontal angle.

Mr. L. WOOD said, they would have to cut at such an angle as would begin with the coal and stone.

Mr. WARRINGTON replied that they would take away about an inch of coal in front, leaving it about a half-inch per foot, so that the back part would leave about an inch of stone under the coal, and the next time it would be a little less inclined downwards.

The SECRETARY—Will you say whether you think it possible to apply compressed air to this machinery ?

Mr. WARRINGTON—Mr. Carrett would answer that question better than I can.

The SECRETARY—Or whether you consider that the great power now obtained by water is absolutely necessary ?

Mr. FIRTH—I think I can answer that question. I think I can convince you that a straight-action machine can be worked by compressed air.

The SECRETARY—I raised the question as applied to the Kippax machine.

Mr. FIRTH—The question is——

The CHAIRMAN—Would it not be better to allow Mr. Carrett to answer for his own machine ?

Mr. CARRETT—From the experience we have had we find that water is more useful than air in transmitting power, and the effect of using air compressed is that a portion of power is lost by the displacement of its latent heat. The loss in transmitting water along a pipe, is only loss arising from friction. The loss of pressure in this case is 75 lbs. per square inch. Water is used in preference, because it is non-elastic. If you use an elastic medium the action would be percussive. That has a different effect from the other. The one is an action like that of the slotting machine, and the other more like that of a hammer. The use of water is comparatively new, and it has merits which will be appreciated more with time and experience. It is easy to suppose that people will at present have some prejudice against it; but that it can be made use of the hydraulic press has proved. If air could be pressed into an hydraulic machine something then might be said in favour of the use of air in such a case as this.

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The SECRETARY—-You said the loss would be 75 lbs of pressure in 1000 yards: what is the size of the pipes ?

Mr. CARRETT—One-and-a-half inches and two inches. If the pipes are larger, the available pressure is greater.

Mr. L. Wood—What would be the quantity of water flowing through the pipes at that loss of pressure ?

Mr. CARRETT—-About forty gallons per minute. If the pumps which make the water pressure have 400 lbs. pressure at the other end, that pressure will be less by 75 lbs; the remaining pressure has nothing to do but be applied to the working of the machine, that is the best practical test.

Mr. LANDALE—Does this variation of pressure not arise from the speed?

Mr. DICKINSON—It is the motion.

A MEMBER—Friction.

Mr. FIRTH—It seems to be the question now to decide which is the best medium, compressed air or water. We have gone on the principle that compressed air is best. Of course there is a great deal to be said in favour of the one, and a great deal perhaps in favour of the other. But Mr. Donnesthorpe, who is also the patentee of one machine, is in favour of compressed air, and has been from the first, and when he took out the patent for a straight-action machine he found many difficulties in the way, because the machine had to be made so very heavy that it could not resist the vibration of the blow;

and to obviate that he patented an improvement which is the culminating point of the invention, and without which the straight-action could not be brought to a practical issue. In that invention he claims not only the right to use air, but also any other suitable power. [Mr. Firth here quoted the specification of Mr. Donnesthorpe's patent, the passage commencing with the words:—"This invention has for its object," and ending with the words—" Carriage of considerable weight." That was the difficulty (Mr. Firth continued,) they had found.   This was the quotation to which he particularly referred. [He then quoted the passage containing the words—" Other suitable means."] But in spite of this, Mr. Donnesthorpe still maintained that compressed air was the best, although they considered that he had the chance of using any suitable power.   He mentioned this to show the meeting that they had had large experience of even the disadvantages of air, but that they considered that the advantages were more in the case of air than in the case of water. [Mr. Firth here produced a diagram.] They worked their machines now with an engine which had a 7-inch

cylinder worked at 20 lbs. pressure. It was only necessary to enlarge the pipe somewhat, and the chances were that there would be very little escape. It was easy to keep the joint tight at that pressure, but should there be any escape it was no detriment to the men as it was small. Then, as the temperature of the exhausted air was generally about freezing point this escape was a boon to the labourers. If water were used the machine would have to be worked up the dip to allow the water to come down, and the farther they were from the shaft the greater the column of water they would have to raise before they brought power to bear upon the machine.

