NORTH OF ENGLAND INSTITUTE OF MINING ENGINEERS.

TRANSACTIONS.

VOL. XVII.

1867-8.

Newcastle upon Tyne:

Andrew Reid, Printing Court Buildings, Akenside Hill.

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Advertisement

The Institution is not, as a body, responsible for the facts and opinions advanced in the papers read, and in the Abstracts of the Conversations which occurred at the Meetings during the Session.

Report.

The Council, in presenting to the Members of the Institute their Report for the past year, have again the pleasing task of congratulating them upon the continued favourable progress and prospects of the Institute.

They have again to report a large accession of members, which is the more encouraging since the admission of Mechanical Engineers having now ceased to be a novelty, the increase may be considered due, more to the general interest taken in the Institution than, to its sudden extension to a new branch of the profession. So that, in comparing the gross increase of members (61) with the gross increase of last year (70), there is much cause for congratulation. From this gross increase of

61, however, they have to deduct for death and other causes 21, which leaves the net increase of 40 for 1867-8.

In lamenting the demise of a valued member, Mr. William Watson, they have their attention drawn to the deep interest he took in the success and prosperity of the Institute. For they find that in bequeathing his exceedingly valuable collection of drawings and plans to his brother, Mr. John Watson, he suggested that they might be presented to the Institute. This gentleman has kindly responded to his late brother's proposition, and the Institute has thereby become the possessor of a large and valuable collection of drawings, sections, borings, and papers, arranged in the most systematic and scrupulously careful way, forming a most useful and accessible mass of information on all matters affecting the geological strata and mining records of the district.

Adverting to the Transactions and Papers, the Council think that the past year has not been behind its predecessors in the value of the essays produced. Mr. Cooper's paper " On an Outburst or Sudden Issue of Fire-damp at Strafford Main Colliery, Barnsley, Yorkshire, October 1st, 1867," elicited much valuable discussion, and affords matter for congratulation that there are appliances at the command of the miner which enable him to preserve life during such highly dangerous contingencies.

They must also here draw attention to a new career of usefulness in

which the Institute has entered, in making grants of money to Committees to enable them to report on matters of interest. Two of these Committees have presented most valuable and exhaustive Reports, and the Council have no hesitation in saying that the experiments therein quoted, and the data given, will form standards for guidance and information to the profession, either here or abroad, for many years.

With regard to the Safety-Lamp Report, they consider nothing has been so conducive, since the invention of the lamp itself, to the safety of the miner. It has pointed out the weak points of this valuable invention, and has shown how the same may be remedied, so that the miner's lamp may be in reality and effectually that which before it was only partially and nominally, a safety-lamp under all the ordinary circumstances induced in mining operations.

With respect to the Tail Rope Committee, the Council think they are also entitled to the thanks of the Institute. A portion only of their Report is before the members, but it is hoped that the whole will be printed before the conclusion of the present volume. The more severe and irksome duties of preparing for publication the immense mass of information elicited from the investigation, has principally fallen upon the engineer, Mr. Emerson Bainbridge, and the Council feel convinced that all who have read that portion which is now in print, will bear testimony to the able way in which this arduous duty has been performed.

With respect to the Committee on Safety Cages, a large mass of information has been obtained, and the Council have no doubt, that at an early meeting of the Institute, a full report will be presented. It is a subject of peculiar difficulty, and the delay that has already occurred is due to the sense of responsibility the Committee feel in approaching so important a subject.

The Committee for investigating the question of Smoke Prevention, has only lately been appointed. It has already decided on a plan of action, and the proceedings of the Institute will, no doubt in the course of a few months, be enriched with its Report; and another proof that the coal of this district can be smokelessly consumed will be added to that most convincing and unbiassed report of Mr. T. W. Miller, printed in 1864, by command of the House of Commons, all the points of interest in which appear in the reports of Messrs. Richardson and Bunning, in Volume XIV. of your Proceedings.

The Council cannot dismiss the subject of Committees without giving a summary of the work effected by the Building Committee.

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Through its recommendation a Limited Liability Company has been formed to purchase a portion of the present site, and erect thereon a commodious and elegant structure in every way suited to the requirements of the Institute and Coal Trade.

The remaining portion of the site has been presented to the Trustees for the erection of the "Wood Memorial Hall," and an elegant, suitable, and appropriate design has been supplied by Mr. Dunn. The whole of the preliminary formalities connected with the purchase of the site and the formation of the Limited Liability Company are definitely completed, and with respect to the fund at the disposal of the Committee for the erection of the Memorial Hall, although at present it is inadequate to the completion of the object contemplated, yet from the general favour the design has met with, and from the assurances of large additional support, it is hoped that there will be nothing to prevent the commencement of the buildings at an early period of the ensuing year ; and it is to be desired that those subscriptions which it is understood have been withheld whilst the Committee have been undecided as to the form the memorial should assume, will be handed in at once now the matter has been so satisfactorily arranged. It is certainly to be regretted that the buildings have not been already commenced, but unexpected difficulties connected with the transfer of the property have alone prevented it.

The Council beg to state that they have endeavoured to appreciate and utilize the influence for good such a valuable and influential institution is capable of exerting and bringing to bear on this populous and intelligent district, and these efforts they consider should be continued and increased in order that England in general, and this district in particular, should not be behindhand in the scientific race for greatness now open to competition, not alone, as formerly, to Englishmen, but to all the nations of the world. England, to maintain her position, will have to look very closely, not only to the preservation and economical employment of her vast mineral resources, but she will also have to see that her workmen shall be enabled by a well-directed and intelligent course of education to effect the same with skill, safety, and economy, so that she may not to her disgrace be outrun by other nations possessing less natural advantages.

Fully impressed with the importance of this subject, the Council have had earnest deliberations in conjunction with the North of England United Coal Trade Association on the subject of Technical Education, which has resulted in Mr. Daglish and Mr. Cochrane having given evidence before Mr. Samuelson's Committee on Scientific Education, and which has

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further resulted in Mr. Daglish having induced Mr. Buckmaster to visit this locality and explain generally the mode in which Government assists in developing Technical Education amongst the working classes. The movement thus commenced and assisted by this Institution will, the Council hope, progress, and enable their successors at the next yearly meeting to place before you more tangible marks of success.

With respect to those meetings of the Institute, which have been so far diversified as to contain in addition to their interest in a scientific point of view, some of the more pleasing features of an excursion, the Council have to notice that, with the same kind feeling toward the prosperity of the Institute which prompted Mr. John Taylor to offer Ryhope Colliery, and Mr. Spencer the Engine Works at Sunderland, to the inspection of the members, Earl Vane, at the suggestion of Mr. Daglish, invited the members of the Institute and their friends to visit the important Harbour Works and Collieries at Seaham. The Council consider the large attendance at these meetings proves them to be exceedingly attractive, and greatly conducive to the welfare of the Institute, and that Earl Vane and Mr. Daglish, as well as Mr. John Taylor and Mr. Spencer, deserve the warmest thanks of the Institute, for the courteous way in which their hospitality was extended.

The Council conclude by stating that in furtherance of the same principle, they have endeavoured to resuscitate the general mode in which the anniversary day was wont to be celebrated, and have made arrangements for such members as may be desirous, to dine together after the business of the meeting, and they have satisfactory assurance that this arrangement has met with your approval, by the number of acceptances which have been received.

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Finance Report.

Your Committee have pleasure in reporting the continued satisfactory state of the finances of the Institute. The number of members has been considerably increased during the last year, viz., 32 members and 8 graduates, being 40 in all. The amount of arrears now due are considerably less than last year, viz., £54 12s. against £95.

The receipts and expenditure are much the same as in former years, with the exception of the payment of £500, being the deposit on the purchase money for the site of the Memorial Hall.

This exceptional payment causes the expenditure to exceed the income of the past year by £133 2s. 7d, making the entire capital of your Institute £3,174 18s. 11d.

LINDSAY WOOD.

G. B. FORSTER.

JOHN DAGLISH.

[x] Dr. THE TREASURER IN ACCOUNT WITH THE NORTH

[table]

[xi] OF ENGLAND INSTITUTE OF MINING ENGINEERS. Cr.

July 1st, 1868.

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Patrons

His Grace the DUKE OF NORTHUMBERLAND.

His Grace the DUKE OF CLEVELAND.

The Right Honourable the EARL OF LONSDALE.

The Right Honourable the EARL GREY.

The Right Honourable the EARL OF DURHAM.

The Right Honourable the EARL VANE.

The Right Honourable LORD WHARNCLIFFE.

The Right Honourable LORD RAVENSWORTH.

The Right Reverend the LORD BISHOP OF DURHAM.

The Very Reverend the DEAN AND CHAPTER OF DURHAM.

WENTWORTH B. BEAUMONT, Esq., M.P.

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Honorary Members

	ELECTED. Ordy.	Hon.
WILLIAM ALEXANDER, Esq., Inspector of Mines, Glasgow ..		1863
JOHN J. ATKINSON, Esq., Inspector of Mines, Chilton Moor, Fence Houses	1853	1856
LIONEL BROUGH, Esq., Inspector of Mines, Clifton, Bristol ...		1855

JOSEPH DICKINSON, Esq., Inspector of Mines, Manchester ... 1853

THOMAS EVANS, Esq., Inspector of Mines, Field Head House,

Belper 1855

PETER HIGSON, Esq., Inspector of Mines, 94, Cross Street,

Manchester 1854 1856

THOMAS WYNNE, Esq., Inspector of Mines, Stone 1853

* T. RUTHERFORD, Esq., Inspector of Mines, Halifax, Nova Scotia 1866

* JAMES P. BAKER, Esq., Inspector of Mines, Wolverhampton ... 1853 1866

* THOMAS E. WALES, Esq., Inspector of Mines, Swansea...... 1855 1866

* RALPH MOORE, Esq., Inspector of Mines, Glasgow 1866

* G. W. SOUTHERN, Esq., Inspector of Mines, 89, Park Road,

Newcastle-on-Tyne 1854 1866

* FRANK N. WARDELL, Esq., Inspector of Mines, Pontefract,

Yorkshire....................... 1864 1868

MATTHIAS DUNN, Esq., Ex-Inspector of Mines, Highland Villa,

Central Road, Upper Norwood, London 1853

JOHN HEDLEY, Esq., Ex-Inspector of Mines, Derby 1853 1858

CHARLES MORTON, Esq., Ex-Inspector of Mines......... 1853

GOLDSWORTHY GURNEY, Esq., Bude Castle, Cornwall ... 1853

M. DE BOUREUILLE, Commandeur de la Legion d'Honneur,

Conseiller d'etat, Inspecteur General des Mines, Paris ... 1853

DR. H. VON DECHEN, Berghauptmann, Ritter, etc., Bonn am Rhine, Prussia 1853

HERR R. VON CARNALL, Berghauptmann, Ritter, etc., Breslau,

Silesia, Prussia.................... 1853

M. DE VAUX, Inspecteur General des Mines, Brussels, Belgium 1853

M. GONOT, Ingenieur des Mines, Mons, Belgium 1853

Life Member

	Ordy.	Life.
H. J. MORTON. Esq., Garforth House, Leeds, Yorkshire......	1856	1861

* Honorary Members during term of office only ; elected under Rule 5 as altered.

OFFIC E R S, 18 6 8-9.

President.

GEORGE ELLIOT, Betley Hall, Crewe.

Vice-Presidents.

FOUR MINING ENGINEERS.

JOHN TAYLOR, Earsdon, Newcastle-upon-Tyne.

WM. ARMSTRONG. Wingate Grange, Ferry Hill.

J. T. WOODHOUSE, Midland Road, Derby.

G. B. FORSTER, M.A., Backworth House, near Newcastle-upon-Tyne.

TWO MECHANICAL ENGINEERS.

SIR W. G. ARMSTRONG, Jesmond, Newcastle-upon-Tyne.

J. F. SPENCER, North-Eastern Engine Works, Sunderland.

Council.

TWELVE MINING ENGINEERS.

LINDSAY WOOD, Hetton Hall, Fence Houses.

JOHN DAGLISH, F.G.S., Dene House, Seaham Harbour.

T. DOUGLAS, Peases' West Collieries, Darlington.

J. B. SIMPSON. Hedgefield House. Blaydon, Newcastle-upon-Tyne.

WM. COCHRANE, Seghill House, Dudley, Northumberland.

S. C. CRONE, Killingworth Colliery, Newcastle-upon-Tyne.

JOHN MARLEY, Mining Offices. Darlington.

T. G. HURST, F.G.S., Tynemouth.

A. L. STEAVENSON, Crossgate, Durham.

G. C. GREENWELL, F.G.S., Poynton and Worth Collieries, Stockport, Cheshire.

W. A. POTTER, Cramlington House. Northumberland.

W. LISHMAN, Bunker Hill, Fence Houses.

SIX MECHANICAL ENGINEERS.

R. S. NEWALL. Ferndene, Gateshead.

JAMES MORRISON, 34, Grey Street, Newcastle-upon-Tyne.

J. F. TONE, C.E., Newcastle-upon-Tyne.

WM. BOYD, Spring Gardens Engine Works, Newcastle-upon-Tyne

F. C. MARSHALL. Jarrow, South Shields.

JAMES NELSON, Bonner's Field, Sunderland

THOS. E. FORSTER, 7. Ellison Place, Newcastle-upon-Tyne,)

EDWARD POTTER, Cramlington, Northumberland.) Ex-officio.

Treasurer.

EDWARD F. BOYD, Moor House, near Durham.

Secretary

THEO. WOOD BUNNING, Newcastle-upon-Tyne.

List of Members

AUGUST, 1868.

The dates of election are given as accurately as they can be obtained from the Transactions.

Members are respectfully requested to inform the Secretary of any error which they may observe, and to supply the date of election where left blank.

		ELECTED.
1	Ackroyd, Thomas, Berkenshaw, Leeds	March 7, 1867.
2	Adams, W., Severn House, Roath Road, Cardiff...	1854.
3	Aitken, Henry, Falkirk, North Britain......	March 2, 1865.
4	Allison, J. G., 84, Cumberland Row, Newcastle-upon-Tyne	May 2, 1868.
5	Allinson, T., Belmont Mines, Guisbro'	Feb. 1,1868.

6 Anderson, C. W., St. Hilda's Colliery, South Shields Aug. 21, 1852.

7 Anderson, Jos., Solicitor, Neville Hall, Newcastle-upon-Tyne .... Oct. 1, 1863.

8 Anderson, William, Rainton Colliery, Fence Houses Aug. 21, 1852.

9 Appleby, Charles Edward, Reinshaw Iron Works, near Chesterfield .... Aug. 1, 1861.

10 Armstrong, L., Cowpen Colliery, Blyth, Northumberland .... March 3, 1864.

11 Armstrong, Wm., Wingate Grange, Ferry Hill,Durham ...... (Vice-President) Aug. 21, 1852.

12 Armstrong, Sir W. G., C.B., Jesmond, Newcastle-upon-Tyne......(Vice-President) May 3, 1866.

13 Ashwell, Hatfield, Anchor Colliery, Longton, North Staffordshire.............. March 6, 1862.

14 Asquith, Thos. W., Seaton Delaval Colliery, Dudley, Northumberland .... Feb. 2, 1867.

15 Attwood, Charles, Holy wood House, Wolsingham,Darlington........... ... May 7, 1857.

16 Aytoun, Robert, 3, Fettes Row, Edinburgh ... Aug. 1, 1861.

17 Bagnall, jun., Thomas, Wbitby, Yorkshire ... March 6, 1862.

ELECTED.

18 Bailes, Thos., jun., 3, Normanby Terrace, Gateshead .... Oct. 7, 1858.

19 Bailey, W. W., Kilburn, near Derby ...... May 13,1858.

20 Bailey, Samuel, The Pleck, Walsall, Staffordshire June 2, 1859.

21 Bainbridge, Emerson, Seaham Collieries, Sunderland .... Dec. 3, 1863.

22 Barkus, Wm., jun., Tynemouth......... Aug. 21, 1852.

23 Barclay, A., Caledonia Foundry, Kilmarnock, North Britain .... Dec. 6, 1866.

24 Bartholomew, C., Doncaster, Yorkshire ... ... Aug. 5, 1853.

25 Bassett, A., Tredegar Mineral Estate Office, Cardiff 1854.

26 Bates, Matthew, Cyfarthfa Iron Works, Merthyr Tydvil .... Feb. 1, 1868.

27 Beacher, E., Thorncliffe and Chapeltown Collieries, Sheffield .... 1854.

28 Beanlands, Arthur, University College,Durham... March 7, 1867.

29 Beck, Alexander, Mons, Belgium......... Dec. 7, 1867.

30 Bell, John, Normanby Mines, Middlesbro'-on-Tees Oct. 1, 1857.

31 Bell, Isaac Lowthian, Washington, Washington Station, N.E. Railway .... July 6, 1854.

32 Bell, T., South Moor Colliery, Chester-le-Street, Durham ... ...1854.

33 Bell, Thomas, jun., Usworth Hall, Gateshead ... March 7, 1867.

34 Benson, T. W., Allerwash, Hexham ...... Aug. 2, 1866.

35 Berkley, C, Marley Hill Colliery, Gateshead ... Aug. 21, 1852.

36 Bewick, Thomas J., Neville Chambers, Newcastle-upon-Tyne .... April 5, 1860.

37 Bidder, B. P., Powell, DuffrynCollieries, Aberdare May 2, 1867.

38 Bigland, J., Bedford Lodge, Bishop Auckland ... June 4, 1857.

39 Binns, C, Claycross, Derbyshire... ...... July 6,1854.

40 Biram, Benjamin, Peasely Cross Collieries, St. Helen's, Lancashire .... 1856.

41 Birkbeck, Geo. Henry, 34, Southampton Buildings, Chancery Lane, London..... Dec. 7, 1867.

42 Bolckow, H. W. F., Middlesbro'-on-Tees...... April 5,1855.

43 Bourne, Peter, 39, Rodney Street, Liverpool ... 1854.

44 Bourne, S., West Cumberland Hematite Iron Works, Workington............ Aug. 21,1852.

45 Bourne, Thos. R., Rawcliff, Garstang, Lancashire Oct. 4, 1860.

46 Boyd, Edw. F., Moor House, Durham (Treasurer) Aug. 21,1852.

ELECTED.

47 Boyd, Nelson, Belfast Foundry, Donegal Street, Belfast .... March 3, 1864.

48 Boyd, William, Spring Gardens Engine Works, Newcastle-upon-Tyne (Member of Council) Feb. 2, 1867.

49 Breckon, J. E., Park Place, Sunderland...... Sept. 8, 1864.

50 Brettle, Thos., Mine Agent, Dudley, Worcestershire................. Nov. 3,1866.

51 Broadbent, Jubal C, Drake Street, Rochdale, Lancashire .... March 7, 1867.

52 Brogden, James, Tondu. Iron and Coal Works, Bridgend, Glamorganshire... 1861.

53 Brown, J., Harbro' House, Barnsley, Yorkshire... Oct. 5, 1854.

54 Brown, John N., 56, Union Passage, New Street, Birmingham... ... ... 1861.

55 Brown, Thos. Forster, Guildhall Chambers, Cardiff 1861.

56 Brown, Ralph, Ryhope Colliery, Sunderland ... Oct. 1, 1863.

57 Bryden, John F., Hematite Iron Works, Whitehaven .... Nov. 3, 1866.

58 Bryham, William, Rose Bridge, &c, Collieries, Wigan, Lancashire ... ... Aug. 1, 1861.

59 Bryham, Wm., jun., Ince Hall, Wigan...... Aug, 3,1865.

60 Burn, James, Rainton Colliery, Fence Houses ... Aug. 2, 1866.

61 Burrows, James, Douglas Bank, Wigan, Lancashire................. May 2,1867.

62 Buxton, Wm., Neal Street, New Whittington, Chesterfield............. Aug. 1, 1861.

63 Cadwaladr, R., Broughton Colliery, Wrexham, Denbighshire ...... 1855.

64 Campbell, James, Staveley Works, Chesterfield ... Aug. 3, 1865.

65 Carr, Charles, Cramlington, Newcastle-upon-Tyne Aug. 21, 1852.

66 Carr, Wm. Cochrane, Blaydon-on-Tyne...... Dec. 3, 1857.

67 Carrington, Thomas, jun., Kiveton Park Coal Company, near Sheffield........... Aug. 1 1861.

68 Catron, Joseph, Wylam Colliery, Newcastle-upon-Tyne................. Nov. 3. 1866.

69 Chadborn, Beckit T., Pinxton Collieries, Alfreton, Derbyshire.............. 1864

70 Chapman, Matthew, Plashetts Colliery, Falstone, Northumberland .... Aug. 1 1868.

71 Childe, Rowland, Wakefield, Yorkshire...... May 15, 1862.

72 Clark, William, Moreton Hall Colliery, Chirk ... April 7, 1866.

73 Clark, William, Victoria Engine Works, Gateshead Dec. 7, 1867.

74 Clark, Christopher Fisher, Garswood, Newton-le-Willows.............. Aug. 2, 1866.

75 Clark, George, Ravenhead Colliery, St. Helen's, Lancashire.............. Dec. 7, 1867.

76 Cochrane, W., Seghill House, Dudley, Northumberland ......(Member of Council) 1859.

77 Cochrane, C, The Ellowes, near Dudley, Staffordshire................. June 4, 1857.

78 Cochrane, B., Alden Grange, Durham ...... Dec. 6, 1866.

79 Cockburn, William, Upleatham Mines, Upleatham, Marske .... Oct. 1, 1857.

80 Cockburn, Geo., 8, Summerhill Grove, Newcastle-upon-Tyne .... Dec. 6, 1866.

81 Coke, Richard George, Tapton Grove, Chesterfield, Derbyshire...... .... May 5, 1859.

82 Cole, W. R., Bebside Colliery, Morpeth...... Oct. 1, 1857.

83 Collis, William Blow, Heigh House, Stourbridge, Worcestershire .... June 6, 1861.

84 Cook, Richard, East Holywell Colliery, Earsdon, Newcastle-upon-Tyne ....1860.

85 Cooke, John, 4, Mulberry Street, Darlington ... Nov. 1, 1860.

86 Cooksey, Joseph, West Bromwich,-Staffordshire... Aug. 3,1865.

87 Cooksey, J. H., West Bromwich, Staffordshire ... Aug. 3, 1865.

88 Cooper, Philip, Rotherham Colliery, Rotherham, Yorkshire.............. Dec. 3, 1857.

89 Cooper, Thomas, Park Gate Colliery, Rotherham, Yorkshire.............. April 2, 1863.

90 Cope, J., Pensnett, Dudley, Worcestershire ... Aug. 5, 1853.

91 Cope, W. S., North Staffordshire......... May 2, 1867.

92 Cossham, H., Hill House, Bristol, Somersetshire... Sept. 6, 1855.

93 Coulson, W., Shamrock House, Durham ... ... Oct. 1, 1852.

94 Cowen, Joseph, jun., Blaydon Burn, Newcastle-upon-Tyne .... Oct. 5, 1854.

95 Coxon, S. B., Usworth Colliery, Washington Station, Durham .... June 5,1856.

96 Coxon, Alfred, Bedlington Colliery, Morpeth ... Dec. 6, 1866.

97 Craig, W. Y., Hamcastle Colliery, Stoke-upon-Trent .... Nov. 3, 1866.

98 Crawford, T., Little Town Colliery, Durham ... Aug. 21, 1852.

99 Crawford, Thos., Howlish Offices, Bishop Auckland Sept. 3,1864.

100 Croften, J. G., Thornley Colliery Office, Ferry Hill Feb. 7, 1861.

101 Crone, Joseph Robert, Killingworth Colliery, Newcastle-upon-Tyne Feb. 1, 1868.

102 Crone, S. C, Killingworth Colliery, Newcastle-upon-Tyne (Member of Council) 1853.

103 Crow, George, 2, Park Road, Newcastle-upon-Tyne Feb. 2,1867.

104 Crudace, S. D., Willington, Durham ... ... March 7,1867.

105 Crudace, Thomas, Waratah, Australia ... ... 1862.

106 Curry, James, Turston, Pontefract ...... 1864.

107 Daglish, John, F.G.S., Dene House, Seaham Harbour (Member of Council) Aug. 21, 1852.

108 Dakers, W., Seaham Collieries, Sunderland ... April 7, 1866.

109 Darlington, James, Springfield House, near Chorley, Lancashire......... ... Aug. 1, 1861.

110 Darlington, John, Moorgate Street Chambers, London, E.C. .... April 1, 1865.

111 Davidson, James, Blyth Place, St. Bees, near Whitehaven... .... Feb. 1,1868.

112 Davidson, James, Newbattle Colliery, Dalkeith ... 1854.

113 Davison, A., Hastings' Cottage, Seaton Delaval, Dudley, Northumberland......... Feb. 4, 1858.

114 Dawson, Thomas J., 1, Havelock Street, Newcastle-upon-Tyne .... April 6, 1867.

115 Dees, J., Whitehaven .... Nov. 1, 1855.

116 Dennis, Henry, Brynyr Owen, Ruabon, Denbighshire................. Aug. 1,1861.

117 Dickinson, W. R., South Derwent Colliery, Annfield Plain, Gateshead .... Aug. 7, 1862.

118 Dixon, George, Lowther Street, Whitehaven ... Dec. 3,1857.

119 Dobson, S., Halswell Cottage, Cardiff ...... May 3, 1855.

120 Dobson, Thomas, Haltenlengate, Haltwhistle ... March 7, 1868.

121 Dodd, Benjn., Seaton Delaval Colliery, Dudley, Northumberland .... May 3, 1866.

122 Doming, Elias, 41, John Dalton Street, Manchester Aug. 3,1865.

123 Douglas, T., Peases' West Collieries, Darlington ....(Member of Council) Aug. 21,1852.

124 Dunne, D. G., Greenfield Colliery, Hamilton, North Britain .... April 6, 1867.

125 Dyson, George, Sands, near Ferry Hill...... June 2, 1866.

126 Easton, J., Nest House, Gateshead ...... 1853.

127 Elliot, G., Betley Hall, Crewe ... (President) Aug. 21, 1852.

128 Elliott, W., Weardale Iron Works, Towlaw, Darlington .... 1854.

129 Embleton, T. W., The Cedars, Methley, Leeds ... Sept. 6, 1855.

130 Embleton, T.W., jun., The Cedars, Methley, Leeds Sept. 2, 1865.

131 Feare, G., Camerton Coal Works, Bath...... 1861.

132 Fenwick, Barnabas, Broomhill Colliery, Acklington......... .... Aug. 2, 1866.

133 Fidler, Edward, Platt Lane Colliery, Wigan, Lancashire............. Sept. 1, 1866.

134 Firth, William, Birley Wood, Leeds ...... Nov. 7,1863.

135 Firth, S., 14, Springfield Mount, Leeds...... 1865.

136 Fletcher, C.E., Jos., 69, Lowther Street, Whitehaven .... 1857.

137 Fletcher, Isaac, Clifton Colliery, Workington ... Nov. 7, 1863.

138 Fletcher, Herbert, Ladyshire Colliery, Little Lever, Bolton, Lancashire............ Aug. 3, 1865.

139 Flood, Peder Boyesen, Seaham Harbour...... Dec. 7,1867.

140 Foord, J. B., Secretary General Mining Association, 52, Old Broad Street, London ... Nov. 5, 1852.

141 Forster, G. B., M.A., Backworth House, near Newcastle-upon-Tyne ... (Vice-President) Nov. 5, 1852.

142 Forster, Thomas E., 7, Ellison Place, Newcastle-upon-Tyne (PastPresident, Member of Council) Aug. 21, 1852.

143 Forster, George E., Washington. Gateshead ... Aug. 1,1868.

144 Fothergill, Joseph, Cowpen and North Seaton Office, King Street, Quay, Newcastle-upon-Tyne................. Aug. 7, 1862.

145 Fowler, Geo., Hicknall Colliery, near Nottingham July 4, 1861.

146 Frazer, Benjamin, 28, Broad Chare, Newcastle-upon-Tyne .... Oct. 4, 1866.

147 Frazer, William, Rewcastle Chare, Newcastle-upon-Tyne................. Oct. 4, 1866.

148 France, W., Cliff Terrace, Marske, near Redcar... April 6, 1867.

149 Fryar, Mark, C.E., Royal Insurance Buildings, Corn Street, Bristol............ Sept. 7, 1867.

150 Fryer, Mark, Team Colliery, Gateshead...... Feb. 3, 1859.

ELECTED.

151 Gainsford, William Dunn, Handsworth Grange, near Sheffield .... Aug. 1, 1861.

152 Gainsford, Thomas R., Darnall Hall, near Sheffield .... Nov. 5, 1864.

153 Gardner, M. B., Turnhurst Colliery, Tunstall, North Staffordshire............ Oct. 6,1859.

154 Garforth, W. G., Lord's Field Colliery, Ashton-under-Lyne....... ... ... Aug. 2, 1866.

155 Gilchrist, T., Newbottle Colliery, Fence Houses... March 2, 1865.

156 Gillett, F. C, 5, Wardwick, Derby ...... July 4, 1861.

157 Gilroy, G., Ince Hall Colliery, Wigan, Lancashire Aug. 7, 1856.

158 Glover, B. B., M.E., Newton-le-Willows, Lancashire................. Aug. 2, 1866.

159 Goddard, William, C.E., Golden Hill Colliery, Longton, North Staffordshire March 6, 1862.

160 Gooch, G. H., Lintz Colliery, near Burnopfield, Gateshead.............. Oct. 3, 1856.

161 Gott, Wm. L., Shincliffe Collieries, Durham ... Sept. 3, 1864.

162 Greeves, J. O., Roundwood Colliery, Horbury, Wakefield, Yorkshire Aug. 7, 1862.

163 Green, Wm., Jan., Garesfield Colliery, Blaydon-on-Tyne ... . Feb. 4, 1853.

164 Greener, Thos., Etherley Colliery, Darlington ... Aug. 3, 1865.

165 Geeenwell, G. C., F.G.S., Poynton and Worth Collieries, Stockport, Cheshire

(Member of Council) Aug. 21, 1852.

166 Greenway, Edward, Brierly Hill, Dudley, Worcestershire .... June 1, 1867.

167 Greig, D., Leeds............... Aug. 2, 1866.

168 Griffith, N. R., Coppa Colliery, Mold, Flintshire 1866.

169 Haddock, James, Ravenhead Colliery, St. Helen's, Lancashire.............. Dec. 7, 1867.

170 Haggie, P., Gateshead .... 1854.

171 Hales, Chas., Maes-y-dre, Mold, North Wales ... 1865.

172 Hall, T. Y., Towneley Colliery Office, Quay, Newcastle-upon-Tyne .... Aug. 21, 1852.

173 Hall, William F., Shotton Colliery, Castle Eden, Ferry Hill........... May 13, 1858.

174 Hall, Henry, Spennymoor, Ferry Hill ...... Aug. 2, 1866.

175 Hanon, Jules, 91, Rue Herenthal, Antwerp ... March 7, 1867.

ELECTED.

176 Harden, J. W., Folshill Colliery, Coventry ... 1859.

177 Harper, Matthew, Whitehaven .... Oct. 1, 1863.

178 Harrison, T. E., C.E., Central Station, Newcastle-upon-Tyne .... May 6, 1853.

179 Harrison, Robert, Eastwood Collieries, Nottingham 1861.

180 Harrison, W. B., Norton Hall, Cannock, Staffordshire................. April 6,1867.

181 Harper, J. P., 74, Osmaston Street, Derby ... Feb. 2, 1867.

182 Hawthorn, W., C.E., Newcastle-upon-Tyne ... March 4, 1853.

183 Hawthorn, Thomas, 12, Elswick Villas, Newcastle-upon-Tyne .... Dec. 6, 1866.

184 Herdman, John, Park Crescent, Bridgend, Glamorganshire .... Oct. 4. 1860.

185 Heckels, R., Wearmouth Colliery, Sunderland ... Nov. 5, 1852.

186 Hedley, Edward, Osmaston Street, Derby ... Dec. 2,1858.

187 Hedley, W. H., Consett Collieries, Medomsley, Burnopfield, Gateshead 1864.

188 Heppell, Thomas, Pelaw Main Collieries, Birtley, Fence Houses ...... Aug. 6, 1863.

189 Heslop, James, Peases' West Collieries, Darlington Feb. 6, 1864.

190 Hetherington, David, Netherton, Morpeth ... 1859.

191 Hewlett, Alfred, Haigh Colliery, Wigan, Lancashire................. March 7, 1861.

192 Higson, Jacob, 94, Cross Street, Manchester ... 1861.

193 Higson, P., jun., Brookland, Swinton, Manchester Aug. 3, 1865.

194 Hill, Arthur .... Aug. 2, 1866.

195 Hilton, T. W., Haigh, Wigan .... Aug. 3,1865.

196 Hodgson, R., Whitburn, Sunderland ...... Feb. 7, 1856.

197 Homer, Charles S., Chatterley Hall, Tunstall ... Aug. 3, 1865.

198 Hood, Archibald, Whitehill Colliery, Lasswade, Edinburgh............... April 18, 1861.

199 Hopper, John, Britannia Iron Works, Houghton-le-Spring .... Sept. 2, 1865.

200 Horsley, W., Whitehill Point, Percy Main ... March 5, 1857.

201 Horsfall, J. J., Bradley Green Colliery, near Congleton............... March 2, 1865.

202 Horton, T. E., Prior's Lee Hall, Shiffnal, Shropshire................. 1861.

203 Howard, Wm. Frederick, Cavendish Street, Chesterfield, Derbyshire ... Aug. 1,1861.

204 Hudson, James, Albion Mines Pictou Nova Scotia 1862.

ELECTED.

205 Humble, Jos., jun., Garesfield, Blaydon-on-Tyne June 2, 1866.

206 Humble, W. J., Forth Banks West Factory, Newcastle-upon-Tyne .... Sept. 1, 1866.

207 Hunt, A. H., Pelaw Main Office, Quayside, Newcastle-upon-Tyne .... Dec. 6, 1862.

208 Hunter, Wm., Moor Lodge, Newcastle-upon-Tyne Aug. 21, 1852.

209 Hunter, William, Morriston, Swansea, Glamorganshire .... Oct. 3, 1861.

210 Hunter, Wm. Slingsby, Moor Lodge, Newcastle-upon-Tyne .... Feb. 1, 1868.

211 Hunting, Charles, Fence Houses......... Dec. 6, 1866.

212 Huntsman, Benjamin, West Retford Hall, Retford June 1,1867.

213 Hurst, T. G., Tynemouth (Member of Council)... Aug. 21, 1852.

214 Jackson, Henry, Astley and Tyldesley Collieries, Tyldesley, Manchester Aug. 1, 1861.

215 Jackson, John, Clay Cross, Chesterfield...... Aug. 1, 1861.

216 Jarratt, John, Kepier Grange Colliery, Fence Houses .... Nov. 2, 1867.

217 Jenkins, M.E., William, 2, Woodfield Place, Cardiff ...... Dec. 6, 1862.

218 Jobling, T. W., Point Pleasant, Wallsend, Newcastle-upon-Tyne ... ... Aug. 21, 1852.

219 Johnson, John, Chilton Hall, Ferry Hill...... Aug. 21, 1852.

220 Johnson, R. S., Sherburn Hall, Durham...... Aug. 21, 1852.

221 Joicey, John, Urpeth Hall, Fence Houses ... Sept. 3,1852.

222 Jones, E., Granville Lodge, Wellington, Salop ... Oct. 5, 1854.

223 Jones, John, F.G.S., Secretary, North of England Iron Trade,

Middlesbro'-on-Tees...... Sept. 7, 1867.

224 Kenrick, Wm. Wynn, Wynn Hall, near Ruabon, Denbighshire ... 1862.

225 Kendall, W.,Blyth and Tyne Railway, Percy Main Sept. 1, 1866.

226 Kennedy, Myles, M.E., Ulverstone ... ... June 6, 1868.

227 Kimpster, W., Quay, Newcastle-upon-Tyne ... Sept. 3,1852.

228 Knowles, A., High Bank, Pendlebury, Manchester Dec. 5, 1856.

229 Knowles, John, Pendlebury Colliery, Manchester Dec. 5, 1856.

230 Knowles, Thomas, Ince Hall, Wigan ... ... Aug. 1,1861.

231 Knowles, Andrew, jun., Eagley Bank Colliery, Bolton, Lancashire........... Dec. 3, 1863.

232 Knowles, Kaye, Little Lever Colliery, near Bolton Aug. 3, 1865.

ELECTED.

233 Knowles, R. M., Turton, near Bolton ...... Aug. 3, 1865.

234 Lamb, Robert, Cleator Moor Colliery, near Whitehaven .... Sept. 2, 1865.

235 Lamb, R. O., Axwell Park, Gateshead ...... Aug. 2, 1866.

236 Lancaster, John, Ashfield, Wigan......... July 4, 1861.

237 Lancaster, John, jun., Hunwick and Newfield Collieries, Ferry Hill ... March 2, 1865.

238 Lancaster, Joshua, Kirkless, near Wigan...... Aug. 3, 1865.

239 Lancaster, Samuel, Kirkless Hall Colliery, Wigan Aug. 3, 1865.

240 Landale, Andrew, Lochgelly Iron Works, Fifeshire, North Britain,. .... Dec. 2, 1858.

241 Laverick, G. W., Zion House, Chesterton, near Newcastle-under-Lyne 1860.

242 Lawrence, Henry, Grange Iron Works, Durham... Aug. 1, 1868.

243 Laws, John, Blyth, Northumberland ... ... 1854.

244 Lees, Samuel, Barrowshaw Colliery, Greenacres Moor, near Oldham...... Aug. 2, 1866.

245 Leslie, Andrew, Hebburn, Newcastle-upon-Tyne... Sept. 7, 1867.

246 Lever, Ellis, West Gorton Works, Manchester ... 1861.

247 Lewis, Henry, Annesley Colliery, near Mansfield... Aug. 2, 1866.

248 Lewis, Thomas Lewis, Gadlys Uchaf, Aberdare ... Feb. 1, 1868.

249 Lewis, T. Wm., Mardy, Aberdare ...... Sept. 3, 1864.

250 Lewis, G., Coleorton Colliery, Ashby-de-la-Zouch Aug. 6, 1863.

251 Lewis, Wm. Thomas, Mardy, Aberdare...... 1864.

252 Liddell, J. R., Nedderton, Northumberland ... Aug. 21, 1852.

253 Liddell, M., Tynemouth......... ... Oct. 1, 1852.

254 Lindop, James, Bloxwich, Walsall, Staffordshire... Aug. 1, 1861.

255 Lishman, Wm., Etherley Colliery, Darlington ... 1857.

256 Lishman, Wm., Bunker Hill, Fence Houses (Member of Council) March 7, 1861.

257 Lishman, John, Haswell Colliery, Fence Houses... June 2, 1866.

258 Livesey, Thomas, Chamber Hall, Hollinwood, Manchester .... Aug. 1, 1861.

259 Livesey, Clegg, Bredbury Colliery, Bredbury, Stockport .... Aug. 3, 1865.

260 Llewellin, David, Glanwern Offices, Pontypool, Monmouthshire ... Aug. 4, 1864.

261 Logan, William, Littletown, Durham ...... Sept. 7, 1867.

262 Longridge, J., 3, Poet's Corner, Westminster, London, S.W. ..... Aug. 21, 1852.

263 Love, Joseph, Brancepeth Colliery, Durham ... Sept. 5, 1856.

264 Low, Win., Vron Colliery, Wrexham, Denbighshire .... Sept. 6, 1855.

265 Lloyd, Thomas H., Chapel Street, Brierly Hill, Worcestershire .... June 1, 1867.

266 Maddison, W. P., Thornhill Collieries, near Dewsbury .... Oct. 6, 1859.

267 Maddison, W., Woolley Colliery, Darton, Barnsley Dec. 6, 1862.

268 Mallet, Bobert, C.E., F.R.S., 7, Westminster Chambers, Westminster,

London, S.W. ... Nov. 7, 1863.

269 Mammatt, John E., C.E., Barnsley, Yorkshire ... 1864.

270 Manners, G. T., Birtley Iron Works, Gateshead... 1866.

271 Marley, John, Mining Offices, Darlington (Member of Council) 1853.

272 Marshall, Robert, 10, Three Indian Kings Court, Quayside,

Newcastle-upon-Tyne ...... 1856.

273 Marshall, John, Smithfold Colliery, Little Halton, near Bolton ... ... 1864.

274 Marshall, F. C, Jarrow, South Shields (Member of Council) Aug. 2, 1866.

275 Matthews, Richard F., South Hetton Colliery, Fence Houses .... March 5, 1857.

276 Maurice, Arthur H., 3, Temple Row, Wrexham, Denbighshire .... Sept. 1, 1866.

277 May, George, North Hetton Colliery, Fence Houses March 6, 1862.

278 McCulloch, H. J., Broxhill House, Oadby, Leicester .... Oct. 1, 1863.

279 McGhie, Thos., Cannock Chase Colliery, Walsall, Staffordshire .... Oct. 1, 1857.

280 McGill, Robert, St. Helen's Colliery, St. Helen's, Lancashire.............. 1862.

281 McMurtrie, J., Radstock Colliery, Bath...... Nov. 7, 1863.

282 Middleton, J., Davison's Hartley Office, Quay, Newcastle-upon-Tyne ......1853.

283 Miller, Robert, Strafford Collieries, near Barnsley March 2, 1865.

284 Mitchinson, Robert, jun., Kibblesworth Colliery, Gateshead .... Feb. 4, 1865.

285 Monkhouse, Jos., Gilcrux Colliery, Cockermouth June 4, 1863.

286 Moore, J. H., Smeaton Park, Musselburgh, Edinburgh .... Feb. 2, 1867.

287 Morison, David P., Pelton Colliery, Chester-le-Street .... 1861.

288 Morris, William, Waldridge Colliery, Chester-le-Street, Fence Houses ... 1858.

289 Morrison, James, 34, Grey Street, Newcastle-upon-Tyne (Member of Council) Aug. 5, 1853.

290 Morrison, H. M., East Cross Street, Sunderland .... Feb. 3, 1856.

291 Morton, H., Lambton, Fence Houses ...... 1852.

292 Morton, H. T., Lambton,.Fence Houses...... Aug. 21, 1852.

293 Muckle, John, Monk Bretton, Barnsley...... March 7, 1861.

294 Mulcaster, H., Colliery Office, Whitehaven ... July 6, 1854.

295 Mulcaster, Joshua, Crosby Colliery, Maryport ... June 4, 1863.

296 Mulvany, Wm. Thomas, 1335, Carls Thor, Dusseldorf-on-the-Rhine, Prussia Dec. 3, 1857.

297 Murray, B. .... Aug. 2, 1866.

298 Murray, T. H., Chester-le-Street, Fence Houses ... April 18, 1861.

299 Napier, Colin, Westminster Colliery, Wrexham, Denbighshire .... Aug. 1, 1861.

300 Nasmyth, James, Cornbrook Colliery, near Ludlow, Shropshire .... Feb. 1, 1868.

301 Naylor, Joshua T., 10, West Clayton Street, Newcastle-upon-Tyne ... ... Dec. 6, 1866.

302 Nelson, James, C.E., Bonner's Field, Sunderland ....(Member of Council) Oct. 4, 1866.

303 Newall, Robert Stirling, Ferndene, Gateshead ....(Member of Council) May 2, 1863.

304 Nicholson, William, Seghill Colliery, Newcastle-upon-Tyne .... Oct. 1, 1863.

305 Nicholson, Marshall, Middleton Hall, Leeds ... Nov. 7, 1863.

306 Noble, Captain, Jesmond, Newcastle-upon-Tyne Feb. 3, 1866.

307 North, Frederick, Arleston House, Smithwick, Birmingham.............. Oct. 6, 1864.

308 Ogden, John M., Solicitor, Sunderland ...... March 5, 1857.

309 Oliver, Wm., Stanhope Burn Offices, Stanhope, Darlington............... 1862.

310 Oliver, John, Victoria Colliery, Coventry ... April 1, 1865.

311 Oliver, Geo., Peases' West Collieries, Darlington 1864.

312 Palmer, A. M., Wardley Colliery, Heworth, Gateshead .... 1853.

313 Palmer, C. M., Quay, Newcastle-upon-Tyne ... Nov. 5, 1852.

314 Pattinson, John, Bensham Lodge, Gateshead ... May 2, 1868.

315 Pearce, F. H., Bowling Iron Works, Bradford, Yorkshire .... Oct. 1, 1857.

316 Pease, J. W., M.P., Woodlands, Darlington ... March 5, 1857.

317 Peel, John, Springwell Colliery, Gateshead ... Nov. 1, 1860.

318 Perrot, Sam. W., Hibernia and Shamrock Collieries, Gelsenkirchen,

Dusseldorf...... June 2, 1866.

319 Piggford, Jonathan, Castle Eden Colliery, Ferry Hill................. Aug. 2, 1866.

320 Pilkington, Wm., jun., St. Helen's, Lancashire ... Sept. 6, 1855.

321 Potter, E., Cramlington, Northumberland ... Aug. 21, 1852.

322 Pottee, W. A., Cramlington House, Northumberland (Member of Council) 1853.

323 Powell, T., Coldea, Newport, Monmouthshire ... Sept. 6,1855.

324 Rake, A. S., Consulting Engineer and Naval Architect, Newcastle-upon-

Tyne ...... Sept. 7, 1867.

325 Ramsay, J. T., Walbottle Hall, near Blaydon-on-Tyne........... ... Aug. 3, 1853.

326 Keed, Robert, Felling Colliery, Gateshead ... Dec. 3,1863.

327 Rees, Daniel, Lletty Shenkin Colliery, Aberdare... 1862.

328 Reskerne, J. .... Dec. 6, 1866.

329 Richardson, Henry, Backworth Colliery, New-castle-upon-Tyne .... March 2, 1865.

330 Ridley, George, Cowpen Colliery, Blyth, Northumberland .... Feb. 4, 1865.

331 Robinson, Robert, jun., Bishop Auckland...... Feb. 1, 1868.

332 Robson, J. S., Butterknowle Colliery, Staindrop, Darlington .... 1853.

333 Robson, Neil, 127, St. Vincent Street, Glasgow ... 1861.

334 Robson, Thomas, Lumley Colliery, Fence Houses Oct. 4, I860.

335 Rockwell, Alfd. P., M.A., Norwich, Connecticut, United States, America ... Dec. 2, 1858.

336 Ronaldson, James, Clough Hall Coal and Iron Works, Stoke-upon-Trent......... Aug. 2, 1866.

337 Roscamp, J., Acomb Colliery, Hexham...... Feb. 2, 1867.

338 Rose, Thomas, Merridale Grove, Wolverhampton 1862.

339 Ross, A., Shipcote Colliery, Gateshead ...... Oct. 1, 1857.

340 Rosser, Wm., Mineral Surveyor, Llanelly, Carmarthenshire ... ... 1856.

341 Routledge, William, (J. B. Foord), 52, Old Broad Street, London, E.C. .... Aug. 6, 1857.

342 Rusby, W. J., Glass House Fields Engine Works, Radcliffe, London, E. .... Aug. 1, 1868.

343 Russell, Robert, Gosforth Colliery, Newcastle-upon-Tyne .... Feb. 6, 1864.

344 Sanderson, R. B., West Jesmond, Newcastle-upon-Tyne .... 1853.

345 Sanderson, Thomas, Seaton Delaval, Dudley, Northumberland ... Aug. 7, 1862.

346 Scarth, W. T., Raby Castle, Darlington...... April 4, 1868.

347 Scott, Andrew, Coanwood Colliery, Haltwhistle ... Dec. 7, 1867.

348 Seddon, William, Lower Moor Collieries, Oldham, Lancashire.............. Oct. 5, 1865.

349 Shield, Hugh, Woodifield and Whitelee Collieries, Crook, Darlington........... March 6, 1862.

350 Shortreed, Thomas, Park House, Winstanley, Wigan .... April 3, 1856.

351 Simpson, J., Rhos Llantwit Colliery, Caerphilly, near Cardiff.............. Dec. 6, 1866.

352 Simpson, L., South America, per E. Simpson, Dipton, Gateshead........... 1855.

353 Simpson, R., Ryton Moor House, Blaydon-on-Tyne................ Aug. 21, 1852.

354 Simpson, John Bell, Hedgefield House, Blaydon-on-Tyne

(Member of Council) Oct. 4, 1860.

355 Smith, F., Bridgewater Offices, Manchester ... Aug. 5, 1853.

356 Smith, J., jun., M.E., Thornley Colliery, Sunderland Feb. 4,1853.

357 Smith, Edmund J., 14, Whitehall Place, Westminster, London, S.W. .... Oct. 7,1858.

358 Smith, Thomas Taylor, Oxhill, Chester-le-Street... Aug. 2, 1866.

359 Snowball, James, Stourbridge Fire Clay Works, Gateshead ... ... 1866.

360 Snowdon, Thomas, Stockton-on-Tees ...... Aug. 1, 1868.

361 Sopwith, A., 103, Victoria Street, Westminster, London, S.W. .... Aug. 1, 1868.

362 Sopwith, T., F.G.S., etc., 103, Victoria Street, Westminster, London, S.W. May 6, 1853.

363 Southern, Robert, Old Silkstone Collieries, near Barnsley .... Aug. 3, 1865.

364 Spark, H. K., Darlington............ 1856.

365 Spencer, T., Ryton, Newcastle-upon-Tyne ... Dec. 6, 1866.

366 Spencer, J. F., North-Eastern Engine Works, Sunderland ...(Vice-President) Aug. 2, 1866.

367 Spencer, W., Monkwood Colliery, Chesterfield ... Aug. 21, 1852.

368 Steavenson, A. L., Crossgate, Durham (Member of Council) Dec. 6, 1855.

369 Stephenson, W. H., Summerhill Grove, Newcastle-upon-Tyne .... March 7, 1867.

370 Stephenson, George R., 24, Great George Street, Westminster, London,

S.W. ...... Oct. 4, 1860.

371 Steel, Charles R., Ellenborough Colliery, Maryport March 3, 1864.

372 Stenson, W. T., Whitwick Colliery, Coalville, near Leicester ... Aug. 5, 1853.

373 Stobart, H. S., Witton-le-Wear, Darlington ... Feb. 2, 1854.

374 Stott, James, Basford Hall, Stoke-on-Trent ... 1855.

375 Straker, John, West House, Tynemouth...... May 2, 1867.

376 Sutcliffe, John C, North Gawber Colliery, Barnsley 1864.

377 Swallow, R. T., Pontop Colliery, Gateshead ... 1862.

378 Swallow, John, Harton Colliery, South Shields ... Aug. 6, 1863.

379 Taylor, H., Tynemouth............ Sept. 5, 1856.

380 Taylor, J., Earsdon, Newcastle-upon-Tyne (Vice-President) Aug. 21, 1852.

381 Telford, W., Cramlington, Northumberland ... May 6, 1853.

382 Tennant, John, East Holywell Colliery, near Newcastle-upon-Tyne .... April 4, 1868.

383 Thomas, Wm., Heyford Iron Works, near Weedon Feb. 2, 1867.

384 Thompson, Joseph, Norley Colliery, Wigan, Lancashire .... April 6, 1867.

385 Thompson, Joseph, Seaham Colliery, Sunderland Feb. 2, 1867.

386 Thompson, John, Marley Hill Colliery, Gateshead Oct. 4, 1860.

387 Thompson, John, Field House, Hoole, Chester ... Sept. 2, 1865.

388 Thompson, T. C, Milton Hall, Carlisle...... May 4, 1854.

389 Thompson, Astley, Kedwelly, Carmarthenshire ... 1864.

390 Thompson, James, Bishop Auckland ...... June 2, 1866.

391 Thompson, Robert, jun., Waterloo Colliery, Leeds Sept. 7, 1867.

392 Thorman, John, Ripley, Derbyshire ...... 1861.

393 Tinn, Joseph, C.E., Royal Insurance Buildings, Corn Street, Bristol.............. Sept. 7, 1867.

394 Tone, John F., C.E., Westgate Street, Newcastle-upon-Tyne (Member of Council) Feb. 7, 1856.

395 Trotter, J., Newnham, Gloucestershire ... ... Nov. 2, 1854.

396 Truran, Matthew, Dowlais Iron Works, Merthyr Tydvil, Glamorganshire ... Dec. 1, 1859.

397 Turner, Wm. Barrow, C. and M.E., Barrow-in-Furness .... Dec. 7, 1867.

398 Tweddell, Ralph Hart, Sunderland ...... Oct. 5,1867.

399 Vaughan, John, Middlesbro'-on-Tees ...... April 5, 1855.

400 Vaughan, Thomas, Middlesbro'-on-Tees...... 1857.

401 Waddington, C. L., Burnley, Lancashire...... March 7, 1867.

402 Wadham, Edward, C. and M.E., Millwood, Dalton-in-Furness.............. Dec. 7, 1867.

403 Walker, Geo. W., Bulwell, near Notts ...... Sept. 7,1867.

404 Wallau, Jacob, Gateshead .... Nov. 2, 1867.

405 Waller, William, 82, Northgate, Darlington ... 1866.

406 Walton, W., Upleatham Mines, Redcar...... Feb. 1, 1867.

407 Ward, Henry, Priestfield Iron Works, Oaklands, Wolverhampton .... March 6, 1862.

408 Warrington, John, Kippax, near Leeds ... ... Oct. 6, 1859.

409 Watkin, Wm. J. L., Pemberton Colliery, Wigan... Aug. 7, 1862.

410 Watson, Henry, High Bridge, Newcastle-upon-Tyne................. March 7, 1868.

411 Webster, R. C, Ruabon Collieries, Ruabon, Denbighshire .... Sept. 6, 1855.

412 Weeks, John G., North Gawber Colliery, near Barnsley .... Feb. 4, 1865.

413 Westmacott, Percy G. B., Elswick Iron Works, Newcastle-upon-Tyne ... June 2, 1866.

414 Whalley, Thomas, Orrell Mount, Wigan...... Aug. 2, 1866.

415 Whitaker, Thomas, Tynemouth......... June 6, 1868.

416 White, Jos. T., 68, Westgate, Wakefield...... March 1, 1866.

417 Williams, E., (Bolckow, Vaughan, and Co.), Middlesbro'-on-Tees ..... Sept. 2, 1865.

418 Willis, James, Washington Colliery, Washington Station, County of Durham... March 5, 1857.

419 Wilmer, F. B., Duffryn Collieries, Aberdare ... June 6, 1856.

420 Wilson, J. B., Haydock, near St. Helen's, Lancashire .... Nov. 5, 1852.

421 Wilson, R., Flimby Colliery, Maryport ...... April 3,1856.

422 Wilson, J. Straker, Avon Yale Coal Company, Britonferry, Glamorganshire Dec. 2, 1858.

423 Wood, C. L., Howlish Hall, Bishop Auckland ... 1853.

424 Wood, Lindsay, Hetton Hall, Fence Houses (Member of Council) Oct. 1, 1857.

425 Wood, W. H., West Hetton, Ferry Hill...... 1856.

426 Wood, John, Flockton Collieries, Wakefield, Yorkshire................. April 2, 1863.

427 Wood, William O., Brancepeth Colliery, Willington, Durham .... Nov. 7, 1863.

428 Woodhouse, J. T., Midland Road, Derby (Vice-President) Dec. 13, 1852.

429 Wright, C, Tylden, Shireoak Colliery, Worksop, Nottinghamshire ... 1862.

430 Yardley, John, Burntree, Tipton ...... Nov. 3, 1866.

Graduates.

1 Armstrong, William, jun., Seaham Colliery, Sunderland .... April 7, 1867.

2 Atkinson, W., Rainton Colliery, Fence Houses ... June 6, 1868.

3 Auberey, William, jun............. March 7, 1867.

4 Booth, R. L., Medomsley, Burnopfield ...... 1864.

5 Clarke, Nathl., jun., Beamish Park, Fence Houses June 6, 1868.

6 Coates, C. N., Skelton Mines, Guisbro'...... May 3,1866.

7 Coulson, Francis, Shamrock House, Durham ... Aug. 1, 1868.

8 Cowlishaw, John, 74, Osmaston Street, Derby ... March 7, 1867.

9 Fletcher, Geo., Trimdon Colliery, Trimdon Grange April 4, 1868.

10 Forster, J. T., Washington, Gateshead...... Aug. 1, 1868.

11 Grace, E. N., Lumley Colliery, Fence Houses ... Feb. 1, 1868.

12 Harrison, John G............... Oct. 6,1864.

13 Heckels, W. J., Wearmouth Colliery, Sunderland May 2, 1868.

14 Heslop, C, Upleatham Mines, Marske ...... Feb. 1, 1868.

ELECTED.

15 Hilton, James, Wigan Coal and Iron Co., Limited, Wigan, Lancashire ... Dec. 7, 1867.

16 Home, George, Rainton Colliery, Fence Houses June 6, 1868.

17 Longbotham, Jon., Waldridge Colliery, Chester-le-Street .... May 2, 1868.

18 Maughan, James A., Benwell Colliery, Newcastle-upon-Tyne .... Nov. 7, 1863.

19 Marley, John William, King's College, London ... Aug. 1, 1868.

20 Nevin, John, Mirfield .... May 2, 1868.

21 Panton, Frederick, Seaham Collieries, Sunderland Oct. 5, 1867.

22 Parrington, Matthew W., Page Bank Colliery, Durham .... Dec. 1, 1864.

23 Peile, William, Corkickle Forge, Whitehaven ... Oct. 1, 1863.

24 Ramsay, Thomas Dunlop, South Durham Colliery, via Darlington .... March 1, 1866.

25 Sheridan, Frederick, Framwellgate Colliery, near Durham .... June 6, 1868.

26 Siddon, Frederick, Wigan Coal and Iron Co., Limited, Wigan, Lancashire June 1,1867.

27 Sopwith, T., jun., Towneley Colliery, Blaydon-on-Tyne................. Nov. 2, 1867.

28 Taylor, W. N., Ryhope Colliery, Sunderland ... Oct. 1,1863.

29 Wardell, Stuart C., Towneley Colliery, Blaydon-on-Tyne .... April 1, 1865.

30 Watson, Matthew, Thornley Colliery, Ferry Hill... Mar. 7,1868.

31 White, H., Moorhouse, near Durham ... ... 1866.

32 Wild, J. G., Peases' West Collieries, Darlington... Oct. 5, 1867.

33 Verner, Frederick, Cowpen Colliery, Blyth ... March 7, 1867.

34 Vernon, John O., Brancepeth Colliery, Willington, Durham .... Sept. 7, 1867.

List of Subscribing Collieries.

Owners of Stella Colliery, Ryton, Newcastle-upon- Tyne.

„ Kepier Grange Colliery, by Durham.

„ Leasingthorne Colliery, Ferry Hill.

„ Westerton Colliery, Ferry Hill

„ Black Boy Colliery, Bishop Auckland.

„ North Hetton Colliery, Fence Houses.

„ Haswell Colliery, Fence Houses.

„ South Hetton and Murton Collieries, Fence Houses.

„ Lambton Collieries, Fence Houses (Earl Durham).

„ Hetton Collieries, Fence Houses.

„ Whitworth Colliery, Ferry Hill.

„ Ryhope Colliery.

„ Rainton Collieries (Earl Vane).

Rules.

I.—The objects of the North of England Institute of Mining Engineers are to enable its members, comprising Mining and Mechanical Engineers, and other persons connected with or interested in Mining, to meet together at fixed periods and to discuss the means for the Ventilation of Coal and other Mines, the Winning and Working of Collieries and Mines, the Prevention of Accidents, and the Advancement of the Sciences of Mining and Engineering generally.