Mr. MARLEY—I wish to ask Mr, Garrett a question. I think you use the same water over again and again. The first supply is all you require?

Mr. GARRETT—Yes, decidedly; and we can also work either in a dip or on a rise. The back pressure is no impediment

Mr. MARLEY—The advantage to a machine worked by water is to have a dip. If you work to the rise, every yard you go above the bottom of the shaft you increase the difficulty.

Mr. WARRINGTON—We are working at twenty-seven feet from the shaft at present, and have 13 lbs. of back pressure.

Mr. DUNN remarked, that the index would tell the truth. A statement had been given of the exact index at both ends of the pipe.

Mr. L. WOOD enquired whether a considerable amount of pressure would not be lost in consequence of the velocity of the water in coming back. Mr. Warrington had said that they were working twenty-seven feet to the dip, and the water would be going through their pipes at a considerable rate.

Mr. WARRINGTON said, the difference was not appreciable by means of the gauges, but then the gauges would not indicate very accurately; they would not indicate to 10 lbs; and in this case they did not indicate a sufficient variation to be observable.

Mr. L. WOOD—It is natural that there must be a certain amount of power lost.

Mr. WARRINGTON said, there must be. The velocity would be very considerable, perhaps three hundred feet per minute.

Mr. L. WOOD—Yes, but the loss in returning would be the same as in going.

Mr. WARINGTON—You lose it both ways, going down and coming up.

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Mr. MARLEY—It would be an advantage to know the relative cost of Firth's machine and Carrett’s, independent of patent rights; simply what would be somewhere near the cost of the machine—not to a few-pounds, but about what price ?

Mr. CARRETT—A machine like the one that may be seen outside the door, or another that will cut from four inches above the rail upwards is from £100 to £125. We have got now to making it with cast steel. That increases the original cost, but it is far more useful. But if you are to choose to work a machine by hand and to give over holding on by the top, and traverse the machine by hand, the cost would be reduced to about £60, but the machine would not be self-acting in all movements. It is hoped that eventually we shall make it so that it can work twenty-four hours per day. I believe I did not answer the question about air. Air cannot be worked in this machine: the machine is made for a non-elastic medium, and air is elastic. Water being the most practicable and the cheapest it is made for that. Air would knock out the end of the cylinder in a very short time.

Mr. FIRTH—Our experience, and the experience Mr. Donnesthorpe has had, in working his machines (the 28th April, 1863, is the date of the patent, and since that time we have had some experiments with air), is that we have done some good work, and the bottom of the cylinder is not knocked out. We consider that machine to be almost identically the same, and that it is suitable for both air and water. As to the cost, Mr, Donnesthorpe has been engaged on other matters independently of cutting, and that being the case, he is trying to put so many adjuncts to it, that it is difficult to say what the actual cost of the straight-action machine will be.

Mr. MARLEY-—Approximately ?

Mr. FIRTH—The pick machine would cost about £100. We have not had much experience in making them. We have not made many alike. We have worked in seams from two to five feet, and on gauges from sixteen inches to two feet ten inches. A machine like this would cost about one £100.

Mr. GARRETT-—Can you tell us the extent to which it is a self-acting machine—such a machine as would cost £100? Can it be set to work if you stand twenty yards from it ?

Mr. FIRTH—I should only have to go into the patents to answer that question, and I think you had better consult them.

Mr. GARRETT—Has any one seen a machine work self-acting before

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this hydraulic machine, a machine that continues to cut and traverse when you do not notice it?

Mr. FIRTH said, that Donnesthorpe's machine had been made to work on the self-acting and roof-pressure principle. The pick, which was the first successful machine, was the first to succeed the patent of 1861. They had got in this machine the two principles, straight action and roof-pressure, and the other together.

Mr. MARLEY—Some gentlemen present may have seen Harrison's circular cutting machine. It would be an advantage to have some particulars with respect to that.

Mr. L. WOOD—I suppose Mr. Marley refers to me. Mr. Harrison was kind enough to let me have one of his machines to try, but I consider it is not advisable that I should go into particulars, as it has not been worked more than a week in our seam, which is a very hard one, and some parts of the machine were too light for it. I have had a letter since I came here, from Mr. Harrison, in which he says that he has made some improvements. At the Bishop's Close Colliery, where Mr. Harrison is the engineer, it has been working, and has cut at the rate of a square yard a minute. Our coal being harder, the picks would not stand, but I have no doubt that that can be obviated by strengthening and making them of a different shape. Its motion is entirely self-propelling. It has two rotary cylinders, and the rotary cutter is working on the second motion. I shall not go into the details of the work done by it on account of the machine being imperfect, but it is being improved every day.

Mr. COOPER wished to have one single point explained: did the machine get the full depth at once?

Mr. L. WOOD—Yes, it is simply a circular machine revolving with two or three arms. Two arms practically are found to act best.

Mr. COOPER—What depth does it cut?

Mr. L. WOOD—Three feet.

Mr. COOPER presumed it would occupy the space of six feet. He presumed that it would revolve in a circle of six feet ?

Mr. L. WOOD—No, you cannot get the centre of the revolving cutter close to the coal, the diameter of it is six feet, but practically you can have the chocks set within five feet of the face of the coal. About a foot farther than for Firth's machine.

Mr. FIRTH said, a yard of room was all that was required for Firth's machine.

Mr. L. WOOD did not think this was practically a difficulty in working. They must have more than six feet to get round the bord ends.

Mr. LANDALE asked how much did it cut in a minute?

Mr. L. WOOD said, it was cutting a square yard per minute.

Mr. FIRTH would like to hear Mr. Wood's or Mr. Daglish's opinion as to the working of the pick machine (Donnesthorpe's) which he had had now two years. He had kept on at them, although the first they had sent him were very poor, but now he thought they were as near perfection as the pick machine could be expected to be. He asked Mr. Wood whereabouts he was working ?

The CHAIRMAN said, this was very interesting, and the meeting would be glad to hear those gentlemen.

The SECRETARY—Mr. Firth, did not you say the machine was entirely self-acting?

Mr. FIRTH-—No; I said Donnesthorpe's machine could be made self-acting, but ours is not so. We prefer that it should not be so. It has a little impetus which wants humouring with the hand. That is a little disadvantage until you get accustomed to it.

The SECRETAY—As to the stroke of the pick,—if it does not get the full stroke round—suppose, for instance, that it sticks in a hard stone, or in a piece of pyrites.

Mr. FIRTH had seen the machine under all phases, and had known it necessary at times to attach the handle [he referred to the diagram to explain this]. They had always preferred not using the roof pressure to this pick. They knew some places where it would be impossible to use the roof pressure, and they had tried to get the pick machine to work in every seam from two feet high, where a man would go.

Mr. MATHEWS understood Mr. Warrington to say that they were cutting three and a quarter inches. They could cut away the stone below the bottom seam ?

Mr. WARRINGTON—Yes.

Mr. MATTHEWS—You would require seven and a quarter inches if you allow for your tramway and sleeper.

The CHAIRMAN—I think Mr. Warrington explained that.

Mr. MARLEY—The question is how far your rails are below the machine.

The CHAIRMAN-—If I understand aright, the first length or two, say six feet, it would be a disadvantage, but since he is three and a quarter inches below the seam, he puts the machine horizontally, and then that is all he wants.

Mr. WARRINGTON—It is not a disadvantage even in the first instance.