2.—The Members of the North of England Institute of Mining Engineers shall consist of four classes of Members, viz.:—Ordinary Members, Life Members, Graduates, and Honorary Members.

3.—Ordinary and Life Members shall be persons practising as Mining and Mechanical Engineers, and other persons connected with or interested in Mining.

4.—Graduates shall be persons engaged in study to qualify themselves for the profession of Mining or Mechanical Engineers.

5.—Honorary Members shall be Mining Inspectors during the term of their office, and other persons who have distinguished themselves by their literary or scientific attainments, or who have made important communications to the Society.

6.—The Annual Subscription of each Ordinary Member shall be £2 2s., payable in advance, and the same is to be considered due and payable on the first Saturday of August in each year, or immediately after his election.

7.—The Annual Subscription of each Graduate shall be £1 1s., payable in advance, and the same is to be considered due and payable on the first Saturday of August in each year, or immediately after his election.

8.—All persons who shall at one time make a donation of £20 or upwards shall be Life Members.

9.—Each Subscriber of £2 2s. annually (not being a member) shall

be entitled to a ticket to admit one person to the rooms, library, meetings, lectures, and public proceedings of the Society; and for every additional £2 2s., subscribed annually, another person shall be admissible up to the number of five persons; and each such Subscriber shall also be entitled for each £2 2s. subscription to have a copy of the Proceedings of the Institute sent to him.

10.—Persons desirous of being admitted into the Institute as Ordinary Members, Life Members, or Graduates, shall be proposed by three Ordinary or Life Members, or both, at a General Meeting. The nomination shall be in writing, and signed by the proposers, and shall state the name and residence of the individuals proposed, whose election shall be balloted for at the next following General Meeting, and during the interval notice of the nomination shall be exhibited in the Society's room. Every person proposed as an Honorary Member shall be recommended by at least five Members of the Society, and elected by ballot at the following General Meeting. A majority of votes shall determine every election.

11.—That the Officers of the Institute shall consist of a President, six Vice-Presidents (four of whom only to be mining engineers), and eighteen Councillors (twelve of whom only to be mining engineers), who with the Treasurer and Secretary (if Members of the Institute), shall constitute a Council for the direction and management of the affairs of the Institute; all of which Officers shall be elected at the Annual Meeting, and shall be eligible for re-election, with the exception of any President or Vice-President who may have held office for three consecutive years, and such three Councillors of the Mining Engineers, and two Councillors of the Mechanical Engineers who may have attended the fewest Council Meetings during the past year; but such Members shall be eligible for re-election after being one year out of office. Voting Papers, with Lists of Officers, shall be posted by the Secretary, to all Members of the Institute, at least fourteen days previous to the Annual

Meeting; such Voting Papers to be by them filled up, signed, and returned under cover, either personally or through the post, addressed to the Secretary, so as to be in his hands before the hour fixed for the election of Officers. The Chairman shall, in all cases of voting, appoint scrutineers of the lists, and the scrutiny shall commence on the conclusion of the other business of the meeting. At meetings of the Council, five shall be a quorum, and the Minutes of the Council's proceedings shall be at all times open to the inspection of the Members of the Institute.

12.—That the Vice-Presidents who have become, or may become,

ineligible, from having held office for three years, shall be, ex officio, Members of the Council for the following year.

13.—A General Meeting of the Institute shall be held on the first Saturday of every month (except in January and July), at two o'clock; and the General Meeting in the month of August shall be the Annual Meeting, at which a report of the proceedings, and an abstract of the accounts of the previous year, shall be presented by the Council. A Special Meeting of the Institute may be called whenever the Council shall think fit, and also on a requisition to the Council, signed by ten or more Members.

14.—Every question which shall come before any meeting of the Institute shall be decided by the votes of the majority of the Ordinary and Life Members then present.

15.—The Funds of the Society shall be deposited in the hands of the Treasurer, and shall be disbursed by him according to the direction of the Council.

16.—All papers sent for the approval of the Council shall be accompanied by a short abstract of their contents.

17.—The Council shall have power to decide on the propriety of communicating to the Institute any papers which may be received, and they shall be at liberty, when they think it desirable, to direct that any paper read before the Institute shall be printed and transmitted to the Members. Intimation, when practicable, shall be given at the close of each General Meeting of the subject of the paper or papers to be read, and of the questions for discussion, at the next meeting; and notice thereof shall be affixed in the rooms of the Institute a reasonable time previously. The reading of papers shall not be delayed beyond such hour as the President may think proper, and if the election of Members or other business should not be despatched soon enough, the President may adjourn such business until after the discussion of the subject for the day.

18.—Members elected at any meeting between the Annual Meetings shall be entitled to all papers issued in that year.

19.—The Copyright of all papers communicated to and accepted by the Institute shall become vested in the Institute; and such communications shall not be published for sale, or otherwise, without the permission of the Council.

20.—All proofs of discussion forwarded to Members for correction must be returned to the Secretary not later than seven days from the date of their receipt, otherwise they will be considered correct and be printed off.

21.—The Institute is not, as a body, responsible for the facts and opinions advanced in the papers which may be read, nor in the abstracts of the conversations which may take place at the meetings of the Institute.

22.—The Author of each paper read before the Institute shall be allowed twelve copies of such paper (if ordered to be printed) for his own private use.

23.—The Transactions of the Institute shall not be forwarded to Members whose subscription is more than one year in arrear.

24.—No duplicate copies of any portion of the proceedings shall be issued to any of the Members unless by written order from the Council.

25.—Each Member or Graduate of the Institute shall have power to introduce a stranger to any of the General Meetings of the Institute, and shall sign, in a book kept for the purpose, his own name as well as the name and address of the person introduced; but such stranger shall not take part in any discussion or other business, unless permitted by the meeting to do so.

26.—No alteration shall be made in any of the Laws, Eules, or Regulations of the Institute, except at the Annual General Meeting, or at a Special Meeting, and the particulars of every such alteration shall be announced at a previous General Meeting, and inserted in its minutes, and shall be exhibited in the room of the Institute fourteen days previous to such Annual or Special Meeting, and such Meeting shall have power to adopt any modification of such proposed alteration of, or addition to, the Rules.

Report of the Building Committee.

In accordance with the resolution of the Council, dated October 5th, we have gone into the whole question of the purchase of the present site, and the erection of suitable buildings for the accommodation of the Coal Trade, Mining Institute, and also the proposed Memorial Hall.

The site, one of the most valuable in Newcastle, we are unanimously of opinion, ought to be at once secured at the price arranged, namely, £5,000.

It will be seen on reference to the plan proposed by Mr. Dunn, the architect recommended to us by the Council, how admirably it is suited to the various requirements of the case.

The total available area for building is 931 square yards, which at £5 7s. 5d. per square yard gives £5,000, the price agreed to. It is proposed to set apart 296 yards of this as the site for the erection of the Memorial Hall.

The site for the purposes of a Memorial Hall will be very appropriate, by reason of its proximity to the Coal Trade Offices and Mining Institute, and by the skilful arrangement of Mr. Dunn, the hall has a distinct and prominent individuality, with an excellent frontage, harmonising with the larger building devoted to the Institute, and sharing in the general harmony of the whole.

Considering, however, the fact that the Memorial Hall will be a room devoted to the purposes of this Institute for ever, and that any further expense to the Institute for such a room as they require will be avoided, we recommend that the 296 yards so appropriated shall be presented to the fund for raising the Memorial Hall, and that the remaining portion of the site shall be reserved for the purposes of the Institute and Coal Trade, in the way hereafter described.

As regards the Memorial Hall, Mr. Dunn estimates than an ornamental and suitable building, of which we herewith hand you the detailed plans, could be erected for £4,000, exclusive of the site.

About £2,300 of this sum are in hand; and as the Committee

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recommend the Institute to present the site, the remaining sum of £1,700 we are assured will be easily obtained.

As regards the Institute, Mr. Dunn estimates that £4,580 would provide a suitably decorated building, arranged not only to afford most ample accommodation for conducting your business with that of the Coal Trade, but containing suites of offices that would be eagerly sought after, and afford a large income. This sum, with the £3,520, the value of the site, gives a total of £8,100.

The building, as will be seen from the accompanying plans, contains 9 large offices on the ground floor, 10 on the first floor, and 10 on the second floor, the rental from which might reasonably be set down at £215, £195, and £140 respectively, or an aggregate rental of £550, less taxes and sundries, which might probably reduce it to £500 per annum nett.

The first floor of this block of buildings would contain ample accommodation for the Coal Trade and Mining Institute, with both of which Institutions we propose terms of rental should be arranged for a long term of years, and we recommend that the Mining Institute should reserve the right to secure such rooms as they require.

The rental of £500 is equivalent to nearly 6 1/4 per cent, on the estimated outlay of £8,100, which we are assured by Mr. Dunn will not be exceeded. Such an outlay, therefore, promises to be a fairly profitable undertaking, but as it is not desirable for the Institute to go into speculations of this nature, and as contributions cannot be anticipated to meet the case, we recommend that a Limited Liability Company be formed amongst the members of the Coal Trade and Mining Institute for the purpose of raising the requisite funds, and that the nominal capital be £9,000, in 450 shares of £20 each.

The Committee having, from conversation with many members of the Coal Trade and Institute, every faith in the feasibility of the scheme, urgently press its adoption by this meeting.

The following gentlemen have agreed to form the Provisional Directory, and take the necessary steps towards enrolment and the issue of shares:--

Thomas E. Forster, Esq.; J. Straker, Esq.; Hugh Taylor, Esq., Chipchase; Collingwood L. Wood, Esq.; Robert S. Newall, Esq.; E. F. Boyd, Esq.

October 19th, 1867.

[1]

NORTH OF ENGLAND INSTITUTE

of

MINING ENGINEERS.

GENERAL MEETING, SATURDAY, SEPT. 7, 1867, IN THE ROOMS OF THE INSTITUTE, NEVILLE HALL, NEWCASTLE-UPON-TYNE.

T. E. FORSTER, Esq., President op the Institute, in the Chair.

The Secretary read the minutes of the Council, after which the following gentlemen were elected:—

Members—

Robert Thompson, Jun., Waterloo Colliery, Leeds.

George W. Walker, Hetton Colliery, Fence Houses.

Andrew Leslie, Hebburn.

A. S. Rake, Bank Buildings, Newcastle-on-Tyne.

John Jones, F.G.S., Secretary North of England Iron Trade, Middlesbro'.

Mark Fryar, F.G.S., Royal Insurance Buildings, Corn Street, Bristol.

Joseph Tinn, C.E., Royal Insurance Buildings, Corn Street, Bristol.

Graduate-

John O. Vernon, Brancepeth Colliery, Willington, Durham.

Two new safety-lamps were presented to the Institute—one by Mr. Teale; and the other by Mr. Samuel Higgs, Junior, of Penzance, accompanied by a letter of explanation.

It was resolved, at the suggestion of the President, that both these lamps be handed over to the Lamp Committee for examination.

Mr. Steavenson said, he had seen many accounts of trials of safety-lamps made in the south, where credit seemed to be taken for experiments which had already been made at Hetton.

[2]

Mr. G. B. Forster said, there could be no doubt of the priority of the experiments at Hetton, since he had shown a proof of the Report of the Lamp Committee to some of the gentlemen at Barnsley four months ago.

Mr. Daglish said, the Report had been read four or five months ago, but its publication was delayed for some further experiments.

Mr. Marley suggested that the Lamp Committee with the Secretary should prepare a suitable paragraph, to be put in the papers, giving an account of the experiments. He begged to move a vote of thanks to the gentlemen who had presented the two lamps.

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

At the request of Mr. Waller, the discussion upon his paper on Pumping was postponed.

The meeting was then made special to consider the following alteration of Rule 5, viz. :—That the words " mining inspectors during the term of their office and other " be inserted after the words " honorary members shall be."

The proposed alteration was unanimously adopted.

Mr. Morison said, that before the Tail-rope Committee's Report was read, he would wish to draw the attention of the meeting to some experiments which he had made with safety-lamps at Hetton Colliery, where the Lamp Committee's labours took place, and which were repeated last week at Barnsley. He was sorry to hear that the Lamp Committee had given up their duties, for he wished his lamps to be tested before them.

Mr. Daglish said, the Lamp Committee had not yet abrogated their duties, and they would be glad to test these lamps.

Mr. Morison said, he would be glad to hand them over.

The President said, the great object was to get a lamp that was perfectly safe.

Mr. Morison stated that he had two lamps tried. One had a single-glass and the other a double-glass. In the single-glass lamp the interior gauze is protected by the glass cylinder from any current of either air or explosive mixture. In the double-glass lamp, the light of which is equal to the Clanny lamp, the flame is so perfectly isolated that even when exposed to wind with a velocity of 50 feet per second it was scarcely affected, whilst the Davy, Clanny, and Geordy, were immediately extinguished. This lamp is put out by an explosive mixture when the

[3]

velocity is under 10 feet per second, and when the velocity is increased the amount of gas which continues ignited is so small, that, although in one experiment it was exposed to a velocity of 12 or

13 feet per second for more than 14 minutes, it kept cool, and at the expiration of that time went out.

SUMMARY OF EXPERIMENTS.

At Hetton Colliery, on the 10th June last, the lamps were tried with the following results :—

		Velocity.			
No.l—The single-glass lamp	...	8 feet per second	...	Went out in 5 seconds.	
" "	...	" "	...	" 7 "	
" "	...	" "	...	" 7 "	
No. 2—The double-glass lamp	...	" "	...	" 27 "	
" "	...	" "	...	Gas burned 1 1/2 minutes.	

At the velocity or sixteen feet No. 1 was exposed twice to the current without firing, the time being eighty-five and sixty-two seconds respectively.

At the velocity of twenty-three feet it was exposed four times without firing, the gas burning in the lamp.

At the velocity of twenty-five feet it was subjected five times to the current in different positions without firing, the gas burning in the lamp.

No. 2 was tried twice at this last velocity without firing, the gas burning slightly.

On the 9th August, also at Hetton, further experiments were made at velocities varying from nine feet to twenty-five feet per second with both natural and artificial gas, the results being nearly similar to those described above. The No. 2 lamp, upon which some alterations had been made, passed the flame twice, owing to a defect in the exterior shield. When this was remedied, it was exposed five times at a velocity of twenty-five feet per second without passing the flame or even heating.

Some experiments were made at Barnsley on the 4th September, but, owing to the unsatisfactory nature of the apparatus, and the deficient supply of gas (which was irregularly directed upon the lamp from a hose only one inch in diameter), as well as from the low velocity of the explosive current, they were perfectly useless to determine the comparative safety of the lamps tried. In proof of this, it may be mentioned that the ordinary Clanny went out in about five or six seconds in every experiment at the velocity of ten feet a second, while the Geordy was sometimes extinguished immediately, sometimes after a long period (in one case four minutes six seconds), and occasionally fired.

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Mr. G. B. Forster suggested that the Secretary should send out a notice, that any one having a lamp to be tested should send it to the Lamp Committee.

Mr. Marley said, it had been suggested that the Lamp Committee had done its work. To remove any doubt about it, as to whether it was yet in existence, it would be better to re-appoint it, intimating, as Mr. Forster had suggested, that they would be glad to receive lamps from any one to be tested. He, therefore, begged to propose that Mr. Atkinson, Mr. Lindsay Wood, Mr. Daglish, and Mr. G. B. Forster be re-appointed, and that they continue in office during the current year making experiments ; and that these and any other lamps be submitted to them.

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

Mr. Steavenson asked Mr. Morison how he ascertained the speed in his experiments ?

Mr. Morison said, the box was exactly the same as the Committee had used. The velocity was ascertained by Dickinson's anemometer.

Mr. Marley moved, that the next meeting be made special for considering certain alterations in Rules 1, 11, and 20.

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

The Secretary then read a summary of the Tail-rope Committee's Report.

The report was ordered to be printed.

The meeting then separated.

REPORT OF A COMMITTEE

APPOINTED BY THE

NORTH OF ENGLAND INSTITUTE OF MINING ENGINEERS,

TO

TEST SAFETY-LAMPS UNDER CERTAIN CONDITIONS.

In consequence of a communication made to the President of the Institute by Mr. G. C. Greenwell (see Vol. XII., page 72), relative to the fact of an inflammable vapour being given off by the gauzes of safety-lamps when heated to a high temperature, you were pleased to appoint a Committee to investigate and report on the subject.

Your Committee have carefully investigated this important matter, and now beg to submit detailed statements of the different series of experiments on the subject, together with the conclusions at which they have arrived, from a consideration of the results of the various experiments.

EXPERIMENTS MADE AT HETTON COLLIERY, APRIL 17, 1863, ON SAFETY-LAMP GAUZES.

EXPERIMENTS.

[table]

[6]

[tables]

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[tables]

[8]

[tables]

SUMMARY.

1.--- That if a new gauze can be heated quickly to a red heat, it will, under certain circumstances, give off fumes, which will inflame at that temperature. (no. 1)

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2.—That similar results can be obtained by smearing a gauze with oil.   (Nos. 2, 3, 4, and 5.)

3.—And, further, that oil on being poured over red-hot iron will ignite.

We may conclude, therefore, that this phenomenon is due to the presence of oil adhering to the gauze.

That by heating to a high temperature the oil is volatilised and removed, and the gauze can again be raised to a red heat without these results.   (Nos. 2 and 4 A.)

But the action returns if any oil is smeared on the gauze. (Nos. 5 and 11.)

And cannot be removed except by the gauze being again heated red-hot.   (Nos. 3 and 4.)

That the ignition of the vapour externally takes place when the gauze is inserted within a red-hot tube (No. 1, &c), but not when a piece of red-hot iron is inserted within it.   (Nos. 8, 9, and 10.)

The gauze becomes much sooner heated red when put within the red-hot tube than when the iron is inserted within it.

It is essential, therefore, that the gauze be rapidly heated red; if not, the oil is volatilised without being ignited.

We come, therefore, to the following conclusions:—

1.—That if rapidly heated to a high temperature, a safety-gauze gives off fumes which will ignite.

2.—That under all known conditions under which safety-lamps are used, this could not occur.

That if a gauze be previously thoroughly acted on by caustic potash and sulphuric acid, it will not, on being heated by having a red-hot iron rod placed within it, give off fumes sufficiently inflammable to ignite on the outside.

(There was considerable doubt about the gauze, so heated, firing even on the inside.)

The conclusion to be arrived at therefore is, that the oil is simply attached to the outside of, and is not incorporated in, the body of the iron.

Your Committee then proceeded to carry out a series of experiments with ordinary illuminating or coal gas, on the velocity at which it is necessary to move a lamp in an inflammable mixture to cause an explosion, and on the various circumstances affecting this important question,

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such as varying the proportions of gas and air, the materials of gauzes, and the size of mesh of the gauze.

The experiments were conducted in a box, as shown in the drawing, with glass sides, through which the result of each experiment could be observed. In the box was fitted an upright spindle, which passed through the bottom of the box, and was made to revolve by means of a handle on the outside of the box, the number of revolutions of the spindle being quadrupled by means of toothed gearing. A horizontal arm was attached to the vertical spindle, and upon the arm was fixed, by means of set-screws, the safety-lamp to be experimented on.

The top of the box was provided with a hinged lid, which was opened by the force of the explosion and allowed the expanded contents of the box to escape, thus preventing any serious results. The gas was admitted at the top of the box by a horizontal pipe, pierced by numerous small holes. Attached to this apparatus was a small gasometer, by depressing which the various mixtures of gas and air were prepared in the box.

The following are the dimensions of the apparatus :—

The box was 2 ft. 7 1/4 in. long, 2 ft. 4 in. wide, and 1 ft. 4 3/4 in. deep.

Sectional area of box .... 6.1 square feet.

Length of arm on which, the lamp was placed ... 10 1/2 inches.

Distance travelled by lamp for one revolution ... 5.5 feet.

Diameter of gasometer......... ... ... 2 feet 11 inches.

Sectional area of gasometer .... 6.68 square feet.

1 inch fall in gasometer put into the box ... 0.5567 cubic feet of gas.

In the first experiments the time was taken, as in similar experiments made by others previously, with an ordinary seconds watch, by counting the revolutions of the handle. It was soon seen, however, that this was not sufficiently accurate, especially in ascertaining the maximum terminal velocity previous to explosion. A large seconds timepiece was then used, and an additional piece of mechanism attached to the apparatus by which a bell was struck at each revolution. This gave better results, but still not sufficiently accurate to be entirely satisfactory. A further addition was then made to the apparatus, by means of a small eccentric placed on the spindle of the whirling arm itself; a reciprocating motion of the eccentric-rod was thus obtained at each revolution; the end of this spindle pressing on the detaching spring of a French marking seconds timepiece recorded velocities of upwards of six revolutions per second with the greatest accuracy.

The apparatus was farther improved by adding a drum to the spindle in lieu of the handle; this was turned by the unwinding of a cord by a

[Plate 1 Apparatus for testing safety lamps, scale 1in. to a foot]

[Plate 2 Apparatus for testing safety lamps, scale 3/8in. to a foot]

[11]

weight attached to it, and the velocity was regulated by a brake. As, however, the increasing velocity of the descending weight made it almost impossible, by means of the brake, to keep the lamps moving at the same rate throughout, it was thought desirable to get some other more regular motive power, and this was supplied by driving the rope round the drum from the fly-wheel of a small donkey-engine. By this means the machine was made self-revolving and self-recording. In order to prevent the velocity of the lamp from causing a current of air to follow it, which of course would lessen the actual velocity with which the lamp impinged on the air, a small fan or vane was introduced in one side of the box. This was attached to a vertical spindle, worked through a small lever and eccentric-rod from an eccentric at the top of the main spindle, to which the arm carrying the lamp was attached. By this means, when the lamp was on the opposite side, the fan was moved almost to a right angle to its original position, which was parallel to the side of the box, and thus intercepted and checked the current.

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EXPERIMENTS WITH A DAVY LAMP (IN REVOLVING APPARATUS).

Fibst Series.

[table]

* The figures in the column marked " degree of heat" denote the different degrees of heat as follows :—1 signifies white heat; 2 light red heat; 3 dark red heat; 4 dull red heat; 5 little heat; 6 invisible heat.

[13]

[tables]

[14]

[tables]

[15]

[table]

From these experiments your Committee draws the following conclusions—

1st.—By revolving a Davy safety-lamp in certain mixtures, not only of ordinary coal-gas and air, but also of the less explosive pit-gas and air, at certain velocities, the external gas will be ignited.

This was clearly demonstrated by your late lamented President by the experiments described in his valuable paper on this subject, published in the first volume of your Transactions.

2nd.—In a mixture of coal-gas and air, the gas has been ignited by a lamp revolving at a great velocity, but the gauze of which had not attained a red heat, thus proving that in this experiment the flame passed through the gauze and was not ignited by the gauze itself attaining high temperature.

3rd.—In mixtures where there is a great excess of gas in the proportion of one to five of air the explosive force is very slight, the flame, which is of a yellow colour, passes sluggishly over the box and the explosion is prolonged ; where the air is more abundant in proportion of one of gas to eight of air, or thereabouts, the colour of the flame is blue, and the explosion is violent and rapid.

4th.—The lowest velocity at which the flame passed was thirteen feet per second. (Experiments 13 and 36.)

In experiments, with a revolving apparatus, however, several elements arise, which may materially affect the results. It has been stated by some experimentalist that the action of air moving against a stationary body is not similar to that of a body moving rapidly in a still atmosphere,

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and, farther, that the action of a body moved rapidly in a circle is not the same as when moved in a straight line; probably, however, these elements are of but slight importance. In using any revolving apparatus for experiments of this nature, however, it is most difficult to arrive at a certain knowledge of even the average velocities, and quite impossible to ascertain the ultimate maximum velocity at the moment of the passage of the flame. Necessarily the diameter of the whirling arm must be small, therefore, in order to obtain a high velocity of the extremity, the revolution must be very rapid. This renders it impossible to obtain accurately and unerringly the peculiar circumstances of each lamp when the flame passes ; the general appearance being that of a continuous light, in consequence of the rapidity of the revolutions, so that the eye cannot follow the lamp. Again, there can be no doubt but that in so confined a space the rapid revolving of the arm and attached lamp must cause a corresponding motion of the atmosphere inside the box, which alters considerably the actual rate at which the lamp impinges on the air; this was, however, to a great extent, overcome by the addition of a farther piece of mechanism, whereby a flat vane interrupted the air-current at each revolution of the arm, thereby causing it to be comparatively stationary.

There is, however, a still more fatal element of inaccuracy, viz., the formation of carbonic acid in the confined box by the combustion of the gas by the lamp, rendering it quite impossible to know the composition of the gas in the box at the time of the explosion.

By the mechanism attached to the machine for self-recording the revolutions, a much greater degree of accuracy has been attained in these experiments than has ever heretofore been arrived at in other experiments of a similar character.

After your Committee had ascertained that in mixtures of ordinary pit gas explosions occurred when a common Davy-lamp was revolved at the rate of thirteen feet per second, they felt at once that the matter was so serious that a re-arrangement of the system of experiments was absolutely necessary, in order to ascertain accurately and conclusively the exact velocity of current required to effect this disastrous result. It was then determined to adopt a mode whereby a current of air and gas of known proportions and of known velocity should impinge on a lamp at rest.

A box was constructed 20 feet long and 11 1/2 inches by 6 1/2 inches in section, with glass sides and hinged top, in which the safety-lamp was placed, and near to it one of Dickinson's Anemometers, which showed

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by the inclination of the vane the exact velocity of the current at the moment of the explosion.

The apparatus was fixed in the return current at Eppleton Colliery, and a communication effected by pipes with the intake current, by which a velocity of 1,200 feet per minute or 20 feet per second could be obtained through the box in which the lamp was placed. The gasometer used in the previous experiments was also connected with this box, and by marking the fall of the top of the gasometer, the exact mixture was ascertained (the most explosive mixture was found to be about seven to one). The gasometer was filled from a blower in the mine, so that the lamp was actually exposed in these experiments to precisely the circumstances of actual practice.

It will be observed, however, that only a portion of the experiments given in the table are made with pit gas, i.e., the ordinary explosive gas of coal-mines. In consequence of the difficulty of obtaining a sufficiently large quantity, this gas was only used in the experiments with the Davy-lamp.

The result of these experiments was so alarming that your Committee hesitated to bring their report forward until the results were verified by a more numerous series of experiments, many of which have been witnessed by other members of your Institute.

[18]

EXPERIMENTS.

[tables]

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EXPERIMENTS.

[tables]

The general results of the experiments may be stated thus :—

An inflammable mixture of pit-gas and air moving at the rate of eight feet per second against a stationary Davy-lamp without a shield will explode. The addition of an ordinary shield to a Davy-lamp is of little benefit; when the shield fits closely, and extends from the top to the bottom of the gauze, it affords some protection, but still at a velocity of twelve feet per second the flame passes.

A Clanny-lamp under similar circumstances will explode in a mixture passing at nine feet per second.

A Stephenson-lamp will explode at nine feet per second. It will be observed that in some experiments (Nos. 31 and 32) the flame passed the Stephenson-lamp before the glass was in any way injured. In experiment No. 29 the glass was clearly observed to break after the lamp had fired the mixture, and was being withdrawn into the cold air for examination.

A Mueseler-lamp passed the flame as easily as a Davy-lamp, viz., at eight feet per second.

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NORTH OF ENGLAND INSTITUTE

OF

MINING ENGINEERS.

GENERAL MEETING, SATURDAY, OCT. 5, 1867, IN THE ROOMS OF THE INSTITUTE, NEVILLE HALL, NEWCASTLE-UPON-TYNE.

T. E. FORSTER, Esq., President of the Institute, in the Chair.

The Secretary read the minutes of the Council, etc., after which the following gentlemen were elected :—

Members—

William Logan, Littletown.

Ralph Hart Tweddell, Sunderland.

Graduates—

Frederick Panton, Rainton Colliery, Fence Houses.

J. G. Wild, Peases' West Collieries, Darlington.

The following alterations of Rules I., XI., and XX. were adopted:—

Rule I.—The objects of the North of England Institute of Mining Engineers are to enable its Members, comprising Mining and Mechanical Engineers, and other persons connected with or interested in Mining,* to meet together at fixed periods, and to discuss the means for the Ventilation of Coal and other Mines, the Winning and Working of Collieries and Mines, the Prevention of Accidents, and the Advancement of the Sciences of Mining and Engineering generally.

Rule XL— That the Officers of the Institute shall consist of a President, Six Vice-Presidents (Four of whom only to be Mining Engineers), and Eighteen Councillors (Twelve of whom only to be Mining Engineers), who, with the Treasurer and Secretary (if Members of the Institute), shall constitute a Council for the direction and management of the affairs of the Institute, all of which Officers shall be elected

* The Italics show the alterations.

at the Annual Meeting, and shall be eligible for re-election, with the exception of any President or Vice-President who may have held office for three consecutive years, and such Three Councillors of the Mining Engineers, and Two Councillors of the Mechanical Engineers who may have attended the fewest Council Meetings during the past year; but such Members shall be eligible for re-election after being one year out of office. Voting Papers, with Lists of Officers, shall be posted by the Secretary to all Members of the Institute, at least fourteen days previous to the Annual Meeting ; such Voting Papers to be by them filled up, signed, and returned under cover, either personally or through the post, addressed to the Secretary, so as to be in his hands before the hour fixed for the election of Officers. The Chairman shall, &c.

Rule XX.—All Proofs of Discussion, forwarded to Members for Correction, must be returned to the Secretary not later than seven days from the date of their receipt, otherwise they will be considered correct and be printed off.

Mr. Waller's paper on Pumping then came on for discussion.

Mr. Steavenson said, this subject may be treated in various ways, for although all have the same object in view, viz., obtaining accurate data as to the ultimate cost of raising water, yet so far as we, an engineering body, are concerned, it is essentially necessary that we proceed methodically, and know exactly wherein we practice economy, or in what particular part of the system applied, in each case, we fail.

Now nothing can possibly be wilder than the modes of proceeding adopted by our friends in Cornwall, when undertaking similar enquiries, the results of which are given monthly in " Lean's Engine Reporter." There the water raised is estimated not measured, the power of engines estimated not indicated, and the fact is, if a set of pumps were working a month without a clack they would be in the regular course of calculation doing extraordinary feats, since it would be taken for granted the usual quantity of water was raised, and the economy of fuel (through the engine having little or nothing to do) would be triumphantly paraded. It is impossible accurately (even for practical purposes) to estimate the water raised—the pumps vary in diameter at different lifts, some are only from the high levels, and all leak more or less.

The earliest attempt to measure the water delivered was made by Mr. Henwood, at Huel Towan, who estimated the deficiency at 7 or 8 per cent.; subsequently by Mr. Wicksteed, who weighed and measured the water from three lifts of pumps at Holmbush, and found a deficiency of 10 per cent. In September, 1839, the water of four strokes of Eldon's engine was separated and measured out of a cistern, with a plunger of 14 inches diameter, and stroke 7 1/2 feet, lift 34 fathoms, the calculated contents of the pumps were 49 gallons, the delivery 47 = 4 per cent.

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deficiency, and experiments of my own confirm the fact of a loss of from 4 to 10 per cent. But there are yet greater discrepancies in many results given as obtained by various engineers, and which cannot be too clearly pointed out in the interests of all concerned. Doubtless all aim at doing the most work for the least money ; and to the owners of a colliery, or the proprietors of water-works, it may be a matter of indifference where the skilful arrangements exist so long as the results are obtained, but if we follow the Cornish system of calculating the millions of pounds raised one foot, by a consumption of 112 pounds of coal, we are entirely overlooking—

1st. Quality of coals—Price of coals.

2nd. Description of boiler and fittings.

3rd. Heat of feed water.

4th. Condition of pumps.

5th. Class of engine.

These are all-important considerations, and should be dealt with distinctly. It is no merit in my engine and pumps that I raise a large quantity of water with a ton of coals if the superiority is in the fact of my employing a Cornish boiler, and so economise fuel; neither is it any demerit in my boiler arrangements if they afford large quantities of steam with a small consumption of coal, while, through the faulty adaptation of the engine and pumps, the steam is wasted, and so in the end bad results are obtained in the water raised from the mine.

We require to know whether the engine, or boilers, or pumps, are individually good or bad.

In these remarks I wish it to be clearly understood that I appreciate the value of Mr. Waller's statistics, and deem them very interesting, and have endeavoured to bring them into comparison with the system at present in use at Tursdale Colliery. I have already, on various occasions, given the results obtained by other methods of pumping, adopting the coefficient of useful effect in actual water raised, compared with the steam pressure on the piston.

In order to obtain data similar to Mr. Waller's, it is necessary to have an independent range of boilers, which can seldom be met with, and I have, therefore, only been able to give the following as a fair average of colliery practice where the water is wound.

The water is drawn at nights, and also at the week end, in water tubs, by the same engine and ropes as are used for drawing the coals in the daytime.

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The rate of drawing is 50 tubs per hour of 300 gallons each; depth of pit, 550 feet—

300 x 50 x 10 x 550 = 82,500,000 foot pounds.

Coals consumed 0.45 tons per hour ... = 21.60d.

Engine and fireman per hour ... ... „ 8.75

Ropes (charging 2/3d. against water) ... „ 1.50

Stores .... „ 0-47

32-32d.

Then 32.32d [divided by] 82,500,000 = 0.391d. per million foot pounds.

As this was the only comparison I had the opportunity of making, it is fair to take the average of Mr. Waller's, with which it does not compare unfavourably.

Mr. Lionel Brough said, that the best Cornish engines had indications of the horse-power regularly taken.

Mr. Steavenson said, he held a letter from Mr. Lean which stated that the power was merely estimated.

Mr. Brough said, he felt sure they gave the indicated horse-power. The duty now performed by the Cornish engine was, however, not quite so good as it was twenty-five years ago.

Mr. Gr. B. Forster inquired if Mr. Steavenson had allowed anything for the wear and tear of guides and cages ?

Mr. Steavenson said, he had allowed for stores.

Mr. Gr. B. Forster said, that drawing water in tubs entailed additional cost in ropes.

Mr. Steavenson said, no doubt it was heavy. He was not advocating the system of ropes. There might, however, be cases where it was desirable to adopt that system.

Mr. Atkinson said, the chances were that Mr. Waller had not allowed for deterioration of pumps. Perhaps he would be kind enough to explain.

Mr. Waller said, that he could vouch for the figures given for the Liverpool Water Works, inasmuch as the results were from actual experiment and not from any theoretical data. He was unable to state the diameter of the pumps, but gave the experiments in the table subjoined as the means whence the quantities were arrived at.

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THE YIELD OF ONE STROKE OF PUMP.

[table]

In the Windsor engine the length of each stroke and the quantity of water were measured, and thus it was proved that a 9 feet 6 inch lift actually averaged a lift of only 8 3/4 feet, thus partly bearing out Mr. Steavenson's assertion as to the full theoretical value of the pumps not being realized. In the Green Lane engine the delivery alone was taken, and a similar loss from the theoretical amount was found. There, in 1865, pumping was actually done at the small cost of .178 pence per million foot pounds. With regard to the question raised by Mr. Steavenson, it was hardly fair to make a comparison with engines where the steam was ready for work, and could be ready again next morning, and to have all the loss charged in favour of pumping as against winding. They knew cases where guides got out of order, and the tubs stuck, and they had a run at the ropes to get them disengaged.

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Mr. Steavenson—You are not speaking of north-country practice now ?

The President—I hope this is not the case in the north.

Mr. Waller said, he would not say where it was, but he had known it to happen, and the work had to stand for about an hour. With regard to the actual cost, he merely adduced the examples given to show the same system in operation both with bad and good engines. There were originally four tables, and he had put them in one, bringing the average result to .41d. He thought Mr. Steavenson's results unfair, as they did not include the cost of delivering the water, superintendence, and the wear of the tubs, &c. As for what had been said that he had made no allowance, and had given the theoretical quantity for the actual delivery, he wished to say that the figures given in his paper were the actual measured deliveries, and the cost included all expense for superintendence, repairs, and renewals, within the time named ; in one case including a new boiler and well timbers ; in two cases new pumps or alterations to the old ones, every expense attending the working being from the audited accounts. And, moreover, that in the case of the Green Lane engine 175 gallons per stroke were raised to allow the clacks to be changed ; but this quantity raised in the drawing lift is not credited as being wasted and not supplied. He wished the figure of 1,000 gallons raised 100 feet, or 1,000,000 foot pounds, suggested by Mr. Bunning, to be adopted as a useful general standard. Mr. T. J. Taylor, in his paper entitled " Suggestions towards a Less Local System of Draining Coalmines," in the Transactions, Vol. V., p. 137, says—"I have before me several statements of the actual expense of lifting water from our mines, and find that it amounts very nearly to a farthing per ton of water upon a standard depth of ninety fathoms. This includes all current charges, but not interest or redemption of capital," this being 1,209,600 foot pounds.

Mr. Steavenson—That is by a Cornish engine, I suppose ?

Mr. J. J. Atkinson—It is said to be an average of these two counties.

Mr. Waller said, he had given the tables, and all the facts were given. The official papers were on the table. Mr. Filliter, of Leeds, had given as a result that the expense for 250 feet on 1,000 gallons did not exceed a halfpenny. At South Staffordshire it was lower than this, 0.10d.

Mr. J. J. Atkinson, referring to the column in the diagram, giving the quantity in gallons, said it did not show the percentage by which it came short of the theoretical quantity.

Mr. Steavenson said, he did not mean to say that Mr. Waller's results were wrong ; he merely took Mr. Lean's letter as a basis, and

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said that the Cornish people paraded mere calculated and supposititious results.

Mr. Waller said, he had not done so, as every possible means was adopted to arrive at the actual quantities, and the cost was .178d. on the large quantity of 2,736 million gallons for one year's work, and included repairs and superintendence.

The President—With interest on capital ?

Mr. Waller—No; exclusive of interest.

Mr. Steavenson—My example was the only one I have obtained. It does not do for Mr. Waller to pick out his best comparisons and put them against my single one; let him take an average.

The President said, he thought he would soon be able to show an example of water forced from the bottom.

Mr. G. B. Forster said, they should quote an engine which did nothing but wind water if they wanted to have a fair comparison.

The President said, Mr. Steavenson was quite right in saying that winding water would be cheaper than pumping; but that would depend on the quantity of water they had to deal with.

Mr. Cochrane said, at Elswick, where he formerly had one side drawing water, a rope lasted him twice the time, now he had ceased to do so. It was only drawing water six hours out of the twenty-four. It would not be a fair proportion to divide the cost of ropes equally between the tonnage of coal and water drawn; for no doubt in drawing water the ropes suffer more than when drawing coal.

Mr. Steavenson said, he could not say he was an advocate for winding by rope.

Mr. J. J. Atkinson said, they would want a great deal more information before they could come to any definite conclusion.

A Paper by Mr. Daglish, " On a New Application of the Water-Gauge for ascertaining the Pressure of the Ventilating Column in Mines " was then read:—

The ordinary mode of using the water-gauge in mines, for ascertaining the ventilating pressure, is to place it between the intake and return currents, as near as possible to the bottom of the shaft in the mine. The water-gauge, however, placed in this position, does not give the actual difference of pressure due to the differences of the weights of the downcast and upcast columns of air at their different temperatures, but only the excess of this amount of pressure over the pressure absorbed by the friction of the currents in the shafts.

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This loss of pressure from shaft friction in deep pits, especially where large quantities of air are moving at high velocities in the shafts, reaches a considerable amount, and very sensibly reduces the indications of the water-gauge as ordinarily employed. By placing in the downcast shaft, however, a range of pipes closed at the lower end by being connected to one leg of a water-guage, the other leg being open to the upcast shaft, the loss of pressure due to the friction of the air passing down the downcast shaft is avoided, and thus not only is the advantage gained of a greater difference in the level of the water in the two tubes, than exists under ordinary circumstances, and thereby enabling the existing state of the ventilating pressure to be more easily observed and recorded; but inasmuch as the velocity in the downcast shaft diminishes with a diminished temperature of the upcast shaft, the increased difference of level referred to above is not a constant quantity, but also varies with the heat of the upcast shaft; hence, a water-gauge so fixed, not only gives a greater extent of scale under the ordinary state of the ventilation of the mine, but also a greater range of scale under variation of temperature.

Another advantage gained by this mode of using a water-gauge is its freedom from the momentary oscillations which are so objectionable in the water-gauge as ordinarily used, and which prevent very accurate readings.

But the chief benefit to be derived from the application of a long range of tubes in the downcast shaft, is that of being able to place the water-gauge on the surface in any position that may be most desirable, as its action is not interfered with by extending the pipes to any length or in any direction, inasmuch as the column of air in the pipe is dormant and its pressure consequently not reduced by friction.

At Seaton Colliery, belonging to Earl Vane, the depth of the shaft is 254 fathoms to the furnace in the Hutton seam; the upcast shaft is 14 feet in diameter, and the quantity of air going down the downcast shaft is 200,000 cubic feet per minute, and this quantity becomes increased to 300,000 cubic feet per minute in the upcast shaft by expansion due to the high temperature. The ordinary ventilating pressure of the mine, as indicated by a water-gauge fixed in the mine in the usual way, is 3 inches, and becomes as low as 0.7 inches when the furnaces are out for repairs to the shaft.

The dotted line on the accompanying diagram exhibits the range of the water-gauge readings, placed in the ordinary position in the mine between the upcast and downcast shafts, taken once each day for a fort-

[Plate III Diagrams of Readings of the Water Gauges at Seaham Collieries...]

night. The black line exhibits the readings of the water-gauge placed in the colliery office, by means of a pipe from the bottom of the downcast shaft, on the principle previously explained.

The office is 200 yards distant from the top of the pit, which is 508 yards deep; there is, therefore, 708 yards of pipe (in this case the ordinary half-inch gas-pipe).

It will be observed that in the customary application of the water-gauge the height of the water column due to the ventilating pressure is 3 inches, falling to 0.7 inches when the furnaces are out, being a range of little more than 2 inches; whilst in the new application the ordinary reading is 5 inches, falling to a minimum of 1.5 inches, having, therefore, a range of 3.5 inches, or nearly double.

By the addition of a galvanic battery the instrument could be made, if this be considered advisable, to ring a bell when the pressure became reduced below a fixed point.

Mr. J. J. Atkinson explained, in the absence of Mr. Daglish, that a water-gauge, as thus applied, gave the friction of the downcast together with the workings. It simply added the friction of the downcast to the ordinary water-gauge at the bottom of the shaft.

Mr. Brough said, they might do away with the water-gauge altogether if they only made their returns good enough.

Mr. Steavenson—Is it self-registering ?

Mr. Willis—No; by the description the gauge is taken to the office and read over at any time.

Mr. J. J. Atkinson—The cost of doing this is not great; only small gas pipes are necessary.

Mr. Brough said, they would require 300 fathoms of them at Monk-wearmouth. He was afraid the pipes would always be getting out of order and deceiving them.

Mr. Steavenson said, he hoped in course of time that ventilating machines would supersede furnaces, and then the water-gauge at bank would give the friction of both shafts and workings.

Mr. Brough said, that no doubt there were conditions and circumstances which did not admit of furnaces.

Mr. Steavenson—When you get 300 fathoms you must have them.

Mr. Brough—One hundred is a pretty good depth for a furnace.

Mr. Willis said, that machinery was said to have done eleven inches in Belgium.

Mr. Heckels asked if any object was to be gained by this new water-gauge ?

Mr. J. J. Atkinson said, it merely made the scale more readable and observable. They might read it at the colliery office as frequently as was necessary.

Mr. Brough said, that of all the instruments in the world none was more valuable then the water-gauge when put to its legitimate and proper use.

On the motion of the President, Mr. Daglish was thanked for his interesting paper; and Mr. James Watson, introduced by the President, then produced and explained the working of a model of a new cage, the object of which was to prevent over-winding. Mr. Watson was thanked for his model, and the subject was referred to the Safety-cage Committee.

The meeting then separated.

NORTH OF ENGLAND INSTITUTE

OF

MINING ENGINEERS.

GENERAL MEETING. SATURDAY, NOV. 2, 1867, IN THE ROOMS OF THE INSTITUTE, NEVILLE HALL, NEWCASTLE-UPON-TYNE.

T. E. FORSTER, Esq., President of the Institute, in the Chair.

The Secretary having read the Report of the Building Committee, the President moved that it be received. This was seconded by Mr. Newall.

Mr. G. B. Forster said, the Committee would be happy to answer any question.

The President remarked that the Institute had not the means for carrying out the proposed scheme. It would be best in the hands of a Limited Liability Company.

Mr. C B. Forster said, he had no doubt the offices would let for a much larger sum than was estimated for them.

The President—Can we bind Mr. Dunn so that the estimate shall not be exceeded ?

Mr. Dunn said, the estimate included everything. The hall could be put up for £3,000.

Mr. Newall said, the buildings would form a great ornament to Newcastle, and the Institute would at once get a comfortable room to meet in. He begged to move the adoption of the report.

Mr. Sopwith said, he took some little interest some time ago in suggesting the idea of a Memorial Hall. Having heard of this design, and having now an opportunity of looking at it, he must say that it appeared to him to carry out the intention in an admirable and judicious manner, combining usefulness with the sentiment so generally agreed on. He thought it would be a means of expressing great respect for the first President of that Institute, and at the same time it would form a most useful place for the meetings of the Institute, combined with useful offices. He begged to urge the unanimous adoption of the report.

The motion was then put from the chair, and carried unanimously, when several gentlemen present gave their names as shareholders, and a large amount was taken up.

Mr. G. B. Forster, in answer to Mr. Rake, said, the Directors would probably call up £8,000 out of the £9,000 of capital.

The following gentlemen were then elected:—

Members-

Jacob Wallau, Gateshead.

John Jarratt, Kepier Grange Colliery.

Graduate—

Thos. Sopwith. Junr., Towneley Colliery, Blaydon.

Mr. Beck, from Belgium, after being introduced by the President, submitted to the meeting specimens of iron sleepers as now in use in a great number of Belgian collieries, as well as in some collieries in England —as at Chesterfield, Derby, and Sheffield. He hoped to introduce the system also into the collieries of this district. Mr. Beck handed round drawings and prospectuses of the invention, and proceeded to give a verbal description of its merits.

Mr. E. P. Boyd said, an idea of the same kind had been adopted at Grange Colliery. There was a two-sided projection attached by bolts to an iron sleeper, and the iron rail was slipped into the middle of it.

Mr. Beck stated that this system was well known to him, that, in fact, it was a flat piece of sheet iron with projections rivetted on, so that each sleeper, thus made, was composed of seven pieces, and was flat at the bottom, could be easily bent, and did not bed itself sufficiently into the ground to be stable, and that there was also not sufficient bearing outside the rail. Whereas, in the system of Legrand, of Mons, in Belgium, both the chair and the sleeper are formed together of but one piece of wrought iron, and the edges being turned down, as shown in the drawing, they took firm hold of the ground and prevented the sleeper from being easily moved.

The President said, another good property was that there were no nails to get into the horses' feet.

Mr. Beck, in reply to the President, said, the invention was patented. There were two rails, the lighter one was used for the temporary road, and the heavier for the fixed road. The best recommendation that could be given for this invention was that all the collieries in Belgium adopted it. He could send them to any station here at the rate of £14 10s. per ton, or even less where a large quantity was ordered.

On the motion of the President, seconded by Mr. Hurst, the thanks of the Institute were given to Mr. Beck for his explanations.

The meeting then separated.

[Plate IV, A. Legrand's System of Chair-Sleepers]

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NORTH OF ENGLAND INSTITUTE

OF

MINING ENGINEERS.

GENERAL MEETING, SATURDAY, DEC. 7, 1867, IN THE ROOMS Of THE INSTITUTE, NEVILLE HALL, NEWCASTLE-UPON-TYNE.

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

The Secretary read the minutes of the Council and last proceedings, after which the following gentlemen were

elected :—

Members— Andrew Scott, Coanwood Colliery, Haltwhistle.

Edward Wadham, Civil and Mining Engineer, Barrow-in-Furness.

William Barrow Turner, Civil and Mining Engineer, Barrow-in-Furness.

William Clark, Victoria Engine Works, Gateshead.

James Haddock, Ravenhead Colliery, St. Helen's, Lancashire.

George Clark, Ravenhead Colliery, St. Helen's, Lancashire.

Peder Boyesen Flood, Seaham Harbour.

Alexandre Beck, Mons, Belgium.

George Henry Birkbeck, Engineer, 34, Southampton Buildings, London.

John Clay, jun., Engineer, Malmesbury House, East Dulwich, London.

Graduate-

James Hilton, Wigan Coal and Iron Company, Wigan, Lancashire.

The Secretary then read a further Report irom the Salety-lamp Committee.

Mr. Lindsay Wood explained that in some cases the Committee used pit gas in their experiments; but in other cases they were obliged to use ordinary illuminating gas. Their object had been to ascertain the velocity at which the explosive current was passing, the degree of heat, and whether the lamp exploded or not.

Mr. Hurst said, it was desirable at the next meeting, when the

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Report came on for discussion, that a specimen of each lamp should be produced.

Mr. Lindsay Wood assented.

On the motion of Mr. Hurst, seconded by Mr. Douglas, the thanks of the meeting were given to the Committee.

Mr. G. B. Forster said, the greatest part of the labour as well as the ingenuity had fallen on Mr. Wood. The Committee knew of other lamps which required to be tested, and they hoped in another month to be ready with a further Report.

The Secretary then read a paper describing the various patents which have been taken out for Coal-cutting machines, prefacing the subject by the following remarks.

Seeing that there had been a lack of papers to be read at the last two or three meetings, and finding that I had by me several papers respecting Coal-cutting machines, I thought it probable that an analytical and explanatory list of the patents which had been taken out from the commencement for coal-cutting would be useful and interesting.

I do not intend at this meeting at all to go into them seriatim, for their name is legion, but merely to give some outline of a few of the principal features exhibited in some of the more prominent inventions, and in some way to classify the various means employed.

I must premise that I have included all the patents for boring or drilling rock in the category. They are so placed by the Patent Commissioners, and I think with reason, for the mining engineer has frequently to encounter rock in getting at the coal.

The patents for getting coal and stone, then, may be divided under six heads.

1st.—Where picks, similar in construction to those used by hand, are employed.

2nd.—Where a number of tools or teeth are employed, so that they can be successively brought to act in the way of sawing.

3rd.—Where the process commonly termed slotting is adopted, and the coal is undercut by means of a groove.

4th.—When this groove, instead of being slotted in the coal, is drilled in, a long and rough cutter protruding itself, forming a hole in the coal to commence with, and being dragged along, the slot or groove is formed.

5th.—Varieties in the process commonly called boring.

6th.—By blows.

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Each of these six sections is divided into endless varieties, and each again is dependent upon three main principles for giving them motion, namely, air, water, and steam.

Irrespective of all these patents, there is a numerous class of inventions for tramways, pit-props, modes of fixing the machines to their work, contrivances for boring the coal, in order to supersede blasting, and for other contrivances too numerous to mention.

I propose, therefore, to give the numbers and dates of all the patents, with some explanatory word or words affixed, stating to which class they may respectively be referred.

Where the invention seems to present some interesting features, either of excellence in its construction or as forming some special type, I propose either giving a small sketch illustrative of its action, or transcribing a portion of the specification or claim, as may seem most useful.

Having in the course of my professional experience had occasion to refer to a great many of the specifications, I have the permission of the Council to complete the series to the present date, so that all that has been done in this way may be readily ascertained by any one interested in the subject.

To most enquirers the explanatory catalogue above referred to will be found amply sufficient, and by its help the blue books can be readily referred to, for any details respecting claims, and the wording of the specifications.

The Chairman said, they were much obliged to Mr. Bunning,* and hoped he would still improve his paper before printing, by using any observations which gentlemen might forward. They would also see that the Secretary had taken the trouble to mention the subjects on which they would like to have papers. He hoped, however small the amount of information they might be able to give on any of these subjects, they would not be slow to furnish it.

The meeting then separated.

* At the suggestion of Mr. Boyd, the Secretary has extended his paper to all patents connected with mining, and has looked over all the blue books connected therewith ; this has necessitated a considerable delay in the preparation of the paper, although it is now nearly ready for printing. Any gentleman who has information of the particulars of the practical application of any patent connected with mining would confer a favour by sending them. Such particulars, added as notes appended to the various inventions, would be interesting.

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SECOND REPORT ON SAFETY-LAMPS.

In continuing their Report on Safety-lamps, your Committee enjoy a much greater feeling of satisfaction in reference to the subject of their investigations than when they presented their first Report.

In it they were obliged to make known the insecurity, under certain conditions not previously fully appreciated and realized, of the safety-lamps, so long looked upon as the safeguard of the miner.

Immediately on this fact becoming clearly evident to your Committee, after the long series of careful experiments made by them, distributed over a period of five years, they felt it their duty at once to publish this as the most important result of their investigations. They have now the more pleasing duty of announcing, that out of a number of lamps which have been submitted to them for trial by various inventors, several are perfectly safe under all known conditions to which they can be subject, except in case of actual breakage.

They have further the still more pleasing task of bringing to your notice a lamp, the suggestion of one of their own number, Mr. Lindsay Wood, which combines perfect safety with great simplicity. This invention is handed over to the Institute of Mining Engineers (unfettered by any patent restrictions), and consists simply of surrounding the flame of a Clanny lamp with a short cone or cylinder of safety-gauze, which reaches only to a little below the top of the glass cylinder of the lamp. Several other lamps have been previously made with interior gauzes, such as Mr. Higg's and others, but they explode at certain velocities, and the safety of this lamp consists in the interior gauze being kept below the top of the glass cylinder, and being of small interior area, only a small quantity of gas can be burnt within it. When exposed to a current of explosive mixture, the gas burns gently within the cone, which, being below the top of the glass, and out of the direction and influence of any current, however strong, never becomes highly heated. Not only, therefore, is the lamp safe in any current or mixture of explosive gas, but it is a double safety-lamp, and should there be any faulty place in the outer

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gauze, or should the glass be broken by the workman's pick or otherwise, the lamp still remains safe. And your Committee further think, that the Institute, by taking up this question and appointing a committee to investigate it, has been the means of producing inventions which will be most important in lessening the risks attending mining operations; and they beg to recommend that as this particular lamp has been improved by one of your Committee, it should be called the " Mining Institute Lamp."

Of the other lamps sent to your Committee for trial, two are the patented inventions of Mr. D. P. Morison, who (with other inventors) has been allowed by your Committee numerous opportunities of testing his invention at the apparatus erected with so much ingenuity and care by Mr. Lindsay Wood, at Hetton Colliery. His No. 1 lamp is a modification of the Stephenson lamp, only having the glass outside, instead of inside, the gauze; his No. 2 lamp is a modification of Cail and Glover's lamp. Both of these lamps go out when exposed to a current of a mixture of explosive gas, and are, therefore, perfectly safe, so far as respects currents of fire-damp.

The Nos. 1 and 2 lamps, the invention of Mr. John Daglish and Mr. P. B. Flood, are both perfectly safe in any mixture or current. No. 1 is a modification of the Davy-lamp, having the addition of an external brass cylinder, entirely enclosing the gauze, except a small portion in the front, which is covered with glass; No. 2 lamp is a modification of the Clanny-lamp, by the addition of a similar protecting cylinder. All ordinary Davy and Clanny-lamps can be rendered perfectly safe by the addition of this protecting cylinder.

A lamp, the invention of Messrs. Ritson and Bell, of Pelton Colliery, was also tested by the Committee, which seemed perfectly safe; they are not, however, able to give any description of this lamp, since the inventors intend protecting it by letters patent, but have not yet done so.

JOHN J. ATKINSON.

LINDSAY WOOD.

C. B. FORSTER.

JOHN DAGLISH.

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LAMP EXPERIMENTS.—30TH SEPTEMBER, 1867.

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LAMP EXPERIMENTS.—THIRD SERIES.—OCTOBER 14th, 1867 (Continued).

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NORTH OF ENGLAND INSTITUTE

OF

MINING ENGINEERS.

GENERAL MEETING, SATURDAY, FEB. 1, 1868, IN THE ROOMS OF THE INSTITUTE, NEVILLE HALL, NEWCASTLE-UPON-TYNE.

T. E. FORSTER, Esq., President of the Institute, in the Chair.

The Secretary read the minutes of the Council.

A letter was also read from Messrs. Pease, stating that, whilst declining to take shares in the new company, they would have pleasure in making a donation of £100 towards the Institute and Coal Trade offices.

A letter from Mr. Marley, declaring his intention to throw open his patent for Safety-cages, was also read.

The following new members were then elected :—

Members— Robert Robinson, Jun., Bishop Auckland.

Matthew Bates, Cyfarthfa Iron Works, Merthyr Tydvil.

William Slingsby Hunter, Moor Lodge, Newcastle-on-Tyne.

Lewis Thomas Lewis, Gadlys Uchaf, Aberdare.

W. Walton, Upleatham Mines, Redcar.

James Nasmyth, Cornbrook Colliery, near Ludlow, Shropshire.

James Davidson, Blyth Place, St. Bees, near Whitehaven.

T. Allinson, Belmont Mines, Guisbro'.

Joseph Robert Crone, Killingworth Colliery, Newcastle-on-Tyne.

Graduates —

E. N. Grace, Lumley Colliery, Fence Houses.

C. Heslop, Upleatham Mines, Redcar.

Discussion was then invited on Mr. Daglish's paper on "A New Application of the Water-gauge for ascertaining the Pressure of the Ventilating Column in Mines."

Mr. Daglish said, that since he wrote the paper he had had an

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opportunity of visiting the works of one of the largest gas apparatus manufacturers in London, Mr. Sugg, who had paid great attention to pressure-gauges (or water-gauges), especially for the purpose of testing the illuminating power of gas, which requires very delicate pressure-gauges. He (Mr. D.) had ordered several, and he hoped to have the opportunity of presenting them for examination before the next meeting. There were several self-registering gauges in operation in the mines in this district—one at Haswell Colliery had been some time in operation; it indicated throughout the twenty-four hours the exact pressure of the ventilating column. The last paragraph of his paper alluded to adapting mechanism to ringing a bell, for the purpose of calling attention to any irregularity ; he found that it was already done at large gas-works, it being a very important matter there ; a galvanic apparatus attached to mechanism rings a bell in the office when the pressure is beyond or below a certain limit. Pressure-gauges are also used, which multiply very largely; in many of the shallow mines, where the pressure is only about half-an-inch, these could be used with great advantage.

The President, said, they were much obliged to Mr. Daglish for his offer to show these implements.

The Secretary then read a paper by Mr. Philip Cooper, of Holme's Colliery, Rotherham, Yorkshire, on " An Outburst or Sudden Issue of Fire-damp at Strafford Main Collliery, Barnsley, Yorkshire, 1st Oct., 1867."

The President said, the outburst, according to his calculation, had come out at the rate of from 2,000 to 3,000 feet per minute. It was quite possible that the whole of this gas might have come from the floor of the mine.

Mr. Steavenson said, when the paper came on for discussion there was one question which might arise, and that was whether, supposing they had been working in pillar and stall, they might not have tapped the gas in the first working, and so got gradually quit of it.

Mr. G. B. Forster moved a vote of thanks to Messrs. Pease for their promised donation of £100.

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

The President moved a vote of thanks to Mr. Marley.

Mr. A. Stansfield Rake seconded the motion, which was carried unanimously.

Thanks were also moved to Mr. Cooper for his paper, after which the meeting separated.

ON AN

OUTBURST OE SUDDEN ISSUE OF FIRE-DAMP

AT

STRAFFORD MAIN COLLIERY,

BARNSLEY, YORKSHIRE, 1st OCTOBER, 1867.

By PHILIP COOPER.

Several outbursts or sudden issues of fire-damp having occurred in the collieries of the South Yorkshire District, without the circumstances attending them having been correctly recorded, I have, with the assistance and concurrence of the viewer of the colliery, Mr. Robt. Miller, who has supplied the principal facts, prepared the following statement of that which occurred at the above colliery on Tuesday morning, the 1st of October, 1867.

The outburst occurred in the Silkstone bed, which is 240 yards deep from the surface, and nearly six feet in thickness, with a good grey metal roof. A few inches of the bottom of the bed is a coarse coal, which is not worked, and below which about two feet of very hard stone indeed is found. There is no record of the strata below this hard stone at this colliery. In adjoining collieries a considerable thickness of bind or grey metal stone is found, with many floors or horizontal partings. At about forty yards below the Silkstone bed a ten-inch bed of coal exists, and at about twelve yards further the Whin Moor bed, the lowest in the Middle Coal Series of the district, is met with.

Formerly the mode of working was by leading and following up benks with bord-gates in the coal, but for some years it has been worked by long-wall in districts, having strait or narrow-work drifts in the coal for the rolleyways and airways. The benks are driven bord, which is nearly full rise of about 1 in 10. They are usually worked about thirty-three yards in width, with a gate-road or tramway packed through the goaf up the middle of the benk. They are generally worked in a nearly

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unbroken line of face, and the roof stands remarkably well along the face, and sometimes for a considerable distance back into the goaf. Previous to the late outburst, the floor or thill had not been observed to lift or creep much. The quantity of fire-damp given off in the strait or whole work is constant, but not extraordinary. The goaves, no doubt, yield it freely.

The ventilation arrangements for the north part of the pit, including the Top Level district of benks, where the outburst occurred, are shown on the plan.

Mr. Miller states that fire-damp had not been seen in the goaves of this series of benks, north of Wood's benk A, for at least nine months, until Saturday, the 28th, and Monday, the 30th of September, the pit being at work both days, when a little was seen behind the packs between Nos. 7 and 8 gates; but that it was reported free from it on the morning of the outburst.

At about 1 a.m. on Tuesday, this series of benks was examined from the north end by the deputy, Joseph Walton, southward to No. 6 benk, where he met Joseph Philips who had examined them from the south end. Walton visited the shifters working on the Nos. 9 and 10 gates, and Philips those between Nos. 3 and 5 gates. There is proof of their having made a proper examination, each having left the proper dates chalked down in the face of the benks, as is the custom of the collieries of the district generally. They reported the benks all quiet, and in their ordinary condition.

Several nightmen or shifters were working on the different gate-roads from 10 p.m. on the Monday. Carlile and Walsh were repairing No. 10 gateway, and they report that the benk faces became uneasy about 2 a.m. on Tuesday, and got worse between 5 and 6 a.m., when one of them proposed to send for the overman, but was put off by his partner, and did not do so. Holling and Slater were repairing in No. 9 gateway, and report that they heard the face uneasy for sometime, and that it was weighting very heavy when they left a little before 6 a.m., and they warned the colliers whom they met on the road to listen their places before going in.

The colliers commence work about 6 a.m. Their account of the occurrence, as near as can be ascertained, is as follows, namely, Walshaw and his brother were in the bord marked B. Robinson and his trammer were in the benk marked C, and Stones, Dickenson, and two trammers were in the gate marked D. All the lamps belonging to the former were first fired and then extinguished.

[Plate V, Plan of the Workings in the Silkstone Seam, Strafford Main Colliery]

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Grill and Tyas were taking out timber in the north side of the benk marked D. They felt a rush of air mixed with dust, and they put out their lamps before the fire-damp reached them.

In Wood's gateway, marked E, were Milnes and Youll, who felt a rush of air and dust. Their lamps were extinguished by fire-damp. They got out by the cross-gate F, the fire-damp following them very strong, and found the door at G partly open with some curves in the doorway.

There were no other workmen in the face, to the top of No. 5 gateway, where five in all were listening, as they thought No. 5 benk was weighting and uneasy, when they felt a rush of wind and dust, and firedamp firing within their lamps, which were soon extinguished by it. They ran along the face towards No. 3 gate-road, two of them, Forley and Waites, falling overpowered by the fire-damp. Forley states that in a while, finding some fresh air on the floor, he felt better, and could have got out, but Waites seemed asleep or powerless. He remained with him near H, on the plan, until Mr. Miller and others found and brought them out, Waites being unable to walk.

Up No. 6 gateway Woodhead and Littlewood and their trammer were filling a corf, when they heard a noise as if the top was breaking heavily, right across from No. 7 benk to theirs, then a rush of wind and dust; two of their lamps, firing within, went out. They retreated down the gate-road, having one lamp burning until Littlewood, returning to the face, fell overpowered by the fire-damp. Woodhead and the trammer tried to get him out, until their lamp was put out by the fire-damp, when they retreated and left Littlewood, who was rescued afterwards. He can recollect of nothing after falling until brought out into the fresh air by Mr. Miller and another.

The colliers and trammers belonging to Nos. 8, 9, and 10 gates had stopped at the pass-bye, at the bottom of No. 8 gateway, where all their lamps were extinguished by fire-damp, one of them being particularly remarked as having filled with fire before going out.

In the tenth gateway Walsh felt a rush, and the air backing his lamp fired within and went out. His mate and two colliers, who were on the outbye side of the corf, got away before him. He says he felt right enough when he got out to the level, but when found had not determined which way to go out, as he still heard men working beyond him.

In No. 11 gateway and No. 5 jenny bord at I the fire-damp fired in the lamps and extinguished them, the workmen coming out by the top-level in the dark. In a very short time the fire-damp was seen in the top-level at U.

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From these statements I have marked the limits to which the retreating workmen observed fire-damp by a black line, parallel with the passages observed to be filled.

At the north end of the district fire-damp backed a current of air of about 4,200 cubic feet per minute to I, which was moving at a velocity of of about 140 feet per minute. At the foot of No. 9 gateway another current of about 1,800 cubic feet per minute from the doors J and J, and a scale of about 1,000 cubic feet per minute through the regulator K, making a current of about 7,000 cubic feet per minute at L, which was increased by a current passing up No. 2 jenny bord and No. 3 gateway, and scaled through the doors M of about 4,000 to 5,000 cubic feet per minute, making in all from No. 3 gateway, a current of not less than 11,000 to 12,000 cubic feet per minute at O, moving at a velocity of fully 360 feet per minute, and in which the safety-lamps in use were all extinguished by fire-damp.

Six hours after the outburst the fire-damp fired in the lamps on the floor at P, and near the roof as far out as T. The current from the benks being about 11,500 cubic feet per minute, and it having been joined by one from the south of about 5,500, making about 17,000 cubic feet at Q. At T it was joined by another current of about 8,000, making in all about 25,000 cubic feet per minute. Beyond T fire-damp was not seen.

These measurements were taken by a Biram's anemometer, no allowance being made for friction.

On being able to enter the benk faces it was found at the corner of Nos. 7 and 8 benks at V, that the roof had fallen sufficient to contract the airway very much, and from this point between the pack-wall and the coal, nearly up to the face of No. 7 benk, the airway was squeezed into not more than twelve square feet area, this fall having been caused at the time of the outburst. It was also found that along the face from V, between the pack-wall and chocks and the face, the floor was lifted up, reducing the height to little more than a yard right across to No. 9 gateway. There was also a wide crack in the floor, shown on the plan by a dark waved line, passing downwards through the seat or bottom coal into the stone below, extending at least from the south end of No. 8 benk, at V (probably it went some distance into No. 7 benk), to the gateway of No. 9 benk. Subsequently on the face having been advanced about four and a half feet, a crack was observed in the floor, beyond which it was depressed three or four inches, the floor between the larger crack and this one being lifted up and hollow.

Several of the metal props or puncheons were broken, and they and

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the pack-clogs were pressed over into the face; but the roof, along the face, was not broken up or fallen; and, although the face has been advanced upwards of ten yards, the roof has not yet been found to be fractured.

The height of No. 8 gateway, close up to the face, was reduced to two and a half feet; and No. 9 gateway was similarly affected, but not so low. Nos. 7 and 10 gateways were not disturbed. The gateways 8 and 9 were only reduced in height, and not broken up as if by creeping, the only creep break in the floor being that across the face of Nos. 8 and 9 benks, the effect gradually lessening beyond the No. 9 benk gateway.

In No. 7 benk the roof had fallen for some time as the timber was moved forward ; but in No. 8 benk the roof had not fallen for twenty-four yards back from the face. Several cracks or breaks in the roof existed previous to the outburst. One crossed No. 7 gateway at forty-three yards, and No. 8 gateway at twenty-four yards ; another crossed from 9 to 10, at eight or nine yards ; and another at about sixteen yards from the face, the latter not seen in No. 8 gateway. These are shown by dotted lines.

Mr. Miller considers these cracks or breaks in the roof had undergone no alteration at the time of the outburst. It is, however, quite possible that up to a certain height the roof had settled previous to the outburst, and above that height a considerable area of goaf may have been open with the roof above it upstanding. I have frequently seen this the case where four or five feet of the roof, immediately above the coal, settled freely from a parting, without breaking, whilst the stone above also remained unbroken, thus forming a very large area of open space, which might be full of fire-damp without being seen. The weighting, or working of the goaves for such a length of face, namely, from No. 5 to No. 10 gateways, or a distance of say 150 yards, for several hours before the outburst, seems to me to support this view. There is no proof that the roof settled gradually during the time it was weighting, breaking, or working, but rather the contrary, the rush of wind and dust being the usual effects of an extensive area of goaf falling ; the gas showing itself for three days previously in No. 7 and 8 benks, also seems to corroborate this view.

Four hours after the outburst, fire-damp issued strongly from the crack in the floor from the north or intake end at the top of No. 9 gateway, and as far as it could be examined along towards the No. 8, where the safety-lamps could not be taken. The fire-damp could be felt issuing very strongly by the hand, but could not be heard. Until the 3rd of

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October, the second day after the outburst, the lamps could be taken no further than the top of the No. 9 gateway, on the intake side, and to between the sixth and seventh benks, on the return side. On that day the fall at the corner of No. 8 benk was removed, after which, by keeping the lamp from the crack in the floor, the face could be examined.

On the 7th of October, when I saw it, fire-damp was issuing strongly from the floor crack, but we could find none in the goaves, except in Nos. 9 and 10 benks. So far back as could be seen in No. 8 the roof was not broken or fallen, only settled down whole. The fire-damp continued to issue, but gradually reducing in quantity to the 9th of November, when the gateway of No. 8 was cleared, and the crack closed with cement, so as to force the issue to some other point, out of the benk face, when working in it was resumed. On the 13th of November, and for three days after, the roof having been breaking in Nos. 7, 8, 9, and 10 benks, fire-damp was found above the level of the top of the coal in the goaf. Since the 18th of November fire-damp has not been seen.

The ventilating furnaces are placed in the Silkstone bed, sixty yards from the upcast shaft at W, and are supplied solely with fresh air, the return air passing into the shaft eighteen yards below the furnace drift. The nearest point the fire-damp was seen to the upcast pit was 290 yards distant at T, the bed dipping from that point to the shaft, about 1 in 10. There are two furnaces, having sixty-six square feet of fire-grates surface, or thirty-three feet each. They consume about seven tons of slack or small coals in the twenty-four hours, and produce the following quantity of air : —

			Cubic feet per minute.
Fresh air to the furnaces	....		10,500
Silkstone bed—South side	....	33,000	
„ North side	....	37,000	
		---------	70,000
Parkgate bed at a depth of about 130 yards	......		12,000
Flockton bed at a depth of about 80 vards ...	...		8,000

Total ventilation 100,500

The whole of the Silkstone bed, except at the bottom of and to a listance of about 110 yards from the downcast pit, was lighted with Stephenson's safety-lamps, and all of them which came in contact with he fire-damp were quickly extinguished, the workmen having to find heir way out in the dark.

Such, as nearly as can be ascertained, were the circumstances attending this very serious outburst of fire-damp. Although the district was

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all in a fair working condition, and quiet when examined by the deputy a few hours before its occurrence, the outburst was not without warning sufficient to have enabled the workmen to escape, had it not occurred just when they were entering their places and commencing the work of the day; indeed, many of them had not reached the place. Had the shifters given proper warning, probably none of the colliers would have been exposed to it. However, at the last, after having shown for a length of time strong symptoms of disturbance, the outburst seems to have been sudden and violent. In a few minutes, probably less than seven, Mr. Miller calculates 2,000 yards in length of face, and gateways of an average area of twenty-five square feet, were filled with fire-damp, so strong as to overpower some of the workmen, and which fired within and extinguished the safety-lamps. In some cases it travelled with the air faster than the workmen. It pressed back against the current to I, where 4,200 cubic feet per minute were passing at the rate of 140 feet per minute. It rendered a current of air at Q of at least 17,000 cubic feet per minute explosive for at least six hours, and only ceased to be explosive when the total current amounted to 25,000 cubic feet per minute at T. In about thirteen hours it ceased to render explosive the current at O, and in about fifty-four hours fire-damp could not be seen, except at the crack or opening in the floor, from which it continued to issue, gradually reducing in quantity.

Had naked lights been used in this district, or had the fire-damp come in contact with a damaged lamp, no doubt a most serious explosion must have been the result, very possibly succeeded by the most serious calamity—a standing fire—at the large blower issuing from the floor. Notwithstanding the Stephenson's safety-lamps were most severely tested by being exposed to an explosive current, moving at velocities from 200 to perhaps 600 feet per minute, no explosion ensued; but, on the contrary, they were themselves quickly extinguished. It is however, quite possible that this arose in some cases from an excess of firedamp, as proved by its overpowering so suddenly some of the workmen. It is worthy of special notice, that although the current along the face—the highest level—continued explosive for a considerable length of time, it did not do so down the gate-roads more than an hour at most.

Whether the outburst caused the disturbance, or was the result of it, is worth consideration. We have all the symptoms of creep caused by the superincumbent weight of the unfallen roof, in this case. We have, for four hours, the goaves weighting or working, followed by the floor cracking for a considerable distance along the face, and parallel to it, in

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all probability accompanied and succeeded by a settling of the roof in the goaves over a very considerable area. These symptoms and results are, however, often seen unconnected with the issue of fire-damp. In this case are there any reasons for believing that a large portion of the fire-damp which issued was forced out of the goaves by the settling of the roof ? I am inclined to the opinion such was really the fact; it was, however, sufficiently clear that there had been a large issue from the floor, for it seemed to be still coming out for the whole length—forty-four yards—of the crack, four hours afterwards. On the whole I believe the issue to have been the result of a sort of creep caused by the ordinary working.

These outbursts have frequently occurred in the Barnsley or South Yorkshire District, both in the Silkstone and other beds, and, I believe, most frequently in working long-wall or benk work to the rise. It is a matter for serious consideration whether such a mode of working, under such circumstances and liabilities, is a proper one to be pursued. Had the goaf been on the rise of the workings, with ascensional ventilation, if such an issue should have occurred, it probably would never have been seen where the workmen were employed, because the floor would probably have cracked in the first instance on the rise side of the goaf, and would, consequently, have gradually drained the underlying strata of fire-damp as the workings proceeded down-hill; and also more especially because fire-damp would not have accumulated in the ordinary working on the lower edges of the goaves, and, consequently, could not have been pressed out by the settling of the roof or goaf. Even were an outburst equally likely to occur in this mode of arrangement, the fire-damp having a natural tendency to pass off to the rise would be very much less likely to be seen near the workmen. It is, no doubt, a serious matter to alter the usual and general mode of working pursued in any large colliery; but it does seem that in collieries liable to outbursts of firedamp, working on the rise edges of large goaves is attended with more danger from fire-damp than when working on the lower edges.

It is also matter for serious consideration what kind of safety-lamps should be used in collieries liable to such

outbursts; for whatever kind may be selected, one important condition or requirement seems to be the quality of self-extinguishing when exposed to fire-damp.

The position of the ventilating furnaces also requires special arrangement, for had the total quantity of air in circulation been less, or bad it passed through the colliery with a less number of splits, or especially had the air ascended to the shaft from the point marked T,

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instead of descending, the return air would, in all probability, have reached the furnace in an explosive condition, had it not been isolated from the returns, and supplied with fresh air.

For the facts of this case I have relied principally on Mr. Eobt. Miller; it is, however, but right to state that I alone am responsible for the opinions and deductions advanced.

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NORTH OF ENGLAND INSTITUTE

OF

MINING ENGINEERS

GENERAL MEETING, SATURDAY, MARCH 7, 1868, IN THE ROOMS OF THE INSTITUTE, NEVILLE HALL, NEWCASTLE-UPON-TYNE.

G. B. FORSTER, Esq., in the Chair.

The Secretary read the minutes of the last meeting, and the minutes of the Council. He also read the following letter from Mr. John Watson, until recently a coal-factor on the Coal Exchange, London :—

High Bridge Works, Neweastle-upon-Tyne,

February 26th, 1868.

Dear Sir,—I beg leave to inform you that my late brother, William Watson, by his Will, has bequeathed to me his entire collection of colliery plans, borings, etc., with a suggestion that they might (if I approved thereof) be presented to your valuable and interesting Institution.

That suggestion I have deemed it advisable to carry into effect, and I have, therefore, to ask the favour of your intimating to your Council that, by this, I place those records at their disposal.

I need scarcely state to you that many of those documents are of ancient date, having been the property and work of my late father, and I trust the collection may be considered worth the acceptance of your Institute.

I may add that until your accommodation becomes enlarged, the whole can

remain where they at present are, that is, in my late brother's office, in this

building.

I am, my dear Sir,

Yours truly,

JOHN WATSON.

Thomas E. Forster, Esq., President of the North of England Institute of Mining Engineers.

The Chairman moved, that the meeting gratefully accept Mr. John

Watson's very useful and valuable present. He believed it would prove to be a valuable collection of mining records.

Mr. Morrison seconded the motion. It would form a good beginning for a collection of papers that might be very interesting to the members of that Institute.

The motion was unanimously adopted.

The following gentlemen were elected:—

Members -

Mr. Thomas Dobson, Haltonleagate, Haltwhistle.

Mr. Henry Watson, High Bridge, Newcastle-on-Tyne.

Graduate—

Mr. Matthew Watson, Thornley Colliery, Ferry Hill.

The Secretary then read a paper describing the various patents which had been taken out for winding, and other matters connected with the Coal Trade. This paper, together with the one on Coal-getting, will be found in Appendix 2 of this volume.

Mr. Steavenson, in moving a vote of thanks to Mr. Bunning, said, that nothing was more desirable than that each member should obtain accurate statistics, and that they should tabulate for future reference the information so obtained.

The Secretary in acknowledging the vote of thanks, said he had thought of printing this paper in the form of an Appendix, and if it was thought desirable he would do so. He could not bring it down to a later date than 1866, because there was a difficulty in getting the specifications; but the patents of the following years might be put in future Appendices.

NORTH OF ENGLAND INSTITUTE

OF

MINING ENGINEERS.

SPECIAL GENERAL MEETING, SATURDAY, APRIL 4, 1868,

IN THE ROOMS OF THE INSTITUTE, NEVILLE HALL,

NEWCASTLE-UPON-TYNE.

T. E. FORSTER, Esq, President of the Institute, in the Chair.

The Secretary read the minutes of the previous meeting, After which the President stated that His Grace the Duke of Cleveland had kindly consented to become a Patron of the Institute. The following gentlemen were then elected:—

Members—

Mr. John Tennant, East Holywell Colliery, Newcastle.

Mr. W. T. Scarth, Raby Castle, Darlington.

Graduate—

Mr. George Fletcher, Trimdon Colliery, Trimdon Grange.

The Secretary then read a memorandum from the Building Committee, in which they recommend the sale, to " The Institute and Coal Trade Chambers Company Limited," of the plot of ground and buildings now in the possession of Messrs. E. F. Boyd, William Armstrong, William Cochrane, John Daglish, and George Baker Forster, on conditions specified.

The recommendation was confirmed by a unanimous vote.

Mr. Cooper's paper on the "Outburst of Fire-damp at Strafford Main Colliery, Barnsley," then came on for discussion.

Mr. Cooper said, he had nothing further to add, except that there had been a subsequent settling of the roof in this district, unattended

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with a discharge of gas. Mr. Miller, the viewer of the colliery was present, and would give any explanation.

Mr. Miller said, that the settling which had taken place since, confirmed him in the opinion that the outburst was entirely from the floor; at least anything from the roof was merely supplementary. It was from a break in the floor. He had been very incredulous up to the time of its occurrence of any such outburst. It was very heavy, and if they had not had Stephenson's lamps, they would all have been lost.

The President said, he had no doubt it was from the floor.

Mr. Steavenson said, he would just repeat the question he raised last meeting. Supposing that instead of working by long-wall, they had been working by pillar and stall, he thought there was every probability that the gas would have been tapped and let off gradually. This brought into consideration the relative value of each system. He would ask Mr. Miller whether he did not think that the long-wall system caused the greater difficulty ?

Mr. Millee said, he had no reason to think the case would have been otherwise had they been working by pillar and stall. The floor consisted of two feet of very hard stone, next to the coal foot or bottom of the seam, and below that a milder stone, which seems to contain a great quantity of gas.

This had been pent up for a long time, and within a large area. He did not know whether the pillar system would have made any difference.

The President said, the outburst of gas at Tyne Main was from the floor.

Mr. G. B. Forster said, yes, it was from the floor and came off at a fault. He would ask Mr. Miller if he did not think the long-wall system was more likely to produce large cracks in the floor than the board and pillar system ?

Mr. Miller—Perhaps it was.

Mr. Cooper said, his opinions were expressed in the paper generally. The question of working depended on what was the cause of the outburst. As regarded the cause, it was a question whether the gas was situated in the measures above and below the coal in a state of very high tension, or whether it was from an accumulation of gas in some pent up place in the ordinary form. He believed it had never been proved what was the exact tension of gas, nor the pressure with which it would issue into an isolated space. He believed that it had been proved that gas had been pent up in an isolated space until the pressure was above that of high pressure steam in boilers. If that be so, any mode of

working that had the effect of causing the floor to upheave without breaking, and form spaces in that upheaval without a fracture in the floor, might result in a high state of tension in the gas in such spaces. In working long-wall where there is a strong floor, it was almost invariably the case that the floor does heave and perceptibly lift (but not fractured here and there and lifted in all sorts of forms as in board and pillar workings, but simply bent up) until a fracture results, before which the gas may be in a highly compressed condition. When the pressure, from whatever cause—whether from the mode of working or the tension of the gas itself—makes the fracture, gas must invariably come off with great force. His opinion was that the outburst was a natural result under the circumstances of working. It was the essence of long-wall working to work to the rise. When these sudden issues do occur, whether the gas is naturally and originally in a state of high tension in this position, or whether it has assumed this form, having issued from the solid strata into an isolated space, he thought it was more than probable that the quantity of gas given off was increased by that contained in a free condition in the upper portion of the goaf itself. He had no hesitation in saying that gas might exist in these conditions. There was a good current of air on the edges of these goaves, and it could not be seen until the roof settles, when there is a great weight, and the gas is thoroughly compressed. It is then given off in a longer or shorter time, most quickly, if it be the first settling of the roof. He was satisfied that there were enormous quantities of gas unseen and scarcely suspected in many goaves until the roof begins to settle uniformly.

Mr. E. F. Boyd asked, if Mr. Cooper wished the meeting to understand that if gas in the rise part of the mine became compressed by the lowering of the roof, it would get in a position in the thill after that ?

Mr. Cooper—No.

Mr. E. F. Boyd—Your heaving occurred in the thill.

Mr. Cooper—I think the mass of the gas came from the floor, but some from the goaf.

Mr. Boyd said, he thought it was beside the question to account for gas in the upper part of the workings. That was an every-day circumstance. They were met to consider the difficulty arising from gas being in the thill, in long-wall working.

Mr. Miller said, this was a floor in which they could not observe signs of heaving gradually.

The President—When it does heave, it cracks.

Mr. a. B. Forster—Does it not heave if worked by board and pillar ?

Mr. Cooper—It is never worked by board and pillar.

Mr. G-. B. Forster said, there was a paper by Mr. Thomas John Taylor, in the early volumes of the Transactions on the question of gas existing in a state of tension.* In board and pillar working, the floor is broken up in different parts, and the gas escapes by degrees ; but in long-wall working the floor is lifted over a considerable area without being broken ; the gas thus accumulates to a considerable extent, and when a crack does occur in the floor the gas is discharged in large quantities.

Mr. Cooper said, there had been many outbursts in Derbyshire and Yorkshire. Most were attended with fracture of the floor, but in others there was no appearance of fracture in the floor. There had, in all cases, evidently been a great settling in the roof. Experience in that district proved that gas did accumulate above the level of the air in goaves. He thought it probable from gas having been seen in these goaves that some of the gas so given off might be driven from the roof, though he believed there was a large quantity from the floor.

The President said, it did not follow that these outbursts and heavals were always from the floor. He knew an instance, in 1829 or 1830, at Jarrow, when there was a dreadful explosion in the Bensham seam. He examined the pit with the late Mr. Buddle. The gas came into the board where the men were working, and it had evidently burst away a large piece of coal from the face. He forgot the quantity of coal blown off, but it was at least a couple of tons weight.

Mr. G-. B. Forster—Is not the roof very strong ?

Mr. Cooper—It is a very good roof.

Mr. G. B. Forster said, he knew a case where the roof stood well until a considerable area of coal had been removed, and when the roof did break, the concussion was so great that all the lights in the pit were blown out.

Mr. Cooper said, one fact should not be lost sight of with regard to the safety-lamps. In this case the velocity preceding the outburst had been given in the paper. It was impossible to tell what the velocities were at the actual outburst. Possibly they were reduced in some, and in other portions of the district increased ; but taking the original speed, Stephenson's lamps were exposed to a velocity of about ten feet per second, and the whole were extinguished. He believed this was a higher velocity than that given by the Safety-lamp Committee, when they found the same kind of lamp exploding with ordinary street gas. He thought

* " Proofs of the subsistence of the fire-damp of coal mines in a state of high tension in situ, and practical conclusions to be deduced from this circumstance."—By Thomas John Taylor, Vol. I.

it was worthy of attention. It seemed the lamps were more liable to go out than to explode under the circumstances of this case.

Mr. Daglish said, the circumstances were not similar. In the experiments the object was to explode the lamp. In ordinary working, the lamp might be shielded by a man's body. The mere fact of knowing the rate at which the current travels would not give the velocity at which it impinged on the lamp. If it was very little inclined it might prevent the firing of the lamp. Many of the lamps which had been thought safe a considerable length of time, on some change of position were found unsafe. It was a negative kind of proof.

Mr. Morrison said, there was another thing to consider. The sudden outburst of gas might render the mixture more than explosive. The proportion of gas to the air might be more than the Safety-lamp Committee used in their experiments.

Mr. Cooper said, he did not refer to this with the view to invalidate the experiments of the Committee. All he said was, it was so in this particular case. His own opinion was that the velocity was increased to fifteen feet per second. He mentioned this to call attention to the difference between the gas in the coal mine and the gas with which those experiments were tried.

Mr. Daglish—The Committee used pit gas.

Mr. Miller felt a strong inclination towards the old lamp. It would have exploded, no doubt, with manufactured gas.

Mr. Cooper said, there was a further reason for the velocity being higher than that given by the Safety-lamp Committee. The boxes they used were small. Although, perhaps anticipating the discussion on the lamps, there was one point he should like to name. He had stated in the paper that these lamps had been put out from an excess of fire-damp ; but there must have been a period when the gas came on the lamps in which the mixture was in the most favourable condition for explosion.

Mr. Gr. B. Forster—The same conditions were present in the experiments.

Mr. Morrison—Stephenson's lamp explodes at a velocity of nine feet per second, after an interval of eleven or twelve seconds.

Mr. Cooper—It is very satisfactory to know that it did not fire in this case.

Mr. Marley said, before they closed it was only right to ask Mr. Cooper if he would allow the paper still to stand for further discussion. Many members, and he for one, had not been able to read Mr.

Cooper's paper, and, therefore, could not take part fully in the discussion to-day. He would ask Mr. Cooper one question in connection with this special thill—whether he had ever observed it when heaving, to ascertain if it were possible to put drill holes down to test whether there was gas or not ?

Mr. Cooper said, he happened to have seen this locality before. It was, as in every case of long-wall working with a strong floor, in passing up the gate-road a flattening, close to the face, was observed. This flattening advanced with the working of the coal. He did not know that the floor was ever known to break before. He believed where long-wall working was on a large scale, the floor was not very liable to break, except where it was tender. In this particular case the workings were situated to the rise. The pit was ventilated by a fresh air furnace. If it had been an ordinary furnace, and the gas had returned to the furnace in an explosive condition, there would certainly have been an explosion.

Mr. Marley—If the thill was likely to rise two or three feet in the bed, and they had not tried it with a drill, it might yet be done.

Mr. Cooper thought it might be done very readily. Perhaps Mr. Miller would try it.

Mr. Marley—Perhaps you would try it before the discussion comes on again. If a drill hole was put down it might anticipate any further outbreak. By Mr. Cooper's leave he would move that the discussion be again adjourned.

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

Mr. Archibald Dunn attended and gave some explanations as to the different portions of the new buildings proposed to be erected by the " Institute and Coal Trade Chambers Company Limited," and the uses to which they could be applied.

The Second Report of the Safety-lamp Committee then came on for discussion.

Mr. Cooke said, he had a suggestion to make, and that was that in all their experiments the Committee had not tried a Stephenson's lamp, modified as he was going to suggest. Mr. Watson was preparing the lamp for him, and he would send it to the Committee. The flame passed from these holes and not down the gauze.

The President—It will not be an old " Geordy."

Mr. Cooke—It is an improved " Geordy."

Mr. L. Wood said, in a common Stephenson the flame burns at the

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top of the lamp inside the gauze, which becomes hot, and then the flame passes through it. It makes no difference what part of the lamp the explosive mixture enters at, it must go up the chimney.

Mr. G. B. Forster said, in any Stephenson lamp there must be some aperture to admit air. What caused the explosion was, there was a current of air through the lamp.

Mr. Cooke said, he would be satisfied if they would agree to test it.

Mr. Wood said, that one of the clerks at Hetton Colliery had invented a small addition to the Stephenson lamp, which was likely to make it a safe one. It consisted of a copper cylinder above two inches long, and of the same diameter as the glass of a Stephenson-lamp; this cylinder is filled with a series of small tubes one-tenth of an inch in diameter, and is fixed on the top of the glass of the lamp, and the flame not being able to pass up through these tubes the lamp is extinguished, but as it had not been sufficiently tested he did not bring one with him to-day.

Mr. Morrison said, there was one rather important point not attended to by the Committee, and that was the quantity of light given by each lamp to the pitman. Because it was not only important to have a good light, but it also removed from him the temptation to open his lamp to increase the light. Looking into Ure's book, he saw the different degrees of light which he assigned to each lamp. The standard (a wax candle six to the pound) was equal to two ordinary pitman's candles, 3.50 Museler's lamps, 4.25 Clanny's, 8 Davy's, and 18.5 Stephenson's. It would be a matter of much importance to take the light given by each.

Mr. Gr. B. Forster said, it was quite true that the Committee had not looked at this, as they considered they were appointed to report on the question of safety only. But if the Institute wished it, they would be glad to take this point into consideration in a future report.

Mr. Cooper said, he did not know whether in giving the velocity the Committee had taken off the area of the lamp from the area of the boxes. The boxes were 12 inches by 4 or 6 inches, and the proportion of the Clanny lamp, or even of the Stephenson, would be very considerable; and if not taken off it would increase the velocity, and the consequence would be that the lamps would explode at a higher velocity than was stated.

Mr. Wood said, the size of the lamp was taken off the area of the box as accurately as they could measure it. It was difficult to measure a lamp in that space, but if the velocity was greater than was calculated, the error was on the right side. It had been said that the experiments

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made on the Museler lamp were not tried on a proper model. He believed the lamp they had tested was the Museler lamp in use in Belgium. Since then he had got one sent over from Belgium which they called their Government lamp. There was a considerable difference in the length of the internal tube, the one in the Government lamp being much longer and coming much closer down on the top of the flame, causing it to give less light, but it did not pass the flame so readily as the other, but when the head of the lamp is sloped from the current it fired as readily as the other, so that there was not much difference between the two.

Mr. Douglas said, there was one point to which he wished to direct attention on general grounds. The question was whether the recommendation of the Committee was to be confirmed. The lamp referred to by the Committee, was Mr. Lindsay Wood's lamp, which, it was said, combines perfect safety with a good light. He (Mr. D.) rather took exception to the word perfect. Again, it was proposed to call it " The Mining Institute Lamp." He had heard an expression of opinion from the gentleman himself, which quite coincided with his own, that the Institute, as a body, ought not to identify itself with the inventions or opinions of its members. The 21st Rule provides " that the Institute is not, as a body, responsible for the facts and opinions advanced in the papers which may be read." If they were to adopt this recommendation it might give rise to a difficulty. Science was advancing, and the perfect lamp of to-day might not be the perfect lamp of to-morrow. He would suggest that Mr. Lindsay Wood's name be attached to this lamp, and not that of the Mining Institute; especially as Mr. Wood himself was of that opinion.

Mr. Cooper said, the whole of the mining public had their eye on these experiments, and they were excessively anxious to know what was to be relied upon for safety. They had arrived at a point which was anything but satisfactory; and the Institute ought to be very careful in fixing on any lamp as a standard. So far as he could judge, he thought the efforts of the Committee should be directed to improving the lamp now in use—possibly in the way suggested by Mr. Wood, namely, to have tubular tops instead of perforated ones. If the lamps now in use could be made to insure all the necessary conditions of safety, either for ordinary workings or extraordinary outbursts, it would be an excellent thing. He was glad to hear of the contrivance for improving the Stephenson lamp. If it failed, some other means might be adopted for making it safe without having an organic change in the lamp itself. He believed Mr. Wood's was a modification, not completely changing the old lamp.

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Mr. Boyd said, it would be well to confine the name of the lamp to Mr. Lindsay Wood as the result of the completion of the best experiments of the day, without saying it was the Mining Institute lamp.

Mr. L. Wood was quite of opinion that they ought not to identify the name of the Institute with any lamp. As far as coupling his name with the lamp was concerned, he believed the modification was as much due to the other members of the Committee as to himself; and if the lamp was to have a name, the names of the other members of the Committee should appear as well. With regard to Mr. Cooper's suggestion, to make modifications of other lamps, the object of the Committee had been to get a lamp that was perfectly safe, without reference to cost. Many collieries would find it costly to alter their lamps, but their duty was, if possible, to make a safe lamp, which might be modified to suit the existing ones.

After some further conversation, Mr. Steavenson moved that it be designated " The Hetton Lamp."

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

Mr. Marley said, it would be well if the Secretary, when he obtained any fresh specifications and plans of new patents, would insert a notice of them in the Institute papers, so that every member would have an opportunity of knowing and inspecting the same.

The Secretary, at the request of the Steam Collieries Association, brought before the notice of the meeting Mr. G. B. Galloway's method of preventing smoke at sea, the leading feature of which consists in passing the unconsumed products of combustion over the heated contents of an auxiliary furnace.

Mr. Galloway himself attended, and gave explanations of his method.

Mr. Newall said, he would state a fact in regard to the consumption of smoke. They consumed their own smoke by a plan which had been in use twenty-five years. Without using a second fire, they made no smoke whatever. By simply letting in sufficient air, they consumed the smoke.

After some discussion the President said, the subject would require a little further consideration, but Mr. Galloway was entitled to their thanks for bringing it forward. He begged to propose a vote of thanks.

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

The meeting then separated.

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NORTH OF ENGLAND INSTITUTE

OF

MINING ENGINEERS.

GENERAL MEETING, SATURDAY, MAY 2, 1868, IN THE ROOMS OF THE INSTITUTE, NEVILLE HALL, NEWCASTLE-UPON-TYNE.

T. E. PORSTER, Esq., President of the Institute, in the Chair.

The Secretary read the minutes of the previous meeting; also three letters—one on the subject of the proposed testimonial to Dr. Richardson, of London ; another requesting the loan of models for a Polytechnic Exhibition to be held at Low Walker ; and a third from Mr. Cochrane on Technical Education, suggesting that one or two members should be appointed a deputation to give evidence on the subject to the Committee, which would meet on or about the 8th May ; the Chamber of Commerce had resolved to take a similar step in the appointment of a Committee. The Council, at their meeting to-day, had recommended that models be lent to the Walker Exhibition ; and that Mr. Elliot, Mr. Isaac Lowthian Bell, and Mr. Cochrane be asked to give evidence to the Committee on technical education.

The following gentlemen were then elected :—

Members— John Pattinson, Bensham Lodge, Gateshead.

John George Allison, 34, Cumberland Row, Newcastle-upon-Tyne.

Graduates—

John Nevin, Mirfield.

William J. Heckels, Wearmouth Colliery, Sunderland.

Jonathan Longbotham, Waldridge Colliery, Chester-le-Street.

CONSUMPTION OF SMOKE.

Mr. Lishman, in responding to the invitation of the Council to members having experience in the consumption of smoke from boiler chimneys, would lay before them a few facts and observations in as brief a form as was consistent with the importance of the subject under consideration.

He need hardly observe that any consumption of black smoke emitted is a clear saving of fuel.

Having given some considerable attention to this subject, and not having obtained very satisfactory results from the different modes tried, is the apology for laying the following five or six different means of consuming smoke before this meeting, with the hope that other members will contribute their quota of information to the question under consideration.

1st.—In 1857, we tried a plan suggested by Mr. Jossa, of Sunderland, at several colliery boilers, which consisted of a fire-brick arch thrown over the ordinary fire-grate, on which the coal was supposed to be partially coked, and the smoke emitted therefrom consumed by means of the bright fire below. The partially coked coal was then pushed forward to feed the lower furnace. This plan was found to be injurious to the boiler, and insufficient for raising steam, and did not consume the smoke without special attention from the stoker.

2nd.—The smoke emitted from one fire carried over another bright fire adjoining by means of flues. The draught, by this plan, was insufficient for raising steam.

3rd.— The admission of heated air at the bridge by means of a side flue. This required more attention than the ordinary fireman could be made to give, and did not prevent smoke.

4th.—The admission of heated air by means of a flue in the brickwork at the end of the grate bars. The air was admitted under the grate and conveyed up a flue into an arch thrown over at the far end of the grate so that the heated air would ignite the smoke passing from the fire when passing over the bridge.

5th.—By dividing the ordinary fire into two, by means of a partition, and firing each side alternately, passing the smoke from the side last stoked over the brighter fire of the side previously stoked. This did not answer.

5th.—Jukes' revolving furnace is a good smoke consumer, with due attentibn. It does not stand the coal we have to fire with. We have now two working daily ; repairs are expensive.

7th.—Vickers' furnace rack motion, self feeding, is a perfect smoke

consumer. We have three of these in use, very costly to uphold with grate bars ; we have tried several kinds, they soon require to be renewed.

The Secretary said, he would make a few remarks on the patent of Jossa's, described as having a peculiar arrangement of furnaces, whereby the coal or other fuel was subject to dry distillation before being consumed, and the gases evolved thereby were brought into economical use without emitting smoke, the peculiarity of the invention being in the use of a metal spout or cylinder containing the fuel. Being inclined, it thence falls below the boiler, where the fuel is subject to dry distillation; the gases are made to increase the heat, and the coal falling on the fire burns there without smoke. An invention brought out in 1858, consisted in so constructing the furnaces of steam boilers, that the fire would burn downwards, so that smoke would pass through the hot coal and be consumed. When he was at the Ouseburn Engine Works, a boiler was fitted on this plan at Mr. Plummer's mill. The only fault it had was that the tubes required constant attention. With respect to the second mode described by Mr. Lishman, the passing of the smoke over a bright fire, led him to make some observations respecting such patents, about 180 in number, more or less, which brought this principle into action. First of all, James Watt, in 1785, patented an invention for consuming the smoke and increasing the heat, by causing the smoke and flame to pass through very hot pipes, or mere holes, which were intensely hot. Huggin, in 1823, brought out a smoke consuming apparatus, by placing a fire of coke or other material which does not smoke, so that the smoke from the furnace passed through it to be consumed. Hall, in 1839, had a method of consuming the smoke, by dividing the furnace into two parts by a longitudinal partition, making two distinct furnaces. They were charged successively, and the smoke of each furnace, as it was charged, passed into the other to be consumed. With respect to Jukes' patent, it was working at the new winning at Boldon. He had been there seeing it work, and there seemed to be no smoke. It appeared to be a very important question, and he might mention, if anybody here was interested in the matter, or had an interest in any screw colliers or ships that were building, that a gentleman had mentioned to him that he would be glad to provide a boiler fitted with Jukes' patent at his own expense ; and would withdraw it if it was found not to answer the purpose. As this question was coming so frequently, of late, before the notice of the Institute, he had taken the liberty of getting an abridgment of inventions for the consumption

of fuel, published by the Patent Commissioners. It contained a list of more than four thousand patents, all admirably arranged. There was a second part about to be issued.

Mr. Rake stated, that in the year 1852 or 1853, he had applied hollow bars for water, in a similar way to that described by the Secretary, to a boiler at the Attercliffe Steam Mill, Sheffield, the distilled gases with a plentiful mixture of air passing through an incandescent mass supported on fire-bars formed of water tubes, which caused rapid circulation and saved fuel.

Mr. W. Boyd asked, if there was a patent mentioned which was taken out by Beattie, of the London and South Western Railway ? He adopted another chamber in which he burnt coke, passing the products of the first, in which he burnt coal, over it. It answered its purpose as far as consuming smoke ; but the system was expensive to keep up. He burnt coke in the second furnace. The air was admitted underneath the grate bars.

Mr. Waller—A double fire-box, as mentioned, was put into the Condor, on the Liverpool and Manchester Line, in 1844 or 1845, by Mr. Dewrance. Mr. Beattie only claimed a combination of the double furnace with some water heaters. Beattie's claim was in connection with some water tubes.

The Secretary said, Beattie, in 1853, had an arrangement for a combination of two or more furnaces, with a combustion chamber or chambers, with an apparatus for supplying heated air. There was a small fire-place to contain the coke. There were two combustion chambers, one below the other.

Mr. Lishman said, he had tried to consume the smoke by passing it through a coke fire, but he could not manage it.

Mr. Newall said, he could show a perfect example of combustion of fuel. At their works they had adopted a very simple mode, and one by which fuel could not possibly produce smoke. This was by admitting a sufficient quantity of air before the gases evolved were cooled below the temperature necessary for ignition. He objected to the term

" consumption of smoke," because, when smoke was produced you could not consume it. It ought to be termed consumption of fuel without the production of smoke. This was done easily, and at a great saving of expense. They simply admitted the air to be mixed with the gases produced by the coal before they were cooled. It might either be let in through small holes at the bridge, or admitted at the door, or both. They admitted it at the door, through holes of rather less than half an

inch, and, except for three-quarters of a minute, when a fresh supply of fuel was thrown in, they made no smoke. The consumption of fuel, without smoke, was a matter of importance in this district where there was nothing but bituminous and semi-bituminous fuel. The matter ought to be thoroughly discussed by this Institute. It was impossible to consume smoke by the plan of Mr. Galloway, which had been patented hundreds of times. Until you admit air to the gases, no taking the smoke from one fire to another would consume it. The mere smokeless emission of heated gases from the chimney was no indication that combustion had been perfectly effected, carbonic oxide might, nevertheless, still be passing off. If the air for the combustion of the gases was heated it was a mistake; the colder the air the better, because it contained more oxygen per cubic foot. There was no necessity for heating it. The gases would be consumed most completely if they adopted the plan of Mr. Williams, Secretary of the Dublin Steam Navigation Company. He formed an air grating equal to five square inches for each square foot of grate surface, and with that he succeeded in consuming fuel without smoke.

Mr. Greenwell said, a short time ago, when he was in the neighbourhood of Wigan, he was shown something which had been done to consume the smoke, and that was effected by building up the bridge at the back of the fire with bricks to within two inches of the bottom of the boiler, and putting holes into the wall which was so built. Holes were made in the fire door in front, and with a little care in the firing, the effect was to consume the smoke. He tried the experiment himself with a two-flued boiler. He built up the bridges within two inches of the inside of the flues. Air was admitted through the fire doors, and he also had holes through the brickwork. With careful firing the smoke was consumed.

The President—We want something that does not require careful attention.

Mr. Greenwell—A little care will do it.

Mr. Jas. Nelson said, that he could not see himself that the passing of the heated products of one furnace to another was anything but a crude adaptation of Jukes' method, which did it in a perfect manner. The fire might be divided into imaginary portions. The first consisted of the raw material, and the next was made in the form of coke. The third division was the place where the products of the first imaginary division were being burnt. He did not see why, by making actual divisions instead of imaginary ones, they would succeed better. He did not see that the fireplace being put into a different position—making it double

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itself—would be an advantage. In any self-feeding furnace the coals go in and get warmed and partially burnt, and then pass into an intense fire further on.

Mr. Waller, at the outset of his remarks, said, he must object to the title of the subject for discussion, as smoke once formed cannot be consumed, or if so, at a greatly increased cost, whereas prevention of smoke by the combustion of the fuel means economy in steam generation. Smoke may be briefly stated to be particles of carbon taken up and carried off in the steam formed from the water held in the fuel; and in the gassy coals of the district, analysis has shown that there is nearly half a ton of water given off in the perfect combustion of one ton of fuel. Smoke may be formed by the condensation of the heated gases—a piece of wire gauze held in the flame of a gas light will cause the gas, the mixture of carburetted hydrogen—to become smoke by condensation; this takes place in locomotive engines, but is more of a special example than what is understood to be smoke in general terms. There are two essentials in the chemistry of the subject ; there must be sufficient oxygen for the combustion of the hydrogen, and sufficient for the combustion of the carbon. To attempt to heat smoke, and by admixture burn the unconsumed gas and carbon, requires a further expenditure of fuel, for it is acknowledged that flame is of a much greater temperature than incandescent fuel, and means would have to be provided, if possible, to raise the chamber to the heat of flame itself, hence it appears to be almost impossible, or certainly impracticable. To prevent smoke the fuel must be consumed in the furnace, and there is no real difficulty in this—it has been done, and is done, without any smoke being emitted— and for this purpose there must be sufficient draught, properly distributed. In the furnaces set under boilers, the distance between the bottom of the boiler and the firebars varies from 8 inches to 4 feet ; the thickness of the fuel varies from 3 inches to 18 inches, or even 24 inches; now, in this last case, as the whole of the air for the combustion of the fuel, and be it remembered (the fuel produces the greatest amount of dense smoke when only partially consumed) the whole of this air has to be drawn through the thick mass of fuel, or at the sides of it, supplying a sufficiency of oxygen to the carbon, but leaving none for the gases above the fuel. Look at the fire-doors and see the evidence of a demand for more air, the doors crack and admit a partial supply, but the warning is lost upon us. Apparatus applied may hide, the evil—as for instance, a volume of air being mixed with these unconsumed products renders it less dense, but does not cure the evil; the steam jet of

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the locomotive, and the split bridge of the fixed boiler, are both of this class ; the latter being productive of much evil to the fabric of the boiler about the locality of the bridge, by contraction ; drawn seams and cracks being the result. Jukes' furnace is largely used in the district— I will speak of it as really Jukes' furnace, without the sundry additions now found. This furnace is but simply an automatic feeder, there are no helps for combustion, it merely carries the fuel of an even regular thickness, simply proving that firing by competent men, under certain conditions, can be smokeless. I can accept this furnace, as this, and no more, and it is merely evidence that what has been done, and is being-done by hand in other boilers, is possible with this fuel. Twenty years ago, boilers both Cornish and plain cylinder were proved to be able to be worked without producing smoke, and they can be again ; but why do we not find it ? The answer is plain. In all cases where smoke is produced it will be found that the boiler is worked beyond its proper capacity, and negligently—fuel heaped on and fires forced. A thin fire is more productive than a heavy one, and is nearly smokeless.

It will be admitted that the hottest part of the fire is that acted upon by the air. In ordinary cases, therefore, the hottest fire is on the bars ; the use of fire-bars is simply to riddle out the ashes, and as the fresh fuel is supplied on the top of the other, it seems only reasonable that the supply of air should be where it is most needed.

The length of the furnaces often prevents proper attention being paid to the regularity of the fire in thickness.

In attempting to arrive at any solution to this difficulty draught is the first requisite ; and next, the chamber, in which combustion is to be formed, must be adapted to the fuel to be used.

The process of coking upon the dead plate, or volatilising the gases before the coal iff pushed on the fire, has the double advantage of preventing that cooling of the furnace which takes place from coal being thrown on the fire, and also of the fresh fuel being behind the hot fuel, and thus in principle imitating the Jukes' and other mechanical feeders.

There is a furnace in use in Sheffield where the ordinary bridge forms a seating for the boiler; the furnace is thus closed, but egress is given at the sides, the flames meeting behind that wall and passing along the boiler. A writer in the " Engineer" lately said that the furnace should not be under the boiler but in a special chamber, the flame only passing under the boiler or along the flue, and there is a good example of this in the North, the fabric of the boiler being also better for it. It is generally found that where boilers fired by hand have been altered to

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self-feeding furnaces, there has been a falling off in the quantity of steam generated, thus proving that the boilers had been overtaxed.

Recent observation has shown that in the most perfect combustion of fuel the flame from gassy coal will reach 30 or even 40 feet; and in some of the long boilers of this district the whole of the brick-work surrounding the flue has been red-hot. This may be seen at the end of an 80 feet boiler at the Thornaby Ironworks, where fuel and the gases from the blast-furnace are both used. Experiment has shown a greater heating power in the combustion of gassy coal than in Welsh coal and charcoal ; hence, the subject is of greater value in this district, the results being :—

Fuel.	Quantity of water in lbs. evaporated per lb. of fuel
Charcoal	12.2 to 12.5
Anthracite	13.0 to 13.1
Hard Yorkshire	13.75
Yorkshire Wallsend	14.85

South Yorkshire (average of 7 samples)	... ...	15.0
Welsh...	... ...	15.12
Derbyshire gas coal	... ...	15.5 to 16.0

In experiment with engines with Welsh coal the consumption was 4.05 lbs. per horse-power per hour, or 10.25 lbs. water per lb. fuel.

In another 4.42 lbs. per horse-power, or 10.0 lbs. water per lb. of fuel.

With Yorkshire coal the result was 5.45 lbs. of fuel per horse-power, or 7.75 lbs. water per 1 lb. fuel.

This proves that the more rapid combustion of the Welsh coal was in its favour, while the loss of the Yorkshire coal in smoke was against it as compared with the above laboratory experiments.

Mr. Spencee said, although he differed from Mr. Waller in the conclusion he came to, that Jukes' was simply a feeder and did not tend to production, he agreed with him in his general conclusion. They would find that these systems for introducing air tended to injure the boiler, and did not do any good. The whole question of smoke consumption resolved itself into two or three simple points—smoke consumption was dependent on getting a certain temperature in the furnace ; all smoke was caused by the large proportion the fresh unconsumed coal bore to the coal in a hot incandescent state. All these patents were means for obviating this difficulty. Take a fire of six feet, three-fourths of it green fuel, and one-fourth simply hot coal, that was not sufficient to raise the temperature in the unburnt three-fourths to

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get rid of the smoke. Any attempt to burn the smoke when the hot portion was so small, would be fruitless. There must be a due proportion between the two, and that was the whole secret—this was accomplished by Jukes. The low position of the bar enables a portion of the fuel to get so hot as to be able to absorb and burn up the green portion which is put on bit by bit. It was the same if you take a marine boiler. He knew many cases where, by lowering the fire bars three or four inches, you get an improved result; the higher temperature is kept up, and the cold surface of the unburnt fuel is capable of mixing for a longer period of time with the hotter portion. The great object is space in the furnace, bringing the fire bars a considerable distance from the boiler, and increasing the amount of the burning portion. He had purchased, on behalf of the company he represented, Williams' apparatus. They were using smith's coal at 4s. per ton. The boiler was attended to by a boy at 12s. per week, and it was as smokeless now as at the time when first used. It showed that while Williams' views on smoke consumption were perfectly correct, it was necessary to give some attention to have a large space and a small portion of green coal in the front, so that there might be a large portion of hot coal. If all firemen were properly instructed on this point, there would be a considerable reduction in the consumption. The coal used was small, not larger than the tip of your finger, and with ordinary instructions to a boy, there was scarcely any smoke at all. Jukes' patent tended to increase the portion of hot coal.

Mr. Wm. Boyd said, he had found in his experience of marine boilers that there was an advantage in enlarging the size of the furnace and lowering the bars, so as to get a greater space between the fire and the top of the furnace. There was another condition which had not been mentioned, and which was essential to the consumption of smoke, namely, that the boiler should not be tested beyond its reasonable powers. He had unfortunately an instance of this in his own works. Owing to an alteration within the last twelve months or so, a considerably increased demand was made on the boiler, which had been used to work without the least smoke whatever; he had, however, now been seeking for the means of altering the furnace by which smoke might be consumed; and he believed that he was obliged to do so because the boiler was being forced beyond its powers. It is the case that you lessen the production of smoke by pushing the green coal forward by a hand process similar to that used in Jukes', thereby providing a sufficient quantity of hot incandescent fuel to maintain the temperature of furnace as mentioned by Mr. Spencer. In all cases for North country coal the furnace should be short and wide.

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In one or two marine boilers lately built by him, the space between the back of the bridge and the back of the combustion chamber has been closed up, with the exception of certain apertures—allowing certain holes, half an inch in diameter, regulating the admission of air at the back of the furnace. The proportion of the openings they had hitherto found sufficient was less than Mr. Newall mentioned, being 3 1/2 inches to the square foot.

Mr. Spencer repeated that the next important point was to maintain the proper proportions of green and hot coal.

Mr. Nelson said, any self-acting furnace achieved this in an effective manner.

Mr. Steavenson said, there were two elements to be considered—one, the prevention of smoke, and the other the economical value of the fuel. He believed that whenever smoke was prevented, and the products of combustion carefully carried away, they would get the best results. None of the gentlemen had given them any results of their experiments. As he had tried Jukes' and Vickers', he would give the result of his own experiments during twelve hours. He found that the common fire raised 6.20 pounds of water to the pound of coal. Jukes' gave 6.60 pounds; and another of Jukes', made by another firm, gave seven pounds. At the same time Vickers' only gave five pounds to the pound of coal. No doubt Jukes' bars were very good. There was a saving in labour by the application of spouts and the self-feeding of coals on the fire, and in firemen's wages. There was this drawback, that unless they were kept in first-class order they would get into a bad state. Sometimes, owing to the negligence of the men, they got into bad order.

The President—Do you find more economy in firing ?

Mr. Steavenson—Yes; and you get more water to the pound of coal.

Mr. Spencer—What is the temperature of the water ?

Mr. Steavenson—Something like 70 degrees when put into the boiler.

Mr. Spencer—The pressure ?

Mr. Steavenson—40 lbs. It was a cylindrical boiler, 5 feet diameter and 50 feet long.

Mr. Newall said, six or seven pounds with Jukes' was a miserable result.

The Secretary said, this result might be explained by the nature of the coal; when trying experiments at Devonport, they got 10.71 pounds, but they were burning the very best coals. This boiler was probably fired with very small coal.

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Mr. G. B. Forster—And not with steam coal.

The Secretary said, with respect to using large steam coal, it would be interesting to know if small had the same practical calorific value used with Jukes' furnaces. He certainly was struck with the beautiful work he saw at Boldon; if they could be applied in large steamships, where forty or fifty furnaces were used, small railways could be made to convey the coal from the bunkers, and a large number of stokers dispensed with, for the furnace doors need never be opened for twenty-four hours. At Devonport, however, we found the larger the coal the better the result. He thought putting Jukes' furnaces on board steamships well worth a trial.

Mr. Spencer said, he saw one at Bradford, but the engineers complained they could not get the same amount of steam. The fire was so sluggish, in proportion, that they were obliged to abandon it. .

The Secretary—That objection would hold to a certain extent; but do you not think the furnace of a steamship might be modified to receive these furnaces ?

Mr. Spencer said, the furnace was a matter of so many designs, and you have so many conditions to fulfil on board a steamship, that the difficulties would be very great. He thought the question of large and small coal was important. The reason why large coal was preferable was that the result depended on burning the fuel well without choking; but if they put in small coal there was a choking up. They burnt 20 lbs. per hour per square foot, but in land boilers where they had more time 8 lbs. per hour per square foot was thought sufficient. On board steamships they could not afford to adopt these plans. Unless they got a rapid result it was useless.

Mr. W. Boyd said, even 20 lbs. was a moderate estimate. 22 and 24 lbs. was sometimes necessary.

Mr.. Galloway here desired to make some remarks, but was informed that he, not being a member, had no right to take part in the discussion, but he might give any explanation through a member.

Mr. Newall said, Mr. Galloway admitted that his plan had never been tried. It, therefore, simply remained a matter of patent record, as one of hundreds that had gone before him.

Mr. E. F. Boyd said, Mr. Crawford, at Elvet Colliery, furnished an example of the complete consumption of smoke. There was a very high chimney made especially, and they adopted Jukes' furnace. This arrangement most effectually answered the purpose.

Mr. Steavenson said, Mr. Galloway complained of an error which

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had been made in describing his patent as one among many others that passed the smoke through the fire. His passed it over the fire.

The Secretary said, many of these patents passed it over the fire.

Mr. Spencer suggested that they should appoint a committee of inquiry on this subject. It was of vital importance to the North of England. A committee of inquiry might collect all the facts which turned up. Papers bearing on the subject were all very well, but they only gave the particular views of the writer. They wanted the substance of all the information that could be obtained.

Mr. Rake said, if Mr. Spencer put that as a motion, he would have great pleasure in seconding it.

The resolution was agreed to, and a committee was appointed, consisting of Messrs. J. F. Spencer, Wm. Boyd, A. L. Steavenson, A. S. Rake, James Nelson, and W. Waller, with power to add to their number.

Mr. Steavenson said, that although Mr. Newall thought the results he quoted not good, they were quite equal to colliery work in general.

Mr. Newall—I quite agree with you that the results in colliery boilers are generally bad, and the great cause is they get coals too cheap.

The meeting then broke up.

NORTH OF ENGLAND INSTITUTE

OF

MINING ENGINEERS.

GENERAL MEETING. SATURDAY, JUNE 6, 1868, IN THE ROOMS OP THE INSTITUTE, NEVILLE HALL, NEWCASTLE-UPON-TYNE.

T. E. FORSTER, Esq., President of the Institute, in the Chair.

The Secretary read the minutes of the previous meeting, and reported that there had been three Council meetings held to convey the wishes of the Council to the gentlemen appointed to give evidence before the Committee on Technical Education. After much discussion, it was thought that Government should be requested to appoint a general inspector or manager to the district, and that he be empowered to visit the outlying villages and report thereon, and have general control over the teachers.

The following gentlemen were elected:—

Members—

Myles Kennedy, M.E., Ulverstone.

Thomas Whitaker, Board of Trade Inspector, Tynemouth.

Graduates—

Nathaniel Clarke, Jun.