Mr.COOPER—This machine is to be carried by a rail, and cannot

work below the top of the rail, that must be above the base of the bed, and what has been taken up. He begins four inches from the bottom of the bed.

The CHAIRMAN—But he might sink his sleepers.

Mr. COOPER—That is another expense.

Mr. MATTHEWS—He must cut away the stone.

Mr. WARRINGTON—It is easier to let the pick point downward by setting the machine over.

Mr. CARRETT produced a rough diagram in explanation of some of these remarks.

The CHAIRMAN thought it was a very great advantage that the stone could be cut, because it saved the coal.

Mr. CARRETT said, that a little experience last week had shown that it was easier to cut the stone than the coal, because there were no pyrites.

Mr. L. WOOD said, there was no reason why the pick machine could not be set at the same angle and in the same mode: he did not think there was any difference between the two machines, or even between them and the circular machine in that respect.

Mr. WARRINGTON—The same applies to all machines.

The CHAIRMAN had known an instance where a man had worked more to cut coal than to cut stone.

Dr. BIRKENHEAD said, he had not seen any of these machines, though he had heard much about them. In the first place it was not more than four or five years since they were almost without a machine of any kind for cutting coal, and now they had he might say, a large number comparatively speaking of inventions for replacing manual labour by machinery. Before that time there had been a machine invented by the late Mr. Peace, which was used in the Hey Collieries, at Wigan. He had never seen it in action, but it was not successful, and therefore it had been disused. Until a recent period that was the only machine with which he had been acquainted. There being now so many they could not be surprised—the same having to be gained in all cases—that they had similar principles adopted in the construction, and similar details used in working them out. Thus they had cautions advertised in the papers about infringements of patents. The question at present seemed to be between air and water. He was inclined to think that if experiments were made on the machine, air would be found practicable, although Mr. Carrett thought the movement was simply rectangular and not reciprocating, he thought that would not be found to be so.   He thought the

motion would be found to be the same as in the ordinary steam engine. One remark occurred to him as arising out of Mr. Donnesthorpe's patent. That gentlemen claimed the right to use "any other medium." It was this kind of indefinite language, which attempted to include all that had been invented, and also all that ever might be invented, which seemed to him to be objectionable, and likely, ultimately, to lead to very great change in the patent laws.

The CHAIRMAN—We cannot enter into the patent question at all.

Dr. BIRKENHEAD—The remark simply occurred to me on account of what has been read.

Mr. LANDALE thought some gentlemen might recollect a machine, exhibited at the Exhibition in 1851, which was a circular saw. The coal which had been cut by it was lying about it. It had a great number of teeth, like a circular saw, and made a complete revolution.

The CHAIRMAN—Do you know whose it was?

Mr. EVANS—Charles Waring's.

The CHAIRMAN—I think there was a coal-cutting machine introduced in your district by a man named Johnson, many years ago.

Mr. W. ARMSTRONG—-I have a distinct recollection of one invented by George Stephenson.

Mr. FIRTH—I think there were at least thirty before 1851.

Dr. BIRKENHEAD said, that Mr. Peace's was a circular movement.

Mr. L. WOOD remarked that Johnson's and Watson's patent was the one alluded to by the Chairman.

The CHAIRMAN said, that machine had been cumbersome.

Mr. L. WOOD said, they had tried it.

Mr. COOPER would like to know what was the working area—the space which the machine required to revolve in—the space they must necessarily keep open between the chocks and the face.

Mr. L. WOOD said, Harrison and Dyson's revolving pick machine requires a space of five feet between the chocks and the face.

Mr. COOPER—But you must have six feet along the face unsupported.

Mr. DAGLISH—Three feet are inside the coal.

Mr, COOPER—The circular machine must require six feet open and unsupported by timber, along the face.

Mr. L. WOOD—-You require that much for a man to work in.

Mr. COOPER—You can timber nearer than six feet along the face for any other machine. You can put props within three or four feet of each other, and remove them for this gentleman's machine (Carrett's).