Frederick Sheridan, Framwellgate Colliery.

George Horne, Rainton Colliery.

William Atkinson, Rainton Colliery.

Some further observations, by Mr. Cooper, on "An Outburst or Sudden Issue of Fire-damp at Strafford Main Colliery, Barnsley, Yorkshire, 1st Oct., 1867," were presented to the meeting, and read by the Secretary.

Mr. A. S. Rake read "A Descriptive Paper on A. S. Cameron's

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Special Steam-pump," and with illustrative diagrams referred to its use in mining operations and elsewhere.

The Secretary stated that Mr. Joseph Cowen, jun., had kindly sent a specimen of coal from Port Natal, which was accompanied by the following interesting communication from Mr. Ralph E. Ridley, of that place:—

The sample of coal sent to you was taken from the side of a little stream, which, apparently, has cut through the strata and exposed the coal. The seam is four feet thick, with two feet of slate ahove and below it. Above this seam are two other seams, too thin to be worked. What may exist below no one has attempted to ascertain. Mr. Gavin traced the main seam a considerable distance along the course of the stream, the thickness and general appearance of the coal continuing very uniform. He then went some distance further and inspected another seam running parallel with that from which he had got the coal. On the banks of this second stream he found a similar seam; this, also, he traced, and then on calculating the extent of the country between the streams, and as far as the coal was seen to be cropping out on the banks, it was found to contain an area of thirty square miles. The coal is seen on both sides of both streams, but no attempt was made to ascertain how far it extended in either direction. On this point I do not think any reliable information has yet been made public, but persons living both north and south of the place where this sample was taken, state in the newspapers that considerable seams of coal are to be seen in their localities. Seams of eight feet and eleven feet have been mentioned. The district from which the coal was obtained, and where it is said to be cropping out everywhere, lies at the foot of a range of hills which form the western boundary of the colony. The coal seams are met with at the foot of these hills throughout the entire length of the colony, for, when a Kaffir, working for Messrs. Harcourt and Macminn, saw the coal their waggon had brought down, he at once said—" Oh, there is plenty of that where I come from," and pointing to a peak about thirty miles away, he said—" It is just on the other side of that hill." He also said—" The Kaffirs there use it for fuel." This peak is near the Umzimkulu, which forms the southern boundary of the colony, while the waggon had just brought its load from the extreme north. Persons living in the intermediate district report the coal cropping out at various parts.

This district is about 4,000 feet above the sea, and the coal dips to the south-east. Now, if we travel to the south-east, at about sixty miles from the coast, the country suddenly drops several hundred feet to an elevation of about 2,500 feet above the sea-level, and here, again, abundance of shale, and one thin seam of coal are seen from which the village blacksmith draws his supply. Then if we go on to the coast district, we do not find the coal at all on the surface, but the coaly shale is abundant. If you have a map of the colony by you, and will draw a line from the source of the Umzimkulu to the mouth of the Umlazi, you will have on the north side of the line the portion of the colony where coal (or indications of it) have already been found.

Such are our prospects of coal, and now as to its accessibility for shipping purposes. To make it of much value, it must be delivered cheaply at the port; and means must

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be provided there for supplying large steamers quickly and safely. It has been proposed that a jetty should be run out into deep water, along which a railway could be laid, and at the end of which ships might ride and take in their coal. To this it is objected that the force and suddenness of the south-east gales, and the strength of the vast rollers that come over the Pacific are such as to make this method of shipping the coal a very unsafe one. But we have at Durban a splendid bay in which ships ride with perfect safety, only the water on the bar, at the entrance, is often very shallow and never deep enough for large ocean-going steamers. This bay and its entrance remind me forcibly of the Tyne and its mouth. The bay is like what Jarrow Slake used to be, only the former is deeper; indeed, after the bar is passed, you enter the bay by a passage about 500 yards wide, and very deep. The bay itself is fifteen to twenty miles in circumference, with a small island in the middle. The water over the most of it is only a few feet deep. On the north side of the entrance is a long stretch of land, exactly like the Herd Sand, opposite South Shields; and on the south side of the entrance is a high abrupt headland, called the "Bluff" (on which is the lighthouse), very similar to the rock upon which Tynemouth Priory and lighthouse stand. The current from the north, and the ground swells from the south, between them raise up the bar of sand. Several years ago the plucky Natalians proposed to run out two piers exactly as you have done at the Tyne with such good effect. Representations were made to the mother country, and a bold engineer of the red-tape school turned up, who declared himself able, without personal inspection, to effect the removal of this bit of sand, at an expense of £165,000. The plans were sent, the money borrowed, and the work begun. The running out of piers, such as that on the Herd Sand, is but a work of time; and though short of the appliances your contractor had, a pier of a similar character has been pushed out on the north side of the harbour here to a considerable length. On the south side the construction of a pier has been found a very different matter. This, like your north pier, is exposed to severe storms and heavy seas, and requires massive material for its construction. Nature has fortunately provided a protection for the building of such a pier. Prom the Bluff Point a ridge of rocks stretches out in about the proper line for erecting the pier on that side. The south slope of this ridge is exposed to the full force of the immense rollers that come in from the Southern Ocean, while the ridge itself operates as a kind of breakwater to lessen the power of the waves, so that an erection which would be swept away if placed on the south side, might be expected to stand if placed on the opposite side. An attempt was made to erect a stone pier on the south side of the ridge; but the south-east gales swept everything away until the work was given up as hopeless. Had it been erected on the lee-side of the ridge, probably it would have stood. Were this pier carried out in conjunction with that now being erected to the north, the water in the bar would undoubtedly be greatly deepened as at the mouth of the Tyne. The tides are not so high here as with you, nor is the stream which flows into the bay equal in volume to the Tyne, so that the scour on the bar might not be so powerful. There is, however, about two miles to the north, a river (the Umgeni), just about the capacity of the Tyne. The space between the Umgeni and the harbour is a deep blown sand, so that if a larger volume of water were required to deepen the bar, it could thence, at no great expense, be obtained. There can be little doubt but that in a few years a fine harbour with a deep entrance could be obtained, and ships of heavy tonnage find shelter and supplies.

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The coals, if found in the coast district, could be easily brought to the ships, the country being comparatively level. If it be necessary to go to the midland district, more than one survey has proved that a railway can be made and worked at a moderate cost. Should it be necessary to go still further up country where the coal crops out, the line could be more easily constructed than from Durban to Pietermaritzburg. It is true the rise of the land is very considerable, so that, go as we may, there will be an ascent of several thousand feet. But, perhaps, this may be an advantage rather than otherwise, seeing that the coal has to come down while empty waggons go back. It would be convenient if we could manage as you do in Northumberland to pull up the empty waggons by the force of the full ones going down. Unfortunately a few hills and valleys prevent this.

The coal has been analysed by Mr. John Pattinson, and found to contain :—

Fixed carbon	63.44
Volatile hydro-carbons	22.64
Sulphur	2.04
Ash	10.50
Moisture	1.38

	100.00

On the motion of Mr. Hurst, seconded by Mr. Bewick, the thanks of the Institute were given to Mr. Cooper, Mr. Bake, and Mr. Cowen, for their several contributions.

Mr. Willis stated that Lemielle's ventilator was now at work at Washington Colliery, and with very good results. He would be happy to show it to any of the members who might wish to see it, on receiving a couple of days' notice.

The meeting then separated.

FURTHER OBSERVATIONS

ON

SUDDEN ISSUES Of FIRE-DAMP.

By PHILIP COOPER.

In a paper published in the first volume of the Transactions of this Institute, the late Mr. Thomas John Taylor treats of the condition of firedamp in coal-mines in a most able, interesting, and instructive manner. He adduces satisfactory proofs that in deep mines it exists in its normal condition, in a state of great density, and corresponding elasticity; giving instances of its force of issue exceeding a pressure of from sixty to seventy pounds per square inch beyond the force absorbed in overcoming the resistance opposed to its issue, by the substance of the coal, etc. Is this density and elasticity, or what Mr. Taylor calls its tension, due to the pressure under which it exists ?

That a bed of coal supports the weight of the whole of the superincumbent mass of strata to the surface is sufficiently clear, but insufficiently appreciated. If we take the average weight of such strata at 112 pounds per cubic foot, we have a pressure of upwards of three-fourths of a pound per square inch for every foot in depth from the surface. The Silkstone bed at Strafford Main Colliery being 720 feet from the surface, the pressure of the strata will be equal to 540 pounds per square inch, or about 36 atmospheres. Such a pressure, although inadequate to liquefy firedamp, must produce intense action during its discharge, even in exceedingly minute quantities. If such a pressure really exists, the shivering off of fragments from the solid coal during the early stages of working deep mines must cease to excite surprise. It also seems to afford a rational mode of accounting for sudden issues of fire-damp.

Geologists consider it demonstrated that our coal-beds are of vegetable origin. It has been computed that the original thickness of such a coal-

bed as the Silkstone could not be less than six times its present thickness ; it must, therefore, together with its gaseous contents, have been reduced during its consolidation by pressure, from twelve to two yards in thickness. This need cause little wonder when we consider that in the case (Strafford Main Colliery) under consideration it now exists under a compressive force of not less than 324 tons per square yard at the depth named.

In working a coal-mine the area for supporting this pressure is reduced in proportion to that from which the coal is extracted, and the pressure increased on the remainder in proportion. When nearly half of the coal was worked in the North of England by the first, or board and pillar working, during the early portion of this century, the remaining pillars, being inadequate to support the weight, were pressed into the subjacent strata, and produced extensive creeps. A most interesting description of one is given by the late Mr. Buddle, in Volume II. of the Transactions of the Natural History Society of this town. A creep had resulted from the mode adopted in working the high main seam at Wallsend, which produced a remarkable effect on the metal coal seam below it, which is described by him as follows :—

" The metal coal seam lias been worked to a very limited extent. It could not be worked to profit, owing to the seam, as well as the roof and thill, being broken and dislocated by the creep in the high main seam, which lies 7 1/2 to 8 fathoms above it, as shown in the annexed diagram (A), which is drawn to a scale showing the relative proportions of the pillars and excavations, or board rooms, in the main coal seam, and the manner in which the rising of the metal ridges in the latter has fractured the metal coal seam, as well as the strata between the two seams. In a great part of the colliery the pillars were only eight yards thick, and the boards four yards wide, in which case the fractures of the metal coal seam occurred as represented in the diagram. By this it will be seen that in working the metal coal in a headway's-course direction, as from A to B in the diagram, an upcast and downcast hitch of twelve to eighteen inches is formed immediately under the board rooms in the main coal seam, and that the roof between these hitches is completely broken and shattered, so that they cannot be passed without the aid of very strong 'gallows timbering' or framework. Besides, as in working the metal coal seam, the boards can only be driven in the solid coal between these hitches, they require an extra quantity of timber to support them from the want of the firm support of the coal on each side, and the difficulty of working the seam is still further increased by the fractures occasioned by the headways metal ridges in the main coal seam, which run at right angles to boardways metal ridges, represented in the diagram. This seam abounds in inflammable air."

This is, perhaps, the most interesting example on record of the remarkable effect of creep on underlaying strata. We have a solid un-

[Plate VI, Diagram A.]

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worked bed of coal, lying forty to fifty feet below the bed which had been worked in the whole, broken up into a series of parallel faults, of one to one-and-a-half feet each, the intervening mass having been upheaved to that extent beneath the old board rooms. The depth of the high main seam in this case was 666 feet, consequently the weight resting on each square yard of the solid coal was very nearly 300 tons. About 40 per cent, seems to have been worked in the whole working, leaving 60 per cent, to support the superincumbent strata, which would thus have to sustain a pressure equal to 500 tons per square yard; therefore the effect described by Mr. Buddle was the result of such pressure, which for a block of coal or pillar eight yards by twenty yards, was not less than 80,000 tons.

What is the effect of this pressure on long-wall working ? The banks are turned out of what is called the bank level. Suppose the length of bank face is 200 yards, and the breadth of coal worked out 50 yards, the depth being 240 yards from the surface as at Strafford Main ; and suppose this space has fallen to a very limited height, which is a very usual state of things in opening out a district of new banks, we have, under such circumstances, the enormous weight of 3,240,000 tons of strata, supported by the edges of the coal surrounding this limited goaf of little more than two acres, which is equal to 1,620,000 tons for each side of 200 yards in length, or 8,100 tons for each yard in length, in addition to the weight of the strata overlying such yard.

The writer does not suggest that the first yard of solid coal beyond the face of the banks supports the whole of this 8,100 tons, it probably extends several yards on to the solid coal; each square yard, however, of the coal surrounding the edge of such goaves must sustain a much greater weight than was sustained in the case described by Mr. Buddle. It is not, therefore, surprising that the floor or thill in long-wall working should be to some extent, and to a very great depth, upheaved by such enormous pressure; indeed the only surprise is that it should not be more so than it is. It is, however, a fact that it is upheaved. The writer has very carefully noticed this circumstance in a number of cases of long-wall working. It is clearly observable by the roads in the gateways always appearing flatter for a few yards next the face. What is peculiar is, that the upheaval appears generally to be so deep and massive, that vertical fractures in the floor are very rarely met with.

The writer wishes to direct special attention to the fact, that these cases of sudden issue from the floor are most frequent where the working of the banks has only been extended to about the distance named, that

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is to about fifty yards, or to where the first great weight has fairly settled on to the pack walls in the goaves, and also at the time of such settling.

The state of things seems to be thus:—The working face advances slowly, accompanied by a fragmentary falling of the roof, to no great height in the goaves, and by a gradually extended deep and massive upheaval of the floor, unaccompanied by vertical fractures, forming horizontal spaces more or less open, which are gradually filled with fire-damp of high tension, until at length the whole weight of the strata of the goaf, to the extent of perhaps 1,000,000 tons, settles down on the pack walls, and debris within the goaf area, pressing down the floor with irresistible force, still further compressing the very dense fire-damp, until with uncontrollable violence it forces an exit at the point of least resistance, parallel with the face of the coal, and between it and the pack walls of the goaf, pouring out of the floor into the surrounding workings with enormous pressure, a " vast and violent" quantity of fire-damp. If at the time of such an occurrence fire-damp has been lodged in the upper portions of such a goaf, it will be added to that discharged from the floor by the settling of the roof.

To the writer such appear to be the conditions and circumstances connected with sudden outbursts of fire-damp in working long-wall. In this he is confirmed by the experience of several persons accustomed to such mode of working. In some cases fractures of the floor are not subsequently observable ; they may, however, exist back within the goaf area, or the issue may have been from the roof alone.

In miniature, a similar action of the floor as above described must be familiar to many members of the Institute in working whole boards in the Hutton seam, at a depth of about 1,000 feet. In scores of instances the writer has seen a few inches in thickness of the coarse coal underlying that seam, but which is not worked with it, upheaved, elastic, unbroken, and hollow, and from which fire-damp issued with considerable violence, when tapped for the purpose. On applying a light to the issuing fire-damp, a complete pillar of flame reaching to and extending along the roof is a common occurrence, succeeded by a settling of the floor, accompanied by the noise so well known as working or cracking of the coal, and, perhaps, half a score of the props which had previously been set, falling out from becoming too short. In a few cases the writer has known the fire-damp burst up the floor and ignite at the naked light of the collier, while he was engaged holing, to his great

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fright but little injury. The circumstances, however, although on a very small scale, may be considered analagous to those connected with the enormous outbursts occasionally met with.

Without fully considering the matter, some persons may find a difficulty in accounting for the very large quantity of fire-damp given off in some cases of sudden issue. Is it possible such immense quantities can have been stored in the space of two or say one acre ? One acre or say a space 100 yards by 50, not more than that occupied by three banks each 33 yards in widtn, contains for every foot in thickness 45,000 cubic feet. With a free parting a few feet above the coal bed, it is not at all an unlikely circumstance to find a space of one foot in thickness, of the extent named, above the fallen stone at that height, if the roof above be of a strong character. Only a few days ago the workmen at Mount Osborne Colliery, near Barnsley, were so frightened that they rushed from the mine undressed in the greatest alarm, by the effects of an upstanding goaf 60 yards by 50, or three-fifths of the area supposed above, suddenly falling to a free parting about 4 1/2 feet above the roof. Suppose, then, the space (45,000 square feet) stated above to be filled with fire-damp, a sudden settling of the roof would force out into the face, and upon the workmen, in a few seconds, 45,000 cubic feet of fire-damp. If at the same time and from the same cause a space or a series of spaces in the floor, only half the thickness, containing firedamp of six times the ordinary atmospheric density, was suddenly compressed and forced out, an additional 135,000 cubic feet would be forced into the workings ; a quantity of pure fire-damp sufficient to render explosive 1,800,000 cubic feet of mine space, which would render a passage of the area of thirty square feet explosive for a distance of 60,000 feet, or 20,000 yards, or upwards of eleven miles.

Such then are the elements, and as is now contended for, the ordinary elements of danger attending working coal seams under such circumstances and conditions.

It is not necessary that the fire-damp accumulation may have been that of a day or a week, it may have been that of months preceding the issue, and is more than sufficient to account for the most devastating explosion ever known.

Is it possible in any way to foresee, avoid, or provide for such a serious emergency ? It is unnecessary to say ordinary ventilation utterly fails to meet the requirements of the case. The subject is one of great anxiety to those having charge of mines liable to be subject to such

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serious danger. It is no matter of wonder they should be anxious for the exclusion of naked lights, at whatever cost, or to secure a safety lamp on which they could rely, or that they should incur serious cost in providing fresh air furnaces, isolated from the possibility of contact with the return air currents.

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A DESCRIPTIVE PAPER

ON

THE "SPECIAL" STEAM PUMP.

WITH A FEW FACTS RELATIVE TO ITS USE IN MINING AND OTHER OPERATIONS,

By ALFRED STANSFIELD RAKE.

By the permission of the Council of the Institution, the writer purposes laying before you in as concise a form as possible the following paper relative to this contrivance, which he trusts may prove not only of passing interest, but also of some material use to the members of the North of England Mining Institute, and to the coal trade at large.

As an illustration he has had prepared a sectional elevation of one of the smaller sizes used for feeding boilers of fifty horse-power, capable of delivering at 100 strokes per minute, about 650 gallons of water per hour. A specimen of this size is on the table, and a sectional diagram is before you, and it may be observed that the steam cylinder is three inches diameter, and the water cylinder or pump one-and-a-half inches diameter, the stroke being necessarily the same in each case, viz., 9 inches. The relative diameters, to which he will advert presently, are of course subject to considerable modifications, to suit special purposes, both in arrangement and design, but the one now before you is sufficient to elucidate the principle of its action. The steam and water cylinders A and B are placed in a line with each other, and they are connected by a connecting piece H, the end flanges of which form the covers for both cylinders. On reference to the specimen, it will be seen that this connecting piece forms a protection of the piston-rod from any external violence, just so much of it being removed as is necessary to enable a spanner to be got in to tighten up the gland nuts; moreover, the

[Diagram, The "Special" Steam Pump, longitudinal section showing one pair of pump valves only]

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pump and steam cylinder are thus made rigid, and therefore expensive foundations are unnecessary. The chief peculiarity consists in the steam cylinder which is made with a double set of steam passages, one pair of these passages leading from the valve face to the ends of the cylinder, in the usual way, and the other pair extending from near the ends of the steam-chest to the inner ends of small cylindrical chambers, formed one on each cylinder cover FF. Each of these chambers is fitted with a piston valve GG, which closes an opening in the cylinder cover, these valves being (except when moved by the piston) kept against their seats by the pressure of steam on their backs; the outer ends of the valve chambers-being placed in free communication with the steam-chest by small passages shown in the diagram. The main slide-valve E covers the exhaust port and one pair of steam ports, and it is made of double D section as shown, so that when it is moved to the right, steam is admitted into the right hand port, and vice versa. In the diagram it is shown in the position it occupies when steam is being admitted into the left hand port, the other port being placed in communication with the exhaust. On the back of the valve are a pair of lugs, which fit between collars or other arrangement formed on a spindle, which connects, and, indeed, is cast in one piece with a pair of plungers DD, which work in the cylindrical portions forming the ends of the valve-chest CC, and into which the second pair of steam ports open. These plungers are either made to fit their cylinders slackly, or some other arrangement is sometimes made to allow a small leakage to take place past them, the steam thus passing being shut in, when either plunger travels beyond the port, thus forming a cushion to check the motion of the valve. In case the engine should stop in such a position that both steam ports are closed by the double D slide valve, a spindle worked by an external handle is provided, this spindle carrying an internal finger I, by which the valve can be shifted, so as to throw either end of the cylinder into connection with the steam. When the pump is at work this spindle remains stationary, as the valve has not sufficient travel to touch the internal finger I.

The action of the apparatus is very simple, and may be explained as follows. It will be seen by the diagram that the piston is about the middle of its stroke, from left to right, the left hand port being in communication with the steam, and the right hand with the exhaust; on arriving at the end of its stroke it will press back the piston valve G, by coming in contact with its projecting spindle. The steam in one end of the upper or supplementary cylinder forming the steam-chest is thereby

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at once allowed to escape into the right hand end of the steam cylinder, and thence (from the position of the main valve) into the exhaust. This being the case, the pressure is removed from the back of the right hand plunger D, connected with the main valve, and the pressure of steam on the back of the left hand plunger then forces it to the right, the slide valve being, of course, carried with it. This movement admits steam to the right hand end of the cylinder and places the left hand end in communication with the exhaust; the piston then performs its return stroke from right to left, and the operations, already described, are again carried out at the left hand end of the cylinder, so that by a repetition of this action a constant motion is effected. The pumps are all double-acting, and the parts generally are so accessible that, although still hot with steam, the valves, etc., may be taken out in hardly more than one minute, and there is certainly no arrangement now practically at work in which a smaller moving weight is required for the valve motion. In the proportion of the diameter of the pump to the length of its stroke, the modern practice of a comparatively large ram, and short rapid strokes has been abandoned, and by preference we have rather adopted the practice of our forefathers, in having a small diameter of pump, with a long stroke, and fewer number of them. The modern donkey-pumps are mostly made single-acting, and very rapid in motion; some of the most approved makes being intended for as much as 200 strokes per minute; the consequence is, that the pump-barrel has not time allowed to fill itself with water, nor the valves to close before the pump has traversed a portion of its return stroke, so that a large proportion of the duty is lost, and power expended without result, besides churning the liquid and aerating it so highly as to be often very objectionable.

In the " Special" steam pump under notice, a result has been often secured equal to 90 per cent, of the cubic capacity of the pump, and with Holman's improved valves, it is expected to do this regularly. In all the smaller sizes of these pumps the plunger is made of solid gun-metal, without any packing whatever, and being always immersed in the liquid, it is found to work most excellently, and with a minimum of friction. The valves and seats now used are constructed according to the improvements of Mr. Stephen Holman, of the firm of Messrs. Tangye Brothers and Holman, of London. One of these valve seats is on the table and a sectional diagram is annexed ; the peculiarity consists in there being no central seating or wings, so that the least possible aereal resistance or obstruction is offered to the free passage of the liquid through the seat-

[Plate VII, Holman's Improved Pump Valves]

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ings, It is well known that the speed and efficiency of reciprocating pumps is limited to the capability of their details, to withstand wear and tear, and this is greatly reduced by the comparatively silent action of the valves. Mr. Holman has introduced mineralised junction India-rubber rings as valve seatings, one portion of which is rendered hard, for the purpose of keeping it true and holding it firmly in position, and the other portion is comparatively soft to ensure a silent and sound seating to the valve.

The flexible seatings are secured in their places by means of screwed rings, affording every facility for examination and renewal when necessary, and by the removal of gridiron valve seats as used for India-rubber disc valves, and also of all arms and centres, as used for spindle valves, as hitherto made, a much greater depth of guide boss is obtained and less wear and tear consequent on the cutting action of gridiron valve seats.

Last but not least, there is less resistance to the passage of the water as the valve, instead of being a flat disc, is made of a parabolic form. It will also be observed that a tubular buffer is placed above each valve, the upper end embracing the guide-rod, and the lower end the boss of the valve, thereby preventing any leakage through the centre of the valve, and preventing it rising too high ; in addition to this, it acts as a spring assisting to close the valves quickly, for the return stroke of the engine, a most important feature, and the value of which will be hereafter attested in connection with the increased efficiency observed in a pump now at work. Every one of these pumps is tested with steam and water before leaving the manufactory, and the steam cylinder is always first tested alone without the pump being attached, when the action of the valves is so rapid, so sensitive, and so certain that they are found never by any chance to allow the piston or plungers to touch the ends of the cylinders. They have also been worked at a speed as low as one stroke in two minutes and a half, the return stroke being equally certain and decided.

The small model on the table is worked by compressed air, and to any gentleman interested, the writer will be glad to show the larger one on the table similarly at work, if he will favour him with a call at his offices in Mosley street.

The working by compressed air, is understood to be in many cases a sine qua non in coal mining, as in some cases the radiation of heat from steam pipes injuriously affects the floor, or roof of the workings, and where that is not the case, the exhaust steam proves a nuisance.

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Wherever steam can be used it will, probably, be found much cheaper than compressed air, which involves separate engine and air-pumps; and to do away with the exhaust steam, it has occurred to the writer that a very simple expedient might be resorted to, by having an open ended surface condenser, inclined towards the sump or well, so that the water from the condensed steam may readily escape by its own gravity. The circulating water for condensation purposes being supplied by the delivery pipe in its passage out of the pit.

The purposes for which these pumps are used are very varied, and embrace every application for which steam driven pumps are adopted. They are exceedingly simple and accessible, there being, in fact, but five working parts in addition to the four valves which are inevitable in all double-acting pumps. This reduction in the number of working parts, and the fact of their being all self-contained, and out of harm's way, renders the cost of repairs a very trifling matter indeed, and very seldom necessary. In conclusion, the writer begs to submit a few of the places where these pumps have been in constant operation for some time past, amongst which are—

Messrs. Whitbread & Co., Brewers, London, for feeding boilers and for pumping hot and cold liquor.

The Bedford Water-works, raising 6,000 gallons per hour, 140 feet high, through half a mile of pipes. This pump is worked by an eight horse-power portable agricultural boiler.

At the Frood and Pont Plas Main Iron-works and Collieries, for feeding boilers, with very satisfactory results.

At the Dungannon Stone Quarries, Ireland, where they are pumping a considerable quantity of sand and dirt with the water.

At Messrs. Barrow's, and also two other tan-yards in Bermondsey, London, pumping a good deal of tan through with the liquor.

Two at the Carnarvon and Bangor Slate Quarry, one eight inches steam cylinder by six inches water cylinder, and the other sixteen inches by seven, to raise water 150 feet high.

One supplied to Joseph Whitley and Co., Leeds, sixteen inches by seven inches, used as a fire engine, and delivering three one-inch jets at the same time over buildings sixty feet high.

Two at the Imperial Gas Works, London, placed down in wells thirty to forty feet deep, and steam taken down from boiler at the surface.

Two at the Phoenix Gas Works, London, pumping tar and ammoniacal liquor, also two at gas-works at Hull, and one at Middlesbro'-on-Tees, for the same purpose, all working very satisfactorily.

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One at Messrs. Coombe, Delafield, and Co.'s Brewery, London, sixteen inches diameter of steam and seven inches water cylinder, pumping 10,000 gallons of hot liquor per hour, seventy-five feet high, with a steam pressure of only eight lbs. per square inch.

One at Messrs. Ashby and Co.'s Brewery, Staines, Middlesex, pumping hot wort at 200° Fahrenheit, and cold liquor when required, at eighty strokes per minute. This pump is fitted now with Mr. Holman's improved valves—see specimen on table—and would previously only make fifty strokes per minute.

The Westminster Brymbo Collieries, near Wrexham, have one six inches by three inches, feeding boilers in lieu of Giffard's injector, and they have also one twelve inches by eight, to raise 8,000 gallons per hour from a pit 110 feet deep, steam conveyed from surface.

Mr. Gidlow, Ladies Lane Colliery, near Wigan, has also one six inches by three inches, and has ordered a second for feeding boilers.

Some time since one was supplied to Messrs. Bagnall and Sons, Bilston, Staffordshire, for fixing in one of their coal pits. Steam was conveyed down to it through 900 feet of piping, and it answered its purpose admirably in drawing off some accumulations of water, and is always left from the Saturday to the Monday, being found to work well all the time, but this of course is not recommended.

[illustration, The Patent Special Stem Pump]

Large numbers have been sent to Russia, Japan, Singapore, and several of large size to India for Indigo works, and the East Indian Government have also had several for irrigation purposes, these being mounted on a cast-iron bed-plate, with a small vertical boiler, complete with all usual fittings, at an extremely moderate price. See illustration.

Finally, the writer submits the following advantages possessed by these pumps.

First.—Their extreme simplicity, minimum working friction, and freedom from wear and tear of their very few moving parts.

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Second.—Their freedom from liability to accident, all the parts being self-contained, except a very short length of the piston rod, which is well protected.

Third.—The extremely small compass into which they will go, rendering them peculiarly adapted for pumping water out of low seams or dip inclines; the one on the table, capable of raising 680 gallons per hour, being only 3 feet 5 inches long x 8 1/4 inches wide, x 1 foot 3 1/4 inches to top of air vessel; and the size does not increase nearly in proportion to the amount of duty developed, a pump capable of raising 19,800 gallons per hour, at a speed of piston of 170 feet per minute, a moderate height, being only about 4 feet 6 inches long x 1 foot 8 inches wide, and 2 feet 6 inches high to top of air vessel.

Fourth.—The very small amount of attention required, as illustrated by the one at Bilston Colliery, before referred to.

Fifth.—The slight and inexpensive foundations necessary.

Sixth.—The very small cost, which is from £10 upwards, according to size and special work they may be adapted to perform.

It may also be added that two have recently been supplied to the Bede Metal Company, Jarrow-on-Tyne, one of which is the same size as that referred to as at work at the Westminster Brymbo Collieries, the other the same size as the one on the table; another of this latter size has also been recently sent to Messrs. Joseph Pease and Partners for feeding boilers at their Brandon Pit, near Bishop Auckland; one is also now being supplied for Messrs. Sheldon and Nixon's chemical works, at Jarrow, and, except the latter, which has not yet been set to work, they are all in most satisfactory operation. The principle is also being applied for blowing engines or air pumps, hydraulic lifts and cranes, lifting the load direct, for some large London establishments, and is applicable to a variety of other purposes, for working present setts or lifting pumps, etc., direct from the steam cylinder, illustrations of which may be seen on application to the author.

NORTH OF ENGLAND INSTITUTE

OF

MINING ENGINEERS.

MEETING AT SEAHAM HARBOUR, ON FRIDAY, JULY 10th, 1868.

A large and numerously attended meeting of the members of the North of England Mining Institute was held at the invitation of Earl Vane, one of the patrons of the Institute, in the neighbourhood of Seaham Harbour, on Friday, July 10th, when many of the most interesting features of Earl Vane's works were inspected. During the afternoon the company assembled in the Lecture Room of the Literary Institute, the President of the Institute, Mr. T. E. Forster, being in the chair, and an able address was delivered by Mr. J. C. Buckmaster, from the Science and Art Department of South Kensington, on the facilities afforded by Government for the establishment and maintenance of a system of scientific education adapted to the working classes.

Mr. Buckmaster, who was very warmly received, said, that he attended, as probably most of those present were aware, for the purpose of explaining some arrangements made by a department of the Government for aiding and promoting a more general knowledge of elementary science. He did not intend to weary the company on this occasion with anything like a long, dry, and tedious discourse on education, although, in the discussion of various social questions, this subject must, for a long time, occupy a very important position. It was impossible to pass through such a district as that they were now in, and to see the various contrivances and combinations which were employed for the purpose of producing certain industrial results, without being deeply impressed with the importance of that knowledge which had contributed so largely to the wealth and influence of the district. It appeared to him, that although much had been done, there still remained much more to do. The district had been singularly favoured by possessing in much abundance raw materials capable of developing great power and wealth; and this had, he was

afraid, in some cases tended to a prodigal disregard of that economic application of force upon which our future success must mainly depend. He had hoped to hear a paper to-day, by Mr. Daglish, on a subject intimately connected with this question, because, however plentiful might be the raw material, they should not be wasteful of that material. Although they might have a large supply of coal, which had constituted the great power of this district for a long period of time, they should not be careless in the use of that coal, they should not consume it without regard to those conditions necessary for its perfect combustion, and which obtain the maximum mechanical equivalent which it gives. It was not his object to discuss questions of this kind. Because the industry of this district was an industry with which he was not intimately acquainted; but this he could say, that progress in science, in discovery, in the application of scientific principles as a means of economic production, must constitute the great power and influence of this country in the future; and a decline in any important branch of industry would be attended with a corresponding decline in the prosperity and power of the country. He thought some anxiety should also be felt with reference to those men who seem to be engaged in mere mechanical operations. After the remarks made that day concerning the organization of a society for the prevention of accidents in coal mines, they would all, doubtless, admit that it was very desirable every man who had to use a Davy-lamp should at least have some knowledge of its construction, although the lamp itself might not be all that could be wished. Was it not desirable—ought it not to be an important part of the education of that man, that he should understand something of the scientific principles upon which that lamp was formed ?—and would not that knowledge, in many instances, contribute to his safety, and teach him those warnings which an educated man would easily understand, but which pass unheeded by the uneducated ? The difficulty of immediately utilizing a new discovery should not deter us. The great principles discovered and proclaimed by Archimedes, unapplied for ages, are possibly, even now, but partially developed to their fullest practical extent. The knowledge of facts and principles should not be considered useless because it has no present commercial value (making money ought not to be the highest object of education). It might sometimes happen that a new discovery in science was made, and its application to the arts became evident at once; but it took two thousand years before those profound mathematical researches and calculations, which resulted from the intersection of a

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cone with a plane surface, laid the basis of those nautical tables by which men were now enabled to navigate their vessels with perfect safety across the ocean. The experiments of Oersted led almost immediately to that system of telegraphic communication which had brought us within a few minutes of our Indian possessions and the great Continent of America. The investigations of Hoffman, with reference to coal tar products, resulted in the production of those analine dyes which were now extensively used in cotton printing. Almost all these discoveries, and their practical application to the arts, had been the result of careful study and investigation, and not chance or accident, for men had first to learn that nature could only be subjugated by obedience to her laws. These facts must be self-evident to those he had the honour of addressing. His chief object was to place before the meeting the facilities which were offered for acquiring scientific knowledge. There had existed, for a long time, a Department of the Government known as the Department of Science and Art. That Department of Science and Art was especially charged with promoting secondary education in this country—to form, if possible, a connecting link between the instruction given in elementary schools and that more advanced scientific instruction which was so intimately connected with the industrial prosperity and welfare of the country. The science minute received the sanction of the Treasury some ten years ago. The desirability of aiding instruction in science was recognised by the Government long before the Exhibition of 1862, or the Paris Exhibition of 1867, or Mr. Samuelson's Committee of 1868. The subjects which are specified in this minute are practical, plane, and descriptive geometry, building construction, or the principles involved in practical architecture, elementary mathematics, advanced mathematics, theoretical mechanics, applied mechanics, acoustics, light, heat, magnetism, electricity, inorganic chemistry, organic chemistry, mining, metallurgy, mineralogy, geology, animal physiology, and its special relations to health, zoology, vegetable physiology, systematic botany, navigation, nautical astronomy, steam, and physical geography. Altogether there were twenty-three subjects aided and encouraged by this minute. He need not occupy time by showing the industrial application of many of these sciences, or their educational value, for they had a great educational value as well as an industrial value; but how was it proposed to encourage a knowledge of these subjects ? In any place without regard to population where a local committee could be organised of not less than five persons, who would agree to act as an examining committee in any one or more of these subjects, there would be

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forwarded to that examination committee, once a year, in May, questions in each or all of these subjects; and if any person were desirous of being examined, no matter whether in chemistry, mining, mathematics, or any other science in the list, the local committee would have sent to them questions on the particular subject or subjects in which the candidate or candidates proposed to be examined. In this way, through the agency of local committees established in small villages and large towns all over the country, there were upwards of 16,000 people examined last May in different branches of elmentary science; but, up to the present time, the scheme had made no progress in this district. There were no classes, there was no organization at all commensurate with the great importance of these subjects to the industries in which many present were engaged. From Darlington to Glasgow there were not three science classes, while in the neighbourhood of Manchester there were fifty. It might be said, " How are we to obtain teachers ?" There was to be found in almost every place some person or persons who already had a fair knowledge of many of the subjects mentioned, and sometimes a person who held a degree from some recognised University. In such cases the examinations were dispensed with altogether, and the Department was prepared to recognise such persons as competent to teach in any of the subjects they liked to take up. But so far as the industry of this district is concerned, the Durham University might never have existed. It ought, long since, to have been a great Industrial University for the North of England ; it is the feeble shadow of Oxford and Cambridge, without its spirit. But suppose an elementary schoolmaster were desirous of becoming a science teacher, it would be necessary for him to pass an examination in the subject or subjects he proposed to teach, and if he were desirous of availing himself of the pecuniary advantages which are attached to his having passed this examination, he would be required to comply with a few simple regulations. A suitable room would have to be provided, and twenty-five lessons given to the pupils between the May of one year and the May of the succeeding year, and those pupils would have to undergo, under the superintendence of the local committee, an examination in the subjects which had been taught; and if any person were desirous of being examined, who was not taught by a certified science teacher, all that he would have to do would be to make arrangements with the local committee for attending the examination. The teacher had a great interest in the results of these examinations. His payment depended upon the success of his pupils. The fees which these pupils

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pay are matters with which the Department had nothing whatever to do, it left these to be arranged locally. The committee may impose such fees as they believe to be reasonable, and within the reach of persons whom they proposed to teach, and if, in their discretion they thought it would be better to abandon these fees altogether, in the case of poor lads, the Department offered no objection. On every pupil who had received twenty-five lessons from a certified science teacher, or from some person holding a University degree, the teacher would receive from the Government £1 if the pupil simply passed the examination. And to pass in any subject was quite within the reach of almost all the best boys in our elementary schools, for after all, science was not the difficult and abstruse thing which most persons imagined it to be. Everything grows interesting just in proportion to our knowledge of it, and it is because the working and other classes in this country have never received any scientific education that they regard it as one of those things far too difficult to be undertaken by children or even grown up persons. On every pupil passing in the fourth grade of the examination, the teacher would receive £2; on every pupil passing in the third grade the teacher would receive £3 ; on every pupil passing in the second grade the teacher would receive £4; and on every pupil passing in the first grade the teacher received £5; so that the payment of the teacher depended entirely upon the grade in which his pupils passed their examination. Last May pupils were examined in different parts of the country whose ages varied from nine years to sixty-four years, and sums of money varying from £7 10s. to upwards of £200 were paid to teachers, on the results of science teaching. Who were the persons engaged in science teaching ? Chiefly such persons who combined the two requisites necessary for a successful elementary teacher, namely a knowledge of the subject, and the ability to impart that knowledge to others—an art, perhaps, difficult to give to a man. These elementary teachers, although not possessing a profound knowledge, were able at least to interest and instruct their pupils, and produce far greater results than men of larger attainments who did not know how to impart the knowledge they possessed. The day of small things must not be despised, and all science must have a beginning. There is a great store of intelligence in this country which might be directed to these results. The working of the scheme in Manchester had not been confined to mere professional teachers, or men who had passed and obtained university degrees; last winter there were fourteen workmen, artisans, actively engaged in teaching classes in

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Manchester and its neighbourhood, and he understood that some of these men had actually given up their work (which he was rather sorry to hear) for the purpose of giving their attention entirely to science teaching. He was sorry for this, because he wanted to bring about a much closer connection between the practical knowledge of the workshop and the theoretical teaching of the class room. There were growing up two classes of men—theoretical men who despised mere practical men, and practical men who too frequently despised the teachings of theoretical men. Now, they wanted the errors of the one corrected by the knowledge of the other, and to introduce into the workshop that theoretical knowledge which would frequently save them from many difficulties. In the purchase of all the apparatus, diagrams, and specimens, which would be required for teaching, the Government would assist to the extent of 50 per cent, of the cost price, on the understanding that those things were required and used for the purpose of teaching. He had shown how the teacher was paid, and what he had to work for. What he had to do was to make his pupils pass, and that would involve upon him some work. No man could gain anything without work, and the man who had never learned to work was a poor miserable creature. The pupils must also be encouraged. A prize of books would be given to any pupil who passed the examinations, and those prizes would vary in value according to the grade in which the pupil passed, and the pupil would himself select the books from a list forwarded for that purpose. These prizes were given to first, second, and third grade pupils, and among the best pupils gold, silver, and bronze medals were given. And, although he was a very loyal man himself, he thought that the gold and silver medals awarded, by the Science and Art Department, were objects worth competing for, and as honourable to obtain, as the silver cups and medals received for successful shooting. And, perhaps, the knowledge necessary to gain the one might in some emergency be quite as useful in the service of his country as the knowledge necessary to gain the other. In addition to these, the Department offered exhibitions and scholarships to the School of Science for three years, with free education. The exhibitions were of the value of £25 a year; but the scholarships were of the value of £50 a year, and, he believed, some of these were either founded or suggested by the late Prince Consort, for the purpose of encouraging among the industrial classes a more general study of elementary science. Those scholarships were open to young men, and they had been supplemented very recently by the scholarships of Mr. Whitworth, so that opportunities now existed such as never existed

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before. No young man need sink now except by his own free will, and if we could give the same impulse to science teaching as we have given to other subjects—if we could make it the prevailing idea of our lives, not many years would pass away before classes and schools were organised in connection with the great works in the district, for the systematic instruction of apprentices and young men in those subjects which specially related to the industries in which they were engaged. He asked what had been done in this direction ? What provision had the Mining Institute made for this kind of education ? As far as he could understand, no systematic effort had ever been made. The members had been content to talk about it; many of them had been content to upbraid the Government for doing nothing; but the Government was and has been greatly in advance of public opinion upon this question, and was prepared to do more than any of the Governments on the Continent; but the country must also do something. For years he had been wandering up and down to impress the importance of this subject on the people. He asked if the Institute was in earnest, and willing to co-operate with the Department in doing this work. The Government could not be expected to do everything. It was useless to multiply and offer facilities to a people who were utterly insensible to the importance of the subject; but if those present had any faith in their profession, or in that education with which many of them were blessed, he asked them to extend the benefit of that education to others, and to do all they could to promote in this district a knowledge of those sciences which would enable them to maintain that position which had for a long time been maintained from causes over which they have had no control. The time had now come when it appeared desirable that they should consider in an earnest and faithful spirit how they could best give effect to this scheme, and how they could best adapt it to the industrial requirements of this important district. Such a subject was by no means beneath their consideration, and they would do well to give it their earnest attention. The lecturer then resumed his seat.

Mr. R. C. Clapham said, he might just mention that when Mr. Daglish, Mr. Cochrane, Mr. Henry Watson, and himself were in London, it became very evident they were ignorant in the North of England of the facilities which the Government were willing to offer for the study of scientific questions ; and they, therefore, waited upon the authorities at South Kensington, to ascertain whether they would send some one down to enlighten them upon the nature of the advantages now held out. As the meeting would perceive, they had been fortunate enough to induce the

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authorities to send down Mr. Buckmaster, whom they had all heard with great pleasure that day. He could say that, as one individual, he should be very happy indeed if Mr. Buckmaster's mission to the north would result in organising some system that would enable the workmen and foremen of the various works and manufactures in this district to make use of those grants of money which the Government were willing to give. It appeared to him, from the information he had, that in the south of England, good use had been made of the grants, whereas the people in the north had neglected to place themselves in a position to receive them. He believed the Government were distributing £15,000 a year for scientific education, and it would be a pity if they did not, in a district like this, endeavour to reap some of the advantages offered by the system. Mr. Buckmaster had undertaken to visit the district in September, and it was his proposition that some systematic organization should be adopted to carry out the scheme which the Government had proposed.

Mr. Daglish then said, after the very able address they had had from Mr. Buckmaster, it was almost unnecessary to say anything more; but he believed Mr. Buckmaster was anxious there should be a little discussion with reference to the proposed plan. When recently in London, he (Mr. Daglish) had an opportunity of seeing Mr. Hunt, the keeper of the School of Records of Mines in Cornwall, and he then ascertained that in Cornwall the system of education was carried out by means of itinerating lecturers and classes, held at centres, where the workmen could best attend. It seemed to him that what was most likely to suit the people in Cornwall, might suit the people in this district also. He felt sure, however, from the very able way in which Mr. Buckmaster had brought forward the subject, that it would not be allowed to rest until some practical result had ensued.

Mr. Buckmaster said, as his remarks had been made without any preparation, if there was any question of detail, or any point not clearly understood, he should be very glad to explain it.

Mr. Greenwell said, he would like to hear more about the qualification, as there were many who would like to give instruction if their own knowledge was likely to come up to the requirements of the Government. If Mr. Buckmaster would be kind enough to further explain to them the necessary qualification of teachers, it would, perhaps, be the means of inducing many to come forward.

Mr. Buckmaster, in reply, said, the examination was quite within the reach of any person who made any pretence to a knowledge of the

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subject. All that was required for the examination was that the teacher should have at least a sound elementary knowledge of the subject he proposed to teach. If any person, either by works he might have written or by his professional connections, was willing to become a science teacher, the Department was willing to recognise such a person, without any examination whatever, as competent to give instruction in the subject he selected for teaching. In many subjects a little careful reading would easily qualify for what was wanted, but, if the pupils required more advanced teaching, the Department would be prepared to assist this more advanced teaching, by helping deserving pupils to the School of Mines in Jermyn Street, to Owen's College in Manchester, or to the Edinburgh University.

Mr. A. L. Steavenson assured the meeting, from past experience, that no difficulty would be experienced in finding a teacher, and if an advertisement were put into a local paper, they would soon find that there was a certificated schoolmaster, or some one qualified to teach, living in the district. They soon found a man living in Middlesbro' who was a certificated teacher, and an arrangement was at once made with him to travel in the district, south and east. He thought if the matter were properly gone about there would be no difficulty in finding a person qualified in all respects for the duty required.

Mr. Scott desired a little information on one or two points. First of all, as regarded the itinerating teachers, whether the Government was prepared, or the Department was prepared, to recommend any such teachers? Secondly, whether there was any staff upon which they could draw for the supply of such teachers ? And thirdly, the mode of ascertaining the proficiency of those who proposed to be instructors, and when the necessary examinations to that end could be made.

Mr. Buckmaster, in reply, said, there would, he thought, be little or no difficulty in providing such itinerating teachers; but, if they had itinerating teachers, that, of course, involved some local pecuniary responsibility, because the teachers must give the whole of their time to teaching. It would be for the local committee to consider whether they could find sufficient work to provide constant employment for such persons; as far as his experience went, it was a mistake to press these classes during the summer, the out-door healthy recreation of the people should not be interfered with. He liked to see young men enjoy themselves, on a summer's evening, too well to advocate nothing but work. The local committee should be prepared, in addition, to give some guarantee to teachers, either by fees or subscriptions, or in any way that should be

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thought desirable. The examination for teachers was held every May, and any person could be examined in any place. If any person was desirous of being examined, all he had to do was to go to the clergyman, or some other responsible and trustworthy person, near where he resided, and say:—"Now, sir, I wish you to write to the Department of Science and Art, for their examination questions, as I wish to qualify for a teacher at their next science examination to be held here." The Department would require the correspondent and some other gentleman to be present at the examination, which would be conducted by means of printed questions forwarded from the Department, the examination taking place, perhaps, in the library of their own Institute, or any suitable place. They would have to sign a paper, saying the candidate had worked these questions without any assistance, and then the Department would see if his knowledge was sufficient to justify them in passing him as a teacher. They had several examinations last May, in small villages, of persons desirous of becoming teachers.

The President said, it appeared that in the North of England very little was known about Government instruction, and the members of the Institute ought to feel very much indebted to Mr. Buckmaster for coming down to enlighten them. No doubt in a short time these classes about which Mr. Buckmaster had just been discoursing would be in full operation. It would be very much to the advantage of the North of England if the suggestion offered should be carried to a practical issue, and, in conclusion, he proposed that a hearty vote of thanks be accorded to Mr. Buckmaster for his address.

Mr. Daglish had much pleasure in seconding the proposal.

Mr. Buckmaster, in replying, trusted that those men, who had for years directed the feeling and opinion of this district on these matters, and had given a ready and cheerful assistance to all questions of social and industrial progress, would now consider how far it could be directed in promoting the scheme which it had been his business and pleasure to explain. His hope of the future depended on this assistance.

On the motion of Mr. Buckmaster, seconded by Mr. Snowball, a cordial vote of thanks was awarded to Earl Vane and Mr. Daglish for their attention, and to the President for his ability in presiding.

This was also acknowledged, and the meeting terminated.

NORTH OF ENGLAND INSTITUTE

or

MINING ENGINEERS.

ANNUAL MEETING, SATURDAY, AUG. 1, 1868, IN THE ROOMS OF THE INSTITUTE, NEVILLE HALL, NEWCASTLE-UPON-TYNE.

T. E. FORSTER, Esq., President of the Institute, in the chair.

The meeting proceeded to the election of officers for the ensuing year, and Mr. L. Wood, Mr. Hurst, and Mr. J. B. Simpson were appointed scrutineers.

The Secretary read the report of the Council, and the reports of the Treasurer and Finance Committee.

The following new members were elected :—

Members— William John Rusby, Engineer, Glass House Fields Engine Works, London.

George E. Forster, Washington, Gateshead.

Henry Lawrence, Grange Iron Works, Durham.

Matthew Chapman, Plashetts Colliery, Falstone, Northumberland.

Thomas Snowdon, Stockton-on-Tees.

Graduates—

John William Marley, King's College, London.

J. T. Forster, Washington, Gateshead.

Francis Coulson, Shamrock House, Durham.

Mr. Cochrane moved that in Rule IV. the words " or mechanical" be inserted after the word " mining."

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

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Mr. Cooper's original paper, and " Further Observations on an Outburst or Sudden Issue of Fire-damp, at Strafford Main Colliery, Barnsley, Yorkshire, Oct. 1, 1867," then came on for discussion.

Mr. Cooper said, there had been holes bored six feet through the floor of the mine without producing any issue of fire-damp. His own impression was that instead of six feet it would be better if the borings had been sixty feet. That view of the subject was supported by what was stated in the second paper, and the evidence of the late Mr. Buddle with respect to the floor of Wallsend Colliery, where they worked 44 feet below the High Main seam, when they found the effects of creep.

The President—That would be down to the bed of coal.

Mr. E. F. Boyd—Is there a bed of coal 60 feet down ?

Mr. Cooper thought there was one at 20 yards.

Mr. Steavenson—Do you consider that the gas exists in cavities, or that it permeates the entire substance of the coal ?

Mr. Cooper said, so far as could be known in the present instance there was no natural crevice—no natural original cavity. He believed the experience of every member of that Institute was that fire-damp was generally found in exceedingly minute quantities, and not in large spaces. Occasionally they did meet with it in a state of high tension, issuing in very considerable quantities. A case of this sort occurred some four years ago, at the Holmes Colliery, where they struck some cracks in the coal, not in connection with a throw, but parallel to and 200 yards from it. A considerable quantity of gas came off with violence, accompanied by water ; but in the Strafford case his own impression was that there was no natural or original cavity, but that it was contained in the measures of the coal in the ordinary way, and given off into cavities that were formed by the upheaval of the floor without its being broken. No doubt fire-damp was met with in coal-mines in several states, or, if not, at least collected under different conditions. It is generally met with entangled in the coal measures, and issues in small quantities.

Mr. Steavenson said, he thought the fact of occasionally meeting with it in large quantities favoured the view that it was sometimes found in large cavities.

The President referred to the case at Jarrow in 1829 or 1830. The miner was working his way, and when he got to a certain point the coal could not bear the pressure of the gas, and was blown out.

Mr. I. L. Bell—To what extent ?

The President—Possibly two feet square. It did not require a large quantity of gas to produce that effect.

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Mr. I. L. Bell said, there was one suggestion he wished to throw out for consideration, and that was, whether this accumulation of light car-buretted hydrogen might not be the result of absorption. They were all aware that charcoal, for example, possessed the power of absorbing some hundred times its own volume of certain gases—particularly ammoniacal— which were absorbed, as it were, and condensed in the interstices of that substance. So far as his knowledge and reflection served him, he believed charcoal was considered at one time the only substance capable of doing this ; but recent investigations had shown that this power was not confined to charcoal. Palladium, one of the densest of known substances, possessed the power of absorbing very many times its volume of hydrogen. Therefore, they had one of the most dense substances absorbing one of the lightest. It was just possible that coal was somewhat analogous to charcoal, and that it had the power of holding condensed a large quantity of fire-damp without any great amount of pressure being required. He had not the slightest ground for saying that such was the case, but he mentioned it as a subject worthy of investigation.

Mr. Cooper said, it would be interesting for Mr. Bell to say what causes would reverse that state of things, so as to occasion violent issues of gas.

Mr. Bell said, they knew quite well that if charcoal was made to absorb a certain quantity of gas it could be made to give it off. He did not know how this might be done ; it might be by the interposition of water.

Mr. E. F. Boyd—Might it not be effected by pressure ?

Mr. I. L. Bell said, if they put in a tube over mercury a quantity of ammoniacal gas and placed in this a small piece of charcoal, previously heated to expel moisture, the absorption of ammoniacal gas would produce a vacuum under the bell.

Mr. E. F. Boyd said, his remark applied to the causes that would liberate the gas already held. The condition would, in some way, have to be changed.

Mr. I. L. Bell—Probably that would be the case.

Mr. Cooper remarked that at Strafford the mine was excessively dry.

Mr. Steavenson said, it was generally understood that gas was owing to a dissolution or change of the constituents of the material of coal. Probably the gas had been present ever since the formation of the coal, and the pressure of the strata above has maintained it in its position. He did not think, however, that the constitution of coal was

clearly ascertained. It would be necessary to bring all the circumstances into consideration which accompanied the formation of coal, and this would require considerable time. It was generally supposed that coal was the remains of decayed vegetable matter ; but for his own part he could not see his way through the difficulties of this subject.

Mr. Cooper said, he thought every person versed in mining admitted that fire-damp was usually given off with very considerable force in small quantities. It would seem that prior to approaching it with a drift, some conditions existed which retained the fire-damp under this expansive force—

whether these conditions were chemical or whether they were due to the causes stated in this paper—the pressure of superincumbent strata—or in the way suggested by Mr. Bell had not been ascertained. In this case there was no proof that the fire-damp came from the bed of coal that was being worked. Possibly it might have come from a lower or a higher bed of coal; but wherever generated it appeared to him that the force was modified by pressure. Whether that was consistent with the idea of Mr. Bell, about the absorption of gas, he could not say.

Mr. I. L. Bell—Possibly in many cases it is as you account for it. The suggestion was merely made as one worth attention.

Mr. Cooper (in answer to a question) said, the length of the working face was 300 yards, and the fracture 40 or 60 yards.

Mr. W. A. Potter said, the nature of the strata which underlie this bed of coal was not favourable, so far as his observation went, to long-wall working, which produced more or less creep, causing the strata to heave up. The colliery of which he had the management for the last eight or nine years was immediately to the rise of the one referred to by Mr. Cooper; but then the mode of working was different. It was the short working, and more like the bord and pillar working of the north. He might say that as a precaution they used the safety-lamp, but he did not think they had ever had an upheaval of the strata below, liberating large issues of gas. When they went through the thill, which was just indurated clay, they found gas issuing, but to no very great extent. He thought the supposition that the gas was absorbed to some extent by the thill a happy one; and were attention directed to the suggestion, most important results might be obtained.

Mr. Cooper said, it was a very important question; but until they could arrive at any satisfactory result as to the cause, they could not deal with the question of prevention. That fire-damp exists naturally in a greatly condensed state there is no doubt. But there were instances

on record of a large outburst of fire-damp without clear evidence presenting itself afterwards of the existence of some cavity, as explained by Mr. Forster; and as in the case given by the late Mr. Taylor, some years ago, where there was a large discharge of fire-damp from some cinder coal at Haswell Colliery, which the drifts penetrated, or nearly penetrated in the vicinity of the whin dyke.

The President—They were in very tender coal, approaching the cinder.

Mr. Cooper—The gas accumulated, under pressure in the spaces of this cinder coal, which was the very thing he was contending for. The spaces for the fire-damp to accumulate in were also overlying it there to a considerable extent, for anything they knew. There was another element of which he had not spoken. Water very frequently produced strong blowers of fire-damp. Where there was sandstone with fissures, and fire-damp issued with the water, there would be a greater amount of force than in ordinary circumstances, owing to the pressure of the water. Any person who had carefully noted where outburst had occurred, in long-wall working, would observe that they generally occur where the workings were advanced to the limit of say 40 or 50 yards. It was exceedingly difficult to tell what was the origin of the outburst in this case. No doubt the floor was upheaved at the moment of the gas being given off. But whether it was by the natural state of gas in very high tension—or whether it was, as he fancied himself, the result of the mode of working—his impression was that the gas might have been given off in the ordinary way by a moderately slow discharge into spaces upheaved in the floor; and subsequent to this the immense weight fractured the floor and forced the gas out suddenly. That was his notion, of course based on the facts of the case. He might go a step further, perhaps, and consider how to meet these cases. He had very great diffidence in doing this, as it referred to a mode of working which was very largely practised in the Midland Counties, and on the whole, a mode of working that had been very free from explosions. This mode of working produced cavities which the fire-damp filled, as had been stated in his paper, in a similar way to the case of upheaving of coal in the Hutton seam, where fire-damp came off with considerable force. In both cases the issue of fire-damp, in the first instance, was the ordinary natural issue met with every day in coal mines. It would be well if they could arrange the workings in such a way as to guard against the dangers attending such unexpected issues of gas when they do occur. But if the force of issue were due to the original and natural state of things, and

not to the causes he had tried to explain, it was useless to try because it was simply seeking to avoid an evil which did not exist. He had a strong objection to working coal on the rise edge of a goaf by any mode of working. It was difficult to carry out, and was attended with danger; but in the case of long-wall, he thought it was unusually dangerous, inasmuch as in bord and pillar working there were open spaces, bords, and headways into which gas could penetrate, and so relieve the men from its presence. It could go off at a higher level. But in long-wall it had no place to go to but the very places where the men were working. Such being the case, he considered it very desirable, if it were practicable, to work the coal in some other way, instead of working to the full rise by long-wall. If it could be done, but he was not quite sure that it could, it would be better to work the coal down the hill instead of up. If it were difficult or dangerous to work to the full rise or dip—it might be worked at right angles. It was especially desirable to do so when these long-wall workings were not only going to the rise, but when the return air from them was brought from the dip to the rise. When the return air was from the dip, it would be much safer to have a series of benks. There was another suggestion to be made, and that was, that if they were liable to these large outbursts, no amount of ordinary ventilation, either by the Lemielle fan or by the old furnace, would be sufficient. He thought in long-wall working, with a rise of four or six inches to the yard, it would be much safer in ordinary circumstances to work at the lower level of the goaves.

The President—The same thing applies to pillar working. When the pillars are taken off, the goaf remains.

Mr. Cooper said, he strongly objected to following up the pillar working when it was to the rise of the goaf. If working with naked lights, or in case of a sudden issue, the men are in a position of the greatest danger. He thought that in working by bord and pillar, they should work down the hill, where the place was free from water; in which case it would be much safer and more economical to work downward than upward. He thought the principal point of the whole question was to see if any means could be devised to alter the present mode of working in the way he had suggested, since some of the largest recent explosions, there was reason to think, had arisen from the present system.