The CHAIRMAN- If I understand, when he once gets his three feet in, the machine is all right, and is not taken out again.

Mr. COOPER—But the circle extends along the face, as well as at right angles.

Mr. DAGLISH—In the length of the machine, certainly.

Mr. COOPER—The great practical difficulty in this machine will be found to be to keep the long wall face open.

Mr. WOOD—This machine takes about seven feet in length.

Mr. COOPER said, that with the slotting machine the stone could be supported at intermediate spaces of only a yard or two feet, and they could also support the coal by the stone undercut; but if they had seven feet clear that seven feet must be unsupported. He maintained that the great difficulty was to keep the face up.

Mr. CARRETT said, the hydraulic slotting machine could be made twelve inches stroke instead of eighteen, and instead of three tools there could be four. Under general circumstances the former seemed to suit the usual requirement, and it might be easily seen that if that alteration was made by the addition of one tool; the same total depth could be obtained.

Mr. WARRINGTON asked Mr. Cooper whether by supporting the coal he meant the readiness with which the wedges could he put in immediately behind the slotting machine?

Mr. COOPER—Yes.

Mr. BLACKBURN said, that with the circular machine that could not be nearer than seven or eight feet.

Mr. COOPER thought it could not be less than nine feet. He thought it would be well to bring the different principles of these machines fully before the Institute. The operation of cutting the full depth at once was, he maintained, very important. The really great advantage of these machines was the saving of the per centage of slack. If it was done two three times many seams would he crushed down at that distance, and there would be less saving; therefore cutting at one operation was essential. It would save the expense, and increase the per centage of large coal, which was really the object, for he did not think these machines cut the coal any cheaper than hand labour.

The CHAIRMAN thought they were much indebted to those gentlemen who had brought these machines out for cutting coal. He was satisfied that in a few years they would require them. Manual labour would not be got in this country at all, and that was the most difficult thing they

had to deal with in this and other trades. Whether the hydraulic pressure or the air was the best for working them remained to be proved.

Mr. COOPER—Mr. Harrison's machine could be worked by either.

Mr. L. WOOD—No; the motion of his piston is such, in the present mode of construction, that water power would be too slow.

Mr. EMBLETON said, the slotting machine could not be worked in its present construction by air.

Mr. FIRTH said, that the effect was produced in the pick by a quick blow. Water would not be suitable; but he thought the straight-acting machine could be worked with either.

Mr. COOPER again asked what was the cost ?

Mr. WOOD had never yet seen the two machines working in the same seam under the same conditions, so that they could not get at that practically.

Mr. COOPER knew it was considered that the machines did the work cheaper than it could be done by hand. He thought otherwise—at least in many collieries.

Mr. EMBLETON remarked, that he did not say what the machine would do in other collieries, but at this particular place where the cost was 4 $^{2/10}$ d. per ton. He had stated that the hand labour was 8d. per ton at the same place. He merely described what the machine was doing without reference to any other machine. It struck him that this machine was constructed upon the right principle, and he thought it only what he ought to do, having seen the machine and knowing the mode of construction, and knowing everything respecting it, to lay the little knowledge he had before the Institution. He wanted to keep clear of saying whether one person's patent was better than another; he had no interest in them but he was glad to have this discussion. He hoped that before long they would have a more perfect machine than any which had been mentioned. The thing was at present in its infancy. It was only by discussions of this kind that they could see what the difficulties were, and if he might make a suggestion to the Vice-President it would be, that in order to investigate the matter still further, a committee of members of the Institute should be appointed to go into all these details. His was only a rough paper. He went into no consideration about the pressure and friction produced by passing water through pipes of certain sizes. With respect to that, and the friction, and the action of the air, they knew scarcely anything. No experiment which he had seen would satisfy them as to what the effect would be of using water at considerable distances from

the source of supply. Mr. Marley had asked as to the quantity of water required. All the water which was required was sufficient to fill the pipes and a few gallons more.