Mr. E. F. Boyd said, at those collieries, which he had seen, where long-wall was the custom—at Scremerston for example—the very principle which Mr. Cooper had named was adopted. They kept the face to the edge of the hill, either to the rise, or going at right angles. All the collieries of Northumberland that he knew had done so. The rise was four or five inches to the yard. They all endeavoured to work from

the dip to the rise, because of the pressure coming down the hill upon each particular jud which was at the face of the goaf.

Mr. Matthews said, his experience was totally at variance with Mr. Cooper's. In working by long-wall the gas was more readily dispersed than by bord and pillar. In slow working by long-wall the gas was gradually and constantly given off, the coal was much more easy to work, and they worked neither to the dip nor to the rise, but on the level. He had worked this way in the Hutton seam, at the Low main, the Five-quarter, and partly in the Main coal seams in the Wear and Hartlepool districts.

Mr. Cooper said, he thought he had been particularly guarded not to condemn long-wall working. He thought where the coal was hard and the roof soft it was better than the other mode. He did not refer to the mode of working long-wall, but to this particular mode of working long-wall—for either as applied to long-wall or pillar working, he thought working on the rise edge of goaves was the most unsafe way they could adopt.

Mr. Atkinson asked Mr. Cooper, in reference to fresh air furnaces, if he considered that they increased the quantity of air passed through the workings of a mine, as well as conduced to the safety of the mine. He thought he had seen that opinion expressed in print, in a letter published in a recent issue of the Durham Chronicle, purporting to be written by Mr. Cooper—an opinion which he (Mr. Atkinson) could not adopt, for he thought the fresh air, employed to feed the furnace, increased the friction in the shafts without passing through the workings of the mine; and that, since the chief part of the air did not pass over the fresh air furnace, but cooled the upcast column, any given furnace would naturally consume more coal in any given time, when the whole of the air was passed over it, than it would consume when only a small portion of air was carried over it; and, if so, then it follows, as a mere natural sequence, that the average temperature prevailing in the upcast shaft—the ventilating pressure and the water gauge—and hence, also, the quantity of air circulating through and ventilating the workings of the mine, must be less with a given fresh air furnace than with the same furnace, at the same mine, when all the air passes over it.

Mr. Cooper said, he was not sure that he had introduced this question, but he was quite sure he agreed with Mr. Atkinson. As regarded the matter of safety, he was not quite convinced of the necessity of fresh air furnaces. He had erected one at very considerable cost—one of the best —for the purpose of separating the return air from the fire. Though they had a very large ventilation, 150,000 to 160,000 feet of air, with the

low water-gauge of four or five-tenths of an inch, he did not attribute that to the fresh air furnace. What he claimed for it was separating the return air from the furnace. He believed they could get more air from the old furnace, if it was properly arranged. They all knew, with regard to the old furnaces, that there was a considerable amount of resistance offered to the return air. In practice they put up a large flue and contracted it down at the fire bars. There was the friction of air passing over the old furnace, to set against the friction in the shaft, to get a larger quantity of air to supply the fresh air furnace. When they first began the fresh air furnace, they had not the same amount of circulation that they had immediately before. He attributed this to the large quantity of strata not being then heated. After a while they found the ventilation increased. As soon as he was satisfied that the fresh air furnace was sufficiently heated, he did away with the old furnace, and opened another return into the upcast shaft, and then they got more air by the fresh air furnace than by the return air furnace.

The President said, there was no need of a fresh air furnace. The gas got diluted before it reached the furnace. Did Mr. Cooper ever know of an explosion at the furnace ?

Mr. Cooper said, he thought there were instances recorded, he thought Mr. Woodhouse had one.

The President—He had not a large quantity of air going.

Mr. Cooper—About twenty thousand feet per minute.

The President said, he knew a case where a pit was foul, and the Davy-lamp fired three feet from the furnace, but there was no explosion at the furnace, because the current of air was passing so rapidly that there was no time to explode.

Mr. Cooper said, there was one thing of great importance—having more splits of air. Sometimes they would pass the air for miles without having one.

The President—That is the practice in Yorkshire, but not in the North of England.

Mr. Cooper said, there were collieries worked without any split of air whatever. He had seen a bed of coal worked, ten feet high, without any split. They worked 500 tons per day with no split. They had plenty of doors ; but they did not adopt the mode of splitting the air so that only one split of the air would become in an explosive condition.

The President—The other splits would dilute the gas.

Mr. Steavenson said, he understood there were 12 lbs. of coal used to every thousand feet of air by Mr. Cooper's furnace.

Mr. Cooper—No. One pound per 12,000 feet of air.

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Mr. Atkinson said, the consumption of coal naturally increased the water-gauge. The water-gauge naturally increased with the smallness of the air way.

The President—With Mr. Cooper's small water-gauge there must be good returns.

Mr. Atkinson said, Professor Philips had collected data which he had worked out, and which gave 13,000 cubic feet of air per pound of coal by furnace ventilation, on the average of a considerable number of mines, the water-gauge being double or treble of that mentioned by Mr. Cooper in the case which he had mentioned, and ought, therefore, to involve a correspondingly increased consumption of coal.

Mr. Steavenson said, he wanted to know the ventilating power developed by this furnace. If ten horse-power, it was rather a low amount; since roughly estimated it appeared that the consumption of coal was 78 lbs. per horse-power.

Mr. Atkinson said, that was ten times the ordinary consumption by engines, or five times as great as that by engines driving good fans to produce ventilation in mines.

Mr. Cooper thought it only right to say that the quantities given, being the best examples, were above the average in the North of England, there did not seem to be anything against the fresh air furnace.

Mr. G. B. Forster—The furnace has much more work to do.

CAMERON'S SPECIAL STEAM PUMP.

Mr. Rake, whose paper on this subject stood for discussion, in answer to Mr. G. B. Forster, said, the largest engine which had been made yet was one capable of raising some 44,000 gallons of water per hour, a height of 35 or 40 feet only; but they were gradually increasing the height. Some they had at work now reached a height of 150 feet, and another they had put to work to raise a height of 200 feet. At present they were prepared, according as they could make the pressure of steam available, to raise water to a height of 300 feet, and they hoped to attain a still greater height.

TECHNICAL EDUCATION.

The Secretary said, a letter had been received from Mr. Buckmaster, stating that he had secured a suitable person to take charge of this district, in promoting Technical Education.

A Committee on Technical Education was then appointed, on the recommendation of the Council, consisting of Messrs. L. Wood, W. Cochrane, J. B. Simpson, J. Daglish, E. F. Boyd, A. L. Steavenson, and G. B. Forster.

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SAFETY-CAGES.

Mr. Lishman, in reply to the President, gave testimony to the utility of the Ormerod's safety-link in disengaging the rope from the cage when the latter was in danger from overwinding. An accident of this kind occurred a short time ago at Houghton Pit, Newbottle. The cage was taken up to the pulley at full speed. The rope was disengaged, the cage caught, and no damage was done; the link was put on again, and the pit drawing coals in little over half an hour after the accident occurred.

The scrutineers having completed their labours, the list of officers for the ensuing year was read over.

Mr. Bell then moved a vote of thanks to the retiring President for the manner in which he had discharged his duties during his three years term of office. Any one who had listened to the Report just read must feel that the vitality of the North of England Mining Institute was on the increase, for several subjects were alluded to in a very masterly way, indicating the attention which they severally had received when under discussion. In particular he would recommend to the notice of members one question referred to in the report, viz., the consumption of smoke, and he trusted that the recommendations of the Committee under whose care the question was placed would be followed in the collieries of the County of Durham. [President—Northumberland too.] For the earnest way in which many of the enquiries had been pursued he had no doubt they were indebted to the esprit de corps which had animated their President, upon whose exertions much of their success, no doubt, depended. Believing this to be the case, he had much pleasure in moving a vote of thanks to Mr. Forster for the able manner in which he had discharged the duty of President during the period of his office.

The motion was carried by acclamation.

Mr. Forster expressed his acknowledgments. He said he was obliged to the whole of the members for the great courtesy they had shown him during the time he had been in office. He had no doubt the Institute would go on and prosper—that, in fact, it would become one .of the most useful societies for mining purposes in the world.

The meeting then separated, and a considerable number of the members adjourned to the Turk's Head Hotel and dined together, as previously arranged; Mr. George Elliot, the newly elected President, occupying the chair.

[ERRATA IN APPENDIX No. 1.

D D

Page 50. For --------- read ---------

T2 161 T216tl

Page 61, last line. For 18.5 horse-power read 18.8 horse-power.

1,323 0 0 699 6 0

Page 64. For ------------------- read ---------------

£3,524 14 3 £2,901 0 3

Page 131. For drums read driving-wheel.]

[Appendix]

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[Illustration, Rowley Colliery - Terminus of Surface Chain Road]

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[Illustration, Rowley Colliery - Surface Endless Chain Road]

REPORT OF THE TAIL-ROPE COMMITTEE.

TO THE NORTH OF ENGLAND INSTITUTE OF MINING ENGINEERS.

Gentlemen,—The Committee appointed to report upon the various systems of the Underground Haulage of coals have now the pleasure of presenting their Report. The Tail-rope, the Endless-chain, and two forms of the Endless-rope system have each received the attention of your Committee. They regret that their endeavours to obtain permission to examine the Cinder Hill Endless-rope system are still unsuccessful.

Should any question arise in the discussions which requires the further attention of your Committee, they will be glad to resume their labours.

The expenditure to this date has not reached £75, which is the amount handed to the Committee by your Treasurer, on account of the grant of £100.

The Committee have again to refer to the valuable services rendered by their engineer, Mr. Emerson Bainbridge.

WILLIAM COCHRANE,

HON. SECRETARY.

INTRODUCTION.

In the following Report the four principal Systems of Underground Haulage have been considered in the following order, viz.:—

I.—TAIL-ROPE SYSTEM....................Chiefly in operation in the counties of Northumberland and Durham.

II.—ENDLESS-CHAIN SYSTEM ....Chiefly in operation at Burnley, Lancashire.

III.—ENDLESS-ROPE SYSTEM, No. 1...Chiefly in operation in Nottinghamshire.

IV.—ENDLESS-ROPE SYSTEM, No. 2...Chiefly in operation at Wigan, Lancashire.

The report on each system is commenced by a general description of the chief characteristics of the system, showing the usual methods of applying it.

The report on each engine-plane embraces the following particulars :—

1.—General remarks on the chief conditions of the plane.

2.—Dimensions and particulars of engine, boilers, ropes, tubs, etc.

3.—Description of plane, and method of applying the system.

4.—Abstract of experiments with the Indicator, the results of which show the power required to work each system.

5.—Experiments with Dynamometer, showing the actual tractive power required for a certain load.

6.—Details of first cost of engine, boilers, ropes, tubs, and all plant necessary to work a certain length of plane.

7.-—-First cost of one mile of wagonway.

8.—Cost per annum of leading coals, with a statement of the cost of leading per ton per mile.

The report is concluded by a general Summary, enumerating the relative advantages of each system of conveying coals underground, and describing the peculiar conditions under which each system may be most economically applied, to which is appended a tabular abstract of the report, exhibiting results of experiments, and analysis of the cost of leading, on each of the engine-planes experimented upon.

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COST OF LEADING.*

In the accounts of the cost of leading, which appear in the following Report, the original amounts, taken at the several collieries visited, have been altered in several items; in all cases where the same items have been charged at different prices, they have been reduced to a general standard; and where some have not been considered as belonging exclusively to the engine-plane, the cost on the engine-plane alone has been taken. The alterations made are as follows :—

Ropes.—Iron wire-ropes are charged at a uniform rate of 34s. per cwt.

Coals.—Nuts and inferior unscreened coals at 5s. 6d. per ton. Peas and single screened small at 3s. 6d. per ton.

Repairs to Engines.—These are charged at 5s. per annum per average horse-power exerted; this being found to approximate closely to the general cost of keeping engines in repair over a number of years. This item of cost is thus kept in constant relation to the power at which the engine works.

Repairs to Boilers.—These are fixed at the following amounts, taken from several accounts of the actual cost of repairing a number of boilers:—

£13 per annum for ordinary egg-ended boilers.

£17 do. Cornish or single tube do.

£20 do. double tube do.

Tubs.—The total amount of the cost of maintaining tubs throughout each of the pits was originally taken. It is estimated that two-thirds of this amount will be due to the wear and tear of the tubs upon the engine-plane alone, and this proportion has been taken for all the systems. The cost of maintaining tubs on the Endless-chain planes is much less than on the planes worked by the other systems; but, on the other hand, the proportion of the length of the engine-plane to the distance from the terminus of the plane to the face of the workings, is much greater with the Endless-chain than with the Tail-rope and Endless-rope systems. Had the workings at the Endless-chain collieries been as far from the terminus of the plane as at the collieries working the other systems,

* In considering the comparative economy of the different systems of underground haulage investigated, interest on capital, and the first cost of preparing a wagonway for an engine-plane, are not taken into account.

one-half, probably, of the total cost might fairly have been taken for the proportion of cost due to the plane alone.

As the damage done to the tubs, with the Lancashire Endless-rope system, is much more than with the Endless-chain, and as the face is nearly the same distance from the engine-plane as with the Tail-rope, the same proportion of two-thirds has been observed in making out the cost of leading by this system.

Grease.—No alteration has been made in the various prices of grease at the different collieries, since a greater quantity of an inferior quality will probably be used, and vice versa.

In order to arrive at the cost of grease per annum on each engine-plane, two-thirds of the total amount for grease used in the pit is taken for the Endless-chain, and one-half for all the other systems.

TAIL-ROPE SYSTEM.

NORTH HETTON COLLIERY, COUNTY OF DURHAM.

Manager, L. Wood, Esq.; Resident Viewer, Mr. George May.

In order to give a general idea of the extent to which the Tail-rope system can be applied in leading coals underground along an engine-plane with numerous curves and branches, the following description is given of the arrangement of wagonway, and the method of working the Tail-rope, at North Hetton Colliery, which affords one of the best examples of the many applications of this system in the district.

No experiments were made on the plane at this colliery, as it was thought that the experiments made upon other Tail-rope planes were sufficient to show the power required for working the system.

It will be seen by reference to Plate I. that there are two main wagon-roads in this pit, lying at right angles to each other—No. 1 plane being driven east, and No. 2 north. The following are some of the particulars of the engine and wagonway :—

Engine.		Engine-plane.		
No. of Cylinders......	2	Rails.................... 22 lbs. per yd.		
Diameter of Cylinder	12 in.	Gauge of Way......... 2 ft. 4 in.		
			Main.	Tail.
Length of Stroke ...	24 in.	Rollers.—Diameter	5 in.	8 1/2 in.
No. of Drums.........	4	Weight...	26 lbs.	32 lbs.
Diameter of Drums...	4 ft.	Distance apart......	21ft.	21ft.
Size of Rope (circum.)	2 1/2 in.	Sheaves at Curves diam.	10 1/2 in.	
The Boilers are on the Surface		Tail-sheaves.........	4 ft.	

When the ratio of the pinion to the spur-wheel was as 1 to 2, the engine was found rather too weak for its work, and the proportion was

[8]

therefore, made as 1 to 3. It now goes at a speed varying from 150 to 250 strokes per minute, the usual speed being about 180 strokes per minute. This makes the power exerted to be about 100 H.P., and thus presents the rare example of a Tail-rope engine working, to the utmost of its power.

One end of the shaft of each set of drums is placed on a moveable carriage, by means of which they are put into gear with the driving pinion. The drums are connected to the shaft by means of clutch gear. The engine and drums are placed beneath the wagonway, and the wheels W and W1 which direct the coarse of the ropes for No. 2 plane, as well as several other four feet wheels upon these planes, are also placed under the way. The ropes for the No. 2 plane come to the surface of the wagonway about the point P.

Description of Plane.

[table]

It will be seen from the above that none of the branches are of very great length, and that all the ways rise towards the shaft.

[table]

No. 1 plane consists of a main road, with two branches on each side; at the end of the main road is another way, which, after going in a crosscut direction for a short distance, turns to the north. These five branches are all worked by two of the drums, the other two drums working No. 2 plane and its branches. On the plan (which is drawn to no scale, and is, therefore, in many places out of proportion, owing to the difficulty in showing clearly the arrangement of rails) the ropes are

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shown by dotted lines. In the second west way and the cross-cut way there are two stations; a description of the arrangement of which is given hereafter. The four curves leading from the main way to the branches each have a radius of about 22 yards; the radius of the curve in the first south way is four chains, and of that in the cross-cut way about five chains.

No. 2 plane has one main road and three branches, two to the west and the other in a cross-cut direction. The curves to the branches are about three chains radius, and the curve upon the main road about four chains.

At the far end of each of the branches there is a siding, one way for the full and the other for the empty tubs.

At the inbye end of the first west way there are three putting stations, from which the tubs are led in short sets by ponies to the siding at the end of the engine-plane.

The full way of the shaft siding is raised several feet to form a "kep," or incline; and when the set of full tubs has been drawn on to the top of the "kep," the tubs are let down to the shaft as they are required.

Arrangement of Ropes.—In the working of this and all other Tail-rope planes, two ropes are necessary, which are called Main and Tail-ropes, the former being used for drawing the set of full tubs outbye, and the latter for taking the empty set inbye. When the main rope is bringing the full set outbye, the tail-rope drum runs loosely upon the shaft, and, by applying the brake, the tail-rope is made to run steadily off the drum; when the tail-rope is taking the empty set inbye, the main rope drum is put out of gear, and the main rope is drawn inbye behind the set. It will be seen on the plan of this engine-plane that the ropes for No. 1 plane have a direct lead from the drums, whilst those from the No. 2 plane are taken round pulleys at a right angle not far from the engine.

On No. 1 plane, the ropes connected to the engine are those of the cross-cut way, and the set is supposed to have just arrived at the shaft; thus the main-rope is nearly all wound upon the drum. At the points A and B there are shackle joints on both the main and tail-ropes. The shackle used is of this description, and is secured by the pin A.

[illustration]

When the rope ends to which the set is attached are at the shaft, these joints are always at the points A and B, no matter from which way the last set came.

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Most of the sheaves used in taking the ropes round the curves are fixed horizontally in walling built for the purpose, thus:—

[illustration]

At C and C both the ropes are taken round the curves by small sheaves, as shown in sketch; but at most of the curves only one rope goes round the curve, the tail-rope passing round a four-feet sheave; this arrangement is much to be preferred.

Both main and tail-ropes are 2 1/2 inches in circumference. The large sheaves at the curves, and the tail-sheaves at the inbye end of each of the branches, are 4 feet in diameter; these wheels are placed under the way, and the rails are laid over them. Where the ropes are shown to cross the wagonway on the plan they are arranged to pass under the road.

The total length of main rope on the plane is 2,520 yards, and of tail-rope 9,636 yards; and there are altogether 1,390 small sheaves, and 14 four-feet sheaves upon the planes.

Method of Working the Planes.—No. 1 Plane.—On referring to the plan, it will be seen that the ropes connected to the engine are those of the cross-cut way, and that the ends of all the other branch ropes are lying at the branch ends. Supposing that the next empty set has to go into the second south way; whilst the rope ends at the shaft are being disconnected from the full set and attached to the empty set, the boy attending the switches at B is disconnecting the shackles SS and connecting them to TT; this is done in about two minutes, and is generally finished before the set at the shaft is ready to come away; the boy then opens the switches for the second south way, and everything is ready for the set going in. The set of empty tubs is taken into the branch, and the fall set returns to the shaft before the ropes are altered again. Should the first north way next be ready the

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ends EE are replaced by FF, the switches are put right, and the empty set goes in and the fall set comes out. If the cross-cut way be next ready, it will be seen that, to put the ropes right for this way, four rope ends will have to be connected, two at the station A and two at B.

No. 2 Plane.—It will be seen on the plan that the ropes connected to the engine are those of the third west way, and here also the set is supposed to be at the shaft. All the branches on the plane No. 1 are to the dip; on the contrary, all the branches from the main road on No. 2 plane are to the rise from the shaft.

The branch ropes on the No. 2 plane are connected in the same way as on No. 1 plane, and here also it is necessary to connect four rope ends when the third west way has to be worked, if the second and then the first west way have been worked before it.

In the first west way on No. 2 plane there is an adaptation of the tail-rope which is worthy of notice. The gradient of this way is found heavy enough to cause the outcoming full tubs to pull the tail-rope after them : in taking the empty set inbye, the main-rope is knocked off at the point R, and the set is pulled in by the tail-rope; the full set is afterwards let down the incline by the single tail-rope to R, at which point the main-rope, which is necessary to pull the set on to the

" kep," is attached. The drum man sometimes brings the set out of this way by the brake whilst the engine is working another way. The gradient on the second west way is not heavy enough to allow this method to be adopted.

On the No. 1 plane there are two stations by the side of the main way, to which sets are taken several times during the day. One of these stations is in the cross-cut way and the other is in the second south way. When a set is intended for the station in the latter way, it is taken to LL, and there the ropes are knocked off; the full set stands at MM, and in order to get the ropes to this point, a piece of rope, the length of the set, is attached to the two ends, which are then pulled by the engine opposite to the ends of the full set. Thus, eight connections and disconnections are necessary for each set led from this station.

[illustration]

The arrangement of the station on the cross-cut way, which was made some time after the station just described, is much better. Here

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the way from X to Z is made to dip gently inbye, and when the empty set is brought inbye both rope ends are knocked off at XX, and the set runs forward by itself to ZZ; the ropes are then connected to the full set standing at YY.

The ropes are connected to the set by means of the link shown below. The fastening is secured by a cotter, C.

[illustration]

Duration of Ropes.—It is not known how long the ropes last, as a rope is first a main and then a tail-rope, and is afterwards used as a tail-rope on a lighter plane. The general duration of the rope is supposed to be from two to three years.

Labour.—This item is rather heavy, owing to the numerous branches on the planes. The amount for wages is 41s. 2d. per day. (See reference to cost of labour at North Hetton Colliery in " Summary of Report.")

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LONDONDERRY SEAHAM COLLIERY, NEAR SUNDERLAND,

COUNTY OF DURHAM.

John Daglish, Esq., Manager ; Mr. W. Dakers, Resident Viewer.

The engine-plane at Seaham Colliery is 2,904 yards long, the average gradient being a rise towards the shaft of 1 in 64. There are two stations by the side of the main-way from which coals are led.

The engine (Plate II.) is horizontal, and has two cylinders. The drums are 6 feet in diameter; they are at right angles to the wagonway, and the ropes are taken round the turn by 4-feet sheaves. Besides the drums used for the main engine-plane, there are two others, one of which hauls the tubs from the workings in the Low-main seam to the shaft, and the other is used for taking the full set down from the bankhead to the shaft. Each pair of drums is connected with the engine by a moveable carriage, the single drums being put in and out of gear, as required, by a clutch.

There are two boilers underground, at some distance from the engine.

DIMENSIONS OF ENGINE, BOILERS, ROPES, ETC.

Engine erected, 1856.

[table]

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[table]

[15]

DESCRIPTION OF PLANE.

The bridge rails on the engine-plane are laid on battens. There are two short curves on the plane, one of which is seven chains radius. The gradient is a general dip inbye, the heaviest gradient being 1 in 23.

At each station there are two sidings, with a main-way between; the tubs are taken into the branch-ways over the main-way by moveable rails.

The sheaves for the main and tail-rope are placed 24 feet apart; the tail sheaves are all set between upright battens, about 3 feet from the ground.

DESCRIPTION OF METHOD OF WORKING PLANE.

The full set, generally consisting of 65 tubs, is drawn outbye from the station to which the empty set was last taken, by the main-rope, the tail-rope being attached to the other end of the set; when it has reached the " kep" at the bankhead, these ropes are knocked off, and the set is run down an incline a distance of 450 yards to the shaft by a separate rope, which draws the empty set up to the bankhead; the tail-rope drum is then put into gear, and the empty set is drawn inbye by the tail-rope.

The rope is attached to the fore end of the set by an ordinary hook, but at the other end, the application shown below is used when the set is coming outbye, to prevent the set running amain should the

[diagram]

main rope happen to break. The iron " cow" AB is secured to the bar at B by a pin CD, which hangs over the top of the tub; the short chain on the arm of the " cow " is hooked on to the main chain at E; when this chain is tightened, the pressure upon the short chain raises the " cow " and prevents it from striking the rollers. If the main

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rope should break, the chain attached to the tail-rope slackens, and the " cow " falls and keeps the set from running back.

EXPERIMENTS WITH INDICATOR.

The two Indicators (by Richards) used for ascertaining the horsepower exerted by the engine, together with some Bourdon's pressure gauges, were carefully tested before being used.

Before commencing the experiments, the indicators were applied at two different times to the four ends of the cylinders, and the experiments following were made at the cylinder end at which the average pressure of steam was nearest to the average of the indications of the four ends.

The accompanying plan (Plate III.) of the Seaham engine-plane embodies the Indicator experiments tabulated below. A vertical line is drawn through the section of the engine-plane at each of the points at which Indicator experiments were made. Each end of this line forms an atmospheric line for the diagram taken when the set was at this point on the plane. The diagrams taken when the empty set was going inbye are shown on the upper side, and those taken when the full set was - coming out, on the lower side of the plane. Above and below the section will be seen, at different points on each of the vertical lines, the Time, Speed of tubs in miles per hour, Horse-power exerted, and Effective pressure in the cylinder in lbs. for each experiment; the two latter are drawn to a scale shown on the left side of the plan. Diagrams taken when the engine was going alone, and when the ropes, coupled together, were worked by themselves, are also shown.

The same arrangement of plan is carried out for each of the tail-rope planes experimented upon.

ABSTRACT OF EXPERIMENTS WITH INDICATOR. Nov. 27th and 28th, 1866.

[table]

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ABSTRACT OF EXPERIMENTS WITH INDICATOR—Continued.

[table]

DEDUCTIONS FROM EXPERIMENTS WITH INDICATOR.

I.—Power required to drive Engine Alone (E) :—

At 48 strokes per minute			......	11.1	horse-power.
60	do.	do.	......	13.3	do.
84	do.	do.	......	20.2	do.

II.—Power required to drive Ropes Alone:—

Socket going inbye (C) :—

Engine and Ropes.	Engine alone.*	Horse-power.

48 strokes per minute......	41.7	—	11.1	=	30.6
60 do. do.......	56.0	-	13.3	=	42.7
84 do. do.......	85.3	-	20.2	=	65.1

* No allowance is made for the power required to overcome the " friction of the extra load upon the engine," which is really power expended in moving the load, since, were such load not upon the engine, such power would not need to be exerted. To arrive at the actual power exerted in moving any load, the power required to move the empty engine is deducted from the total indicated power.

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Socket coming outbye (D) :—

	Engine and Ropes.		Engine alone.		Horse-power.
48 strokes per minute......	42.6	—	11.1	=	31.5
60 do. do.......	53.8	-	13.3	=	40-5
84 do. do.	80.7	-	20.2	=	60.5

III.—Power required to take Empty set of 60 tubs inbye, down an average gradient of 1 in 64, at an average speed of 78 strokes per minute, or 12 miles per hour(A) :—

Engine, Ropes, and Set.		Engine and Ropes.		Horse-power.
71.3	-	78.0	=	6.7

Less than power required for ropes alone, owing to the assistance given ob force of gravity.

IV.—Power required to bring a set of 60 full tubs outbye, up an average gradient of 1 in 64, at an average speed of 52 strokes per minute, or 5.6 miles per hour (B) :—

Engine, Ropes, and Set.		Engine and Ropes.		Horse-power	
86-1	-	46.3	=	39.8	For full set alone.

HORSE-POWER EXPENDED UPON THE SET, ROPES, AND ENGINE.

Coming outbye with 60 full tubs up an

average gradient of 1 in 64, at an average

speed of 52 strokes per minute.

	H.P.	
SET	39.8 ...	46 per cent.
ROPES	34.5 ...	40 do.
ENGINE ...	11.8 ...	14 do.
	------	---
	86-1	100

EXPEEIMENTS WITH DYNAMOMETER.*

Before any experiments were made with the dynamometer, it was tested by placing it in a hanging position, and attaching various weights to it. The readings were found to agree with the weights applied.

The experiments with this instrument shew the traction (in cwts.) required to overcome the resistance of the load upon the engine-plane, the readings being taken at the particular points indicated.

In the experiments at Seaham Colliery the dynamometer was applied as shown in the accompanying sketch.

The plank A is prolonged on one side to act as a buffer, to prevent too much slackening of the instrument.

B is an iron crook fixed to an empty tub and made to fit the underside of the dynamometer to support it when slack. After a few trials it was

* The dynamometer experiments are, in the opinion of the Committee, unsatisfactory ; and the comparisons which have been attempted to reconcile the results have not yet afforded sufficient data for the Committee to draw any reliable conclusions. The Committee, therefore, feeling that this subject requires considerably more attention, hope that some member of the Institute will take it up where they have left it. The Committee record the observations only, and the mode in which, they were taken.

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found practicable to work without the crook—the strain keeping the instrument in its proper position.

[DIAGRAMS]

The observer, lying on the tram, watched the needle continually, and noted down the readings at the points at which indicator diagrams were taken.

In the following abstract, the experiments A, B, C, D, and E were simply trials to find to what extent the instrument could be safely applied.

ABSTRACT OF DYNAMOMETER EXPERIMENTS.

[TABLE]

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ABSTRACT OF DYNAMOMETER EXPERIMENTS.—Continued.

[table]

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RESULTS OF EXPERIMENTS WITH DYNAMOMETER.

I,—Strain required to pull the main-rope inbye, the ropes being couple together, and the brake lever being propped

up :—

		Cwts.
At 20 strokes per minute	....	4
51 do. do.	....	4

2.—Strain required to pull out tail-rope, brake lever propped up :—

At 20 strokes per minute	....	16
51 do. do.	....	16

3.—Strain required to pull out 60 full tubs and tail-rope :—

		Tons. Cwts.	T. C.
To start the set alone	....	2	0
Extra to start tail-rope	....	0	15
At heaviest part of plane (1 in 23)		3	7 (once 3 10.)
At bankhead (1 in 54)	....	2	15

TOTAL FIRST COST OF WAGONWAY PLANT.*

		£	s.	d.
Engine	....	550	0	0

Drums	60 0 0
Boilers	223 0 0
Steam and exhaust pipes............	413 0 0
Receiver	16 0 0
Ropes, at 34s. per cwt.............	335 0 0
Sheaves, main, at 3s., complete.........	51 0 0
Do. tail, at 2s. 4d. do..........	40 0 0
Do. extra	5 14 0
Do. 8 feet	17 16 0
Wagonway (including rails, battens, sleepers,spikes, supports for tail sheaves, &c.) ...	977 8 3
Donkey feed pump	5 0 0
260 tubs, at 63s. per tub............	819 0 0
Coupling chains...............	32 10 0

	£3545 8 3

COST PER MILE OF WAGONWAY.

Rails, 3520 yards, at 18 lbs. per yard = 565-70 cwts., at 6s. 6d......................	£183 17 0
Sleepers, 1760 yards, at 6d.	44 0 0
Batten Planks, 10,560 feet, at 2d..........	88 0 0
Plate Nails, 7 cwts., at 20s.............	7 0 0
Spikes, 6 cwts., at 10s. 6d................	3 3 0
Signal Wire, 5-5 cwts., at 35s.............	9 12 6
Supports for Signal Wire	0 8 0

Levers, &c., for Rapping............. 1 4 0

Labour, 1760 yards, at 4 1/2d. 33 0 0

Rollers, Main, 24 feet apart, 220, complete, at 3s. ... 33 0 0

Tail, do. do. do., at 2s. 4d. 25 13 4

Carried forward ... ------------- 428 17 10

* The amount for engine, boilers, etc., in this and all other accounts of the first cost of wagonway plant, is exclusive of the cost of excavations and masonry.

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Brought forward ... £428 17 10

Rope. Main, 1760 yards, 2 3/4 inch at 5-8 lbs. per fathom

= 45.4 cwts., at 34s.......... £.77 3 7

Tail, 3520 yards, 2 1/2 inch, at 5.2 lbs. per fathom

= 78.0 cwts., at 34s.......... 132 12 0

----

209 15 7

Total cost per mile £638 13 5

COST OF LEADING COALS.

MAINTAINING ENGINE) F0R THREE YEARS-

PLANE)

	£	s.	d.
Ropes	798	0	0
Sheaves.................	91	0	0
Tubs	293	7	0
Rails and maintaining way.........	78	0	0
Chains................	9	0	0
Grease.................	547	0	0
Coals (5040 tons, at 5s. 6d.)*........	1386	0	0
Repairs to engines and boiler....	137	0	6

£3339 7 6

Labour ...... Per day of 12 hours—

	£ s. d.
1 engineman	0 4 0
1 fireman	0 4 0
1 drum boy	0 1 6
1 wagonway man	0 4 0
1 greaser (for sheaves)...........	0 2 0
1 run-rider	0 3 0
5 station boys............	0 7 6
1 rapper boy	0 1 3

	£1 7 3

	Days. Years. Days,	£ s. d.
Labour ...	280 x 3 = 840 at 27s. 3d. =	1144 10 0
Maintenance for 3 years (as above) ...		3339 7 6

Total cost for 3 years		£4483 17 6 [divided by]3 =£1494 12s. 6d., cost of leading per annum.

Cost of leading coals per ton per mile up an average gradient of 1 in 64, an average distance of 1.261 miles, the average quantity led leing 522 tons per day, 1.948d

* This high charge for coals is owing to the use of nut coals, the boilers at present being insufficient for the work required to be done. Another boiler is now in course of erection.

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SEATON DELAVAL COLLIERY.

NEAR NEWCASTLE-UPON-TYNE.

T. E. Forster, Esq., Manager; Mr. T. Sanderson, Resident Viewer.

The engine plane at Seaton Delaval Colliery is 2059 yards in length, and is nearly level, having an average gradient of 1 in 643, dipping outbye. All the coals are led from the inbye end of the plane, there being no intermediate stations.

The engine (Plan No. 4), by which the plane is worked, is a single cylinder horizontal engine, and the main and tail drums are on different shafts; the pinion and spur wheels are of the same size, and thus the drum makes one revolution for each stroke of the engine. The diameter of the cylinder is 28 inches, the length of the stroke 6 feet, and the diameter of the drums 6 feet, the main rope drum being covered with a coating of hemp-rope, making it 6 feet 2 inches. The ropes have a direct lead from the drums to the commencement of the plane, the distance from the engine to the point from which the set starts being 231 yards. The engine, during the day, hauls the coal and pumps water into the boilers, and at night pumps into the boilers. There are four boilers, close to the engine, only three of which are in use at the same time.

This plane has been worked by engine power rather more than twenty years, and some years ago, a much greater quantity of coal was led over it than at present. About 480 tons per day are now led, whilst formerly as many as 1300 tons have been led in one day—the average quantity being then 1100 tons per day.

The main-rope originally was 3 1/2 inches, and the tail-rope 3 inches in circumference; the ropes are generally replaced by pieces, and as they are not particular about always using the 3 1/2 inch rope for main-rope, the quantity of this rope is constantly varying, at present there is only 1400 yards of it upon this plane.

DIMENSIONS OF ENGINE, BOILERS, ROPES, ETC.

Engine erected, 1845.

	Ft.	In.
Diameter of cylinder	2	4
Length of stroke	6	0
Diameter of piston-rod (passes through cylinder)......	0	5 5/8
Length of connecting-rod	11	1

	In.	In.
Dimensions of steam ports	2 1/8 x l2	
Do. exhaust do...............	3 1/4 x l2	

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[table]

[25]

[diagram, table]

DESCRIPTION OF PLANE.

The plane is laid with broad topped rails, in 15 feet lengths, weighing 20 lbs. per yard. The way is laid on chairs 3 feet apart, and the gauge of the way is 2 feet 4 inches. There are three slight curves on the plane, all turning in the same direction ; the radius of No. 1 curve is ten chains, No. 2 ten chains, and No. 3 twelve chains. Nos. 1 and 2 curves are close together. The ropes are carried round the curves by bell sheaves 10 inches in diameter. The usual distance of the rollers apart is 24 feet, but this is not always observed; there are three descriptions of rollers used, the 6-inch rollers being most common both for the main and tail-rope.

The ropes run off and on to the drums on the upper side, and are carried near the roof to the station. The tail-wheel inbye is also placed near the roof, and the ropes are raised to it by sheaves.

DESCRIPTION OF THE METHOD OF WORKING THE PLANE.

This plane is worked in very much the same way as the majority of tail-rope planes in this district, but instead of having the usual "kep" for the full tubs to run down upon to the shaft, the way is laid level, and the coals are led from the station to the shaft by horses. On the end of both main and tail-ropes there are fixed about 15 yards of chain, with two or three large links inserted at various distances apart, and one of these links is attached by an iron pin to the loop of the centre bar of each end tub of the set, according to the position of the set at the station. In taking the empty set of tubs inbye, the tail-rope is first connected to the set, and then the main-rope, and the set is drawn inbye by the tail-rope

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drum—the main-rope drum being out of gear, with just a slight weight hung upon the brake-lever, to prevent the drum from over-running the rope. When the set reaches the inbye station it is allowed to stop before knocking off the ropes. The full set is brought out in a similar way by the main-rope drum, the tail-drum running loose on the shaft, with a light weight on the brake-lever.

ABSTRACT OF EXPERIMENTS WITH INDICATOR.* APRIL 17, 1867.

[table]

* No experiments were made with the Dynamometer at Seaton Delaval and Harraton Collieries, as the instrument was out of repair when the other experiments were being conducted.

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ABSTRACT OF EXPERIMENTS WITH INDICATOR—Continued.

[tables]

[28]

It appears from the above results that on an average more power is required when the main-rope is pulling the tail-rope round the return sheave, than when the tail-rope is pulling the main-rope inbye.

[tables]

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[tables]

[30]

[tables]

METHOD OF TAKING OUT ANNUAL COST OF MAINTAINING ENGINE-PLANE.

Ropes.—The amount for this consists:—1. Of the labour expended in three years in keeping the ropes in order. 2. Of the new ropes laid on to this plane in three years, these being necessary to keep the ropes in good working condition; from this is deducted the value of the abandoned ropes.

Sheaves, Rails, and Rapper Wire.—Estimated to last a number of years, and allowance made for the amount they would be worth as old iron, at the end of that time, a deduction being made for loss of weight.

Sleepers and Timber for Sheaves.—Estimated to last a certain number of years, and the first cost divided by this number, to get the annual cost.

Chairs and Spikes.—A certain number estimated to be used annually.

Tubs.—1. Actual amount for labour expended in repairing tubs. 2. Amount for material used in repairing tubs, calculated from actual data. 3. Cost of new tubs built per annum to keep stock in workable condition. The amount is then reduced according to estimate detailed on page 5.

Coals for Engine.—Actual consumption taken, allowance being made for night pumping.

Oil and Tallow for Engine.—Actual consumption taken.

Crease for Tubs and Eollers.—Actual consumption taken.

Eepairs to Engine and Boilers.—Cost taken according to general standard (see page 5).

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COST OF LEADING COALS.

[table]

Cost of leading coals per ton per mile down an average gradient of 1 in 643, the average distance led being 1.170 miles, and the average quantity led being 389 tons per day;-1.882d.

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HARRATON COLLIERY, NEAR DURHAM.

T. Robson, Esq., Manager.

In the application of the Tail-rope System at this Colliery two branches are worked, and the average gradient is in favour of the Full Tubs.

The engine-plane (Plate VI.) is 1795 yards long to the north way terminus, and 1729 yards to the west way terminus. The average gradient from the north way flat to the shaft is a dip outbye of 1 in 83.

At present about 650 tons per day are led along this plane, nearly equal quantities being led from each of the branches.

The hauling-engine (Plate VI.) is vertical, and has two 20-inch cylinders. The drums are 5 feet 2 inches diameter, and the ratio of the pinion to the spur wheels is as 3 to 4, thus causing the drums to make one-third more revolutions than the engine.

The three boilers by which steam is supplied are on the surface, and connected with the other boilers employed on the surface. Juckes' Patent Furnaces are used for firing. The engine works both day and night, but at present is doing very little work at night. The engine-plane has been at work only five years, and the engine, rails, tubs, etc., are in very good condition.

The lead from the engine to the terminus of the plane near the shaft is not direct, the ropes being taken by large sheaves round a right angle 27 yards from the engine.

DIMENSIONS OF ENGINE. BOILERS, ROPES, ETC.

Engine erected, 1861.

[table]

[33]

[table]

[34]

[tables and diagrams]

DESCRIPTION OF ENGINE-PLANE.

The plane is laid with heavy-topped chair rails, weighing 22 lbs. per yard. There are two curves on this plane, both 26 yards radius; No. 1 curve being 66 yards long, and No. 2, 80 yards. The main-rope is taken round the curves by sheaves, 4 feet in diameter, with several 2 feet sheaves, placed close enough together to form an almost regular curve for the rope. The tail-rope is taken round a 6-feet wheel, at No. 1 curve, and a wheel of 8 feet diameter at No. 2 curve.

The return wheels are 8 feet diameter, and are placed diagonally.

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The main rollers are 8 inches diameter, and the tail-rope rollers 13 1/2 inches diameter. The large pulleys used on this plane have wrought iron rods for spokes.

At No. 2 curve the inner rail is laid about 3 inches higher than the other. Though the set passes round this curve at the rate of 10 miles per hour, no accident has ever occurred.

DESCRIPTION OF THE METHOD OF WORKING THE PLANE.

There are sixty-three tubs in a set. In going inbye the set is attached to the rope by two knock-off links, and is taken to the junction A (Plate VI.). As the set is taken nearly alternately into each of the branches, the arrangement of ropes is altered at this junction, as the ropes of the way last visited are then on the set. Suppose the set has been last in the west way, in going inbye again, when it has arrived at this junction, the tail-rope at the inbye end of the set is removed, and replaced by the north way rope ; the shackle connecting the main tail-rope with the west way branch rope being held by a wooden clamp, fixed at the junction, while the end of the north way rope is being attached to it. This shackle-joint is stopped always at the same place; and as the branch rope end is brought to this point whilst the set is coming inbye, they are connected immediately. As this connection is made by the man attending the junction, while the connection at the end of the set is being made by the run-rider, the time taken up by the change is very short— generallv not more than two minutes.

[sketch]

The above sketch shows the position of the ropes just when the tail-rope has brought the shackle-joint near to the clamp, which is then screwed up. As before described, the west way rope is then taken off, and the

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north way rope connected. When the end of the north way rope is not

[diagram]

just opposite to this point, it is drawn up by a winch, fixed here for the purpose. In coming outbye, the set (from either way) comes out to the shaft without stopping. At the fore end of the set is fixed the self-acting knock-off link shown in the sketch. When the set arrives at the top of the "kip," and most of the tubs are over the brow, a piece of iron, fixed to the roof, comes in contact with the arm A, of the knock-off apparatus, and releases the main-rope, which falls off to one side. The engine is then stopped, and the set is let down by the tail-rope, which is still attached, till the first tub (if there are no full tubs standing) reaches the shaft. Whilst going down, "spraggs" are put into the tub wheels, by means of which the tubs are afterwards let down to the shaft as required.

[sketch]

The above sketch represents the knock-off link used at the other end of the set. When the rope has to be disconnected, the cotter, at C, is removed, and the link, L, is pushed off by the foot.

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ABSTRACT OF EXPERIMENTS WITH INDICATOR. APRIL 17, 1867.

[tables]

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[tables]

[39]

COST PER MILE OF WAGONWAY.

[table]

METHOD OF TAKING OUT THE ANNUAL COST OF MAINTAINING

ENGINE-PLANE.

Ropes.—This plane has been such a short time in operation that it is impossible to tell, from the colliery accounts, the actual cost of maintaining ropes. In estimating the annual cost, the value of the ropes after having been two and a half years in use (this time being about the average duration) is deducted from the first cost.

Sheaves, Rails, Chairs, and Rapper Wire.—These are estimated to endure a certain number of years, and an allowance is made for their value at the end of that time.

Tubs.—Labour.—Actual labour for one year taken.

Materials.—The actual cost of wheels, cods, and plates in one year is taken. As the tubs are comparatively new, the quantity of material used is small, and no new tubs have been required since the coals were led over the present length of plane. The amount is then reduced according to estimate detailed in page 5.

Timber for Sheaves and Sleepers.—Estimated to last a number of years, and to be worthless at the end of that time.

[40]

Grease, Oil, and Coal.—Taken at actual consumption.

Repairs to Engine and Boilers.—Cost taken according to general standard. (See page 5.)

COST OP LEADING COALS.

[table]

Cost of leading coals per ton per mile, down an average gradient of 1 in 83, the average distance led being 1.002 miles, and the average quantity led being 586 tons per day:- l.515d.

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MURTON COLLIERY, COUNTY OF DURHAM.

R. F. Matthews, Esq., Manager; Mr. James Dove, Resident Viewer.

The engine-plane at this colliery has been at work since 1853, but up to about four years ago was not more than 2000 yards in length. The quantity led over it daily is now much less than formerly, as many as 520 tons having been led over it in one day. The quantity led now is about 430 tons per day, nearly equal quantities coming from each way.

There are no branches worked by the tail-rope at this colliery; but there is a station (Hallfield station) by the side of the main-way (Plate VIII.), from which part of the coals are led.

The length of plane the coals are led over from the south-east or far-off landing is 2770 yards, and 1978 yards from the Hallfield station, the distance from the engine to the tail-wheel being 2816 yards.

The hauling-engine is a double 18-inch cylinder horizontal engine with 2-feet stroke. The main and tail-drums are 5 feet in diameter, and on the second motion, the revolutions of the pinion-wheel to the spur driving the main drum, being as 2.387 to 1, and as 1.581 to 1 to the spur-wheel driving the tail-drum. The drums are put in and out of gear by shifting carriages.

There are five boilers at a distance of 300 yards from this engine, which also supply another hauling engine.

DIMENSIONS OF ENGINE, BOILERS, ROPES, ETC.

[table]

[42]

[tables]

[43]

DIMENSIONS OF TUBS.

[tables, diagrams]

DESCRIPTION OF ENGINE-PLANE.

The plane is laid with chair rails, in 12 feet lengths, weighing 24 lbs. per yard; the gauge of the way is 2 feet 8 inches. The tub used has wheels 14 inches in diameter, and carries about 10 cwts. of coals.

There are two curves on the plane. No. 1 curve has a radius of 154 yards, and No. 2 a radius of 42 yards. The average gradient of the plane is 1 in 83 rise outbye, and the heaviest gradient is 1 in 25; part of the plane is level, but no part of it dips towards the shaft. The rollers and sheaves used for carrying the rope, are, for the most part, 6 inches in diameter. The main-rope is taken round No. 2 curve by drum sheaves, 2 feet in diameter, and the tail-rope by ordinary 2 feet sheaves.

At the Hallfield landing there is a pair of switches leading on to a double line of rails, for full and empty tubs.

The lead for the ropes from the drums to the engine-plane is direct.

[44]

The main-rope is 2 3/4 inches in circumference when new, and the tail-rope 2 1/2 inches.

Near to the Hallfield landing there is a three-cranked single-action force-pump, worked by the tail-rope by means of three friction wheels placed thus:—

[diagram]

A similar pump is worked by the tail-wheel. It is difficult to arrive at the share the pumps have in the wear and tear of the ropes, but it is estimated in the account of cost of maintenance, at one-third of the whole cost; that is, were the pumps and the wheels necessary to drive them are done away with, the tail-rope, instead of lasting six months as at present, might be worked for nine months.

DESCRIPTION OF METHOD OF WORKING THE PLANE.

There are forty-eight tubs in a set of full or empty tubs. No run rider is employed. The main-rope is attached to the set by fastening the shackle, which is on the end of the chain, to the coupling chain of the end tub, with a pin which is secured by a spring cotter; and the tail-rope is attached by placing the end link of the chain in the centre bar, securing it by the pin which is a fixture on the end of the tub.

[diagram]

In going inbye, when the ropes are attached to the set, the station boy raps to the brakesman, and the set is started. The set is always stopped at the Hallfield landing, till a rap is given from there telling the brakesman into which way he has to go; if for the Hallfield way, the switches are opened and the set passes on to the empty siding. "When the ropes are disconnected the set runs a short distance along the siding, in order to allow the ropes to be attached to the full set. When the set goes into the south-east way no rap is given on the set reaching the flat,

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as the brakesman knows from the position of the rope upon the drum when to stop the engine. The full set is generally standing as nearly as possible opposite to the point to which the empty set runs. Should the set, however, here, or at either of the other stations, not be conveniently situated for the ropes, a lengthening chain (several of which are kept in readiness) is put on, and it is thus very seldom necessary to move the ropes.

In coming outbye, when the set arrives at the bank-head, the station boy raps to the engineman (by a rapper distinct from the main rapper), and the full set is stopped opposite the empty set, part of all of which is generally standing ready to go inbye. When the set stops, the pin fastening the main-rope to the set is usually very tight, and has to be drawn out by a lever, kept for the purpose. This method of attaching is not so convenient as the slip-link fastening, by which the rope can be easily disconnected by the foot.

From the bank-head the coals are taken about half-way to the shaft by a tail-rope ; the tail-rope is then knocked off, and the set runs to the shaft dragging the main-rope after it. The main-rope afterwards draws the empty set up. The cog-wheel for driving the small drums required for this work is under the pinion wheel of the engine, and can be put in and out of gear whilst the engine is working the main engine-plane, by reducing the speed of the engine for a short time.

EXPERIMENTS WITH INDICATOR.

In taking the empty set inbye, and bringing the full set outbye, three diagrams were taken each way, the gradient at each of the three points being different.

In the experiment, "Ropes Alone," the ropes were taken in and outbye with four empty tubs, and the dynamometer was fixed with two of the tubs on each side. Both in going in and coming out a diagram was taken, and the dynamometer was observed, at the same points at which the experiments with the entire sets wrere made.

To find the power absorbed in working the two pumps, they were disconnected from the driving wheels, the rope continuing to traverse the friction sheaves. The engine was indicated at point No. 1 on the plane, and the indication was compared with that taken at the same point and same speed when the pumps were working.

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[table]

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DEDUCTIONS FROM EXPERIMENTS WITH INDICATOR.

[tables]

The result is perhaps owing to the fact, that, when the pumps are working, the load upon the friction sheaves causes them to have an action similar to the application of the brake upon the drum in keeping the tail-rope tight, but when they are out of gear, as was the case in experiment D in coming outbye, the brake has to be more heavily applied to the tail-drums, and it appears to have been put on to such an extent as to make the power required for the ropes alone to be more when the pumps are working than when they are out of gear.

* These are taken at the approximate speed, as the power does not appear to be in proportion to the speed.

** 47 strokes reduced to 49 strokes per minute.

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[tables]

[49]

EXPERIMENTS WITH DYNAMOMETER. JUNE 21st, 1867.

[tables]

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EXPERIMENTS TO FIND FRICTION OF TUBS.

These experiments were made by allowing the tubs to run down an incline, having a regular gradient, and noting the time occupied in traversing a certain distance.

The Manager of the Colliery kindly caused a piece of way to be relaid for a distance of 50 yards to a regular gradient. The difference in height between the commencement and end of the 50 yards was

5.74 feet, making the gradient to be a fall of 1 in 26.13. The experiment was made with five full and eight empty tubs, the weight of the full tubs, including coals, being about 1,804 lbs. each, and of the empty tubs, 688 lbs.

The gauge of the way was 2 feet 8 inches, and the diameter of the tub wheels 14 inches.

The co-efficients of friction are calculated from the formula given below, the quantities for which are supplied by the following table:—

[table]

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It will be seen from the foregoing table that the average co-efficient of friction for the full tubs is 1 [divided by] 56.2 and 1 divided by 46.8] for the empty tubs.   The tubs used in these experiments were supposed to be in an average state of lubrication.

The apparently great amount of friction of a tub with so large a wheel, and running on such a broad gauge, is probably chiefly to be accounted for by the condition of the wheels, most of which, being made of rather soft iron, have a groove worn in the rim of the wheel by the rails.

TOTAL FIRST COST OF WAGONWAY PLANT.

[table]

COST PER MILE OF WAGONWAY.

[table]

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METHOD OF TAKING OUT ANNUAL COST OF MAINTAINING ENGINE-PLANE.

ROPES.-—The total cost or tne new ropes put on to the plane in tnree years is taken, and allowance made for the abandoned ropes, estimating them to have lost one-third of their original weight. One-third of the cost of maintaining the tail-rope is deducted as due to the working of the pumps.

Sheaves.—No separate account is kept of the cost of rollers and sheaves for this plane. They are estimated to endure a certain time, and an allowance is made for worn-out sheaves.

Tubs.—Each item is taken from the actual accounts of material used; and to the cost of repairing is added the number of new tubs annually necessary to keep the stock in good condition, taken on an average of five years. The amount is then reduced according to estimate detailed on page 5.

Rails.—Estimated to endure a certain time.

Rapper Wipe and Sleepers.—Are taken at their actual duration.

GREASE FOR ROLLERS AND TUBS, AND OlL AND TALLOW FOR ENGINE.—Are calculated from the actual daily consumption.

Coals for the Boilers.—Tried for one day, and the same proportion to the quantity of coals led taken for three years.

Repairs to Engine and Boilers.—Cost taken according to general standard (see page 5).

COST OF LEADING COALS.

[table]

[53]

[table]

Cost of leading coals per ton per mile, up an average gradient of 1 in 83, the average distance led being 1.414 miles, and the average quantity led being 407 tons per day:- 2.172d.

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ENDLESS-CHAIN SYSTEM.

INTRODUCTION.

The Endless-chain system has hitherto been almost altogether confined to the collieries at and near Burnley, where it has been in operation for upwards of twenty years. It is also worked in various other parts of Lancashire, but as the Burnley district presents the most numerous and varied applications of the system, it was thought best to confine the following Report to that district.

There are upwards of forty miles of tramway worked by this system near Burnley. The five different planes reported upon are amongst the chief in the district, and are all unlike in some respects.

The following are the planes reported upon, together with their chief characteristics:—

I.—HAPTON VALLEY COLLIERY—

I.—Underground "ginney road" or tramway, with several branches; undulating, with an average gradient nearly level. Engine on the surface.

2.—Surface ginney road, with heavy rise for full tubs.

II.—GANNOW COLLIERY—

1.—Two underground ginney roads, each with heavy rise for full tubs; one worked by an engine on the surface, and the other by an engine underground.

III.—ROWLEY COLLIERY—

1.—Underground ginney roads, dipping towards shaft, worked by engine on the surface.

2.—Surface ginney road, with heavy undulations.

GENERAL DESCRIPTION OF THE METHODS OF APPLYING THE SYSTEM.

The following are a few of the chief peculiarities in the application of the Endless-chain system.

1st.—A double line of tramway is always requisite, one line being used for the full, and the other for the empty tubs.

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2nd.—The chain which moves the tubs rests upon them, and is driven by a pulley at the higher end of the ginney road, there being much more friction upon this wheel than upon that at the lower end of the road, owing to the weight of the full and empty tubs upon the incline.

3rd.—The speed at which the endless-chain is worked varies from two to four miles an hour.

4th.—The tubs are always put on singly, and at distances apart varying from ten to forty yards.

5th.—The tubs are attached to the chain by means of a "fork," which forms one piece with the strap encircling the upper part of the tub. The end of tub oh which the fork is placed, is made to go last in starting up-hill, but in going down-hill is placed first.

6th.—In working branch-ways, motion is transmitted to the chain in three different ways :—

I.—By shafting, and bevel or mitre gearing. (See Plates XIII., XIV., XV.)

II.—By a short endless-chain. (See Plate XXI.)

III.—By a continuous application of the same chain. (See Plates XXXIV. and XXXVI.)

7th.—Unlike the Tail-rope and No. 1 Endless-rope systems, little care is needed in laying the wagonway, since, owing to the low speed at which the tubs travel, slight irregularities are not felt.

8th.—It has hitherto been considered at Burnley that this system could only be worked in perfectly straight lines, that is, without any gradual curve in the road; angles are worked by disconnecting and connecting the tubs again, and for this the attention of a man or boy is required. An exception to this is at Padiham, near Burnley, where a self-acting curve (see Plate XXVIII.) is at work, but as its safe and regular working cannot be depended upon, it is found necessary to keep a man near to it who is also employed at various other work. A similar self-acting curve is at work at Towneley Colliery (see Plate XXIX.), and works very efficiently. No man is employed here, but it is constantly in view of the man attending the end of the tramway.

Hapton Valley Colliery presents several examples of the various methods of applying the endless-chain system. Here two revolving screens are placed close to the terminus of the ginney road at A (see Plate XVIII.), and the full tubs, when disconnected from the chain, run, with only a slight guidance, to the screens.

The sketch on Plate XVI. will give some idea of the method adopted for disconnecting and attaching the full and empty tubs at either end of a ginney road. Here the full tubs are supposed to be coming off the ginney,

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as on the heapstead at Hapton Valley. One rule is always observed in the formation of the termini of these ginneys, viz., on the "coming off" side, the way is made to rise a few yards from the terminus, in order to obtain such a fall as will enable the tub, on leaving, the chain, to acquire an impetus sufficient to take it off the ginney road; and on the "going on" side the way is made to dip from the terminus, so that the tub may run to the chain without the aid of manual labour.

In the sketch (Plate XVI.) the empty tub has just been attached to the chain. This is done by placing a vertical link of the chain in the fork at the end of the tub. If left alone the tub would generally attach itself, but it is usual for the " ginney tenter," who puts the tub on to the ginney road, to connect it to the chain ; this can be done when it is at a distance of five or six yards from the "ginney tenter," and is the work of a second. The full tub has just been disconnected; this is effected by the declination of the way referred to, and by the chain being raised by a small pulley (a), which also guides the chain to its proper position on the main sheave (b). The lines (x y z) represent rods of iron between which the chain passes. In the event of the fork of the tub being affixed in any way to the chain, these rods push the tub off, and prevent it reaching the pulleys. This system of disconnecting and attaching the tubs at the ends of the ginney roads is carried out, with little variation, on all the ginney roads worked at the Burnley Collieries.

On Plate XII. is shown a sketch of the Endless-chain driving wheel generally in use at the Burnley Collieries. An ordinary pulley wheel is surrounded by sheet iron, on which are secured the steel "feet" (T) which are placed about 12 inches apart. The peculiar shape of these feet is adopted as being the best for supporting the chain. A lever at L works the arrangement at C, which, falling upon the clamp F, puts the driving wheel in and out of gear. When the wheel is in motion, should any obstacle stop the chain, the clamp is so regulated as to slip and prevent a breakage.

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HAPTON VALLEY COLLIERY.

UNDERGROUND ENDLESS-CHAIN ROADS.

W. Waddington, Esq., Manager ; Mr. J. Waddington, Resident Viewer.

The Mountain Seam is worked at this Colliery by a day-drift (see Plate XVII.) The coals are brought out by this drift, along the main ginney road, to a heapstead at A on plan, and are there screened, two other ginney roads then conveying them a distance of 2,000 yards to a canal.

The engine for driving the ginney roads is at A on the accompanying plans, Plates XVII. and XVIII, the latter of which is a plan, and the former a section of the ginney roads at this colliery. The engines (see Plate XI) is vertical, with two 12

1/2 inch cylinders, and two feet stroke. This engine is exactly similar to those used for the Hapton Valley surface ginney, and for the Bowley underground and surface ginneys; whilst at Gannow Colliery two single cylinder engines, a plan of which is given on Plate X., are in use.

The working day at this and the other Burnley Collieries is from 7.0 a.m to about 3.30 p.m., but as there are stoppages during this time of one hour for meals, and about two hours for ordinary stoppages, the chain roads can only be said to be 5 h. 30 m. actually at work.

DIMENSIONS OF ENGINE, BOILERS, CHAIN, ETC.

Engine erected, 1853.

[table]

[58]

[tables, diagrams]

[59]

[table]

DESCRIPTION OF PLANE.

The greater part of the Main ginney road is on the surface; the underground part is arched to the station, and is 4 feet 6 inches high. The tramway is laid with angle-iron rails, in 6 feet lengths, having a gauge of 22 inches. Two ginney lines underground are worked by the main ginney, motion being transmitted by shafting and mitre gearing, working underneath the flat sheets at the station (see Plate XIX.) The main road rises from the engine at a gradient of 1 in 20 for 337 yards, and then falls towards the underground station at 1 in 17 for a distance of 286 yards. No. 1 ginney is 1,524 yards long, with a rise of 1 in 381 outbye; and No. 2 ginney is 1,060 yards in length, with an average gradient of 1 in 48, dipping outbye. The Mountain Seam at this colliery has an average section of about 2 feet 9 inches, and this is the utmost height of the two ginney roads referred to, 2 feet 6 inches being the general distance from the rails to the roof. The roads are made about 6 feet 2 inches wide. A separate travelling road is made for the men, about ten yards from the ginney road, which, with the travelling road, forms a double intake for the air.

DESCRIPTION OF METHOD OF WORKING THE GINNEY ROADS.

At each end of every ginney road, a man or boy, according to the quantity of coals coming out, attends both to the full and empty sets. He takes care that every tub is attached to the chain, that a regular distance is kept between the tubs, and that the coming off tub is turned, on becoming detached from the chain, in the right direction. He also has charge of the rapper, with which he can signal to the brakesman when necessary.

The tubs on the main ginney road are ten yards apart, on No. 1 ginney twelve yards apart, and on No. 2 fourteen yards apart; these two latter distances being just suitable for their own general work, and for feeding the main ginney with tubs, ten yards apart. The tubs

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are kept the regular distance from each other by means of a catch, which the ingoing empty tub strikes when it reaches a certain fixed distance from the point of starting. This catch raps to the station, and another tub is then attached. The station is laid with flat sheets. When the empty tubs come down the main ginney, some pass from a to b (see Plate XVIII.), and the rest are taken by the boy attending No. 1 ginney. The full tubs from No. 2 ginney are brought into the station by a curved rail with a slight fall. The man attending the main ginney just puts on the tubs as they come to hand from either branch, and when no coals are out he pulls round the incoming empty tub, and sends it back on the full side; this is not of frequent occurrence, since, when the coals continue to come out slowly, the speed of the engine is reduced.

The driving pulley for the chain is worked on the third motion, and is so arranged that when the engine is going at from 100 to 130 strokes per minute the tubs upon the ginney roads are moving at a speed of two to four miles per hour.

In order to gain sufficient friction on the driving pulleys to prevent the chain from slipping, it is passed two and a-half times round the driving-wheel at one end of the ginney road and half a turn round the wheel at the other end. At Hapten Valley these driving-wheels, on the main ginney road, are four feet in diameter, whilst on the other roads they are only three feet.

Levers are attached to the driving-wheels of the two branches, by which they can be put out of gear, and rapper wires are laid to the inbye end of each of the ginneys. When there is slackness of coals at either of the ginneys, they can have them put out of gear by rapping to the station.

The tubs used hold 3 cwts. of coal, and stand 2 feet 3 inches from the rails. On account of their size, they travel at a greater speed (about 2.7 miles per hour), and are placed at a less distance apart than the tubs on most of the underground ginneys.

The station at the inbye end of the main ginney road at Hapten Valley (see Plate XVIII., and on a larger scale, Plate XIX.) affords a very good example of the method of working branch roads by the Endless-chain system. The method of transmitting motion will be easily seen on the plans referred to.

There are two self-acting Endless-chain roads at work at this colliery, one at the point S on No. 1 ginney, and the other at the point T on No. 2 ginney. The chief objection to these self-acting roads is that a boy is constantly required to attend to the brake, since, unless the tubs

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are attached to the train with perfect regularity, they are apt at one time to remain stationary, and at another to run amain. These self-acting planes, when worked on a heavy gradient, are frequently made to work a level plane at the upper end.

EXPERIMENTS WITH INDICATOR.

The hauling engine was erected for a winding engine, to wind by the Endless-chain, and when afterwards the pit was closed, and the engine put to its present work, a great deal of gearing had to be put up, most of which could have been avoided, had the engine been put up for hauling purposes alone.

Two revolving screens are worked by the engine, which, a short time since, was driving nearly 1500 yards more ginney road than at present.

In the following experiments only one indicator was used, and as the different experiments could only be tried for a short time, the indications of but one cylinder were taken.

ABSTRACT OF EXPERIMENTS WITH INDICATOR.—Feb. 2nd, 1867.

[table]

DEDUCTIONS FROM EXPERIMENTS WITH INDICATOR.

I.—Power required to drive Engine, together with Screens and Gearing (E):— At 120 strokes per minute ...... 8.6 Horse-power.

II.—Power required to drive Main Ginney, No. 1 and No. 2 Ginneys, 258 Full and 260 Empty tubs being upon the roads, and the average gradient being a dip outbyeof 1 in 178 (A):—

	Engine and Roads.		Engine, etc.		Horse-power.
At 120 strokes per minute ...	27.4	—	8.6	=	18-5

[62]

III.—Power required to drive Main Ginney, and the mitre gearing, etc., at the underground station (B):—

	Engine and Main Ginney.		Engine, etc.		Horse-power
At 120 strokes per minute ...	22.9	—	8.6	=	14.3

This is a counterba]anced plane, and as it only has the weight of the tubs, and chain on tubs, to overcome, most of the power is expended on the gearing.

IV.—Power required to drive No. 1 Ginney, the average gradient being a rise outbye of 1 in 381 (C):—

	Engine, Main, and No. 1 Ginney.		Engine and Main Ginney.		Horse-power.
At 120 strokes per minute ...	37.2	—	22.9	=	14.3

V.—Power required to drive No. 2 Ginney, the average gradient being a fall outbye of 1 in 48 (D):—

	Engine, Main, and No. 2 Ginney.		Engine and Main Ginney.		Horse-power.
At 120 strokes per minute ...	23.6	—	22-9	=	.7

This ginney appears almost to have overcome the friction of tubs and chain, .7 horse-power being able to drive it.

EXPERIMENTS WITH DYNAMOMETER.

The dynamometer was tried only upon the main ginney road—Nos. 1 and 2 ginney roads being too low to admit of its being used with safety.

It was first brought in on the empty tub way, and then taken out on the full way. Three other experiments were also made to find the tractive power required to work the Main road and the two branches working separately; these were made in the first 248 yards from the station, rising 1 in 17, and the readings were noted at three different places on the bank.

The dynamometer was attached to the chain, as shown below, by coupling chains on one side, and blocks on the other; the blocks were then drawn up, and the Main chain made slack.

[diagram]

[63]

DYNAMOMETER EXPERIMENTS.—FEBRUARY 5TH, 1867.

[table]

The letters in above Table refer to different points on the Plane (see Plate XVII.)

[64]

TOTAL FIRST COST OF WAGONWAY PLANT.

	£.	s.	d.
Engine.......................	115	0	0
Gearing.................	52	0	0
Boilers......................	210	0	0
Steam and exhaust pipes	23	18	1
Receiver	3	0	0
Chains, at 19s. per cwt................	708	10	2
Main pulleys....................	20	12	0
Tail shafting, &c.......	94	16	5
Extra levers	6	0	0
Foundation for shafting...............	5	5	0
Wagonway (including rails, sleepers, nails, signal wire, &c.)	962	12	7
980 tubs, at 27s. per tub	1,323	0	0

£3,524 14 3

COST PER MILE OF ENDLESS-CHAIN ROAD.

Rails, 1,760 yds. x 4 = 7,040 yds. @ 28 lbs. = 1,760 cwts. @ 5s. 6d.....................	£484 0 0
Sleepers, 1,760 yds. [divided by] 2 = 880 sleepers (6 ft. x 7 in. x 2 in.) @8d........................	29 6 8
Nails, 1,760 yds. x 4 = 7,040 [divided by] 17 per lb. = 414 @ 3d.	5 3 8
Signal Wire, 1,760 yds. @ 12 lbs. per 100 yds. = 1.88 cwts. @25s........................	2 7 0
Signal Wire Supports, 1,760 yds. @ 59 lbs. per 100 yds.= 89 cwts. @ 25s..................	1 2 3
Labour, 1,760 yds. at 8s. per 100 yds.	7 0 9
	--------------
	529 0 4
Chain, 5/8 in., 1,760 yds. x 2 [divide3d by] 3,520 @ 13 lbs. = 408.57 cwts. @ 19s........................	388 2 10
	--------------
	388 2 10

Total cost per mile	£917 3 2

This cost is the same at all the Burnley Collieries where 3-cwt. tubs are used, but where 6-cwt. tubs are employed, the sleepers are usually placed one yard apart—thus doubling the cost of sleepers, and making the amount per mile of wagonway, where 6-cwt. tubs are used, to be £946 9s. 10d.

COST OF LEADING.

The cost of leading coals at the Burnley Collieries is not arrived at from accounts of the actual cost of maintaining way, repairing tubs, engines, etc., of which no separate account is kept, but is, in most cases, calculated from the duration of the different descriptions of plant,

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As the endless chain has been so long in operation in this district, this not difficult to arrive at:—

Tubs are estimated to endure 7 years.				
Rails	do.	do.	20	do.
Chain	do.	do.	12	do.
Sleepers	do.	do.	10	do.

Allowance in each case made for value at end of the time given.

The items of cost which are taken from actual consumption are:—

Oil, calculated from the daily quantity used.

Coals, which are taken on an average of about six months, and

Labour, which is taken from the cost per day.

The amount for tubs is reduced according to estimate detailed on page 5, and the cost of repairs to engine and boilers is taken according to general standard.

COST OF LEADING COALS.

MAINTAINING ENGINE- FOR ONE YEAR

PLANE	£	s.	d.
Chains.................	51	3	8
Pulleys, gearing, and shafting	6	0	0
Tubs	93	0	11
Rails and maintaining way.........	43	8	0
Oil	154	0	0
Coals (539 tons, at 5s. 6d.).........	148	5	6
Repairs to engines and boilers ...	46	15	0
	£542	13	1

Labour ...... Per day of 8 h. 30 m.—

	£.	s.	d.
1 engineman	0	2	8

Ginney tenter (surface)	....	0	1	6
1 greaser (for sheaves, gearing, etc.)......		0	2	8
Ginney tenter No. 1 way	....	0	1	10
Do. No. 2 do..........		0	1	10
1 station man	....	0	4	2
1 do...............		0	3	5
1 station boy	....	0	1	6
1 do...............		0	2	2
		£1	1	9

	Days.	£. s. d.
Labour ...	308 at 21s. 9d. =	334 19 0
	Maintenance for one year (as above) ...	542 13 1
Total cost of leading per annum		£877 12 1

Cost of leading coals per ton per mile, down an average gradient of 1 in 178, the average distance led being 1.005 miles, and the average quantity led leing 372 tons per day,---1.830d.

[66]

HAPTON VALLEY COLLIERY.

SURFACE ENDLESS-CHAIN ROAD.

The coals from Hapton Valley heapstead are led by this ginney road up to the Barclay Hills station, whence they are taken to the canal by another road, having a dip for fall tubs, which is worked by the same engine.

This road has no branches; it is 1,250 yards long, and has an average gradient of 1 in 27, being a rise for the full tubs. About 370 tons per day are led along this ginney road.

The engine is at the Barclay Hill end of ginney road, and is similar to that working the Hapton Valley underground roads. A sketch of the arrangement of gearing for giving motion to the chain is shown on Plate XXI. A good example is furnished at Barclay Hills of the many ways in which the endless-chain can be applied to various hauling purposes about a pit heap. There are here three short roads, each about 18 to 20 yards long, worked by the endless-chain, which respectively take small coals to washing machine, refuse to stone heap, and bring coke from coke ovens.

DIMENSIONS OF ENGINE, BOILERS, ROPES, ETC.

Engine erected, 1854.

[table]

[67]

[tables, diagrams]

[68]

DESCRIPTION OF PLANE.

This plane is laid in the same manner as that at Hapton Valley, except that sleepers are laid every 3 feet, owing to the use of the 6-cwt. tubs. A section of the plane, showing the gradient at various parts, is shown on Plate XX.

DESCRIPTION OF METHOD OF WORKING THE CHAIN ROADS.

This ginney road is worked like Hapton Valley—the only labour required being a man at one end and a boy at the other, together with a portion of the time of a fireman and greaser. At Hapton Valley they teamed from the 3-cwt. tubs, and screened into 6-cwt. tubs, which are put on to this ginney road at a distance of 15 yards apart.

ABSTRACT OF EXPERIMENTS WITH INDICATOR.

[table]

DEDUCTIONS FROM EXPERIMENTS WITH INDICATOR.

I.—Power required to work Engine Alone (C):—

		Horse-power.
At 66 strokes per minute	....	3.22

II.—Power required when all the Ginneys are going:—

		Total power.		Engine alone.		Horse-power.
At 66 strokes per minute	......	36.66	—	3.22	=	33.44

III.—Power required to work the Ginney Road from Hapton Valley to Barclay Hills, 83 full and 83 empty tubs being upon the road, and the average gradient being a rise for full tubs, of 1 in 27 :—

Engine and Engine

		Ginney Road.		alone.		Horse-power.
At 66 strokes per minute......		20.70	—	3.22	=	17-48

EXPERIMENTS WITH DYNAMOMETER.

[table]

TOTAL FIRST COST OF WAGONWAY PLANT.

Engine................. ...	£115	0	0
Gearing and shafting	32	0	0
Boilers	205	0	0
Steam and exhaust pipes..............	4	9	7
Chain, 19s. per cwt...............	275	14	0
Sheaves, main	4	10	0
Shafts	4	10	0
Lever.......................	2	0	0
Wagonway (including rails, sleepers, nails, signal wire, etc.)....................	374	18	6
Tubs, 172 @ £2	344	0	0

	£l,362	2	I

(For cost per mile of Endless-chain road see page 64.)

COST OF LEADING COALS.

Maintaining Engine-Plane F0R 0NE YEAR—

Chains	£19	19	0
Tubs	36	17	2
Rails and maintaining way ...	16	13	4
Oil	57	15	0

Coal (282.5 tons @ 5s. 6d.)	...	84 15 0
Repairs to engine and boilers	...	39 5 0

		£255 4 6

		£ s. d.
Labour	Per day of 8 h. 30 m.—	
	1 ginney tenter	0 2 8
	Proportion of fireman's wages, @ 2s. 4d.............	0 1 3
	Proportion of greaser's wages (for sheaves, gearing, &c.) @ Is. 8d.	0 0 10
	I ginney tenter	0 1 0

		£0 5 9

	Days.	£ s. d.
Labour ...	308 @ 5s. 9d. =	88 11 0
Maintenance for 1 year (as above)		255 4 6

Cost of leading per annum ...		£343 15 6

Cost of leading coals per ton per mile, up an average gradient of 1 in 27, the average distance led being .710 miles, and the average quantity led being

370 tons per day;— 1.019d.

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GANNOW COLLIERY, NEAR BURNLEY, LANCASHIRE.

W. Waddington, Esq., Manager; Mr. J. Waddington, Resident Viewer.

The chief features in the arrangement of the Endless-chain system at this colliery are, that the motion is transmitted by chains in the shaft, and that the ginney roads, which are underground, have heavy gradients.

On referring to the sketch on Plate XXII., it will be seen that two distinct beds are worked at this colliery, called respectively the Top and Low Bed ; the coals from the Top Bed are hauled by the engine on the surface, whilst the engine in the Top Bed works the endless-chain in the Low Bed. The gearing is so arranged that the ginney-roads in both beds can be worked by either engine, but there is scarcely sufficient power to work both chains together at the necessary speed.

The engine now in the Top Bed used to stand on the surface, where, together with another engine of 14 inches cylinder and 2 feet stroke, it worked the plane of 1 in 7 in the Low Bed, by means of a single wire-rope. These two engines could only bring up a set of thirteen tubs, and together could not do the work with the rope which the single 12 1/2 inches engine now does with the Endless-chain.

The method of conveying the chain down the shaft and along the ginney road will be seen on referring to Plates XXII. and XXIII. The chains in the shaft are of 7/8 inch iron, whilst those in the ginney roads are 5/8 inch, with the exception of that on the heavy gradient in the Low Bed, which is 7/8 inch. The chains in shaft are kept tight in order to get sufficient friction by the arrangement shown at W; a similar arrangement is used for the chain driving the Top Bed ginney, but is not shown.

The ginney roads at this colliery are not very extensive, that in the Top Bed being 1,209 yards long, the average gradient being a rise out-bye of 1 in 15, and that in the Low Bed 948 yards in length, with an average rise towards the shaft of 1 in 9.

At present about 231 tons per day is worked in the Top Bed, and about 144 tons per day in the Low Bed.

The work now being done is about half of what they have done with the same establishment. Besides the coal, there is also more than an equal weight of water drawn up the incline, so that to arrive at the actual cost of leading the coals, only half of the total expenses must be taken.

Only the engine working the Low Bed was indicated, but the cost of leading is abstracted for both ginney roads.

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DIMENSIONS OF ENGINE, BOILERS, CHAINS, ETC.

LOW BED.

[table]

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[table]

DESCRIPTION OF GINNEY ROADS.

The conditions of the way are exactly the same as at Hapton Valley, except that the sleepers are laid every three feet, on account of 6-cwt. tubs being used.

In the Top Bed there are three roads, each forming an angle with

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the other, the heaviest gradient being 1 in 12. In the Low Bed there are two ginney roads, the heaviest gradient being 1 in 7.2.

DESCRIPTION OF METHOD OF WORKING THE GINNEY ROADS.

These ginney roads are worked in a similar way to those at Hapton Valley. It will be seen by the sketches that at curves, as at DD, motion is transmitted to the chain by having two pulleys in one shaft. The tubs leave the chain on one road, and are attached to the chain upon the next with the attention of a man or boy. At the shaft the tubs leave the chain about 20 yards from the shaft, and are put into the cage as they come to hand. The tubs in the Low Bed are placed about 20 yards apart, and about 14 yards apart in the Top Bed.

EXPERIMENTS WITH INDICATOR.—LOW BED.

[table]

DEDUCTIONS FEOM EXPERIMENTS WITH INDICATOR

I.-Power required to work Engine and Gearing alone (B):--

At 101 strokes per minute .... 7.89 Horse-power.

II.—Power required to work the three Ginney Roads in the Top Bed, the average gradient being 1 in 9, and the average speed of the tubs about one mile per hour.

		Horse-power.	Engine alone.	
At 101 strokes per minute	......	16.11 —	7.89	= 8.22 Horse-power.

EXPEEIMENTS WITH DYNAMOMETER.

TOP BED.

The dynamometer was applied in the Top Bed in the same way as at Hapton Valley, on a gradient of 1 in 12. The average reading in going inbye was 7 cwts., and in coming outbye 2.3 cwts.

[75]

TOTAL FIRST COST OF WAGONWAY PLANT.

TOP BED.

Materials.

Engine	£50 0 0
Boilers	105 0 0
Steam and exhaust pipes..............	3 5 0
Condenser....................	3 0 0
Chain, 19s. per cwt................	345 19 11
Gearing	84 0 0
Wagonway (including rails, sleepers, nails, signal wire, etc.)	422 18 2
233 tubs, at £2 per tub..............	466 0 0

	£1,480 3 1

(For cost per mile of Endless-chain road see page 64.)

COST OF LEADING COALS.

Maintaining Engine-Plane For one year

	£ s. d.
Chains	24 5 6
Gearing	5 0 0
Tubs	77 13 4
Rails and maintaining way	20 16 9
Oil....................	25 8 4
Coal (305 tons, at 5s. 6d.)	83 7 6
Repairs to engine and boilers.........	24 0 0

	£260 11 5

Labour ...... Per day of 9 hours—

£ s. d.

Engine boy	0 0 10
Greaser (for tubs)	0 0 9
2 ginney tenters, at Is. 2d..........	0 2 4
1 do.	0 2 2
1 do.	0 3 7
1 do.	0 1 8

	£0 11 4

	Days.	£ s. d.
Labour ...	305 @ 11s. 4d. =	172 16 8
Maintenance for one year (as above)		260 11 5

Cost of leading per annum ...		£433 8 1

COST OF LEADING COALS.

TOP BED.

Cost of leading coals per ton per mile up an average gradient of 1 in 15, the average distance led being .687 miles, and the average quantity led being 231 tons per day, 2.147d

Deduct for water leading (1/2)	l.078d.

Actual cost per ton per mile	1.074d.

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TOTAL FIRST COST OF WAGONWAY PLANT.

LOW BED.

	Material.
Engine	£50 0 0
Gearing	94 0 0

Boilers	105 0 0
Steam and exhaust pipes..............	3 5 0
Condenser	3 0 0
Chains, 19s. per cwt.	297 5 2
Wagon way (including rails, sleepers, nails, signal wire, etc.)......	328 19 4
Tubs, 159 @ £2	318 0 0

	£1,199 9 6

COST OF LEADING COALS.

MAINTAINING ENGINE PLANE for one year

Chains..............	£21 3 4
Gearing	5 0 0
Tubs	52 17 4
Rails and maintaining way......	16 10 7
Oil	25 8 4
Coal (488 tons @ 5s. 6d.)	134 4 0
Repairs to engine, pipes, and boilers	19 0 0

	£274 3 7

Labour ...... Per day of 9 hours—

	£	s.	d.
1 engineman......	0	3	7
1 greaser (for tubs).........	0	0	9
1 tenter......	0	3	8
1 do.	0	4	0

	1 do.		0 1 2
			-------------
			0 13 2

	Days.		£ s. d.
Labour ...	305 @ 13s. 2d.	=	200 15 10
Maintenance for one year (as above)			274 3 7

Cost of leading per annum ...			£474 19 5

COST OF LEADING COALS.

LOW BED.

Cost of leading coals per ton per mile up an average gradient of 1 in 9, the average distance led being .539 miles, and the average quantity led being 144 tons per day, 4.817d.

Deduct for water leading (1/2)	2.408d.

Actual cost per ton per mile	2.409d.

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ROWLEY COLLIERY.

UNDERGROUND ENDLESS-CHAIN ROADS.

W. Waddington, Esq., Manager; Mr. J. Waddington, Resident Viewer.

The engine used for driving the underground endless-chain at Rowley Colliery is similar to that in operation at Hapton Valley (see Plate XI).

As at Gannow, the engine, to which the underground ginneys at this colliery are connected, is at the surface, and motion is given to the chain underground by taking the chain down the shaft. By means of a double endless long-linked chain this engine also winds all the coals up the same shaft down which the ginney chain is taken. As will be seen by the sketch on Plate XXV., the endless-chain driving wheel is on the same shaft as the wheel over which one of the winding-chains passes.

Whilst at Gannow the ginney roads all dip from the shaft, the roads at this pit are all in favour of the full tubs, the average gradient being about 1 in 23. No. 2 ginney road has a rise of I in 18; and No. 1 a rise of 1 in 72, with a gradient of 1 in 3.3, over a distance of 78 yards.

The average quantity of coals drawn daily, at this colliery, is about 418 tons.

DIMENSIONS OF ENGINE, BOILERS, CHAIN, ETC.

Engine erected, 1859.

[table]

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[table]

DESCRIPTION OF ARRANGEMENT OF CHAIN AND GINNEY ROADS.

The section (Plate XXIV) will assist in explaining the underground arrangement of chains and wheels.

After passing down the shaft, the chain is taken from the bottom round two 2 1/2 feet pulleys to the 3 feet pulley on the main shaft A. Another pulley on this shaft works No. 1 ginney; and No. 2 ginney is connected by a horizontal shaft and mitre-gearing, taken from the top of the main shaft, to B at the terminus of No. 2. In passing from the bottom of the shaft to the pulley A, the ingoing chain is tightened by a weight W, sliding on two rods, and suspended by a pulley under which the chain passes. The chain in the shaft is 11/16 of an inch in diameter, and is allowed to work about four years, after which it is put upon one of the ginney roads.

At C (see section) on No. 2 ginney line, the chain passes round a pulley and gives motion to another pulley on the same shaft, which works the chain further inbye; there is a small branch here, and as the chain is raised up by the pulley, they can easily take out the empty and put in the full tubs. A small pulley, hung from the roof, would have answered the purpose as well; but this way will shortly be made a ginney road, and a connection with these wheels will then be necessary. There is a similar arrangement at D (see Plate XXV.) on the branch of No. 1 ginney.

At W, near the bottom of the steep gradient in No. 1 ginney, there is a bearing-down pulley, fixed to the roof, under which the chain passes, and is thus prevented from rising to the roof, and becoming disconnected from the tubs. Under this pulley the way is laid upon 9 feet planks— hollow underneath—the spring of which allows the tubs to pass easily under the pulley.

DESCRIPTION OF METHOD OF WORKING GINNEY ROADS.

The endless-chain at this colliery is worked at a speed of about 1 1/4 miles per hour; the tubs are placed about 18 yards apart.

As at Hapton Valley the driving wheels of the two ginney roads have levers for putting them out of gear when necessary.

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As the tubs run upon the incline of 1 in 3.3 with perfect safety, this part of the road is found to be a great convenience, giving, as it does, so much assistance to the other ginney roads.

The tubs are connected and disconnected from the chain in the same way as at Hapton Valley Colliery.

ABSTRACT OF EXPERIMENTS WITH INDICATOR.

[table]

DEDUCTIONS FROM EXPERIMENTS WITH INDICATOR.

I.—Power required to work the Engine, together with the winding-chain working empty tubs in the shaft; all the endless-chain being out of gear, and the chain in the shaft being disconnected from driving-wheel by blocks as shown in sketch (F) :—

At 60 strokes per minute, 3.39 Horse-power.

[diagram]

II.—Power required to work the Engine, together with the winding-chain, and the hauling endless-chain in the shaft, and underground to the pulley A, all other underground chains being out of gear (E) :— At 60 strokes per minute, 3.93 horse-power.

[therefore] Power required to convey the endless-chain down a shaft 75 feet deep, and underground for a distance of 27 yards:—

	Both Chains.		Winding Chain alone.		Horse-power.
At 60 strokes per minute.........	3.93	—	3.39	=	0.54

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CALCULATION OF FRICTION OF CHAIN, ETC., IN SHAFT.

Moving Weight:—

	Cwts.
Pulleys—2 at 4 cwts...............	8
„ 2 at 1 cwt..............	2
,, for tightening chain at bottom ...	1
Suspended weight (W on section)	8
	—
	19

Chain—The two sides of the chain in the shaft

counterbalance each other, so that only the

horizontal-chain is to be considered;

27 yards x 2 = 54 x 16 lbs. per yard ... 7.7

26.7

Speed of chain in shaft 156 feet per minute,

H.P.

.54 x 33,000

Then 112 X 156 feet per minute = 1.02 cwt.

Then total friction = 1.02 = 1

------ --

26.7 25

of total weight of horizontal-chain, pulleys, &c.

III.—Power required to work engine and wind coals, and to drive all the endless-chain roads underground, the average gradient of which is a fall outbye of 1 in 20 (A) :—

At 60 strokes per minute ...... 29.11 horse-power.

IV.—Power required to work engine, wind coals, and to drive No. 1 ginney road only (B) :—

At 60 strokes per minute ...... 30.30 horse-power.

V.—Power required to work engine, wind coals, and to drive No. 2 ginney road only (C) :—

At 60 strokes per minute ...... 30.47 horse-power.

It would appear from the three experiments above, that it requires less power to work both ginney roads together, than when going separately.

The power required for winding coals by this system is shown by this experiment to be

Engine, etc.

30.00 — 3.39 = 26.61 horse-power, to wind 417 tons 75 fas., per day of 8 1/2 hours.

VI.—Power required to work engine and wind coals, the hauling-chain in the shaft being also in motion, but all the underground ginney roads being out of gear (D) :—

At 60 strokes per minute ...... 30.00 horse-power.

From this it will be seen that the working of the underground ginney roads assists the winding of the coals to the extent of

30.00 -- 29.11 = -89 horse-power.

Referring to the results of experiment (D), which show the assistance given by the working of the ginneys to the engine, it would appear that

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these ginneys, when going together, would self-act; but the engine is required, since the ginneys, without its help, cannot take props and heavy material inbye, and further, the connection is found to impart a more uniform motion to the ginneys.

It is important to notice the superiority of these inclines over the self-acting inclines worked by single rope, in their adaptability to planes, the inclination of which is not all in one direction. The gradient given as their inclination is approximate, being simply the average inclination. The beds of the seams at Rowley Colliery, and in the Burnley district generally, are undulating ; this is the case in respect to the No. 1 ginney road at Rowley, which, though having an average dip towards the shaft of 1 in 23, has in one or two places a slight rise towards the shaft. It is owing to the weight of some full tubs being always on the heavy part of the outbye dip, that these ginneys are able to overcome the contrary gradients and self-act. The sets of tubs on self-acting inclines, as worked by ropes in the north, would not be able to run on the No. 1 Rowley plane, since the outgoing full set would probably be stopped by the irregularities of the way referred to.

FIEST COST OF UNDERGROUND GINNEY ROADS.

Engine, Boilers, and Pipes.—As the engine is shown by the indicator experiments to be actually assisted by the working of the underground ginneys, the cost of these items should be considered as belonging altogether to the first cost of minding machinery.

Chain.—The first cost of the pulleys in the shaft, and of the chain down the shaft to the main driving wheel, might also be left out, but as the regularity of the motion of the underground ginneys is effected by their connection with the engine, these items are entered as belonging to the first cost of hauling machinery.

Chain, 19s. per cwt..................	£530	16	0
Pulleys.......................	20	6	0
Shafting................. ...	8	0	0
Shafting, etc.....................	11	0	0
Wagon way (including rails, sleepers, nails, signal wire, etc.)	663	17	7
389 tubs, at 40s. per tub	778	0	0

£2,011 19 7

COST OF LEADING COALS.

MAINTAINING ENGINE-PLANE for one year

Chains..............		£37 12 0
Pulleys and shafting.........		5 0 0
Tubs	75 9 4	
Rails and maintaining way......		29 10 1
Oil		51 6 8
Coal (none used for hauling)		--------------
	£198 18 1	

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LABOUR ...... Per day of 8 h. 30 m.—

1 ginney tenter		£0 3 8
1 do.		0 2 8
1 do.	0 3 2	
1 do.	0 2 10	
1 do.		0 3 2
1 do.	0 1 8	
1 do.		0 2 2

	£0 19 4	

Labour, 308 days at 19s. 4d. = ... £297 14 8

Maintenance for one year (as above) 198 18 1

Total cost of leading per annum £496 12 9

Cost of leading coals per ton per mile down an average gradient of I in 23, the average distance led being .668 miles, and the average quantity led being 418 tons per day ;- l.388d.

SURFACE GINNEY ROAD FROM ROWLEY COLLIERY TO BURNLEY.

This ginney road (see section, Plate XXVI.) takes the coals from Rowley Colliery, 1,980 yards, in a straight line, to a coal depot and canal in the town of Burnley.

The line is laid, with the exception of two lengths of timber gearing —one over a river, and the other to raise the line to the level of the canal—on the open field, and is the best specimen of an undulating ginney road in the district.

The " weight" here, as at Hapton Valley, goes down hill, at an average gradient of 1 in 68 ; the difference of level between the highest and lowest points of the line being 145 feet. It was chosen to experiment upon, to show how little power was required to drive a ginney road under the circumstances mentioned above. It probably exhibits the minimum cost, where power is required, at which coals can be led in this district.

The tubs used hold 6 cwts., and are generally placed 25 yards apart, but this distance is not regularly attended to. The engine for driving this ginney is at the Rowley end of the line, and the " onsetter" or " ginney tenter," who has the handle of the engine close to him, regulates the speed of the engine according to the quantity of coals coming

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to hand from the pit. The general speed of the tubs is about 3.1 miles per hour, and rather more than 400 tons per day are led.

The engine driving the ginney is similar to that at Hapton Valley, and to that used for winding and hauling at Rowley. It also works a small ginney for taking props, etc., on to the heapstead; also one screen and a dredger for lifting the single-screened small. It is not performing one-half the work it is capable of doing.

The engravings which form the frontispieces of this Report are taken from photographs of the Endless-chain Surface Road at Rowley. One is a view of the chain road from Rowley Colliery, showing the appearance of the tubs and chain on the hill side; the other shows the driving pulley, together with the shafting and mitre gear, at the Rowley end of

DIMENSIONS OF ENGINES, BOILERS, CHAINS, ETC.

Engine erected, 1859.

[table]

Boilers...... The 7 boilers at this colliery are all connected, and it is estimated that 1/12th of their power is required for the engine working the ginney road.

[table]

[84]

[table]

DEDUCTIONS FROM EXPERIMENTS WITH INDICATOR.

I. --- Power required to work engine, together with screens and gearing (B):--

At 80 strokes per minute .... 11.45 horse-power

II.—Power required to work the ginney road from Rowley to Burnley, a distance of 1,980 yards, 62 full and 62 empty tubs being upon the road, and the average gradient being a fall for the full tubs of 1 in 68, with an average speed of 3.07 miles per hour (A) :--

	Total Power.		Engine, etc.		
At 80 strokes per minute ...	16.61	—	11.45	=	5.16 horse-power.

[85]

EXPERIMENTS WITH DYNAMOMETER.

[table]

The dynamometer was applied as at Hapton Valley.

It will be seen from the above experiments, that the strain varies from 8 cwts. on the full side to 31 cwts. on the top of the hill, on the empty side.

On both sides, it will be seen that the heaviest strain is on the highest part of the plane, and the lightest on the lowest.

TOTAL FIRST COST OF WAGONWAY PLANT.

	£	s.	d.
Engine	£115	0	0
Gearing and shafting	54	0	0
Boilers (proportioned)	67	1	8
Steam and exhaust pipes..............	40	18	10
Chains, at 19s. per cwt.......	414	11	7
Main shaft..............	3	0	0
Tail pulleys	2	16	0
Wagonway (including rails, sleepers, nails, signal wire, &c.)	591	4	10

144 tubs, at £2 per tub..............	288 0 0

	£1,576 12 11

(For cost per mile of Endless Chain Road, see page 64.)

COST OF LEADING COALS.

MAINTAINING ENGINE-PLANE FOR ONE YEAR

	£ s. d.
Chains.................	30 0 0
Tubs	43 4 0
Rails and maintaining way.........	26 8 0
Oil	57 15 0
Coal (188 tons at 5s. 6d.)	51 14 0
Repairs to engines and boilers.	11 5 0

	£220 6 0

Labour......... per day of 10 hours—

1 ginney tenter	0 3 4
Fireman, at 3s. 4d.............	0 0 6
1 ginney tenter (Burnley)	0 1 2
1 greaser (for sheaves)	0 1 7

	£0 6 7

Days. £ s. d.

Labour ...	308 at 6s. 7d. =	101 7 8	
Cost of leading		220 6 0	

Total cost per annum ...		£321 13 8	

Cost of leading coals per ton per mile down an average gradient of 1 in 68, the average distance led being 1.125 miles, and the average quantity led being 404 tons per day:-- 0.551d.

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BURNLEY COLLIERIES.

EXPERIMENTS TO FIND FRICTION OF TUBS.

These experiments were tried on a piece of level way laid with ordinary edge rails. A weight was hung over a pulley and attached to the tub by a cord, and was taken as the amount of friction when just sufficient to keep the tub in motion without acceleration of speed.

The following is a Table of the experiments made:—

FRICTION OF TUBS.—TABLE OF EXPERIMENTS.

[table]

Scarcely any regularity is to be seen in these experiments, and this is probably owing—

1.—To the great amount of side play the tub wheels have upon the axles, being often more than three-quarters of an inch; this gives the tub a motion from side to side, pushing the side of the wheel against the edge rail, and thus giving constantly varying amounts of friction.

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2.—To some tubs being dirtier than others about the axles, and thus not so open to the application of oil.

It would appear from the experiments that the co-efficient of friction of the Empty 6-cwt. tubs (1/88) is less than that of the Full 6-cwt. tubs (1/68); and that the co-efficient of friction of the Empty 3-cwt. tubs (1/59) • is more than that of the Full 3-cwt. tubs (1/70).

The two last experiments were made with the chain hanging on two tubs, this being the nearest approach to the position of the chain and tubs together on a ginney road.

[89]

CLIFTON HALL COLLIERY.

SURFACE-GINNEY ROAD FROM COLLIERY TO CANAL.

John Knowles, Esq., Manager; Mr. John Barker, Resident Manager.

There are only three engine planes in connection with Messrs. Knowles' Collieries that are worked by the Endless-chain system, and of these only one draws the coal to the rise.

The following are the chief differences between the mode of adopting the Endless-chain here and at Burnley :—

1.—At Clifton Hall no forks are used, the weight of the chain upon the tubs drawing them along; this necessitates a looser chain and a greater distance between the tubs than could be used with the forks.

2.—The tub wheels are flanged, and run upon flat-topped rails.

Forks on the tubs are not used, because it is feared that they would be an inconvenience underground, and it is thought that the labour of putting the chain into the fork is done away with; as before mentioned, at the Burnley Collieries this labour is very slight, the chain almost finding its own way into the fork. As will be seen by referring to the working cost, the wear and tear is in favour of the Burnley system.

The plane at Clifton Hall Colliery (Plate XXVII.), which is 370 yards long, was the only one experimented upon. The coals are drawn up an average gradient of 1 in 71 on the surface, part of the plane having a gradient of 1 in 33, and the rest being level.

The tubs on this ginney road are generally placed about 30 yards apart, but this distance is not always observed; and in order to prevent the chain from touching the ground when the tubs are apart, small iron rollers are placed upon the ginney road, about 22 feet apart. When the tubs are 45 yards apart, the chain suspended between two of the tubs touches one roller.

The top of the tubs used on this plane is iron, and the chain lying along the tub generally has the horizontal link pressing on the edge of the iron at the end of the tub. At 30 yards apart, and going up the gradient of 1 in 33, should a tub happen to be badly greased, the chain runs over it, bringing the next tub up to it, and a stoppage is frequently caused by six to ten tubs being brought together in this manner.

The pulley wheels, one 6 feet 5 inches and the other 4 feet 2 inches in diameter, have a flange on the under side, which is intended to prevent the chain slipping down. Both the wheels are slightly inclined towards the ginney road to prevent the chain from touching the flange, and to

allow it to touch the tubs sooner. The driving pulley was made 6 feet 5 inches in diameter in order to keep the tubs far enough apart to pass through two small tunnels.

The engine at present is not working more than half the day, and the lead and consumption of coals have therefore been taken from several monthly accounts of the year 1866.

DIMENSIONS OF ENGINE. BOILERS, CHAINS, ETC.

[table]

EXPERIMENTS WITH INDICATOR.

[table]

DEDUCTIONS FROM EXPERIMENTS WITH INDICATOR.

I.—Power required to work engine and gearing alone (C):—

At 60 strokes per minute...... ... 1.60 horse-power.

II.—Power required to work endless-chain, 12 full and 12 empty tubs being upon the plane, the average gradient being a rise for full tubs of 1 in 71 (A):—

	Horse-power.		Engine, etc.		Horse-power.
At 60 strokes per minute......	8.52	—	1.60	=	6.92

III.—Power required as above, 8 full and 8 empty tubs being upon the plane:

	Horse-power.		Engine, etc.		Horse-power.
At 60 strokes per minute......	7.11	—	1.60	=	5.51

TOTAL FIRST COST OF WAGONWAY PLANT.

	MATERIAL.		
	£	s.	d.
Engine	55	0	0
Drums	32	0	0
Boilers, gearing, and shafting	110	0	0
Steam and exhaust pipes..............	5	4	0
Chain, 19s. per cwt.	81	12	0
Pulleys	12	19	0
Shafting	3	0	0
Wagonway (including rails, sleepers, nails, signal wire, rollers, etc., etc., etc.)	192	6	9
Tubs, 38 at 35s.	66	10	0

£558 11 9

COST PER MILE OF ENDLESS-CHAIN WAGONWAY.

Rails, 1,760 yds. x 4 = 7,040 yds. at 20 lbs. = 1,257 cwts., at 7s. ...	£439	19	0
Sleepers, 2,882 yards, at 6d..................	72	1	0
Nails, 441 per yard, 3,016 lbs. at 2d...............	25	2	8
Signal Wire, 1,760 yds. at 16.8 lbs. per 100 yds. = 2.64 cwts. at 41s.	5	8	3
Rollers, 480 at 4s.	86	0	0
Labour, 1,760 yards, at 4d.	29	6	8
Chain, 1,760 yards x2 = 3,520 at 13 lbs. = 408.57 cwts. at 19s. ...	388	2	10
Total cost per mile	£1,046	0	5

COST OF LEADING COALS.

The chain is estimated to last twelve years; the rails, which have already been in use for twenty-five years, are estimated to last forty years. The actual cost of keeping tubs in repair is taken, and the cost of grease and coals is made out from actual consumption.

Maintaining Engine-Plane FOR ONE YEAR

Chain	£5	14	6
Sheaves	1	14	8
Tubs..............	2	4	5
Rails and maintaining way	2	16	9
Grease	4	14	9
Coal (200 tons at 5s. 6d.)......	60	0	0
Repairs to engine and boiler	17	2	6
	£94	7	7

Labour	Per day of 9 hours—		
	1 engineman...		£0 3 2
	1 ginney tenter		0 1 8
	1 do.		0 1 0

			£0 5 10

	Days.		£ s. d.
Labour ...	274 @ 5s. 10d.	=	79 18 4
Maintenance for 1 year (as above)			94 7 7

Cost of leading per annum ...			£174 5 11

Cost of leading coals per ton per mile, up an average gradient of 1 in 71, the average distance led leing 0.210 miles, and the average quantity led being 157 tons per day;—-4.630d.*

* It is scarcely necessary to observe that this apparently high cost is entirely due to the small quantity of coals led, and the shortness of the chain road, and that, therefore, this cost does not appear to the prejudice of the Endless-chain system.

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ENDLESS-CHAIN SYSTEM.

REFERENCE TO PLATES.

As several of the plans and sketches of the Endless-chain gearing, etc., shown on the accompanying plates are not mentioned in the foregoing report, the following remarks may be useful in assisting to explain their arrangement and application :—

Plates XIII. and XIV. are two elevations of the driving wheel used at the Newchurch Collieries. These wheels are set in a frame of cast-iron, and have in the trod forks into which the chain passes; the chain, by this arrangement, is only taken half a turn round the driving wheel.

Plate XV. shows one of the methods of transmitting motion at curves or branch-ends. A similar arrangement is shown on Plates XIX. and XXI. On the latter, a sketch of the method of connecting two ginney roads by a short Endless-chain is given.

Plate XXX. represents the method of connecting the driving-gear at Towneley Colliery, near Burnley. The gearing at this colliery is extensively laid out, and affords one of the best examples of Endless-chain machinery in the country. Plates XXXI, XXXII, and XXXIII. are sketches of the arrangement for working branches at Towneley Colliery. By the method shown on Plate XXXI., the chain is carried, at the branch end, over two bearing-up pulleys, which drive the spur gear working the branch way. Plate XXXII. shows a method of working two branches by shafting and spur gear. The arrangement for working a heavy gradient, and that for disconnecting any of the ways from the main way, will be observed. Plate XXXIII. represents another method of transmitting motion by shafting and spur gear. Here the branches lie diagonally.

Plates XXXIV. and XXXVI. represent a method of working branches by a single chain. A reference to the sketches will show how this is effected. The arrows indicate the direction in which the chain moves.

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ENDLESS-ROPE SYSTEM, No 1.

INTRODUCTION.

The method of conveying coals by this system of applying the Endless-rope has hitherto been very rarely adopted. It is chiefly in operation in the Midland Counties.

The following planes have been reported on, but experiments have been made at the first only:—

I.—Shireoaks Colliery, Nottinghamshire—

Underground plane in a straight line, and rising towards the shaft.

II.—California Pit, Wigan—

Three underground planes, branching from the pit, and worked by one engine; a short curve on one of the planes.

Varieties of the No. 1 Endless-rope system are in operation at the following collieries:—

III.—Newsham Colliery, Northumberland—

Straight undulating plane, with no branches.

IV.—Eston Mines, Yorkshire—

A short rope working three branches from a main line.

V.—Cinderhill Colliery, Nottinghamshire—

Level plane, with no branches; Endless-rope worked at slow speed.

This system is a modification of the Tail-rope system. The following are a few of its chief characteristics :—

1.—The rope, as the name implies, is endless.

2.—To give motion to the rope a single wheel is used, and friction for driving the rope is supplied either by clip-pulleys, as at Shireoaks, Newsham, and Eston, or by taking the rope over several wheels, as at the Cinderhill and California Pits.

3.—As only one driving wheel is used, the rope has to be kept constantly tight; this is effected by passing it round a pulley fixed upon a tram, to which a hanging weight is attached.

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4.—Either one or two lines of rails are used—when a single line is adopted, as at Newsham, the rope works backwards and forwards, only one part of it being on the wagonway, and the other running by the side of the way; when two lines are used, as at Shireoaks, Cinderhill, and the California Pit, the rope moves always in one direction, and the full tubs come out on one line, the empties going in on the other.

5.—The set of tubs is connected to the ropes either by means of a clamp, as shown on Plates XL. and XLL, or by sockets in the rope, to which the set is attached by a short chain. The former method is in use at Shireoaks, Cinderhill, and the California Pit, whilst the latter is adopted at Newsham and Eston Mines.

6.—The working of curves and branches has hitherto been scarcely attempted by this system. At California Pit there is a slight curve on one of the ways, which works very well.

The various methods of applying this system are described in the following Reports of the planes visited.

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SHIREOAKS COLLIERY, NOTTINGHAMSHIRE.

C. Tylden-Wright, Esq., Manager ; Mr. John Jones, Resident Viewer.

The No. 1 Endless-rope system has been in operation at Shireoaks Colliery for about four years.

The engine by which the rope is worked is a double horizontal engine, with two 12 1/8 inch cylinders. The boiler is single tubular, with Galloway's cross tubes, and is placed underground at a very short distance from the engine.

DIMENSIONS OF ENGINE, BOILERS, ROPES, ETC.

[table]

[97]

[tables, diagrams]

Work Done ... 320 tons per day of 11 h. (1 h. allowed for meals).

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DESCRIPTION OF ENGINE-PLANE.

The engine-plane is laid with a double way; the empty sets going in on one side and the full sets coming out on the other. It was originally intended to have sets coming out and going in at the same time, but the limited quantity of coals now being drawn renders this unnecessary.

The plane worked by the endless-rope (see section on Plate XXXVIII.) is 750 yards long, with an average rise towards the shaft of 1 in 48; the heaviest gradient being 1 in 29. The same engine also draws coals along a single rope plane, 737 yards long, the average rise of which, towards the shaft, is 1 in 15.

One of Fowler's clip pulleys, 4 feet in diameter, is used, to give motion to the endless-rope. The wheel is in a horizontal position (see plan on Plate XXXVII.) and is connected by mitre gearing to the friction gearing by which it is worked. The pinion friction wheel is 2 feet 8 inches in diameter, and drives two spur wheels of 4 feet diameter, one for the clip pulley and the other for the single rope drum. The friction gearing is found to answer exceedingly well, and is very convenient for putting out of gear, a movement of 1/4 inch being sufficient to disconnect the wheels; this is effected by the shafts of the spur wheels being placed in eccentrics.

As it was found desirable, in the adoption of the clip wheel, to cause the rope to pass round as large a circumference of the wheel as possible, in order to get as much of the grasping effect of the clips as practicable, the ropes at a short distance from the clip wheel are crossed, as shown in sketch below.

[diagram]

In working the endless-rope by the clip-pulley, it is necessary to keep it very tight, as otherwise it is apt to slip out of the clips; this is effected by having the wheel inbye placed on a carriage moving on wheels, and tightened by a chain, passing down a small staple (as shown in next sketch) to which a weight of about 15 cwts. is suspended. The weight descends as the rope stretches, and thus constantly keeps the rope at the same tension.

[99]

[diagram]

The wire rope is 5/8 inch diameter and is made of steel, weighing 1.81 lbs. per yard. The rollers on the wagonway are of wood, 5 inches in diameter, and weighing about 14 lbs. each; they are placed about 15 yards apart.

The tubs used hold about 5.9 cwts. of coal, and there are 31 tubs in a set.

Wrought iron sounding bars, 3/4 inch in diameter, are used for signalling to the engineman; the run-rider carries a piece of iron, with which he strikes the sounding bar; the signal is heard very distinctly when the engine is standing, but when in motion the brakesman has to stand near the termination of the bar.

DESCRIPTION OF THE METHOD OF WORKING THE ENGINE-PLANE BY THE No. 1 ENDLESS-ROPE SYSTEM.

The rope in passing from the clip pulley on the outbye end, and to the tail wheel at the inbye end, goes under the rolleyway for about 80 yards, as will be seen by the plan on Plate XXXIX.; the tubs can thus pass over the rope in coming from the shaft.

[diagram]

In taking the set inbye, the tubs are coupled together at the bank-head, and the run-rider, who rides in the first tub at the front end of the set, first hooks the chain affixed to the clamp on to the iron loop at the end of the centre bar of the tub, and then fixes the clamp (Plate XL.) upon the rope, which is always upon the middle of the way; this clamp is closed by a handle-lever, passing over the curved end, and by the insertion of an iron pin (P) is kept firmly fixed without the pressure of the hand.

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The clamp has such a strong hold upon the rope, that in a case of the set being stopped by some obstruction, the rope has been found to break rather than slip through the clamp.

The clamp having been fixed to the rope, the run-rider strikes the sounding bar, and the rope moves forward, the man pressing upon the handles of the clamp to keep it perpendicular, and the tubs being pulled forward by the chain on the clamp. The set at the start is about 45 yards from the engine, and is on a gradient of 1 in 520 fall; the next or middle gradient is 1 in 47. As the set is found to overrun the clamps in going inbye at this latter gradient, 6 "sprags" are placed in the wheels of the tubs at the end of the set, to prevent the tabs getting together and becoming uncoupled. At a distance of 364 yards from the engine, and about the middle of the 1 in 47 gradient, the clamp is taken off the rope whilst in motion, and the set runs forward by itself. When the clamp is disconnected, the run-rider raps to the engine—though the running away of the rope when disconnected is sufficient to let the brakesman know—and the rope is stopped, the engine then being free to work the single rope way.

There are two stations from which coal is being drawn at present; the first being 640, and the second about 795 yards from the engine. When the " gang" or " set" has to go to "No. 15," or the first station, the points are placed for this, and the set, then disconnected from the rope, runs round the curve into the station; the rope at this curve passes under the rolleyway, so that with this arrangement the clamps could not pass this point. When the set is intended for the far-off station, or "No. 13," it runs down by itself from the "knock-off" point, the " spraggs " being taken out, when necessary, by a boy, who rides with the set for the purpose.

In coming outbye,* the clamp is also placed at the front end of the full set, which is pulled out to within 140 yards of the engine, when the clamp is removed, and the tubs run forward to a point from which they are taken to the shaft by horses.

When bringing the full tubs out, the strain of the full set upon the clamp chain raises the rope a little and prevents the clamp from striking the rollers; but in going inbye, where there is much less strain, the clamp, in passing over the rollers, touches them slightly.

* The expressions outbye and inbye, which occur frequently in this Report, are terms used in the North of England; the former to denote the end of the engine plane nearest to the shaft, and the latter the end nearest to the workings of the mine.

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The engine cannot pull coals from the endless-rope way and the single rope way together; and, if this were possible, it would be hardly worth while, since it never goes for more than 3 1/2 minutes at a time in working the endless-rope.

ABSTRACT OF EXPERIMENTS WITH INDICATOR.—MARCH 15th, 1867.

[table]

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DEDUCTIONS FROM EXPERIMENTS WITH INDICATOR.

I. - Power required to drive the engine alone (D) :-

At 80 strokes per minute.........	5.8	horse-power.
100 do. do.........	5.7	do.
116 do. do.........	6.4	do.

II—Power required to move endless-rope alone (C):—

	Engine and Ropes.		Engine alone.		Horse-power.
At 80 strokes per minute ...	18	—	5.8	=	12.2
100 do. do.	22.6	—	5.7	=	16.9
116 do. do.	26.6	—	6.4	=	20.2

III-—Power required to take set of 31 empty tubs inbye, down an average gradient of 1 in 84, at an average speed of 7.20 miles per hour (A):—

	Engine, Ropes, and Set.		Engine, etc		Horse-power.
At 90 strokes per minute ...	24.5	—	20.3	=	4.2

IV.—Power required to bring out a full set of 31 tubs up an average gradient of 1 in 48, at an average speed of 7.36 miles per hour (B):—

	Engine, Ropes, and Set.		Engine and Rope.		Horse-power.
At 89 strokes per minute ...	62.28	—	20.17	=	42.11

The experiment (E) was made in order to ascertain the saving of power effected by running both full and empty sets together. This is shown to be as follows :—

	Horse-power.
Average horse-power required to take in empty set (A)	24.50
Do. do. bring out full set (B)	62.28

	86.78

Average power required to work both sets together, 50.6 horse-power ; this, when averaged with the power given in experiment 3, series B, gives as the average power expended 47.97

Difference.................	38.81

AVERAGE HORSE-POWER EXPENDED UPON SET, ROPES, AND ENGINE

	Going Inbye - 90 strokes per minute. Horse-power.			Coming Outbye - 89 strokes per minute. Horse-power.	
SET......	4.2	... 17 per cent.	...	42.11	... 68 per cent.
ROPES	14.5	... 59 do.	...	14.37	... 23 do
ENGINE	...5.8	... 24 do.	...	5.80	... 9 do
	-----	----		---------	---
	24.5	100		62.28	100

[103]

EXPERIMENTS WITH DYNAMOMETER.

[table]

These experiments were made with a set of thirty-one tubs, the dynamometer being placed between the first and second tubs.

[diagram]

A piece of iron (A), placed between the two tubs, kept them at a regular distance apart, and prevented the possibility of the chain, by which the dynamometer was suspended, becoming slack.

TOTAL FIRST COST OF WAGONWAY PLANT.

	£	s.	d.
Engine	£240	0	0
Friction gearing...............	72	15	0
Drums....................	35	0	0
Boilers....................	210	0	0
Steam and exhaust pipes	40	15	3
Hot water cistern	28	0	0
Ropes, 65s. per cwt.......	83	9	9
Sheaves....................	19	0	0
Wagonway (including rails, sleepers, nails, signal rods, &c.)	261	4	1
Tubs, 256 @ 39s...............	499	4	0
Coupling chains	10	6	11
	£1499	15	0

[104]

COST PER MILE OF ENDLESS-ROPE WAGONWAY.

DOUBLE LINE OF RAILS.

Rails, 1760 yds. x 4 x 18 lbs. per yd. = 1131.43 cwts. @ 8s. £452 11 5

Sleepers, 3520 (3 ft. 3 in. x 6 in. x 2 1/2 in.), @ 4d. ...		44 0 0
„ 440 (8 ft. x 6 ft, x 2 1/2 in.), @8d.......	14 13 4	
Nails, 9.24 cwts. @ 22s.	10 3 4	
Rapper Bars, 1760 yds. of 0.76 iron, @ 9s.		32 15 3
Rollers, 3520, 1 every 15 yds. = 235, @ 2s.	23 10 0	
Labour, 1760 yds. @ 4d.	29 6 8	
Rope, 3520 yds. @ 1.81 lbs. per yd. = 60.37 cwts., @ 65s.		196 4 0
Apparatus for tightening rope...	17 0 0	

£820 4 0

COST OF LEADING COALS.

Maintaining Engine-plane for one year-

	£ s. d.	
Ropes.................		56 2 6
Clip-pulley		1 16 0
Rollers		8 0 0
Tubs	37 18 6	
Rails and maintaining way.........		12 9 0
Grease.................	39 7 2	
Coals (243 tons, at 3s. 6d.).........		42 10 6
Repairs to engine and boilers		30 15 0

£228 18 8

Labour ...... Per day of 11 hours.

	£ s. d.
Engineman	0 3 7
Fireman	0 1 4

1 wagon way man or platelayer	......	0 2 6
Greaser (for sheaves)	....	0 0 4
1 run-rider	....	0 3 6
1 do.	....	0 1 6
1 do.	....	0 1 3
2 coupling boys	....	0 1 3
1 station boy	....	0 2 6

		£0 17 9

	Days.	£ s. d.
Labour ...	300 @ 17s. 9d. =	266 5 0
Maintenance for 1 year (as above)		228 18 8

Cost of leading per annum ...		£495 3 8

Cost of leading coals per ton per mile, up an average gradient of 1 in 48, the average distance led being 0.365 miles and the average quantity led being 320 tons per day;-- 3.390d.

[105]

Since this colliery was visited, the length of the endless-rope plane and the quantity of coals led, have been increased. About 400 tons per day are now led an average distance of 0.524 miles, without any further employment of labour. When worked out upon the cost of leading, with allowance for the increased quantity and distance, this reduces the

cost of leading per ton per mile to 2.061d.*

* In the " Summary of Report" this cost is taken as the actual cost of leading.

[106]

CALIFORNIA PIT, NEAR WIGAN.

A. Hewlett, Esq., Manager; Mr. J. Lancaster, Resident Viewer.

At this pit the endless-rope is worked on the same plan as that in operation at Shireoaks Colliery. As experiments were made at Shireoaks to show the power required for a certain gradient with this endless-rope, it was thought that a few notes of the mode of applying the system at the California Pit would be sufficient to show anything different in the application of it from what has been already described.

The engine by which the planes are worked is underground. It has two 14-inch cylinders and a 2-feet stroke.

There are three distinct planes worked by this engine, all falling from the shaft. The following are some general particulars of each of the planes :—

Name.	Length.	Average gradient. (Approximate.)	No. of tubs per set.	Time required to bring set out.	Tons led per day.
North Level ...	620 ...	3/4 in. per yd. ...	20 ...	3 min. ...	130
Down Brow ...	1370 ...	2 1/2 „ ...	12 ...	4 „ ...	120
Duke's Slant ...	740 ...	3 „ ...	20 ...	7 „ ...	180

The tubs used hold 6 cwts. Each of the three ways is worked by two driving-wheels, acting as one wheel with a double trod ; these wheels are all close to the engine, and are horizontal. As will be seen on plan of arrangement of engine (Plate XLII.) motion is transmitted to the driving-wheels by mitre-gearing. By an arrangement not shewn on sketch, each of the driving-wheels can be put in and out of gear when necessary ; the three handles required for this are close together in the engine-house, and mitre-gearing is also used for working them.

The rope used for all the ways is of steel, 5/8-inch diameter. The planes have been at work about three and a-half years, and the duration of the ropes is found to be about three years.

The rollers on the plane are six and a-half inches in diameter, and are placed about twenty yards apart.

DESCRIPTION OF METHOD OF WORKING THE PLANE.

As at Shireoaks, the ropes have to be tightened, in order to prevent them from slipping off the pulleys at the two ends of the planes. The tightening is effected by having, a few yards from the double driving-wheel, another pulley fixed on a moveable tram, round which the rope is passed. A chain is attached to this tram, to which a weight is con-

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nected; this weight is hung in a staple, as shewn below, and keeps the rope constantly tight.