The CHAIRMAN—And what is the waste?

Mr. EMBLETON—There ought to be none, and we say there is none.

Mr. CARRETT observed, that the hose which the members had seen outside the building had been borrowed in Manchester, and was necessarily somewhat imperfect. They could make it, however, so that it did not leak a pint a day.

The CHAIRMAN—I believe there are 147 patents for coal-cutting machines, and I hope, that out of these we shall be able to get something good. Those who are of opinion that Mr. Embleton is entitled to the thanks of the Institution will please to hold up their hands.

The resolution of thanks was carried unanimously.

Mr. EMBLETON thanked them sincerely. What he had formerly said, he repeated as to the object with which he had brought the matter forward. He proposed that a committee should be appointed to investigate these matters, and he thought great advantage would result from such an appointment.

Mr. FIRTH seconded the resolution.

Mr. COOPER thought the machines themselves were the best committee, and would prove their own merits.

Mr. DAGLISH supported the resolution. He thought this resolution was within the scope of the Institution, but not to include commercial or trade questions, such as the price and cost of working. There were many points which could only be worked out by a committee. Several gentlemen had taken the trouble to prepare experiments; but from the fact that they were not all made in the same form and tabulated in the same manner, they were of little use. It was within the scope of the Institution to appoint a committee to go into the scientific part of the matter, and to ascertain the loss by friction, heat, etc.

The CHAIRMAN believed there was a committee which had been appointed by the coal trade, at Newcastle, to investigate the subject, and find out, if they possibly could, the best machine for coal-cutting, but he was sorry to say that there had been very few meetings. He believed the trade was prepared to offer £500 for the best, but the difficulty was to get the committee together.

The Secretary said, the great difficulty with these committees was to find a system of making them practically useful. hey could not

expect a gentleman to devote himself to these questions gratuitously: therefore the question was whether the Institution would vote a fund to meet this difficulty. The history of similar committees was that private individuals taxed themselves, and that practically very little good resulted from them.

Mr. DAGLISH said, that was for the committee to consider-. He thought they got better results from the investigations of committees than from those of individuals alone.

The SECRETARY-—Would you defer that for discussion at the general-meeting?

Mr. DAGLISH-I am simply supporting the resolution.

The CHAIRMAN then put the resolution to the meeting, and it was carried.

Mr. EMBLETON said, he should wish-to leave the nomination of the committee to the Council of the Institute. They were more competent than himself or any one present.

Mr. FIRTH—Should they not examine into the merits of the different-patents?

The SECRETARY—That is for the law courts.

The CHAIRMAN—We must not go into the merits of the patent rights.

Mr. FIRTH—We shall be quite willing to give an indemnity to anybody using our machines.

Mr, EMBLETON—The commercial question was left out in the paper I read at Newcastle, because I thought it was contrary to the rules to go into it at all, but at the request of our worthy President, and our present Chairman, I ascertained what was the saving by using the machine.

The CHAIRMAN—Yes, it is contrary to the rules of the Institution to enter into anything about the patent rights of anybody.

Mr. CARRETT observed that Mr. Firth had said that either air or water would work the machine. If they would put water into their machine it could be tried at once.

Mr. Daglish then read the report to the present time of the committee appointed to enquire into the subject of safety-lamps.

Mr. Lishman's paper "On an Explosion at Newbottle Colliery," was then read, and a discussion ensued on both these papers.

A vote of thanks was then passed to the Committee and to Mr. Lishman.

Mr. Daglish read his paper, "On an Improved Water Gauge," and presented a water gauge on this principle to the Institute.

A vote of thanks was passed to Mr. Daglish.

One paper remained to be read, "On the China Coal-field," by Mr. T. Y. Hall. Time not permitting, this was postponed to the next meeting at Newcastle.