[diagram]

The weights required to tighten the rope for each of the ways are—

North Level .... 30 cwts.

Down Brow .... 30 ,,

Duke's Slant .... 40 ,,

All the arrangement of driving-wheels and tightening pulleys is under the way. The rope comes on to the wagonway about eight yards from the driving-wheel.

As will be seen by the particulars of planes given above, the number of tubs in a set is twelve on the Down Brow and twenty on the other planes. The highest average speed is on the Down Brow way, where the tubs run at a speed of 11.7 miles per hour.

A double way is laid the whole length of each plane. On the Duke's Slant and Down Brow ways an empty set is taken in and a full set brought out simultaneously, and as the gradient of both of these planes is considerable, the load upon the engine is lightened by this arrangement. The two planes referred to are sometimes worked together in this way, but they cannot be worked at the same time when the engine is hauling the full coals out, without the assistance of the ingoing empty tubs. This double journey on both of the planes requires the services of four gang-riders. There is only one regular gang-rider; and when others are required, they are taken from the stations at the inbye ends of the planes.

The clamp used at this pit for connecting the sets of tubs to the rope (see Plate XLI.) is different from that used at Shireoaks, in being secured by a ring passing over the ends of the arms, instead of a lever.

On the Duke's Slant and Down Brow ways the rope is connected to the set at the fore end in coming out, and at the back end in going in; and on the North Level, the gradient of which is much lighter, the set is connected at the fore end in going both directions.

There is a short curve of four chains radius on the North Level way, round which the rope and clamp pass easily, though not at a higher speed than seven miles per hour.

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NEWSHAM COLLIERY, NORTHUMBERLAND.

G. B. Forster, Esq., Manager; Mr. W. Charlton, Resident Viewer.

At this colliery the No. 1 Endless-rope system is worked, as at Shireoaks, by the clip-pulley.

The chief peculiarities in the working of this engine-plane are as follows :—

1.—Only one way is used, the empty and full tubs running on the same road, and half of the rope being carried on sheaves by the side of the way.

2.—Instead of the "clamp," used at Shireoaks, the set of tubs is connected to the rope by two short chains, one end of the chain being secured to the tub at each end of the set, and the other attached to a socket in the rope.

3.—The plane is undulating, and thus presents one of the most awkward difficulties to contend with in the working of this system.

The endless-rope is worked by a clip-pulley, driven by one of Fowler's engines, (see Plate XLIII). It is placed underground, and is worked generally at a speed of eighty-five strokes per minute with a pressure of 80 lbs. of steam.

DIMENSIONS OF ENGINE, BOILER, ROPES, Etc.

Engine erected, 1867.

[table]

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[table]

DESCRIPTION OF ENGINE-PLANE.

The engine-plane is laid with flat-bottomed rails, weighing 28 lbs. per yard. There are two very slight curves on the plane, round which the main rope works easily in the centre of the way. The rope by the side of the way is taken round these curves by 3-feet sheaves.

The length of the plane is 836 yards. The road (see section on Plate XLIV.) first rises from the shaft at a gradient of 1 in 40 for a distance of 318 yards, and then falls for a distance of 379 yards, at an average gradient of 1 in 47, the average gradient of the plane being a fall towards the shaft of 1 in 805.

The rope used is steel. By means of a bearing-down pulley, the rope is made to move in nearly the whole circumference of the clip-pulley (see Plate XLIII). The rope has been in use for eighteen months, and is expected to last another year. It is kept tight, as at Shireoaks, by having a hanging weight attached to the sheave at the inbye end of the engine-plane. The weight used here is about 25 cwts.

DESCRIPTION OF THE METHOD OF WORKING THE ENGINE-PLANE.

The full and empty tubs are run in sets of thirty-two tubs. The sets are attached to the rope by chains, 7 feet long, as shewn in the next sketch.

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There are two sockets in the rope, placed at a distance apart convenient for the attachment of a set of thirty-two tubs, to which these

[diagram]

chains are connected. The chains are put on at both ends of the set, the undulations of the plane rendering this necessary. The connection with the set is made simply by hooking on, and with the rope by a screw shackle.

At each end of the plane the rope passes under the way, and in going in and out, when the set comes to this point, it is disconnected from the ropes, and the gradient of the way is so arranged that it runs by itself into the siding.

In going from the shaft, the set of tubs having fallen to the point at which the rope passes from under the way, the chain is attached to the fore end of the set; the engine then moves the set forward over a distance equal to the full length of the set, and the back chain is hung on. The moving of the set forward causes the coupling chains between the tubs to become tight, and the danger of the set over-running the chain at the fore end of the set, when the gradient tailing from the shaft (point A on Plate XLIV.) is reached, is thus avoided.

There are no swivels on the chains connecting the set to the rope, the tightness of the rope rendering them unnecessary.

The sets are taken in and outby, at an average speed of ten miles per hour. In disconnecting the set from the rope at the inbye end, the chain at each end of the set is taken off the tubs, but is not disconnected from the socket on the rope ; this is done before the set reaches the siding, whilst it is moving slowly ; when detached, it runs forward into the siding. At the shaft the leading chain is disconnected from the rope first, and then from the tub ; this is done to allow the shackle to pass over the clip-wheel, which is placed rather close to the terminus of the engine-plane. The chain, at the other end of the set, is taken off the tubs only.

The cost of labour required per day in the working of this plane is as follows :—

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	£	s.	d.
1 engineman..............	£0	4	0
1 boy.................	0	1	9
1 wagonwayman	0	3	6
1 man (at shaft).................	0	3	0
1 man (at sheave station)........	0	2	6
	£0	14	9

The first cost of the engine, including boiler, was £537, and the first cost of the clip-pulley, £102.

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ESTON MINES, YORKSHIRE.*

Resident Viewer, Mr. Thomas Lee.

The No. 1 Endless-rope system has lately been applied at these mines, to work the junction of three inclines, and by its adoption four horses and two boys have been dispensed with. The rope is worked by a clip-pulley, driven by one of Fowler's engines.

The method of applying the rope will be seen on referring to the plan on Plate XLV. At the bottom of each of the inclines, which are self-acting, and lead at heavy gradients to day-drifts, there are sidings for the full and empty wagons. XY is another siding, at the top of an incline, which is not shewn on the plan, and the endless-rope is used to convey the full wagons from the three other sidings to this, and the empty wagons back again.

DIMENSIONS OF ENGINE, BOILER, ROPES, Etc.

[table]

* The arrangement of endless-rope at these mines has lately been abandoned, owing to one of the inclines being laid off, thus leaving the engine insufficient work to do.

Whilst the system was in operation, a saving of upwards of £200 per annum was effected,

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DESCRIPTION OF METHOD OF WORKING THE JUNCTION BY THE ENDLESS-ROPE.

The rope is shewn on the plan (Plate XLVII.) by a dotted line, and is kept tight by a hanging weight attached to the sheave S, which is placed on a tram.

At the points A, B, C there are links or sockets in the rope, by means of which the connection between the rope and the sets of full and empty wagons is made. Each of the links has a certain position to which it is always brought back by the engine, after having been used in moving a load of wagons.

The link A is used for drawing the empty wagons on to the siding of No. 1 incline, and the full wagons from both Nos. 1 and 2 sidings to the siding XY.

The link B draws the empty wagons to No. 2 siding, and the link C on the siding of No. 3 incline conveys the wagons to and from the siding XY. Thus the whole of the work is managed with three links. These links are shewn on the plan in their usual position, A and C each being ready to draw an empty set in their respective sidings. When an empty set is required for the siding of No. 2 incline, the link A brings the set to the points at P, whence it is conveyed by the link B. The wagons are run in sets of twenty at a time.

Suppose a set of empty wagons had to be taken into the siding of No. 1 incline. By means of a short two inch steel chain, with a hook at each end, the set is attached to the rope. The engine draws the set upon the siding to the point T, and it is then disconnected from the rope. Should a set of full wagons be ready for removal to the siding XY, the rope is attached and is brought back to its original position. If no wagons are ready, the engine draws the rope back by itself.

The speed at which the engine can work causes the bringing back of the links to their ordinary places to be so quickly done, that no stoppage is caused.

The rope is also frequently used in bringing the full sets on to the sidings when they fail to run far enough on the self-acting inclines.

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CINDER HILL COLLIERY.*

BABBINGTON AND CINDER HILL COLLIERIES, NEAR NOTTINGHAM.

John Daglish, Esq., Manager and Receiver.

The No. 1 Endless-rope system, as adopted in the No. 4 Pit, Cinder Hill Colliery, differs in its application from the engine-planes previously noticed in being worked at a slow speed, and in taking several sets of tubs in and out at the same time.

The friction necessary for driving the rope is obtained, as at the California Pit, by passing the rope round several sheaves, five being the number employed in this case.

The following are some of the data respecting the engine, boilers, ropes, ways, etc. :—

[table]

* Since the first part of this Report was in the press, permission has been obtained to visit this colliery.

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DESCRIPTION OF ENGINE-PLANE.

The length of the engine-plane is 1170 yards. As at the Shireoaks and California Pits, there is a double line of way at this colliery, the full and empty tubs running on different roads. There are no branches, and the gradient of the plane is level throughout. There is one curve, which is 66 yards in radius.

As will be seen by the sketch on Plate XLVI., the engine has one horizontal cylinder, and works the driving-wheel on the second motion, the proportion of the strokes of the engine to the revolutions of the driving-wheel being as 4 : 1. The method of obtaining friction for the rope will be seen on reference to Plate XLVI. The rope is taken round five wheels of 8 feet diameter, and passes from the upper side of one to the lower side of the next, and so on. The rope is kept tight by having a screw applied to the shifting carriages of the wheels A and B. A plan of the engine-plane is shown on Plate XLVII. The horizontal wheels are all under the wagon way.

A single rope incline is also worked by the engine driving the endless-rope.

DESCRIPTION OF METHOD OF WORKING THE ENGINE-PLANE.

The endless-rope at this colliery is driven at a speed of about two and a-half miles per hour.

The usual number of tubs in a set is thirty-six. Sometimes, but very rarely, there are three sets of full, and three of empty tubs in motion at once, but usually there are not more than two sets on one road and one on the other.

The sets of tubs are connected to the rope by means of a clamp, similar in construction to, and applied in the same way as that used at the California Pit (see Plate XL.). Between the tub and the clamp there is about 10 feet of chain. One man travels on foot with each set. When the set has to be connected to the rope, the clamp is attached to the rope whilst in motion, and the attendant keeping it upright by his hand, walks with every set to the shaft or to the engine, as the case may be. Thus, should six sets be in motion at one time, six attendants are necessary. At the curve A (Plate XLVII.) the rollers are placed five yards apart, and between each roller there is a small drum sheave. The clamp passes round the curve with the rope without any difficulty.

The rope is found to last about three years, and the clamps, which cost 4s. each, about five years. Three tons of coal are consumed per day.

To ascertain the power required for working this application of the endless-rope, the following experiments were made with the indicator.

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ABSTRACT OF EXPERIMENTS WITH INDICATOR.

[table]

DEDUCTIONS FROM EXPERIMENTS WITH INDICATOR.

I.—Power required to drive engine alone (C):—

At 34 strokes per minute........... 1.68 horse-power.

II.—Power required to drive the endless-rope alone, no load being connected (B):—

	Engine and Ropes.			
At 34 strokes per minute ...	7.99	— 1.68	=	6.31 horse-power.

III.—Power required to draw 2 sets of 34 full, and 2 sets of 34 empty tubs, along a level engine-plane, at a speed of 2 1/2 miles per hour (A):—

	Total Power.	Engine, etc.		
At 34 strokes per minute ...	13.60	— 7.99	=	5.61 horse-power.

In the working of the endless-rope at this colliery, the cost of labour required per day is as follows:—

1 engineman	....	£0 3 6
1 fireman	....	0 2 6

3 men attending sets with clamps ...	0	9	3
3 men preparing sets of full tubs	0	10	6
1 man and 1 boy preparing sets of empty tubs	0	5	4
1 boy coupling empty tubs	0	1	4
1 boy cleaning road	0	1	4
1 greaser.......................	0	1	4
1 road repairer....................	0	2	0
	£1	17	1
Deduct proportion of this labour due to single rope plane	0	3	0
Total cost of labour per day	£1	14	1

The cost of leading the coals on this plane is let by contract, at the rate of 1 1/8d. per ton for labour alone; including the extra labour, the cost will be about l 3/8d. per ton, or 2d. per ton per mile.

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ENDLESS-ROPE SYSTEM, No. 2.

INTRODUCTION.

This system of conveying coals is only in operation in the Wigan district, where it has only been in use for a few years. Of the four systems reported on it is probably the least known.

Reports are given on the following planes. Experiments were made and costs extracted at the Bridge and Meadow Pits only:—

I.—Bridge Pit—

Several planes at work, with an average gradient rising towards the shaft. One self-acting curve working.

II.—Meadow Pit—

Single plane rising towards the shaft.

III.—No. 5 Moor Pit—

Single plane, rising at a heavy gradient towards the shaft.

IV.—Mesnes Colliery—

Undulating plane, worked by an engine on the surface.

V.—Scot Lane Pit—

Single short plane, with peculiar method of connecting the tubs to the rope.

The principle on which No. 2 Endless-rope system is worked is very similar to that of the Endless-chain system.

The following are the chief peculiarities in the application of this system:—

1.—A double line of rails is used.

2.—The rope rests upon the tubs, which are attached to the rope either singly or in sets of tubs varying in number from two to twelve.

3.—The connection between the tubs and the rope is effected by a short chain, which is secured to the rope in a way hereafter described.

4.—As with the Endless-chain, the tub or tubs are placed at a regular distance apart, and the rope is driven at a slow speed.

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5.—Motion is given to the rope by large driving pulleys, and friction is obtained by taking the rope several times round the driving pulley.

6.—Curves can be worked by this system.

There are no instances of branches being worked by this method of conveyance, but, as will be seen by the following descriptions, this could very easily be arranged for.

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BRIDGE PIT, NEAR WIGAN.

A. Hewlett, Esq., Manager; Mr. J. Lancaster, Resident Viewer.

The No. 2 Endless-rope system has been at work at this colliery about three years, and is here more extensively applied than at any of the collieries in the district.

The engine (Plate XL VIII.) working the planes at this pit is a double 20-inch cylinder horizontal engine, with a stroke of 3 feet 6 inches ; the boilers are underground, at a distance of 150 yards from the engine. Unlike the general adaptation of ropes in this district, the ropes on the planes are worked by a main driving rope, motion being transmitted by having two pulleys on one shaft. (See plan of engine-plane on Plate XLIX.) This was necessitated by the distance of the engine from the point to which the coals are led. The rope is driven by a main pulley, 14 feet diameter, working on the third motion. The ratio of the strokes of the engine to the revolutions of the pulley is as 7.4 to 1.

DIMENSIONS OF ENGINE, BOILERS, ROPES, Etc.

[table]

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[tables, diagrams]

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DESCRIPTION OF ENGINE-PLANE. These planes are laid with round-topped bridge rails in 12 feet lengths, weighing 18 lbs. per yard. All the planes are laid with a double line of way, one line for the ingoing empty tubs, and the other for the full tubs coming out. The general size of the wagonway is 10 feet by 4 feet, it having been originally made this size. The average gradient of all the ways together is a rise towards the shaft of 1 in 62, the chain brow way (see Plate XLIX.) being a rise to the shaft of 1 in 54, the slant way a fall towards the shaft of 1 in 47, and the main road a rise to the shaft of 1 in 18, part of it at the inbye end rising towards the shaft at a gradient of 1 in 5.5.

With the exception of the curve on the chain brow way, all the planes at this colliery are quite straight.

DESCRIPTION OF ARRANGEMENT OF ROPES.

The total length of the main driving rope, which is steel, and of 1 1/4 inches diameter, is 787 yards. It passes two and a half times round the driving pulley at the engine, and the outgoing rope goes past the shaft to the tightening pulley A (see Plate XLIX.) This pulley is placed on a strong tram, and the rope is tightened by means of a screw attached to the tram; the other end being secured to a piece of fixed timber.

There are two sets of pulleys near the shaft; one B, for working the main way and the slant way connected with it, and the other C, for working the chain brow way. The driving rope in coming from the tightening pulley passes once round the pulley C, and twice round B, there being a much greater load on the plane worked by the pulley at B. These two pulleys and the tightening pulley are 9 feet in diameter. The tightening pulleys are usually 5 feet in diameter ; but it was expected, when this was erected, that it would have to work another engine-plane. The smaller sheave, on the shaft B, is 6 feet in diameter, and that on C, 5 feet. They are put in and out of gear by an apparatus very similar to that used in the working of the Endless-chain system.

The rope working the main road is of steel, and 1 inch diameter, and that on the chain brow way the same diameter of iron. The main road rope passes round a tightening pulley D at about 690 yards from B, and it then passes twice round the pulley E. There are two pulleys on this shaft, that for the driving rope being 6 feet diameter, and that working the slant way 5 feet diameter. The slant way rope (1 inch iron) is tightened at the outbye end by the apparatus at F. (The method in which these ropes are arranged is shown on Plate XLIX.) The

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chain brow way is not straight like the main and slant ways, but has a curve at H, round which the rope passes by means of two 4 feet 6 inch-pulleys, placed horizontal. This curve is at an angle of about 118°, and the rails are laid at a radius of only 5 yards. The rope passes round the tail sheave J, which, as is usual in working a single way by this system, also acts as a tightening pulley ; the tram on which the pulley is placed being fixed as before described. The ropes have just half a turn round the tightening pulleys, and two and a half turns round the 6 feet and 5 feet driving pulleys at C and B.

DESCRIPTION OF THE METHOD OF WORKING THE ENGINE-PLANE BY THE No. 2 ENDLESS-ROPE SYSTEM.

The tubs on the main road are taken in and outbye in gangs of two at a time, 20 yards apart, the heavy gradient at the inbye end preventing a greater number than this from being together. On the chain brow way the tubs are brought out and taken in one at a time, 20 yards apart; and on the slant way, where most of the coals are coming out, from two to twelve tubs at a time are brought out, no regular distance being observed.

The tubs are connected to the rope by means of chains. If the gradient be regular either way, only one chain is put on, at the end of the tub going to the rise. At the Bridge Pit, owing to the way for some distance from the shaft being nearly level, it is necessary to attach chains at both ends. At the point H (see Plate XLIX.), on the chain brow way, the gradient becomes a heavier dip inbye, and a boy stationed here takes the fore chain off the ingoing empty tub, and lays it on the top of the full tub, which comes out with a chain attached to the fore end only. On the slant way only one chain is put on to the ingoing empty tubs, but an irregularity in the way makes a chain at each end of the full tubs requisite.

METHOD OF CONNECTING THE TUBS TO THE ROPE BY CHAINS. The chains by which the tubs are attached to the rope are of 3/8 inch iron, 6 feet long, with a hook at each end. They are connected to the tub as shown in the sketch on the opposite page.

The fore end of the tub is first connected to the rope; this is done by attaching one end of the chain to the second link of the coupling chain of the tub, and throwing the other end over the rope, which is constantly in motion. The chain is then passed twice over the rope, the hand being introduced under the rope to receive the coils, in order to

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let the chain slide loosely on the moving rope till the hook is secured. When the right number of coils of chain (two in this case) has been passed over the rope, the hand is withdrawn, the point A is brought

[diagram]

over the hook, and the chain is pulled tight; it is not until the chain is securely fixed that the weight of the tub is allowed to come upon the chain. The sketch (No. 2) shows the chain just when it has been passed over the hook. When the full weight of the tub is upon the chain, the coils get quite close together and form a very compact and secure fastening. An expert " hooker on" does not need to put his hand between the coils, but passes the chain round the rope, and secures it before the rope has time to move on. The chain, at the back end of the tub, is attached in a similar way to that described above, but with three coils instead of two; this is necessary at the Bridge Pit, owing to the heavy weight of the tub upon the chain for a short distance in going inbye. The tubs on the other planes at this pit are attached in a similar manner. When two or more tubs are put on the planes together, chains are fixed on to the fore and back ends of the " gang," or at one end only, as the case may be. The chain is disconnected from the outcoming tubs, at the back end, by unhooking the chain from the tub; it is then easily loosened from the rope. At the fore end the chain is tight, and the foot is placed upon it, pressing it down, and making it loose enough to admit of disconnection. There is more labour required in the disconnecting than in the attaching at this pit. This description has reference to the taking off of the full tubs at the end of the main road, and here there is a rise towards the shaft. At some other places the terminus of the full way is made to dip slightly, and the chains are removed just when the tub, passing over the brow, loosens the chain at the fore end. On the other hand, the labour required for attaching the empty tubs is less than at other places; here the empty way is made to rise slightly, and the fore

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chain is put on first, and one boy is able to manage both. At another pit (No. 5 Moor), where the empty way, at the start, falls inbye, both chains have to be put on together, thus requiring two boys.

At the top of the main road way at the Bridge Pit, a boy stands about 20 yards from the place to which the full tubs come, and removes the back chain, leaving it hanging on the rope by the hook; it is taken off by the man who disconnects the chain at the fore end, and together with the other chain, is thrown over by him to the place where the empties are hooked on.

The usual time for attaching both chains to the empty tub is about twelve seconds, the minimum time being six seconds, and the time for disconnecting is rather more. Sometimes a stoppage is caused by the fastening of the chain being difficult to disentangle, and the man disconnecting has then to rap to stop the engine, to prevent the tub from reaching the pulley.

The chain is very seldom known to slip on the rope ; when it does, the damage done is often rather heavy, since, should the fore chain slip, the tub going on to the back chain is generally upset, or in the absence of the back chain, it may rest on the plane till the next tub comes up to it, the chain of which not only often knocks the tub off the way, but is sometimes broken itself, and as it is difficult to tell at the engine when such an occurrence takes place, there is much damage done before the engine is stopped. The chief accidents to tubs usually occur at the heavy gradient on the main way at this pit, for should a weak link in the connecting chain break whilst the tub is on this gradient, the tub getting loose generally breaks several other chains and tubs below it.

The slow speed at which the tubs go—being 1.35 miles per hour on the main road, and 1.126 miles per hour on the other ways, is necessary to prevent accidents to the tubs. The rope rests upon the tubs, and unless the way is laid perfectly straight, it is a slight distance from the centre of the tub ; a small angle at a joint of the rails is sufficient to cause this deviation, and should the rope catch any irregularity on the top of the tub, it will sometimes overturn it ; to avoid this much attention is paid to keeping the tubs in good repair, and this partly accounts for the heavy cost of maintaining tubs at this pit.

In the working of the endless-rope at this colliery the apparatus for putting the driving-wheels in and out of gear is found to be indispensable ; such an apparatus is at both the driving-wheels, B and C, and at E at the bottom of the main road. Thus the chain brow, the main road, and the main road with the slant way, can each be worked

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separately; the workings at the inbye end of the main road serve to keep the main way supplied for a short time, when it is necessary to put the slant way out of gear. The lower driving-wheel, at the points B, C, and E, is fixed, and the upper, loose on the shaft, being put in gear by a catch box worked by a lever; the pulleys can be put into gear whilst the driving-wheel is in motion, but the engine is usually stopped in taking out of gear, as the edge of the catch box is liable to get chipped by striking against the fixed part of the boss.

There are two curves on the engine-plane at this colliery, one at the bottom of the main road worked by disconnecting and reconnecting the tubs, and the other which self-acts on the chain brow way. At the former, which turns round an angle of 72°, the motion is transmitted from one pulley to another on the same shaft, as shewn by sketch below (also plate XLIX.). The road is laid round the curve at such an inclination, that the full and empty tubs when

disconnected run by themselves to the place where they are again attached to the rope. There are five hands required here, four boys and one man.

[diagram]

This curve might probably be made to self-act, like the curve at the chain brow way, by means of four or more pulleys, but when it was originally arranged, it was intended to draw a large quantity of coals from other districts besides the slant way.

The curve on the chain brow way is, as before described, of about 5 yards radius, and at an angle of 118°. The ropes are taken round by two 4 feet 6 inch pulleys, each inclining slightly towards the "coming on" side.

[diagram]

The way for the full tubs is laid nearly level, and for the empty a slight rise from the shaft. This arrangement after many experiments having been found to act most efficiently. The pulley wheels are made with

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a large flange on the lower side, to prevent the rope slipping off, and to enable the knot of the chain, connecting the tub to the rope, to pass easily into the trod of the wheels. The use of four pulleys instead of two at a curve of this description would enlarge the radius of the curve, and cause a smaller part of the surface of each wheel to be touched by the rope. Slow speed appears very necessary for working a curve by this system, for the jerk, which occurs when the tub, in passing round a curve, starts away after being stationary for a moment, would probably not fail to cause an accident if taken round at a much higher speed.

A boy, placed near this curve for the purpose of taking off the chains at the fore end of the ingoing tubs, also attends to the curve when necessary.

Near the inbye end of the slant way there is a " flat" at which the tubs are taken off and put on, whilst the tubs passing to and from the terminus are in motion. The place is laid with flat sheets for a few yards, nearly on a level with the rails. The empty tubs are disconnected, and brought under the rope between two outcoming sets of full tubs. Points are laid on to the full way, and a full set or gang of two or more full tubs is put on, when the slackness of the rope indicates a long distance between two full sets.

APPARATUS FOR TIGHTENING ROPES. The tightening pulleys, as used in this system of conveying small sets of one or more tubs by the endless-rope, are fixed, and not similar to those used for the No. 1 Endless-rope at Shireoaks and other places, where the varying strain upon the rope, owing to the set of tubs being at different parts of the plane, makes it desirable to have the tightening apparatus moveable.

[diagram]

The pulley is fixed on a strong timber frame, to which a screw is attached. The screw is secured by a chain to a balk placed upright, as shown in sketch.

It is doubtful what strain is the effect of these tightening screws, but the engineer gives the following as what he estimates to be about the strain exerted.

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Tightening pulley at shaft			....	30 cwts.
Do.	do.	for Slant way	....	10 „
Do.	do.	for Chain brow	....	5 „
Do.	do.	for bottom of Main way		5 „

The wagonway men, or "pushers-on," regulate these screws according to the state of tension in which they find the rope.

The method of splicing the ropes, to make them endless, is the same as that usually adopted. The length of the splicing depends upon the size of the driving wheel, and the number of times made round it by the rope; thus the main way rope was spliced for 18 yards, this being rather more than two and a-half times round the driving wheel.

The engine only having been at work about three years, they are scarcely able to tell yet the duration of the ropes. It is found that the main driving rope is soonest worn, it being finished in about two years. The other ropes are worn in two ways; first, by the friction of the coils of rope upon the pulleys, and second, by the moving of the rope upon tubs. Judging from their present appearance, they are estimated to last seven years.

EXPERIMENTS WITH INDICATOR.

The engine was kept continually at the same speed, and the number of tubs upon the plane counted at the conclusion of each experiment.

Experiment G (engine alone) was made by taking the key out of one of the geared wheels, and allowing it to run loosely on the shaft, there being no apparatus for putting it out of gear.

ABSTRACT OF EXPERIMENTS WITH INDICATOR.—April 17, 1867.

[table]

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DEDUCTIONS FROM EXPERIMENTS WITH INDICATOR.

I.—Power required to work engine alone (G):--

	Horse-Power
At 30 strokes per minute.................	8-59

II.—Power required to work main driving rope (F) :—

	Total Power.		Engine alone		Horse-Power.
At 30 strokes per minute	11.35	---	8.59	-	2.76

III.—Power required to work all the engine roads together, 189 full tubs and 154 empty tubs being in motion, up an average gradient of 1 in 62, at a speed of 1.126 miles per hour on the branch ways, and 1.35 miles per hour on the main way, the total length of rope at work being 4730 yards, and the coals led per day of 10 3/4 hours being 400 tons, the engine working about 8 hours (A) :—

	Total Power.		Engine and Main-rope.		Horse-Power.
At 30 strokes per minute......	42.98	—	11.35	=	31.63

IV.—Power required to work main road and chain brow ways (B) :—

At 30 strokes per minute......	30.63	---	11.35	=	18.28

V.—Power required to work main road and slant ways (C) ;

At 30 strokes per minute......	28.07	—	11.35	=	16.72

VI.-—Power required to work chain brow alone (D) :—

At 30 strokes per minute......	16.75	—	11.35	=	5.40

VII.—Power required to work main road (E) :—

At 30 strokes per minute......	28.31	---	11.35	=	16.96

VIII.—Power required to work slant way alone :—

	Main Road and Chain Brow.				
At 30 strokes per minute......	31.63	---	(16.96)	=	9.27

The above results cannot be fairly compared together, since the load moved varied slightly with each experiment.

EXPERIMENTS WITH DYNAMOMETER.

In making these experiments the dynamometer was attached by fixing clams to the rope about four yards apart, and connecting the dynamometer by means of chains to these clams; a screw was then applied to tighten the chain till the weight of the load upon the plane was wholly on the dynamometer.

[diagram]

The experiments were made upon the main road, the slant way and chain brow way being put out of gear. As it was not considered safe to

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take the instrument upon the heavy gradient, it was tried only upon the level part of the main road, and was first taken 297 yards inbye on the empty side, and then back on the full side.

The engine was kept at the uniform speed of thirty strokes per minute, being the speed at which the experiments with the indicator were made. It was found very difficult to get the same number of tubs upon the plane as when experiments were made with the indicator. In going inbye there were forty-eight full and forty-four empty tubs up the level part of the main road, and sixteen full and fourteen empty tubs upon the gradient of 1 in 5.5. In coming towards the shaft there were forty-eight full and fifty-eight empty tubs upon the level part, and twenty full and sixteen empty tubs upon the heavy gradient.

The readings of the dynamometer at each point, given below, are the averages of the maximum and minimum readings, the pointer often oscillating to the extent of 10 cwts.

ABSTRACT OF EXPERIMENTS WITH DYNAMOMETER.

[table]

EXPERIMENTS TO FIND FRICTION OF TUBS.

Through the kindness of the manager of the Wigan Coal and Iron Co., facilities were afforded, by means of which a series of experiments to obtain the friction of tubs, more reliable probably than those made hitherto at other collieries, was conducted.

The first set of experiments was made in the same manner as those made at Burnley, Seaton Delaval, etc., viz., by drawing a tub by a piece of cord along a few yards of way laid perfectly level. The cord was passed over a pulley and a weight attached, and when the suspended weight was found to be just sufficient to keep the tub in motion, without increasing its speed, this weight, divided by the weight of the full or empty tub moved, was taken as the co-efficient of friction.

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The second series of experiments was made by allowing a tub to start from a state of rest, and noting the time in which it ran down a regular gradient, a distance of 157 feet, and the difference of level between the starting point and the end of the 157 feet, divided by the distance travelled by the tub, with a deduction for the assistance due to the accelerating force of gravity, was taken as the resistance due to friction.

The formula* being as follows :—

Ft.

D Distance travelled by the tub in feet......... = 157

H Difference in level (in feet) between beginning and

end of the distance .... = 8.65

G A constant, being the number of feet travelled by a

falling body in the first second of time ... = 16 1/12

T Time occupied in traversing the plane in seconds.

H D

Then — — = Co-efficient of friction.

D [TxT] G

The third method of obtaining the friction was by letting the tub start from a state of rest, and allowing it first to run down a gradient of 1 in 18.15, and then up a gradient of 1 in 5.89, and taking the distance travelled by the tub divided into the difference of level between the commencement and end of the distance, or H [divided by] D, as the resistance due to friction.

The change from the falling to the rising gradient was not sufficiently gradual to prevent the tub receiving a slight shock at the turning point, and this probably accounts for the co-efficients of friction, as shewn in the following particulars of experiments, being rather greater in series No. 3 than in series No. 2.

Nos. 2 and 3 sets of experiments were both made upon a line of rails laid specially upon the surface. The tub first ran down the falling gradient and thus finished No. 2 experiment, and was then allowed to run up the rising gradient, which was a continuation of the same way, till the tub stopped, thus completing No. 3 experiment.

* This formula is the same as that given on page 50 of this Report, and is taken from the late Mr. Wood's paper on "Underground Conveyance of Coal," Vol. III., page 255, of Transactions.

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TABLE OF EXPERIMENTS MADE TO FIND FRICTION OF TUBS.

[table]

TOTAL FIRST COST OF WAGONWAY PLANT.

	£	s.	d.
Engine	725	6	6
Drums	25	0	0
Boilers	642	0	0
Steam and exhaust pipes	98	10	0
Ropes, steel 70s., iron 34s. per cwt.	565	12	0
Sheaves, main and tail	43	15	0
Do. extra	143	0	0
Wagonway (including rails, sleepers, nails, signal wire, etc.)...........	616	11	1
256 tubs, at 35s. per tub	448	0	0
Chains...................	131	5	0
	£3438	13	1

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COST PER MILE OF WAGONWAY FOR No. 2 ENDLESS-ROPE SYSTEM.

	£	s.	d.
Rails, 1760 x 4 = 7040 yards, at 18 lbs. per yard = 1131.43 cwts., at 6s. 6d...............	£367	14	3
Sleepers, 440, at 9d.	16	10	0
Do. 2640, at 3 1/2d...............	38	10	0
Nails, at 2d. per lb..................	4	17	10
Sounding Rods, 1760 yards at 3.2 lbs. per yard =			

50-28 cwts., at 10s. 6d.................. 26 7 11

Supports for Sounding Rods, 176, at 1s. 8 16 0

Labour in Laying Way, 1760 yards, at 4 1/2d. 33 0 0

Connecting Chains (say) 200 at 14 lbs. = 25 cwts.,

at 30s. 37 10 0

Rope, 3520 yards STEEL at 9.20 lbs. per fa. =

144.57 cwts., at70s. 505 19 11

Rope, 3520 yards IRON at 8.01 lbs. per fa. =

125.87 cwts. at 34s. 213 19 7

Cost per mile when Steel Wire Ropes are used...... 1039 5 11

Cost per mile when Iron Wire Ropes are used 747 5 7

COST OF LEADING COALS.

Maintaining engine-plane for one year -----

	£	s.	d.
Ropes	107	2	9
Sheaves................	11	13	0
Tubs	99	10	5
Rails and maintaining way.........	27	5	8
Oil for engine, etc............	16	18	0
Grease.................	25	19	2
Coal (611 tons, at 3s. 6d.).........	106	18	6
Repairs to engine and boilers....	50	15	0

	446	2	6

			£	s.	d.
Labour.........	Engineman		0	3	6
	Fireman		0	3	3
	2 wagonway-men		0	6	6
	1 do.		0	3	6
	4 station-boys, shaft...........		0	7	2
	2 do.	chain brow.........	0	2	8
	1 do.	telegraph, etc.	0	1	0
	3 do.	tunnel	0	5	1
	2 do.	slant...........	0	2	8
	2 do,	No. 3 brow.........	0	4	4
	2 do.	top of slant.........	0	2	10

			£2	2	4

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		£	s.	d.
Labour ...	260 days at 42s. 4d. =	£550	6	8
Cost of maintenance.........		446	2	6

		£996	9	2

Cost of leading coals per ton per mile, up an average gradient of 1 in 62, the average distance led being 0.602 miles, and the average quantity led being 400 tons per day ;- 3.816d.

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MEADOW PIT, NEAR WIGAN.

A. Hewlett, Esq., Manager; Mr. J. Lancaster, Resident Viewer.

At this colliery the No. 2 endless-rope system is applied on a single plane (see Plate L.) without any curves, and of an average gradient of 1 in 21, rising towards the shaft.

When it was decided to make experiments on this plane, it was thought that it would compare better with several of the endless-chain planes of which particulars are given, and show the working of the endless-rope in a more simple form than the intricate arrangements at the Bridge Pit.

The engine by which the plane is worked is a double horizontal 10-inch cylinder engine, with a 3-feet 6-inch stroke. The driving wheel (an ordinary pulley wheel), which gives motion to the rope, is 6 feet in diameter, and is on the second motion. The proportion of the strokes of the engine to the revolutions or the driving wheel is as 6.1 to 1.

As at the Bridge Pit, the engine is placed at some distance from the terminus of the plane, in order to be near the boilers, which are near the upcast shaft. The rope is conveyed by pulleys from the engine to the point from which the tubs start.

Owing to an arrangement (see Plate L.) for causing the full and empty tubs to self-act on the road near to the shaft, the termini of the full and empty ways are at some distance from each other, at the outbye end of the plane.

The coals are led a distance of 640 yards, the gradient throughout this distance being generally regular. The rope used is iron, 1 inch in diameter, and weighing 8.01 lbs. per fathom. The rails are round-topped bridge rails, weighing 18 lbs. per yard. There is a double line of way, and the distance between the two inner rails varies from 1 foot 6 inches to 2 feet 6 inches, this arrangement being adopted in order to take the rope straight to the 5-feet tail sheave. The road between the two lines of way is used as a travelling road.

An irregularity on one part of the plane necessitates the use of a double chain for connecting each tub or set of tubs in going inbye; but, in coming out, the chain is put on only at the fore end, owing to the heavier load of the full tubs. Thus the empty set consists of twice as many tubs as the full set. Though no rule is observed, there are generally about three tubs in a set on the full, and six on the empty side;

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and the sets are placed from 10 to 40 yards apart. A single tub is seldom put on.

The chains are connected to the rope as at the Bridge Pit, but are usually coiled three times round the rope before being secured.

The tightening pulley, at the inbye end of this plane, which also acts as a tail sheave, is fixed, as at the Bridge Pit, by a screw, which is adjusted when necessary. The rope is not kept very tight, a distance between the sets of 40 yards causing it to trail upon the ground; thus it always rests upon the tubs, and is sometimes by its own weight sufficient to keep them in motion without the chains coming into play.

The speed at which the tubs on this plane move is only 0.8 miles per hour, and even at this speed the coals are brought to the shaft so much quicker than they can be drawn, that the engine is seldom going for more than ten minutes at a time.

About 402 tons per day are led along this plane.

DIMENSIONS OF ENGINE, BOILER, ROPES, ETC.

[table]

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[table]

DEDUCTIONS FROM EXPERIMENTS WITH INDICATOR.

Power required to draw 84 full tubs, in 28 gangs of 3 tubs each, up an average gradient of 1 in 21, 45 empty tubs going inbye at the same time, at a speed of 0.841 miles per hour:—

			Engine alone.		Horse-power.
At 24 strokes per minute ...	15.050	—	3.846	=	11.204

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ABSTRACT OF EXPERIMENTS WITH DYNAMOMETER.

[table]

In these experiments the dynamometer was fixed in the same way as at the Bridge Pit. Owing to the frequent stopping of the engine, the readings were taken at very irregular distances and times. It was found impossible to keep the engine at a steady speed since it was continually affected by the position of the sets of tubs on the incline.

TOTAL FIRST COST OF WAGONWAY PLANT.

	£	s.	d.
Engine	£300	0	0
Driving pulley	6	0	0
Boilers	248	0	0
Steam and exhaust pipes..............	12	17	0
Ropes, 34s. per cwt.	114	16	5
Sheaves	6	0	0
Do. extra	26	0	0
Wagonway (including rails, nails, signal wire, &c.) ...	183	4	6
Tubs and chains (170 tubs at 35s.)	308	3	8
	£1,205	1	7

COST OF LEADING COALS.

Maintaining Engine-plane ......

FOR ONE YEAR—

Ropes..............	£14	19	6
Sheaves	1	0	0
Tubs	37	3	1
Rails and maintaining way......	9	11	7
Grease..............	14	7	1
Oil for engine...........	3	9	4
Coal (221 tons, at 3s. 6d.)	36	13	6
Repairs to engine and boilers ...	00	0	0
	£140	19	1

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Labour ...... Per day of 11 1/2 hours—

1 engineman...........	£0	3	4
1 wagonway man	0	4	0
1 boy attending rapper	0	1	0
2 station men, top of plane, at 2s. 6d.	0	5	0
1 station man, bottom of plane ..	0	3	0
1 station boy do.	0	1	6
	£0	17	10

Labour, 260 days, at 17s. 10d. = ...	£201	16	8
Maintenance for one year (as above)	140	19	1
Total cost of leading per annum	£342	15	9

Cost of leading coals per ton per mile up an average gradient of 1 in 21, the average distance led leing 0.363 miles, and the average quantity led leing 402 tons per day :--2.169d.

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No. 5 MOOR PIT, NEAR WIGAN.

The coals are led at this pit under very similar conditions to the Meadow Pit. There is only one plane, which is in a direct line from the engine, the gradient being almost a regular rise towards the shaft.

The length of the plane is 980 yards, and the average gradient 1 in 13. The plane is worked by a double horizontal engine, having 12-inch cylinders and 2 feet stroke. The driving wheel is 6 feet in diameter, and is on the third motion. The ratio of the strokes of the engine to the revolutions of the driving wheel is as 14 to 1; and as the engine goes about 74 strokes per minute, the speed of the tubs upon the plane is about 1.7 miles per hour.

In the working of this engine-road, the arrangement most worthy of note is that the braking of the engine is attended to by one of the "hookers-on," by means of an iron rod, which extends from the engine to the terminus of the plane. The engine stands about 50 yards from the plane, and is stopped in a moment when required.

[diagram]

There is a slight rise inbye about half-way along the engine-plane, and this necessitates the use of two chains for attaching each set of empty tubs; but as at the Meadow Pit, the heavier load of the full tub keeps the fore chain constantly tight, so that only one chain is needed in coming outbye. The chains at the fore ends of the empty tubs are taken off when the rise referred to commences, and are placed upon the outgoing full tubs.

The full tubs are put on two at a time, and empty tubs in sets varing from one to five tubs.

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MESNES COLLIERY.—INCE COAL AND CANNEL CO.

G. Gilroy, Esq., Manager.

The plane, about 270 yards in length, is worked by the endless-rope at this colliery, and is similar to several of the endless-chain planes at Burnley, in having a heavy gradient dipping different ways.

The engine working the plane is on the surface, and works a driving rope down the shaft, 314 yards deep. The engine is a single 10-inch cylinder horizontal engine, and the driving wheel is 5 feet diameter, working a 1-inch iron rope, which passes two and a half times round the wheel. At the bottom of the pit there are two pulleys placed close together on the same shaft. The driving rope passes two and a half times round one of the pulleys which is 6 feet diameter, and the rope working the plane is driven by the other pulley 4 feet 6 inches in diameter; this rope is nine-sixteenths of an inch in diameter, and also passes two and a half times round the wheel.

As will be seen by sketch (Plate LI.) the ropes pass from the bottom of the shaft to the terminus of the plane at A ; this is the inbye end of the plane, the coals being taken to another pit. From A the plane dips 1 in 7 for a distance of about 200 yards, and then rises at a gradient of 1 in 3 1/2 for a distance of 65 yards. At B two balks are placed near the roof for the purpose of keeping the rope down, but the rope does not appear to press much against them.

Sets of one to four tubs are put on at once on this plane. In coming from A to B only one chain is put on, fastened in the same way as at Bridge Pit, and this is removed at B, and put on at the fore end of the set. At the point C, at the end of the plane, there is a tightening pulley, regulated by a screw, round which the rope passes.

The rope in the shaft is kept tight by having a sliding carriage for the shaft of the two pulleys at the bottom, and fixing it by a screw on the upper side, as shewn by sketch on Plate LI.

Since this colliery was visited, another wheel has been placed on the shaft of the wheel at C ; this wheel works a plane 300 yards in length at right angles to the main road.

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SCOT LANE PIT, NEAR WIGAN.

J. Smethurst, Esq., Manager.

At this pit an incline, 438 yards in length, rising towards the shaft at an average gradient of 1 in 9, is worked by the endless-rope.

The method of connecting the tubs to the rope at this pit is different to that in operation at the Bridge and other pits. Instead of the connecting chains being passed round the rope and thus secured, strong loops of hemp are fastened on to the rope by a wrapping of string, at regular distances apart. One hook of the chain is first attached to the tub, and the hook at the other end is then passed through the loop as shown in the sketch below.

[diagram]

The tubs are sent along the plane one at a time, and as the gradient of the plane is very regular, only one chain is necessary for each tub. The heavy inclination causes the tubs to keep a constant weight upon the chain; on a light gradient the hook would probably be very liable to slip out of the loop. These loops are made of hemp, 1 inch in diameter, and last about four months ; they are strong enough to draw twelve tubs at a time up the plane. They are fixed on to the rope, 17 yards apart, thus making a regular supply of full and empty tubs necessary. Much less labour is required on connecting the tubs to the rope by this arrangement, but it would scarcely be so applicable on an irregular plane, where two loops would have to be provided for each tub or set of tubs. Although the rope passes one and a half times round the driving wheel, the loops are formed to pass round without causing an inconvenience.

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SOUTH WALES ENDLESS-CHAIN SYSTEM.

BRYNDDU COLLIERY, GLAMORGANSHIRE.

B. DANIEL, Esq., Manager.

Since the first part of this Report was printed the above colliery has been visited, and as the mode of conveying coals is unlike any before described, and as it is peculiarly adapted to the circumstances under which it is applied, it is thought desirable to give a short description of this method of working the endless-chain.

DIMENSIONS OF ENGINE, BOILERS, ROPES, ETC.

Engine erected, 1858.

[table]

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DESCRIPTION OF ENGINE-PLANE.

The plane on which the chain is used is 600 yards in length, and descends at the heavy gradient of 18 inches per yard from the shaft. The engine for hauling the coals up this incline is placed on the top of the plane, and works the chain by a horizontal driving-wheel. The ordinary speed of the engine is about 40 strokes per minute. The chain used is made of 1 1/4 inch iron, and has links 7 inches in length.

The engine is horizontal. The arrangement of gearing for giving motion to the driving-wheel will be seen by the sketch on Plate LIII.

The chain runs on rollers, which are placed 75 feet apart. The connection between the chain and the tubs is made by a short chain 2 feet 6 inches in length, made of 3/4 inch iron, with an ordinary hook on each end. A tub attached in this manner to the chain is shewn in the sketch on Plate LII. Only one tub is put on at a time, the distance between each tub being about 50 yards.

A section of the plane is shewn on Plate LII. As will be seen there are eight stations on the plane, at each of which the empty tubs have to be delivered, and full tubs brought away. This is done by the arrangement shewn on the same plate. Two long balanced arms, which are usually parallel with the roof of the wagonway, are drawn down to the level of the way when the tubs have to be put off or taken on at any station. The arms when brought down are level, and are so regulated by the counterbalance W, and the weight hanging over the pulley, as to be very easily moved. There are two arms at each station for both empty and full ways, and these are supported by a beam across the wagonway, shewn by B on the sketch. Between each two arms an iron plate is laid, on to which the tub runs when disconnected from the chain; the tub is then turned on the plate, and taken into the station.

The chain travels at the rate of two miles an hour, and at this speed the tubs can be easily connected and disconnected at the stations, without stopping the engine.

In attaching an empty tub at the top of the incline, the tub is brought close to the commencement of the incline, and the short chain is connected to the tub in the first place, and then to the chain, and immediately after the last connection the tub is pushed forward on to the incline; when the full tub comes to the top of the incline, the chains are disconnected just at the time when the tub coming on the level takes the weight off the short chain.

The cost of the labour required per day for the working of the incline and the stations is as follows.

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1 man to each station—8 at 3s.	£1	4	0
1 boy on top.......................	0	1	6
1 engineman.......................	0	3	3
2 firemen	0	5	4
	£1	14	1

Considering the very exceptional character of the conditions under which this system is worked, and its singular adaptability both to the heavy gradient and to the leading of coals from numerous stations, it is probably the most economical arrangement which could be here adopted.

[000 Report on Underground Haulage - Tabular Summary of Report]

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SUMMARY OF REPORT.

As it would be difficult for the Committee who present the foregoing Report on Underground Haulage, to recommend for general use any one of the five systems reported on, since each one of them is peculiarly, and most advantageously applicable to one or more conditions of wagonway, it has been thought desirable to take a general view of each of the systems investigated, and to endeavour, by a consideration of their respective advantages, to give some idea of their comparative worth under the various conditions in which they are to be found.

TAIL-ROPE SYSTEM.

This system of conveying coal underground is most largely developed in the counties of Northumberland and Durham, where, after many years trial, it has now attained a high degree of perfection.

One of the leading features of the Tail-rope System is that it can be applied under almost any condition of wagonway, the crookedness of the way, irregularity of gradient, and numerous stations and branches, forming no obstacle to its effective working.

On a single road the tail-rope is generally applied,

1.—When the gradient of wagonway dipping inbye, is not sufficient to cause the empty tubs to draw a single rope after them.

2.—When the gradient dipping outbye, is insufficient to make the tubs self-act.

3.—When (as at North Hetton) the full tubs coming outbye will not pull the single tail-rope after them.

This single tail-rope (that is a tail-rope working without a main rope) is in operation in the Main Coal Seam at North Hetton Colliery, where the engine-plane rises from the shaft, and the rope passing round

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a sheave at the inbye end of the plane, draws the empty tubs up the bank, the full tubs being " braked " down. This arrangement is usually adopted when the tubs will not self-act, and where it is desirable to have the engine near the shaft.

The tail-rope is usually applied on branches to supersede horses.

The following are the conditions of the five tail-rope planes reported on :—

North Hetton.—Two main roads, with branches worked both to the rise and to the dip, and with curves on the main road and on the branches.

Seaham.—Engine-plane, with slight curves, rising towards the shaft.

Seaton Delaval.—Engine-plane, with slight curves, level.

Harraton.— Engine-plane, with sharp curve, falling towards shaft; one branch worked.

Murton.—Engine-plane, with curves, rising towards the shaft.

METHODS OF APPLYING THE TAIL-ROPE SYSTEM.

The arrangement of engine, etc., for working the tail-rope system usually consists of an engine with two drums, worked on the second motion—the drums being either on different shafts, and put in and out of gear by shifting carriages, or on the same shaft, clutch-gear being then used for connecting them with the engine. One drum is used for the main-rope, and the other for the tail-rope. At the inbye end of the main road, and of each of the branches from the main road, there is a sheave round which a tail-rope passes, both ends of which, when used on the branches, are brought to a station on the main line ; when only one way is worked, one end of the tail-rope is brought to the station, whilst the other is attached to the tail-drum. In taking a set of tubs, which usually numbers from 30 to 60, inbye, the tail-rope drum is connected to the engine, and in coming outbye, the main-rope drum ; in going both inbye and outbye, the brake is gently applied to the loose drum to prevent the dragged rope from becoming too slack.

When two wagonways are worked in opposite directions from the engine, four drums are generally used, there being then a main and tail-rope for each way.

Curves can be worked by the tail-rope system at any angle and at a comparatively small radius. The curves at North Hetton, of 22 yards radius, have perhaps the minimum radius at which curves can be made

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to work safely. The fact that the sets pass round these curves at the rate of ten miles per hour, and that an accident very rarely happens, is sufficient proof of their efficient working. The sheaves (3 feet diameter), used at the Harraton curves, are doubtless the means of economising the power, and effecting a considerable saving in the wear and tear of the rope.

In working branches by this system there are three methods of attaching the branch rope ends to the main rope; these will be seen by the sketches below, in Nos. 1 and 2 of which the ropes are changed when the set of tubs is near to the branch end? and in No. 3 when the set is at the shaft.

[diagram]

In No. 1, a wheel is fixed near the roof or under the rails, round which one end of the branch rope passes. When the incoming set has to go into the branch, the rope end C replaces D on the fore end of the set, and the end E replaces F on the tail-rope.

In No. 2, the tail-rope always remains entire ; the end A replaces B, and the end B of the rope is brought a little further by the engine, and is then attached to N. This method of attaching the ropes, which is in operation at Murton East Pit, etc., can be worked without a winch, which is generally necessary in No. 1.

In changing the ropes by method No. 3, a very different course is pursued. When a set is taken outby from any station to the shaft, the boy at one of the branch ends changes the ropes, whilst the ropes at the

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shaft are being attached to the empty set. The position of the ropes is so arranged, that when the set reaches the shaft, the shackles on the main and tail ropes are just opposite each other at each branch end, as shewn on sketch, when the rope ends XX are replaced by YY.

This plan is much more expeditious than either of the others, since in No. 3 no time is lost in changing the ropes, as they are generally ready at the branch end before the set is ready at the shaft, but in the other methods, another stoppage, in addition to the time required to change the ropes at the shaft, is necessary.

At Harraton, No. 1 method of changing the ropes is preferred; there is only one branch at this colliery, and they bring out such a large quantity of coal from the two ways, that till the empty set has had time to get to the switches, it is difficult to tell which of the ways is ready for it. It would thus appear that when few branches are worked, and a large quantity of coal is brought out, No. 1 or No. 2 method of changing the ropes is preferable to No. 3.

The labour at a branch end can be managed by one boy ; when Nos. 1 and 2 methods are adopted, a "runrider"* is of some service, as two connections have to be made, and at points often some distance apart; with No. 3 method a runrider is not so necessary, but is generally employed.

When two branches are worked opposite to each other the same amount of labour is sufficient.

Three methods of taking the ropes round curves will be seen on these sketches. In No. 1 the curve has a large radius, and the tail-rope is taken round a single sheave, and along a narrow place, a pillar of coal supporting the roof between it and the curve. The curve in No. 2 is of less radius and no pillar is left. In No. 3, which is generally adopted on very short curves, instead of taking the tail-rope round a single sheave, both ropes are taken round the curve by a number of sheaves.

The tail-rope is often applied to work a plane with no branches, but with one or more stations on each side of the main way, in which case only one set of ropes is used. Murton and Seaham planes present examples of this arrangement. These stations are usually worked by one of the two methods shown on the opposite page.

In No. 1, which represents the arrangement of the North Hetton stations, the ropes are knocked off the empty set in going in at the points AA, opposite to which the full set stands ready to go out.   A

* Rumrider is the name given in the North of England to a man or boy who rides on the last tub of the set, for the purpose of signalling to the engineman in case of an accident; he also assists in connecting the ropes to the set.

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gentle fall in the way causes the empty tubs to run forward, and they are turned by the switch S into the siding BB.

In No. 2, which shows the Seaham Colliery arrangement, the middle way is the main road; the empty tubs, having been brought into the

[diagram]

siding XX, are then brought round the curve A, which consists of two moveable rails. When the full set comes out these rails are removed. With this arrangement the " drivers " have to cross the main road every time they take the empty tubs inbye; this is avoided with the stations worked as at North Hetton.

The connection between the rope and the set of tubs is made sometimes by the arrangement shown on page 44, but more generally by a knock-off link (see pages 12 and 36), a slight blow to which detaches the rope from the set.

The engine and boilers requisite for working the tail-rope system are usually arranged in one of the three following ways :—

1.—The engine and boilers both on the surface, the rope being taken down the pit in wooden boxes.

2.—The boilers on the surface, and the steam pipes taken down the shaft to the engine underground.

3.—The engine and boilers both underground.

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One of these arrangements is fixed upon according to the depth of the shaft, the position of the plane in relation to the upcast pit, etc.   No. 3 is the usual method of arranging the plant for deep pits, while No. 2 is generally adopted for shallow pits, it order to avoid the inconvenience of having boilers underground. No. 1 is not much used, owing to the damage occasioned when a rope breaks in the shaft.

GENERAL ECONOMY.

Owing to the high speed at which the sets of tubs are moved by the tail-rope system, the power required is often very great. The average power exerted in bringing out a full set by this system, on the planes experimented upon, varies from 86 to 149 horse-power. The first cost of the engine, drums, and boilers necessary to produce this power varies from £849 at Seaham Colliery, to £1,410 at Seaton Delaval.

A large number of branches can be worked by the tail-rope system, with almost as little annual expenditure, except in the item of labour, as the same length of road without any branches, since the power required is about the same, the number of tubs not greatly increased, and the wear and tear of ropes is not much more with branches than it is on a road without branches, over which an equal quantity of coal is conveyed. The tail-rope and endless-chain systems differ very materially in regard to the number of tubs used, for with the latter the branches worked are generally continually going, and an increased quantity of tubs is required in proportion to the length of plane at work.*

It will be seen on referring to the tabular Summary of Report, that the annual cost of leading coals on tail-rope planes is considerably in excess of the cost on endless-chain roads ; and when the wear of the ropes, the renewal of the sheaves and rollers, the occasional heavy damage done by the tubs getting off the way, and the heavy consumption of coal owing to the horse-power exerted, are considered, the greater economy of the endless-chain system, which is affected in a very much less degree by the above items, will be understood.

In regard to the item of labour, when several branches are worked, the total cost of labour in leading coals by the tail-rope is about the same as by the endless-chain, although as a rule, branches can be worked by the tail-rope system with much less labour than by any other system.

Below is given an account of the daily cost of labour on the North Hetton engine-plane, and compared with it, is an estimate of the labour

* When the tubs are placed at a considerable distance apart on a main-road without branches, fewer tubs are required with the endless-chain than with the tail-rope system.

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which would be required for a similar arrangement of wagon ways if worked by the endless-chain system.

[table]

It would appear from the above statement that the cost of labour, with the North Hetton conditions of wagonway, is about the same with the endless-chain as with the tail-rope, though it will be observed that the cost of working the branches and branch ends is considerably less with the tail-rope than with the endless-chain.   As the first cost of the

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arrangements for the latter system would, probably be much more than for the tail-rope, owing to the large number of tubs which would be required, and the heavy expense of the chain, numerous pulleys, and a double line of rails, the tail-rope system would perhaps be preferable; on the other hand, the low cost of maintaining tubs and chains in working the endless-chain, and the cost of rollers and motive power for the tail-rope should be borne in mind ; and as regards the comparative capability of the two systems for conveying a large quantity of coals, it should be noted that, whilst at the North Hetton Colliery, about 520 tons per day is the utmost that could be led by the tail-rope, supposing the branches were yielding each the same number of sets, the endless-chain under similar circumstances could bring out more than double this quantity.

The tail-rope system can be compared much better with the endless-chain than with the two endless-rope systems, which are only applicable under certain conditions of wagonway, whilst both the tail-rope and endless-chain systems can be applied under almost any circumstances.

The following are the chief defects in the tail-rope system, as compared with the endless-chain:—

1.—The heavy first cost of engine and drums.

2.—The necessity to cut long stone drifts on meeting large troubles, in order to make an easy gradient.

3.—The wear and tear of ropes.

4.—The heavy expense of an accident on the engine-plane.

5.—The large amount of power required to overcome the friction of the sheaves and rollers, upon which the ropes are carried.

On referring to the table of costs of leading it will be seen that the item of labour composes from one-third to one-half of the total cost, and t as it occupies such a prominent place in the cost of leading coals, it is the source of expense which should chiefly be considered in judging of the relative economy of the different systems of underground haulage. With this in view, it may be stated that the tail-rope, at least under one condition, has an advantage over every other system, viz.:—

When the plane to be worked has numerous branches, and when the gradient of the wagonway and branches is either level or undulating.

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ENDLESS-CHAIN SYSTEM.

The experiments on the endless-chain planes, which follow next in order to those on the tail-rope planes, were all made at the collieries at Burnley, under the management of Mr. W. Waddington.

Although the endless-chain system of leading coals has been in operation at Burnley, and other parts of Lancashire, for a great number of years, it has until lately been very little known in the North of England.

Like the tail-rope, the endless-chain system is adaptable to every condition of wagonway, but differs from the former system in the following important items:—

I.—As a general principle, it may be stated that when the two ends of an undulating plane are at the same level, the power required to work such a plane will be very little more than if the plane were perfectly level.

2.—A heavy gradient can be worked safely and efficiently.