Mr. GILROY moved a vote of thanks to the Chairman. They all knew enough of Mr. Forster to make it unnecessary to say anything of his ability and experience, and so on. What they had to do was to thank him for his services so kindly rendered that day.

The resolution was unanimously carried.

The CHAIRMAN said, this was more than he deserved. He ought to have been there at the beginning of the week, but had been prevented from coming. The papers and discussions had been very interesting, and he thought great good would result from the meeting.

The proceedings here terminated.

NORTH OF ENGLAND INSTITUTE MINING ENGINEERS.

ANNIVERSARY MEETING, THURSDAY, AUGUST 3, 1865, IN THE ROOMS OF THE INSTITUTE, WESTGATE STREET, NEWCASTLE-UPON-TYNE.

EDWARD POTTER, Esq., Vice-President, in the Chair.

The SECRETARY, Mr. Doubleday, read the Annual Report.

The CHAIRMAN, in moving the adoption of the Report, said there were one or two matters to be disposed of. The more important one was whether the papers read at Manchester should form an independent volume, as in the case of the Birmingham meeting; or whether they should be incorporated with the volume of the year. With regard to the success of the meeting, it was very satisfactory, he believed, to those gentlemen who had the privilege of being present. There were some excellent papers read which would be interesting contributions to the proceedings of the Institute.

Mr. DAGLISH read the Report of the Finance Committee.

Mr BOYD read the Annual Balance-sheet, after which the reports were adopted, and the several members proposed at the Manchester meeting were duly elected.

The names of the members composing the Committee appointed at Manchester, to consider the relative merits of Tail-ropes and Endless-chains, were read. It was resolved that three should be a quorum, and that Mr. Dickinson and Mr. Atkinson should be added to the Committee.

The CHAIRMAN said, this Committee must be empowered to go into any necessary expense. Hitherto gentlemen had had to pay expenses out of their own pockets.

Mr. GREENWELL inquired whether those collieries where tail-ropes were used would give facilities for making experiments ?

Mr. ATKINSON said, it might be necessary to have a dynamometer to test the resistance.

Mr. MARLEY said, as to the expenses to be incurred, they had appointed a very large Committee, and it would be impossible to get the whole of them together except on special occasions. It would be well for the Committee when they meet, to appoint a Secretary, who, of course would be much out of pocket in going to Manchester and different places to get statistics, and in carrying out the Committee's rules and requirements. It had been suggested that it would be very desirable if that meeting were to instruct the Council to set aside a sum of money that should be at the disposal of this Committee, for the purpose of reimbursing them for any money they might expend for the better elucidation of any experiment. With regard to the question of Mr. Greenwell, whether collieries using tail-ropes would carry out any experiment, no doubt, as a rule, they would, but still there were many cases in which expenses would be incurred, and it would be well to place a small sum at their disposal. It would also be well that that meeting should instruct the Council to place such sum as they might think prudent for the purpose. They could fix any sum; but he would leave it to the Council.

Mr. DOUGLAS said, he would be glad to propose a motion that the Council direct any amount of money that they think reasonable to be paid for the object in view. He thought those expenses should be trifling. The instrument mentioned by Mr. Atkinson might be of use afterwards and certainly the Institute should pay for that—no doubt the colliery owners would assist them so far as the experiments were concerned. One object of his proposing Mr. Dickinson was, that he, residing in a district where the chain-system was adopted, might be able to gather for the Committee accurate information on that subject.

Mr. DICKINSON said, in his district they had the finest examples of endless-chain work to be met with.

Mr. BOYD seconded Mr. Douglas's motion, which was then put and carried by a show of hands.

The CHARMAN said, the next question was whether the papers read at the Manchester meeting should form a separate volume.

Mr. GREENWELL said, in the absence of all knowledge of the length of the papers that might be read next year, it would be impossible to decide this question at present.

Mr. MARLEY said, it had better be left to the Council. He, therefore, moved that it be left to the Council to determine whether the papers read at Manchester form part of next year's Transactions, or otherwise.

Mr. CRONE seconded the motion, which was carried unanimously.

The CHAIRMAN then moved a vote of thanks to the Lancashire Coal Association, to the Manchester Geological Society, and to various other gentlemen who took part in the proceedings at Manchester.

Mr. BOYD, as one who participated in and enjoyed those proceedings, begged to second the motion.

The motion was carried unanimously.

The SECRETARY was instructed to convey the thanks of the meeting to Mr. Woodhouse, for his able occupancy of the chair during the three first days of the Manchester meeting.

The CHAIRMAN said, at the last meeting he attended, he proposed that the portrait of their President should be hung up in the room of the Institute. They had omitted on that occasion to make any arrangement as to the expense. He now proposed that a minute be entered in their books, that the expense thereby incurred be defrayed out of the funds of the Institute, and that the portrait be hung up in that room.

Mr. ATKINSON seconded the motion, which was carried unanimously.

Thanks were then voted to the South Wales Institute of Engineers for their courtesy in altering their day of meeting, so as not to interfere with the Manchester meeting.

The CHAIRMAN said, they now came to the subjects open for discussion. The first was the Patent Hydraulic Coal-Cutting Machine at Kippax Colliery. Mr. Embleton, who introduced the subject, was not present. He (the Chairman) went over to Kippax and saw the machine; and he was so satisfied with it that he purchased one, which he expected to receive every day.

Mr. LINDSAY WOOD said, he thought this subject had been fully discussed at the Manchester meeting. They had there a long discussion in which all sorts of coal-cutting machines were referred to.

Mr. GREENWELL said, as a committee had been appointed to investigate the subject, would it not be premature to discuss it any further until the Committee had made their report? He begged to move that the discussion be postponed till the Committee had made their investigations.

Mr. CRONE seconded the motion, which was carried by show of hands.

The CHAIRMAN said, the next subject was the Rating of Coal-Mines.

Mr. GREENWELL said, he had nothing further to add on this subject. In accordance with the recommendation in the Annual Report, he thought it was desirable that the discussion on this subject should also be postponed.

The discussion was postponed accordingly.

Mr. DOUGLAS submitted the following motion, of which he had given notice:—"That Rule 12 be altered, and that all general meetings shall be held on the first Saturday of every month, instead of on the first Thursday or Saturday, alternately, of every month." He said he had no statistics to guide him; but having been at meetings held on Thursdays and Saturdays here, he had been led to the conclusion, notwithstanding the pressure of other business, that Saturday was a day on which more members came here than on a Thursday. When the change was made it was an experiment; and he thought sufficient time had passed to induce members to form an opinion which day was best for bringing members together. He begged to propose that Rule 12 be altered.

The SECRETARY said, that Saturday attendances had been the best; but then the hour must be twelve o'clock, on account of other meetings held earlier in the day.

Mr. LISHMAN seconded the motion.

Mr. DAGLISH said, this question had been discussed fully on several occasions; and at length it was decided that the meetings should be held alternately on Thursday and Saturday. He found that if they always met on a Saturday they never would have any lengthened papers and discussions. He begged to propose as an amendment that the days remain as at present.

Mr. L. WOOD seconded the amendment.

On a division, eight voted for the amendment, and five for the original motion. The amendment was consequently adopted.

The officers for the ensuing year were then elected, as usual, by ballot, Mr. Southern and Mr. Berkley acting as scrutineers.

Mr. DAGLISH, in consequence of the accidental omission of a name from the nomination paper, gave notice for a special meeting to alter Rule 11, by striking out the paragraph relating to the nomination of officers. He proposed that in future any of the members should be eligible for office.

The meeting then broke up.

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ILLUSTRATIONS TO VOLUME XIV.

OMITTED

NORTH OF ENGLAND INSTITUTE OF MINING ENGINEERS – annual meeting in July 1865

Visit to Manchester

Programme with maps, names of delegates