3.—Since the chain will only work safely in a straight line, or at the most, round a slight curve, every sharp curve upon the planes necessitates the erection of two pulleys, in order to direct the chain to another course, and requires the attention of a man or boy.

The system is very extensively in operation on the surface at Burnley, and the slow speed at which the tubs are conveyed not requiring a very carefully laid wagonway, they generally lay the way upon the uncut sod, only making embankments, or erecting gearing when a stream or deep defile has to be passed over. The surface of the country is very hilly in this district, and it is therefore more economical to carry the coals from the pits to the canals and railways in tubs by the endless chain than by wagons on ordinary railways.

The endless chain planes reported on are as follows, and are found under the conditions enumerated on page 54 :—

Hapton Valley.—Underground chain road.

Do. Surface chain road.

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Gannow, top bed.—Underground chain road.

Do. low bed.— Do.

Rowley.—Underground chain road.

Do. Surface chain road.

Clifton Hall.—Surface chain road.

As a description accompanies the papers relating to each of these planes, no further reference to them will be necessary, beyond the allusion made to them in the following remarks on the conditions of endless-chain planes.

METHODS OF APPLYING THE ENDLESS-CHAIN SYSTEM.

The engines working the endless-chain at Burnley are nearly all of one class, viz., double 12 1/2 inch cylinder vertical overthrow engines. Motion is transmitted to the wheel driving the endless-chain by means of toothed gearing ; the engine usually goes at a speed of about eighty strokes per minute, and works the driving wheel on the third motion.

The engine plane consists of two lines of rails, one for the fall, and the other for the empty tubs, the tubs moving in opposite directions. The lines are generally laid just near enough together to allow a few inches play between the tubs on the empty and full ways.

In working a straight main way (that is, with no branches) such as the Rowley and Hapton Valley surface planes, by the endless chain, the driving power is generally placed at the higher end of the ginney road. The only wheels requisite for working the chain are the driving wheel at one end, and a " tail" or return sheave at the other end of the plane ; between these two points the chain rests upon the full and empty tubs, the distance of which apart, and the speed at which they are moved, vary according to the quantity of coal passing along the plane, the distance between the tubs being from ten to thirty yards, and the speed from one to three miles per hour.

The wheels round which the chain passes at the two ends of a ginney-road are usually three feet in diameter. The driving wheel, as used at Burnley, generally consists of an ordinary sheave, round which a piece of boiler plate, about ten inches wide, is fixed, and to this are attached about twelve steel or iron " feet," on which the chain rests ; these feet are renewed, as required, and thus the chain never touches the plate. The method invariably adopted at Burnley, in order to get friction sufficient on the chain to prevent it slipping round the driving wheel, is by passing it

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2 1/2 times round the wheel; at Towneley Colliery it is passed 4 1/2 times round. At the Baxenden Collieries, near Newchurch, ordinary sheaves, with forks about 12 inches apart fixed in the trod, are used as driving wheels, the chain only passing half a turn round, and the horizontal link of the chain fitting into the fork. These wheels, which are much preferred at Newchurch, were formerly used at Burnley, but are now altogether abandoned in favour of the bevel-faced wheels. The return wheels, at the other end of the ginney road, are just common 3-feet sheaves, round which the chain passes half a turn.

When there is a curve in a single chain road, either the same chain is taken round the curve by two wheels on different shafts, arranged like the self-acting curves on the surface, or there are two pulleys on the same shaft on which are different endless-chains. If there be no branch way from the curve, the former method is usually adopted, and the road is so formed that the tubs will leave one chain, pass round the curve, and connect themselves to the other chain, without any assistance ; but as this cannot be depended upon, attention is always necessary at a curve. At the Burnley Collieries there is generally a branch end at every curve.

There are only two self-acting curves in the Burnley district, both of which are on the surface (see Plates XXVIII. and XXIX.). These curves generally work very well, and without the occurrence of any accident, but as a badly greased tub, or a tub getting off the way, causes some damage, if not looked to, they are always kept in sight, that at Padiham being within a few yards of a man constantly working at the same place, and that at Towneley within view of the terminus of the ginney road. With very carefully laid rails, and due attention to the exact point at which the rise or fall of the way should be, curves might be worked at almost any angle, and with very little attention.

As far as hitherto proved, it may be laid down as a rule in the working of the endless-chain system, that all curves underground require labour, and thus it is generally desirable either to have a branch or branches from the curve, or to pass the tubs round by the self-acting method described, which could be managed by a boy at 1s. per day. It has yet to be shown to what extent curves can be worked by this system without pulleys. At the Baxenden Collieries, in Lancashire, a curve of about 15 chains radius has lately been commenced on the surface, and is found to work very satisfactorily.

In working branches the chain passes round a wheel at the branch end, which transmits motion to another pulley or pulleys, either on the

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same shaft (see Plate XXIV.), or on another shaft a short distance of ; when the pulleys are on another shaft, motion is given in one of the ways shewn on Plate XXI, either by mitre gearing and shafting, or by a short endless-chain; at Towneley (see Plate XXXI.) motion is transmitted by continuing the same chain past a branch end, and taking it over a pulley which works the branch by means of vertical gearing. The pulleys on the main road for working the branches are generally so arranged that they can be put out of gear, in case of any accident or slackness of work, whilst the other chains continue in motion.

Though it would appear rather difficult to work a branch on each side of the main way to the same point (see Plates XXXIII. and XXXVI.), since the full tubs from one of the branches cross over the course of the empty tubs on the main way, and the empty tubs from the other branch cross the course of the full tubs, the slow speed at which the tubs travel prevents this from causing any inconvenience.

Another mode of working branches is that carried out at Marsden Colliery, near Burnley, where two branches are worked by one chain passing round a single pulley (see Plates No. XXXIV. and XXXVI.). This is the only one of all the methods of working branches in which one branch cannot be put out of gear without stopping another.

In each of the arrangements mentioned for working branches, it is necessary that the tub should leave the chain at the station—becoming attached to it again immediately beyond the pulley, and the attending to the re-attaching of the tubs at the branch ends in this way, is one of the chief items of labour in the cost of leading coals by the endless-chain. The mode of working branches usually adopted at Burnley, is to have shafting and mitre-gearing under the flat sheets, sometimes, as at Hapton Valley, working two branches from the same mitre-wheel (see Plate XIX.).

In working branches by the endless-chain no regular curves are necessary, since at the branch ends the termini of ginney roads are usually laid with flat sheets upon which the tubs are turned; the small tubs used at Burnley can be turned so quickly, that there is often not more than 10 feet from the end of one ginney road to that of another at right angles.

At Gannow and Rowley Collieries the underground endless-chain is worked by an engine on the surface, the chain at the latter colliery being attached to the winding engine. The way in which the chain is conveyed down the shaft is very simple, and is shewn in the section of the Rowley and Gannow underground planes (Plates XXII. and XXIV.).   Whilst a

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5/8-inch chain is used in the workings, a 3/4-inch chain is used in the shaft, the latter being usually kept tight by passing the chain, at the bottom of the pit, round a sliding pulley, to which a suspended weight is attached. A sufficient proof of the efficient working of the chain in the shaft, and of the very small amount of power requisite to take it down the pit, is given by the results of the Rowley experiments, which show that only 0.54 horsepower is required to take the chain 150 yards down the shaft, and 27 yards from the bottom of the shaft to the main driving wheel.

As compared with the tail-rope, the maximum advantage of the endless-chain, as far as the power requisite to drive the system is concerned, is probably realised on an undulating plane, the ends of which are at the same level. A very good instance of the counterbalancing effect of an undulating road is shewn on the Rowley plane, which is 1980 yards long, the highest point on the plane being 145 feet above the lowest, and the average gradient 1 in 68, fall for full tubs; here only 5.16 horsepower is required to work all the tubs, and chain suspended on the tubs. Another instance is at Rowley Colliery, where the average gradient of the planes is sufficient to cause all the tubs to self-act. The planes at this colliery, however, are kept connected to the engine for reasons explained in the Report on the Rowley plane.

The chief feature of the self-acting planes, as worked by the endless-chain, is that a regular gradient is unnecessary, a heavy dip at one part of the plane being sufficient to cause the tubs to self-act. Thus a plane may have a rise for some distance for the full coals, and yet, since there is continually a load upon the heavy part of the plane in favour of the full tubs, self-act. Thus planes can self-act by the endless-chain which could not possibly do so with a rope.

At Burnley, the force of gravity on self-acting planes is sometimes made to work a level plane at the top of the self-acting plane.

Stations are worked by the side of the main chain roads, simply by

[diagram]

having small pulleys fixed to the roof, opposite to the station, on which

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the chain is placed when tubs are required. There are generally iron flat sheets at the stations over which the tubs are brought from the opposite side of the way. A tub, after having been passed over the flat sheets, is allowed to be altogether moving on the rails again before it is touched by the chain, in order that the chain may be sure to reach it in the centre.

The method of leading coals by the endless-chain as adopted at Clifton Hall Colliery, which consists in moving the tubs by the weight of the chain alone, there being no forks on the tubs, can only be recommended when the plane to be worked is level, or nearly level, and where the system is not extensively applied.

GENERAL ECONOMY.

On comparing the cost of leading at Barclay Hills with the Hapton Valley and Rowley underground plane, it may be seen that length of way and the direction of gradient do not affect the cost of leading nearly so much as a number of stations upon a ginney road, which not only increase the labour, but by their necessary gearing, consume a great per centage of the power.

In the foregoing remarks upon the tail-rope system, the case of North Hetton Colliery was taken to shew the comparative economy of labour of the endless-chain and tail-rope, under the North Hetton conditions of wagonway. It is probably just under these conditions, i.e., the working of a number of branches, that the cost of labour becomes about equal in the two systems, the cost being less with the endless-chain when few branches are worked. On a main road without branches the labour with the endless-chain is much less; this will be seen on comparing Seaton Delaval with Rowley surface and Hapton Valley surface planes. At the former, the cost per day is 20s. 6d., whilst at Rowley it is 6s. 7d., and at Hapton Valley only 5s. 9d., about the same quantity of coal being led along each of the planes.

The coupling of the tubs being avoided, a brakesman, a rapper lad, runrider, and drum-boy being unnecessary, and the self-acting nature of the termini of the ginney roads, all tend to reduce the cost of labour; and a considerable item of economy consists in the constant working of the chain, causing the hands attending the ginney roads to be nearly always kept at full work.

The cost of maintaining the planes worked by the endless-chain is very small. The long duration of the chain, the regular speed of the engine, and the slow motion of the chain on the ginney roads, which, escaping

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the accidents common to the quick speed of the tail-rope system, economises rails and tubs, cause the cost to be less than that of any other system. Rollers and sheaves, which, with the tail-rope and No. 1 endless-rope systems, are a source of expense, are not required with the endless-chain.

The chain is estimated at Burnley to last twelve years, but in the Newchurch district, chains are in operation which have been working for more than twenty years.

The horse-power required for the working of this system is very small, and thus a considerable economy of coals is effected. The power required for working the chain roads varies from 5.16 horse-power at Rowley surface ginney, being 1,980 yards in length, to 18.80 horse-power at Hapton Valley, where there is a ginney road 3,207 yards in length. Another item of economy at Burnley is the low first cost of the engines; these engines, when with single cylinders, as at Gannow, cost £50, and when double, as at Rowley, £115.

The only defects of any note in the endless-chain system are :—

1.—Every curve or connection between a branch and the main ginney road requires the attention of a man or boy.

2.—The first cost of wagonway is greater than when tail-ropes are used, owing to the great weight of chain and a double way being requisite.

The endless-chain is found of great service in a hilly district where it can be used, as in Lancashire, on the surface instead of an ordinary railway ; and at Burnley, where the chain roads are seem traversing the country in all directions, the economy of its adoption is very apparent.

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No. 1 ENDLESS-ROPE SYSTEM.

This system of conveying coal is closely allied to the tail-rope, but has hitherto been adopted in the working of under-ground planes, only to a limited extent.

The following planes, the conditions of which are given on page 94, are reported on, and present four distinct methods of applying the system:—

I.—Shireoaks Colliery.—Engine plane, with double way, worked by rope at quick speed, the tubs being attached to the rope in sets, by a clamp.

II.—California Pit.—Ditto, ditto, ditto.

III.—Newsham Colliery.—Engine plane, with single way, worked by rope at quick speed, the tubs being attached to the rope in sets, by short chains secured to sockets in the rope.

IV.—Eston Mines.—Three sidings, worked by the socket connection at slow speed.

V.—Cinderhill Colliery.—Engine plane, with double way, and sets of full and empty tubs running at the same time at slow speed, the sets being connected to the rope by clamps.

Experiments were made, and costs extracted, only at Shireoaks Colliery.

METHODS OF APPLYING THE No. 1 ENDLESS-ROPE SYSTEM.

In the application of this system as adopted at Shireoaks and the California Pit, a double way is used, and the rope moves on rollers in the middle of the way, the sets of tubs being taken in on one way and brought out on the other.

Motion is given to the rope either by a clip-pulley, or by several wheels, round which the rope is taken to obtain sufficient friction. The rope is kept constantly tight by having the return sheave fixed on a moveable tram, to which a weight, hanging in a staple, is attached.

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The set of tubs is connected to the rope by a " clamp," which is held by a boy sitting in the foremost tub. Different descriptions of clamps are used ; the clamp in use at Shireoaks differs (as shewn in Plates XXXIX. and XLI.) in construction from that used on the California and Cinderhill planes. As these planes rise in one direction, only one clamp is employed; but were the planes undulating, two (one for each end of the set) would be required, and as this would make two men or boys necessary for each set, the use of the clamp, under these circumstances, would not be advisable.

The number of tubs in a set varies from twelve, on one of the California ways, to thirty-one at Shireoaks, and the speed at which the sets travel, is about the same as with the tail-rope system.

The clamp is usually attached at the front end of the set, but on one of the California planes the gradient is heavy enough to allow the clamp to be applied to the last tub of the set, in going in; when, as occasionally occurs, the full and empty sets are run together on the plane, this assists the engine.

In the application of this system at Newsham and Eston, motion is given to the rope, which is also kept tight by a hanging weight, by the clip-pulley, as at Shireoaks, and the set of tubs is connected to the rope by means of one or two short chains, which are secured by means of a hook or screw-shackle to a socket in the rope. At Newsham, owing to the undulations of the plane, two chains attached by the screw-shackle are required, whilst at Eston, where the roads are short and level, the set is attached to the rope by a single chain, which is simply hooked on. The Eston arrangement is adaptable when there are numerous short sidings, and could probably be economically applied in the place of horses at collieries where there is a good deal of branch work. The plan at Newsham of having a single way, as with the tail-rope system, and of running one part of the rope on sheaves by the side of the way, is probably the best arrangement of the system, and that which, for the following reasons, may be expected under some circumstances to supersede the tail-rope.

1.—A driving wheel is used instead of two drums.

2.—One-third less rope is required.

3.—The power expended with the tail-rope in overcoming the friction of the brake on the loose drum, is utilized by the employment of a single wheel.

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It has yet to be shewn how far this system is applicable where curves, and the working of branches, have to be contended with. With the clamp connection a slight curve is worked on one of the California planes without any difficulty. No instances are known of curves occurring on wagon-ways where the socket connection is adopted, but in all probability they could be managed without much difficulty, the tightening of the rope being the only obstacle to their efficient working.

The slow motion of the rope as worked at Cinderhill, would allow it to pass round curves of almost any radius. The system adopted at Cinderhill, which consists in having a double way, and in running the sets of full and empty tubs at the same time at a speed of 2 1/2 miles per hour, cannot be recommended owing to the heavy cost of labour, each set being connected by a separate clamp, which is attended to by a man or boy. Friction for driving the rope is obtained at this colliery by taking it round five wheels, and the rope is made tight by having two of the wheels placed on a moveable carriage ; with an undulating plane where the load varies, this method of tightening the rope would not answer.

The chief defect of this endless-rope system, as far as hitherto developed, is its inapplicability to the working of branches from the main way, the tightness of the rope precluding the possibility of offtake links being used, as with the tail-rope. A series of clip or friction pulleys, arranged in a similar manner to the No. 2 endless-rope pulleys (see Plate XLIX.), with disconnecting gear, might, perhaps, answer the purpose, but in this case, as the tubs could not go round the right angle without being uncoupled, the set of tubs would have to be disconnected from the rope and sent by its own impetus round a curve into the branch way, where it would be attached to the branch rope. Of course this would only be possible under exceptional conditions of wagonway, and as considerable labour would be required were the socket connection adopted, the clamp would be the most economical mode of attachment.

Stations by the side of the main way might be worked by the system without much difficulty, but would require rather more labour than by the tail-rope system. At Shireoaks the rope at the station passes under the way, and when the ingoing set is intended for the station, the clamp is removed some distance from the " points," and the set runs into the siding by itself. With this arrangement the set could not go any further inbye, if attached to the rope, but, as explained in the Shireoaks report, the set when going in, is disconnected from the rope before reaching the station, and the inclination of the way is sufficient to take it to

the end of the plane. It will thus be seen that on the Shireoaks plane, stations could not be worked under other conditions than those described. They might, however, be arranged like the tail-rope stations (see page 149), and by having the points leading from the main way to the siding moveable, as shewn below, the difficulty of the rope being endless would be obviated. Here the rail A B moves on a pivot at A ; if the set had to go into the station, this rail would be placed as shewn, the rope passing under the rail; if it were intended for the main road, the rail

[diagram]

would be put into the position A B. More labour would be necessary in leading coals from stations in this way than is requisite with the tail-rope system, which is very well adapted for the purpose.

As this system is capable of conveying a large quantity of coals on a single way, the double way as adopted at Shireoaks may be considered quite unnecessary, and can only be recommended where sockets are used and runriders dispensed with, and where the inclination of the engine-plane is such that one set of tubs will give assistance to another throughout the greater part of the plane.

GENERAL ECONOMY.

This system of applying the endless-rope is scarcely sufficiently developed to justify an opinion being given as to its economy, as compared with that of other systems.

The duration of rope is about the same as with the tail-rope, the preference being rather in favour of the endless-rope system, which requires less rope.

Not quite so much fuel is consumed as with the tail-rope, the power required being rather less, owing to the utilization of the power lost in working with drums.

In regard to the question of labour, the application of the system is

so limited as compared with the tail-rope and endless-chain, that it is only when a main way without branches and stations is worked, that the relative labour charges can be compared. There is a saving in the reduction of labour consequent on the avoidance of drums, and in the labour of connecting the rope to the tubs.

No. 2 ENDLESS-ROPE SYSTEM.

This system of conveying coals is only in operation in the district of Wigan, where it has not been many years in use.

The principle on which the system is worked is the same as that of the endless-chain, wire ropes being substituted for the chain, and the connection between the rope and the tubs being made by short chains, instead of the fork arrangement.

The following planes, the chief characteristics of which are given on page 117, are reported on; experiments to find the amount of power required to work the system, were made at the Bridge and Meadow Pits.

Bridge Pit.—Underground engine-planes, with curves and irregular gradients.

Meadow Pit.—Underground engine-plane.

No. 5 Moor Pit.—Underground engine-plane.

Mesnes Colliery.—Underground engine-plane, worked by engine on the surface.

Scot Lane Pit.—Underground engine-plane, with peculiar mode of attaching the tubs to the rope.

METHOD OF APPLYING THE No. 2 ENDLESS-ROPE SYSTEM.

The application of this system at the Bridge Pit is much more extensive than at any of the other planes (see Plate XLIX.).

The driving wheel at the engine is fixed vertically, as with the No. 1 endless-rope system at Newsham, but is worked on the third motion, like the endless-chain wheels. The driving wheels, at the end of the engine-planes, are placed horizontally, and are arranged with disconnecting apparatus, to allow one or more roads to be standing, whilst the others are at work.

The rope used is one inch in diameter, and passes two and a half times round the driving wheels, the trod of which is shaped to receive it. It is made tight, to prevent it slipping on the driving pulley, by passing it round another sheave a few yards from the end of the plane; this sheave is placed on a rolling tram, which is attached by a screw to a vertical beam in the middle of the way, and the tightness of the rope is regulated by the screw, which, owing to the load upon the plane being

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nearly always the same, is better adapted for this system than the hanging weight nsed for the No. 1 system. It is necessary that the rope for every branch road should have tightening apparatus, similar to that used on the main roads.

The rope rests upon the tubs, which are connected to it by a short chain, secured to one end of the tub or set of tubs when the gradient is in one direction, and by two chains, one at each end of the tub or tubs, when the plane is undulating; these chains are fastened to the rope by a peculiar knot, already described on page 123, in the report on the Bridge Pit plane. This is the method of attachment on all the endless-rope planes at Wigan, except that at Scot Lane, where a hook, at the end of the short attaching chain, is hung on to a hemp loop on the rope.

On all the planes where the endless-rope is in use (Scot Lane excepted) the gradient of the way is so irregular, that a chain is necessary at each end of the tub or set of tubs in going inbye, but in coming out the No. 1 plane at the Bridge Pit is the only road where a double chain is requisite, the wagonway there dipping slightly towards the shaft after a heavy rise.

The number of tubs attached to one connecting chain varies from 1 and 2 at the Bridge Pit, to 6 at the Meadow Pit. When the plane rises in one direction, sets of 6 tubs can be drawn by one chain with almost as much security as a single tub. The tubs or sets are placed from 10 to 40 yards apart. The speed at which the tubs are conveyed is about 1 mile per hour, and even at this speed the quantity of coal brought out is so great that at some of the pits the engine has frequently to stop whilst the coals are being sent up the shaft.

Curves and branch ways can be worked by this system, but whilst the former are much more conveniently worked than with the endless-chain, the working of branches from the main way is attended with much expense.

The tubs can be taken round curves with perfect security, without being disconnected from the rope, and without any attendance being necessary. A radius of 5 yards is found to be convenient for these curves, and thus the cost of curves with a large radius is avoided. Though 120° is the sharpest angle at which curves are worked at Wigan, in all probability almost any angle might be passed round, by the adoption of sufficient pulleys to meet the case.

Branch ways can be worked by the system, but only at considerable cost, since each branch has to be worked by an arrangement of pulleys similar to that used in the endless-chain system, and this necessitates a

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disconnection and reconnection of every chain used in attaching the tubs to the rope. The slant way at the Bridge Pit, which is a continuance of the main way, may be taken as an example of a branch way; at the junction of this way with the main road, the labour of disconnecting is very great.

Stations by the side of the main way are worked as with the endless-chain, but instead of raising the rope on to pulleys, it is just lifted by the hand when the tubs are passed under.

GENERAL ECONOMY.

With the exception of the item of labour, the cost of leading by this system is about the same as by the endless-chain, but the heavy cost of labour, where there are branches from the main way, is sufficient to prohibit its adoption where branches are worked.

The cost of fuel is rather less with the endless-rope, not so much power being required to work this system as the endless-chain ; this is partly owing to the large quantity of coal which can be brought out by this system, and partly to the difference in weight between the chain and rope, the weight of the rope being less than that of the chain in the proportion of 1 : 3.25 with iron wire rope, and 1 : 2.82 with steel ropes. The cost of maintaining ropes is rather more than the cost of chains, calculating the duration of the former at seven years and of the latter at twelve years.

There is, perhaps, one condition of wagonway to which this system could be more economically applied than any other, viz:—

When a main way without branches has a rise only in one direction, and has several curves, sharp or otherwise.

The advantage of the endless-rope system, for this description of plane, over the tail-rope, consists in its requiring less power, less labour, and in the construction of the curves being much less costly.

The system might also be conveniently applied on a short plane, rising heavily in one direction, where a large quantity of coal has to be led; the hemp fastening used at Scot Lane, which economises labour, might be here adopted, and the forks on the tubs would be avoided.

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SOUTH WALES ENDLESS-CHAIN SYSTEM

This system is only in operation in South Wales at the Brynddu Colliery, adopted as being the most economical method of hauling the coals up a heavy gradient of 18 inches to the yard, this being the inclination of the seam of coal worked.

The chain is of iron 1 1/4 inches diameter, and runs on rollers, as with the No. 1 endless-rope. The tubs are attached singly to the chain by means of short chains, with hooks at each end. Stations are worked very efficiently by the arrangement shewn on Plate LII.

The heaviest gradient to which the Lancashire endless-chain system is applied is 1 in 3.3, and a gradient of 12 inches to the yard is probably the greatest inclination at which this system could be safely worked. When it becomes inapplicable, the South Wales system can be adopted; but such heavy gradients are so unfrequent that it will be very seldom brought into use.

This system of leading coals is more applicable than any of the other systems, to the following conditions of wagonway, viz.:—

I.— When the plane to be worked is straight, has a regular inclination heavier than 12 inches to the yard, and has or has not stations by the side of the main ivay.

II.—When the plane to be worked has a regular inclination heavier than 8 inches to the yard, and has stations by the side of the main way.

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SINGLE-ROPE PLANES.

The systems of conveying coals reported upon are those which are applicable to nearly every condition of wagonway, and no data are given as to the economy of single-rope and self-acting planes.

Where a system is peculiar to a district, as with the endless-chain at Burnley, and the No. 2 endless-rope at Wigan, it is used to work planes which have a rise either for full or for empty tubs; with the former condition the full tubs are hauled, in the North of England, by a single rope worked by an engine, whilst, when the rise is for the empty tubs, no engine is required—the full set of tubs drawing the empty set up the hill.

When ropes are in use at any colliery for underground haulage, planes of this description are best worked with ropes, since the forks and double way necessary for the endless-chain are avoided; but if no system be established, the endless-chain is preferable where the rise is against the load, whilst self-acting planes, when regular, are best worked by the single-rope, and when irregular, by the endless-chain.

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REMARKS ON THE COMPARATIVE MERITS

of the

FIVE SYSTEMS OF UNDERGROUND HAULAGE.

As the preceding summary is chiefly of a descriptive and recapitulatory character, the following remarks are added in order to shew more fully the relative merits of the various systems.

In the adoption of a system of underground haulage, the following are the chief considerations:—

I.—First cost of Driving Drifts for Wagonway.

II.—First cost of Engine, Boilers, and Wagonway Plant.

III.—Cost of Labour required for conveying a certain quantity of Coals a certain distance.

IV.—General cost of Maintenance, divisable into:—

1.—Ropes or Chains.

2.—Maintenance of Plant.

3.—Horse-Power required.

To illustrate the following remarks on these heads, a brief abstract of the "Tabular Summary of Report," being simply the average of each system, is given below.

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The South Wales endless-chain system is not shewn in this table, since it is only economically applicable in rare instances.

I.—FIRST COST OF DRIVING DRIFTS FOR WAGONWAYS.

In the working of the tail-rope and endless-rope systems, it is customary to make the wagonway the travelling road for men and horses, and to effect this, the ways have usually a width of 9 to 12 feet, by 6 to 7 feet in height. In the working of the tail-rope and No. 1 endless-rope systems, the quick speed at which the tubs run, makes it desirable to have regular gradients at not too great an inclination, and to attain this object, considerable expense is incurred in driving stone drifts through faults, in taking stone from the top and bottom of the road, and in giving constant attention to the condition of the wagonway. With the two other systems, where the ropes do not touch the ground, and where a slow speed is adopted, no such expense is necessary, since heavy gradients are worked with ease, and slight irregularities in the way cause no inconvenience.

The method in operation at the Burnley Collieries, which consists in making the tramroad at no greater cost than an ordinary coal place, and in having a separate travelling road, which forms, with the tramway, a double intake for the air, must be recommended both for economy and safety. The Burnley wagonways are only from 2 feet 9 inches to 3 feet 3 inches in height, and as a tub seldom gets off the way, little attention to the road, which is accessible from the travelling road by numerous holings, is required. With all the other systems the greater frequency of accidents to tubs, makes it necessary to have the wagonway higher.

II.—FIRST COST OF ENGINE, BOILER, AND WAGONWAY PLANT.

It will be seen that as regards the cost per mile of wagonway plant, the cost of endless-chain system is highest, owing to the use of the chain and of a double way, and that the tail-rope is less than the No. 1 endless-rope system, owing to the former being worked by a single way; taking this endless-rope system as worked with a single way, which, as before remarked, is its most economical adaptation, the cost per mile of tail-rope plant will be the greater, since three miles of rope are necessary for the latter as compared with two miles for the former. With a single rope, the cost per mile of the No. 1 endless-rope way, as adopted at Shireoaks, would be only about £520.

The cost of rollers on the wagonway for the tail-rope and No. 1 endless-rope systems is an expense not borne by the other systems.

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The heavy cost per mile of the No. 2 endless-rope system is chiefly due to the large size of rope used.

As regards the cost of machinery, the average amount of £1,105 for the engine, drums, and boilers required for the tail-rope system, contrasts forcibly with £276 for the endless-chain, this being due partly to the difference of power required to be exerted, and partly to a single driving wheel supplying the place of the drums used for the tail-rope— this item of economy applying also to the two endless-rope systems. The cost for the No. 1 endless-rope is very low, for reasons hereafter explained, whilst the high cost for the No. 2 endless-rope system is chiefly due to a larger engine being employed than is at present necessary; this is evidenced by the fact that the Shireoaks engine expends 62.28 horsepower, with a first cost of £820, whilst the Bridge Pit engine exerts 42.98 horse-power, with a first cost of £1,039.

On the question of primary cost of engines it may be stated that the high pressure engines in use at Newsham and Eston, known as Fowler's engines, are found very economical, both on account of their compactness and small first cost, and of the small expense of maintenance, fuel, and labour required.

III.—COST OF LABOUR NECESSARY FOR CONVEYING A CERTAIN QUANTITY OF COALS A CERTAIN DISTANCE.

It will be seen that the cost of labour varies from 32 per cent, of the total cost with the tail-rope system, to 57 per cent, with the No. 2 endless-rope system. These proportions indicate the high cost in the former and low cost in the latter, of the other items of cost.

Constituting as it does, on an average, nearly one half of the total working expenditure, the cost of labour is one of the chief questions in the consideration of the comparative merits of the different systems of haulage.

It should be remarked generally as to the comparative cost of the tail-rope with the other systems, that the Tabular Summary does not present a fair comparison, since the quantities of coals led, and the distances traversed are much greater, in the instances given, with the tail-rope than with the other systems; and this is partly the cause of the high cost of the labour charge for the endless-chain, which otherwise would shew a more favourable contrast with the tail-rope and other systems.

The heavy cost of labour in the working of the No. 1 endless-rope system, which also exhibits the economy of the other charges, may be said to be partly due to the peculiar condition of the Shireoaks wagon-

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way. The cost of labour by this system, as hitherto developed, is actually less than by the tail-rope; and this is due, firstly, to the labour of attaching the ends of the rope to the set of tubs being much less, since with the endless-rope the two points of connection are always relatively in the same position; and, secondly, to the extra labour consequent on the difference in the amount of power expended, as will be seen on comparing Seaton Delaval and Newsham planes, the cost of labour at the former being 20s. 6d., and at the latter 14s. 9d. per day, the quantity of coal led being nearly the same.

The high cost of the No. 2 endless-rope labour charge is simply an evil of the system, being due to the laborious method of connecting the tubs to the rope, and this suggests the advisability of applying this system only where the adoption of any of the other systems is not convenient.

Regarding the labour required to work the tail-rope, the cost, as a rule, will be found to exceed that of the other systems from the following causes, viz.:—

1.—The amount of power expended causing more labour to be necessary.

2.—A boy being required to attend to the drums.

3.—The employment of a run-rider, and of hands to form the tubs into sets.

In regard to the labour required for connecting the tubs together, this also applies to the No. 1 endless-rope. With the endless-chain it is altogether avoided; but whilst with the endless-chain only one tub can be attached to the chain at once, with the No. 2 endless-rope system the tubs can, with one connection to the rope, be attached in sets of 1 to 12 tubs. This would be an advantage where the tubs are taken in sets from the end of the engine-plane to the putting stations, but as in the laying out of an engine-plane, it is desirable to avoid all horse driving, that is, to arrange for the coals to be " put" from the end of the plane— and this is accomplished at North Hetton by the tail-rope, and at the Burnley Collieries by the endless-chain—it is an advantage only to be made use of, when circumstances limit the extension of the engine-plane.

A runrider for the tail-rope and No. 1 endless-rope system, is only necessary where there are branches or curves, and when danger is consequently more to be feared.

With reference to the methods of connecting the tubs to the rope in the No. 1 endless-rope system, the plan of attaching the set to sockets

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in the rope, as adopted at Eston and Newsham, is to be preferred to the use of the clamp, which always requires an attendant, and which, besides, is only applicable to a limited strain.

It is probably only when a number of branches is worked that the labour charge of the tail-rope system contrasts favourably with the endless-chain and No. 1 endless-rope systems.

IV.—GENERAL COST OF MAINTENANCE.

1.—Ropes or Chains.

This item of cost constitutes, of the cost per ton per mile, from 6 per cent, with the endless-chain system, to 15 per cent, with the tail-rope system. It will be seen that the cost of the former system is less than one-third of the cost of any of the other systems, and this shews very clearly the economy of the endless-chain system, as far as this charge is concerned.

The chief comparison lies between the tail-rope and the No. 1 endless-rope systems. The duration of ropes with the tail-rope is quoted at eight, nine, twelve, twenty-four, and thirty months, and with the endless-rope at eighteen, thirty, and thirty-six months; and as steel ropes are used for the latter system, so far the comparison is slightly in favour of the endless-rope, but in addition to this, the greater length of rope required for the tail-rope system increases the cost of maintenance. On the other hand, the extra wear of the rope due to its tightness in the working of the No. 1 endless-rope system should be considered.

The cost of ropes with the No. 2 endless-rope system is almost as low as the endless-chain, since the rope lasts seven years, but this cost appears high in the table, partly for the reason before assigned, that the quantity of coals, and the average distance led are so small, and partly because so great a length of wagonway is worked at the Bridge Pit.

2.—Maintenance of Plant.

This charge varies from 24 per cent, of the total cost with the tail-rope system, to 34 per cent, with the endless-chain. It will be seen that the cost per ton per mile for this item is almost exactly the same for the endless-chain as for the tail-rope system.

In regard to the cost of maintaining tubs, the endless-chain is shewn to be more than the tail-rope, owing to more tubs being required upon the engine plane. The cost of maintaining tubs is actually much less with the endless-chain, since it is totally free from the accidents which

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occur with the tail-rope, frequently causing considerable damage to the tubs. The cost of upholding tubs with the No. 1 endless-rope system is about the same as the tail-rope cost, whilst the cost of the No. 2 endless-rope system, owing to its irregular action, and to the large number of tubs used, is rather greater.

The cost of upholding engine and boilers, and maintaining way, is nearly the same in each system, the former generally being highest where most power is expended, and the latter greatest with the tail-rope and No. 1 endless-rope systems, the quick speed of which necessitates a carefully laid way.

The cost of grease, etc., will be observed to be highest for the tail-rope and No. 1 endless-rope systems, where sheaves upon the wagonway are used.

3.—Horse-power Required.

Introducing as it does the question of consumption of fuel, and thus to some extent of the cost of labour, this item of economy is very important. It will be seen that the cost of coals varies from 11 per cent, for the No. 2 endless-rope system to 30 per cent, for the tail-rope.

The low cost of the former is partly due to the fact that with this system and with the endless-chain no power is wasted, as with the tail-rope, in overcoming the friction of drums and the brake pressure on the loose dram. The cost of fuel for the No. 1 endless-rope system is low owing to the economical arrangements of boilers, etc., adopted at Shireoaks. It will be seen that at Newsham, where the No. 1 endless-rope is also adopted, only 9 cwts. of coal are used per day.

The cause of the heavy expense for fuel in the working of the tail-rope system is obvious. The average power expended is about 112 horse-power, as compared with 20, 29, and 62 horse-power for the endless-chain, No. 2 endless-rope, and No. 1 endless-rope respectively.

As to the proportion of power expended upon ropes in the working of the tail-rope and No. 1 endless-rope systems, it will be seen that with the former on the average 42 per cent, of the power expended is utilized in the set of tubs, 45 per cent, being required for the rope, while with the latter 68 per cent, is utilized and 23 per cent, expended on the rope. The per centage of power utilized in drawing the set of tubs depends chiefly on the inclination of the wagonway,—being lowest where the gradient is light, as at Seaton Delaval, where 15 per cent, of the total power exerted is required for the set, and greatest where the gradient is heavy, as at Murton and Shireoaks, where the proportion

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of power expended upon the set of tubs is respectively 60 and 68 per cent

With the endless-chain and No. 2 endless-rope systems the power expended in moving the chain or rope is simply in the proportion of the weight of the chain or rope to the total weight moved, and amounts in the former system to about 25 per cent, of the total power exerted, and to about 8 per cent, in the latter.

The most important point of this comparison is between the power required in the working of the endless-chain and No. 2 endless-rope systems (20 and 29 horse-power) and that required for the tail-rope and No. 1 endless-rope systems (62 and 112 horse-power). This is due, firstly, to the avoidance of the friction of the rope or chain on rollers and sheaves, and, secondly, to the reciprocal motion of the two former systems, this movement, which distributes a counterbalancing effect over the whole of an engine plane, being one of the chief characteristics to be observed in the consideration of economy of power.

In conclusion, it appears from the experience your Committee have been able to gain, that, as far as the cost of maintenance and working charges are concerned, the endless-chain system can be applied, with few exceptions, to every condition of wagonway with greater economy than any of the other systems, these exceptions being the cases, 1st, of the tail-rope system where numerous branches are worked; 2nd, of the No. 2 endless-rope system where the plane rises in one direction and has one or more sharp curves; and 3rd, of the South Wales endless-chain system where the gradient is heavier than 1 in 12, or 1 in 8 where stations are worked.

They are led to this conclusion by the fact that in each of the three chief items of working expenditure, viz., economy of power, maintenance of ropes or chains, and cost of labour, the cost of the endless-chain is lower than that of any of the other systems. In the application of this system to curves underground, a man or boy will have to be placed at each curve, but the extra cost caused by this will be more than repaid by the saving in the power exerted.

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The No. 1 endless-rope system is to be preferred to the tail-rope when the plane is undulating, has neither stations nor branches from the main way, and is with or without slight curves.

The No. 2 endless-rope system is only to be economically applied under the conditions stated above, and it cannot be advantageously adopted where the planes are undulating.

The tail-rope system is preferable to the No. 1 and No. 2 endless-rope systems whenever any stations by the side of the plane, or brandies from the main way, are to be worked.

WILLIAM COCHRANE, GEORGE B. FORSTER, JOHN DAGLISH, LINDSAY WOOD, R. F. MATTHEWS,

Acting Members

of the

Tail-rope Committee

EMERSON BAINBRIDGE,

Engineer to Committee.

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[299 Plate LII South Wales Endless Chain System. Brynddu Colliery, Glamorganshire. Section of engine plane worked by the chain]

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[301 Plate LIII South Wales Endless Chain System. Brynddu Colliery, Glamorganshire. Sketch of arrangement for working the endless chain]

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APPENDIX No. 2.

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A DESCRIPTION   OF   PATENTS

CONNECTED WITH

MINING   OPERATIONS.

By THEO. WOOD BUNNING.

Having the permission of the Council to arrange a list of all patents connected with coal-getting, and wishing to make that list as complete and correct as possible, the compiler again looked over the blue-books, and in doing so thought it would be as well to extend the search to all patents connected with mining operations. This list, originally made chronologically, was afterwards arranged in some way according to the different branches affected, thus the whole number has been divided into eight principal divisions.

1.—The first division is made to embrace all such patents as refer to lifting, winding, and safety apparatus. As the whole substance of the earth is acted on by gravity, the very first thing to do in boring to obtain mineral is to arrange some apparatus for overcoming that force without which not even a boring tool can be put in. This operation of lifting, as it proceeds to greater and greater depths, is attended with considerable danger, and requires much careful adjustment and superintendence. It is therefore, to be expected that the number of patents touching on this would be very numerous; they, in fact, reach 26 per cent, of the whole, and up to 31st January, 1866, their number was 160.

2.—The second division is made to contain all patents taken out for mining and sinking, which may be the second portion of the operation. Also an endeavour has been made in this division to keep boring and sinking distinct from boring holes for cartridges, or blasting, and also from boring tunnels. The apparatus for boring holes for powder or explosive compounds will be found under the seventh division, and the arrangement for boring tunnels under the sixth division.   This arrange-

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ment it has been difficult in all instances to follow; but the attempt to so classify them has been made in some cases by placing the same patent under two or more of these heads, where it has seemed advisable. Eight per cent, of the whole, or forty-nine patents, are devoted to this division.

3.—Presuming that boring and sinking will not be long carried on before water begins to show itself, pumping has been taken as the third division; but only those patents have been inserted which appear in the list set down by the Patent Commissioners as applicable to mining, for evidently the number thirty-seven, or six per cent, of the whole, does not include all patents connected with pumping.

4.—The sinking progresses, the water is satisfactorily disposed of, and the air requires attention. Ventilation, therefore, is put next in order, and occupies a prominent place; sixty-three patents having been obtained for this object, or nearly eleven per cent, of the whole.

5.—Artificial ventilation necessarily presupposes the fact that a decrease or insufficiency of quantity is possible, and has to be guarded against; safety-lamps, therefore, occupy the next division, numbering fifty-one patents, or nine per cent, of the whole.

6.—Having now arrived at the coal, the next thing is to get it. One hundred and four patents show how this can be done, being seventeen per cent, of the whole number.

7.—The mechanical methods of bringing down coal after it has been undercut either by machine or by hand, have been placed under the sixth division. Included under this head are explosive compounds, fuses, cartridges, modes of priming, and tools for boring holes for the introduction of such compounds. 14 per cent, of the whole, or 79 patents are for such operations.

8.—Lastly, all patents classed as connected with mining which do not come under any of the above heads are put here together, to the number of 52, or 10 per cent, of the whole.

In following chronologically the different patents taken out a very curious circumstance presents itself, viz.: that these different divisions seem to form themselves into waves as it were, and, as if obeying some law, first one group and then another presents itself in force. The cause of this will be, no doubt, very apparent to any one conversant with the history of mining during the last 50 years, and brings to the compiler's mind an anecdote related of Mr. Sanderson, who for many years was the late Mr. E. Stephenson's secretary at Great George Street, Westminster. On one occasion a gentleman called on him and wished to see Mr. Stephenson on some important business. On being informed that

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Mr. Stephenson was very much engaged, he pressed hard for an immediate interview, stating that his business required also prompt attention, but declined stating its nature. Mr. Sanderson at length said, "I feel sure I can tell you what your business is: you have come to propose a patent brake for locomotives." "Well, really, Sir, how could you possibly have guessed that?" was the response. "Very readily indeed," continued Mr. Sanderson; "there was a terrible smash up on the Midland the day before yesterday and we have had no peace here since." " Well then, as you have guessed my errand I will show you the scheme, it is very perfect and of great importance to the public, for you will see at a glance that it will pull any train up dead that it is applied to." "And the passengers, no doubt, as well," interrupted Mr. Sanderson. The thought immediately flashed through the patentee's mind that by stopping the train so suddenly he would surely sacrifice the passengers. He thanked Mr. Sanderson and promptly retired.

So it is with mining patents, an explosion occurs and a rush of lamp and ventilation patents follows; life is lost by overwinding, and is succeeded by a shower of hooks and clips; coal getting is brought prominently before the public through some advertisement or other circumstance, and hewing patents then are in vogue.

The mode of illustration adopted has been chosen more for the purpose of affording a general view of the nature of the invention than for ensuring actual accuracy, which would entail a vast amount of work and occupy much time that might be more usefully employed. For all practical purposes a very slight sketch will suffice to show the general principles involved; if more positive information be wanted, or any error of description suspected, the blue book can at once be referred to. In the same way the sketches are not copies of the drawings given by the patentees, but rather outlines made simply and rapidly to convey the leading features of the invention to the reader, and these are arranged at the end of each division for the sake of convenience of reference.

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FIRST DIVISION.

LIFTING AND WINDING.

The compiler cannot commence this subject without making a few remarks respecting the number of safety apparatus patents that appear, the leading features of most being the use of a lever with one end attached by a chain to the main-rope, which keeps the other end from touching the guides; when any accident happens the chain is slackened and the short end of the lever is driven into or against the guides by the mechanical action of the parts, the first impetus being given to them by a spring. Almost all the safety-cage systems invented involve this principle, and it is marvellous the number of forms this assumes, either alone or assisted in its action by wedges, rollers, racks, eccentrics, and springs. Possibly the first was invented by Booth in 1842, the first safety-hook being Reed's in 1836.

1728. No. 499. Hodgson. 4d.

Cages.—Making corf bows of iron instead of wood as heretofore, with springs and screws for drawing up coals from the pit.

1763. No. 795. Oxley. 8d.

Winding.—A machine for drawing coals out of pits by means of an engine and cog-wheels.

1766. No. 865. Barber. 10d.

Winding.—For raising water and coals—raises water by alternately filling cylinders with steam, and condensing it with cold water, after the manner of Savory. Raises coal by means of a double water-wheel, reversing the motion, and winds with rope going over and under the drum as at present used. See sketch.

1767. No. 871. Oxley. (No specification.)

Winding and Balancing Ropes.—Machinery for drawing coals by water for counterbalancing ropes.

1767. No. 883. Stokoe. 4d.

Winding.—For raising coal—lifts with a Scotch gin worked by horses.

1772. No. 1025. Budge. 8d.

Balancing Rope.—Applies the fusee barrel, common in watches, to raising heavy weights, the rope being on the small part of the fusee when commencing to lift. See sketch.

1773. No. 1044. Gullett. 1s. 2d.

Winding.—Double water-wheel, similar to No. 865, 1766. The rope

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is coiled twice or thrice round the drum and not fixed thereto, the part winding on is kept from moving laterally by rollers. 1776. No. 1118. Barber. 10d.

Winding.—Winding by steam off the second motion, rope going from top and bottom of drum, driven by a jet of steam working against pallets.

1776. No. 1132. Knowles and Holman. 4d.

Balancing.—Balancing the rope by a counterline working over a spiral wheel, so that the ore alone is lifted, the rope and cage being balanced.

1786. No. 1525. Cameron. 10d.

Winding.—Effected in the ordinary way, the rope going under and over the drum, the change in the direction being effected by trains of wheels much in the manner of an ordinary planing machine.

1786. No. 1529. Storey. 6d.

Winding.—A rope passing round a wheel at the top is taken to a sheave at the bottom of the mine, the weight attached is fixed to the side of this rope. See sketch.

1788. No. 1649. Beaumont. 6d.

Balancing Rope.—Drives coal wagons by means of a handle and cogwheels, lifts coal by the agency of water or wind by means of a double cone, the rope being in the small part of the cone at the commencement of the lift. See sketch.

1788. No. 1660. Curr. 1s.

Lifting.—Safety-Cage.—The corves are shunted past each other. Has several methods of supporting the tub at the top, put in motion by rollers at the top of the cage frame, disengaging inclined planes and springs.

1789. No. 1702. Cameron. 1s. 6d.

Winding, Balancing, Beake, and Endless-Chain.—A heavy weight is made to balance the rope. (2) I stop the machine at each end of the operation by means of a brake applied by hand. (3) In machines worked by steam, I reverse the engine, the reverse being self-acting by means of heavy weights falling when lifted a certain height. (4) Raising coals by endless-chain. (5) For bringing coals from interior of mines by means of endless-chains. (6) For valves in the pistons of the steam-engines. See sketch.

1790. No. 1775. Hateley. 4d.

Winding and Balancing Rope.—Steam-engine. When used for winding, a single or double fusee barrel is used, the rope being on the small part of the barrel when weight is first lifted.

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1791. No. 1834. Banks. 6d.

Winding.—Winding in the usual manner, the pulleys over the pit being in swing frames. Description not sufficiently clear to be intelligible.

1792. No. 1862. Feuillade. 1s. 2d.

Lifting.—Lifting weights by means of a long lever.

1792. No. 1924. Curr. 8d.

Lifting.—By means of pulleys and blocks proposes to diminish size of ropes employed in lifting weights.

1799. No. 2294. Jeffreys. 1s. 10d.

Endless-Chain Winding.—Lifts coal with endless-chains. The endless-chains are at the bottom giving motion to other endless-chains leading into the workings which draw the corves along, which corves are suspended from a pulley on a sort of overhead railway.

1807. No. 3206. Chapman. 10d.

Springs on Winding Ropes.—Preserving ropes by passing the rope under rollers provided with springs to take off the shock. See sketch.

1813. No. 3672. Hughes. 6d.

Screwing Weights up.—Raises gravel by means of a screw.

1813. No. 3711. Curr. 6d.

Ropes.—Applying flat ropes. See sketch.

1836. No. 6978. Slade. 1s. 2d.

Lifting, Endless-Chain Winding.—Makes a series of cages reciprocate up and down the mine. Bodies are lifted by being passed from one to the other. Further claims revolving or endless-chain, whatever material the same may be made of, whenever applied for mining purposes.

1836. No. 6993. Reed. 1s. 4d.

Safety-Hook.—Safety-hook, with moveable tongue to prevent handle from coming out.

1836. No. 7054. Spurgin. 1s.

Endless-Chain Winding.—Endless-ladders, with rollers to guide them.

1842. No. 9414. Booth. 10d.

Safety-Cage, Screwing, &c.—For raising and lowering heavy bodies, by which any ill consequences from the breaking of the rope will be prevented. (2) Raising the bodies by screwing them up, by having screws running down the mine from top to bottom, with rollers on the cages fitting into the threads. Also works a ventilator at the bottom of the mine, off the shaft, carrying the screw. Puts a rack down the whole depth of the mine. There is a lever which

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works in this ratchet, has its long end attached to the lifting rope, which keeps it out of gear. On the rope breaking, the lever falls, and it goes into gear. Employs a small rope attached to the short end of the lever, which, when the large rope breaks assists in keeping it in gear.

1845. No. 10,877. Knowles and Woodcock. 10d.

Lifting.—Puts a tube five feet diameter from top to bottom of the mine, fitted with a piston below, on which is the cage. On the air being exhausted the piston and cage rise together. Gear is attached for enabling the miners ascending and descending to regulate their speed, and the appartus is made to stop itself by means of valves and levers.

1846. No. 11,129. Bovill and Griffiths. 2s.

Lifting.—For raising weights in mines. Two pipes, with slots, go from top to bottom of pit, the pistons within which are attached to the cage, and the load is lifted after the manner of an atmospheric railway. Claims application of the force of the atmosphere when employed as a propelling power on railways or canals, whether applied to tubes with longitudinal or other valves, or whether applied to cylinders or vacuum engines for the like purpose. (2) Propelling carriages by means of drawbars. (3) Application of atmospheric mains, having their longitudinal slots covered as before described, to mining purposes.

1847. 11,557. Fourdrinier, 1s. 4d.

Safety-Cage.—Lifting and loading weights. Claims the mode of combining apparatus as herein described, whereby wedges or friction surfaces are brought into action by means of springs or otherwise, so as to press against the guides and prevent the falling of the apparatus when a rope or chain breaks. Also claims the arrangement of protecting the rope by means of a pipe or shield for the purposes hereinbefore described. See sketch.

1849. No. 12,746. Cowper. 2s. 4d.

Lifting.—Gives up and down strokes to spears—the weights are raised in a way analogous to that used in Cornwall. Patents a hydraulic balance as well, and an improved valve gear. Does not claim reciprocating rods, but claims a system of catches for lowering the carriages or boxes. Claims stages which support the boxes when the spears are moving in contrary directions. The use of the hydraulic balance when the weight is supported by two or more reciprocating rods. An arrangement of steam engine, where the

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traverse of the reciprocating rods may be regulated by cutting off the steam, and also a new valve gear.

1852. No. 417. Puis. 1s.

Ropes.—Forming rope into links. (2) Polygonal drum. (3) Forming the links into a chain by passing them round shafts or stays of iron kept at definite distances apart, and lashing them together. See sketch.

1853. No. 672. Lucas. 8d.

Winding Water.—I introduce a tank underneath the cage so that when the crossbar drops it lifts the valve and allows the water to escape.

1853. No. 1381. Biram. 10d.

Preventing Over-Winding, Winding, and Ventilating.—Claims mode of working drums for flat ropes by means of coupled lifting engines. "The adaptation of a link for starting, stopping, or reversing coupled engines employed in working mines as hereinbefore described." Ventilating mines with a fan having tangential blades.

1853. No. 2157. Barclay. 4d.

Preventing Over-Winding.—Preventing over-winding, by adapting the link-motion, the engineman working a lever to stop and reverse at the exact moment. A self-acting movement to come into play at the precise moment required. A tumbler to be slowly wound up or elevated to a falling point at the time the motion of the engine is to be changed, the tumbler falling reverses the link.

1853. No. 2714. Levick and Fieldhouse. 1s.

Winding.—The drums used for winding, in place of being at a distance from the shaft are placed immediately over it. The periphery of each drum is grooved from the extremities inwards in opposite directions, and two ropes are used. Claims " the combination of parts herein described, wherein the drums are each constructed with worms or grooves to work with two ropes or chains." See sketch.

1853. No. 3027. Marlor. 8d.

Lifting and Ventilation.—Improvements in ascending mines by which the ventilation is increased.

1854. No. 511. Barclay. 1s.

Preventing Over-Winding.—Invention relates to arrangements for preventing over-winding (same as No. 2157). Uses two horizontal

steam-engines. He drives a small shaft from the main shaft, on which is a worm working in a wheel which, at the proper time, reverses the engine. Claims, the engine as described; the application of link-motion to mining engines; reversing by slowly revolving stop; reversing by a weighted tumbler, and the application of a friction brake to be acted upon either by hand or weighted levers, which levers are arranged to be set free, by the ascent of the cages above their proper height; the system or mode of preventing the fall of the cage, by means of a pulley or pulleys, acting friction-ally upon the guide. See sketch.

1854. No. 912. Jones. 10d.

Landing Apparatus.—A square frame is erected round the mouth of a pit, to which frame are attached two lids or doors connected by cranks or rods—a lever causes the lids or doors simultaneously to open or shut as may be required. 1854. No. 1971. Hackworth.
1s. 2d.

Preventing Over-Winding.—Double cylinder expansive engine. 9th claim. Mode of reversing the motion of mine shaft winding-engines without reversing the motion of the driving engine itself, by means of friction clutches and a well-known apparatus in use for planing machines.

1854. No. 1978. Norton. 4d.

Ropes.—Manufacturing ropes by cementing together parallel or very slightly twisted minor strands or sectional portions.

1854. No. 2149. Smith. 6d.

Safety-Cage.—Construction of a miner's cage with safety apparatus, operated upon by spring lanyards. See sketch.

1855. No. 1164. Smith. 10d.

Safety-Cage. — A pair of bent levers connected with the slings, so arranged that their shorter ends will press against the sides of the wooden guides, a spring bow forcing them together. See sketch.

1855. No. 2561. Burrows. 1s. 2d.

Winding.—Use of a conically shaped winding drum having indented on the surface thereof a spiral groove or channel. A mechanical apparatus for forming such spiral groove. See sketch.

1855. No. 2876. Walker. 1s. 2d.

Winding Ropes.—The direct application of a steam engine to work the drum when the same is supported above the mouth of the pit.

(2) Application of wheels with cogs, and chain with open links.

(3) Attaching iron bars to wire ropes to join them together.

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(4) Working two mines with one chain. (5) Improved ropes. See sketch.

1856. No. 456. Griffiths. 6d.

Brake.—In which pressure is used on a toothed wheel, as described, instead of a smooth pulley as usual. See sketch.

1856. No. 585. Emery. 4d.

Safety-Cage.—For arresting the descent of cages. Side racks from top to bottom. Wheels on the cage which turn when the cage is descending properly, but have ratchets which prevent them turning when it is falling, these ratchets being put into gear by the rope breaking and letting a lever fall. See sketch.

1856. No. 596. Palmer. 10d.

Signal.—A galvanic telegraph.

1856. No. 597. Vigars. 4d.

Lifting.—Letting down kibbles or buckets by racks, connected with the pump rods, giving rotatory motion, the direction of which is reversed by clutches.

1856. No. 805. Smith. 4d.

Brake.—An ordinary brake with a cistern on the handle, by filling which with water, any amount of pressure can be put upon the brake.

1856. No. 1092. Bayliss. 4d.

Chain.—In composing the chain of double or treble links, which are welded together during the process of making. 1856. No. 1094. Hackworth. 4d.

Brake.—The cage is fitted with a lever or catch, which stops the movement of the winding machinery. It can also work upon a clutch with a bevelled wheel for the same purpose.

1856. No. 1493. Bates. (Provl.) 4d.

Safety-Cage.—Sustaining bolts, securing the cage, kept back by springs, forced outwards when the chain breaks. 1856. No. 1550. Van Hengel. 10d.

Safety-Cage —The racks are placed at the sides of the guides, and the the catches are upon hinges forced up by springs, and held apart by chains in the usual way. See sketch.

1856. No. 1990. Simpson. 6d.

Safety-Cage.—Ratchet teeth going up and down the mine. Levers with long and short arms, the long arm kept up by a sling attached to the rope keeps the short arm clear of the racks, the rope on breaking lets the short arm engage in the rack, and holds the cage. See sketch.

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1856. No. 2401. Knowles. 6d.

Safety-Hook.—Use of levers and pins for clasping the link of the chain. The pins are formed in one end of a pair of levers, which when open above the joint are closed below, a spring keeps the top ends closed until the bottom ends strike a ring attached to the pulley frame when the cage is released. See sketch.

1856. No. 2409. Burrows. 8d.

Counterbalancing rope by connecting the bottoms of the two cages, or by having an extra rope hanging below the cage.

1856. No. 2631. Vaughan. 6d.

Rope.—An improved band made of strips of thin metal which may be covered or not with gutta percha, &c.

1856. No. 2905. Eaton. 10d.

Springs of India-rubber.—Sheets of India-rubber separated by plates placed between the rope and the cage to prevent undue concussions.

1857. No. 284. Owen. 8d.

Safety-Cage.—Levers with long and short arms and suspending chain to grip the guide. (2) Facilitating the introduction and stoppage of tubs. See sketch.

1857. No. 773. Reid. (Provl.) 4d.

Landing.—An open rectangular frame of timber with doors.

1857. No. 1168. Otway. 1s.

Winding. Landing. Brakes.—Attaching to the cage four spring rollers which are pressed outwards by springs and steady the cage. A moveable cover at the pit mouth. A brake acting upon a brake pulley. The lever is placed near to the hand gear of the engine so that the engineman can apply or remove the brake at pleasure.

1857. No. 1288. Mackworth. 1s. 2d.

Lifting.—Employs endless-bands, made of chains, plates, wire, or canvas, with Jacob's ladders attached. Applies Jacob's ladders to coke-ovens. Jacob's ladders to mix coke and coal, or to mix liquids. The application of elastic cords to react on a piston worked by a rope.

1857. No. 1639. Robertson. 3s. 10d.

Lifting, Safety-Cage, Preventing Overwinding.—Robertson's Derrick, in which the load moves in a horizontal or semi-horizontal plane, by which it is carried by the main pillar. Derricks with diverging back-stays. Wall Derricks with their pivots inside the houses. Derricks without a centre post, in which the winch is fixed

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to the stationary part. The head of the jib is connected to the foot of it. A traversing Derrick. A post Derrick. Stopping the descent of cages. Preventing overwinding by concave and convex groove friction wheels. Grooved gearing, acting on friction brakes by the starting and stopping lever. See sketch.

1857. No. 1667. Heaton. 1s. 6d.

Landing Safety-Cage.—Improvements in self-acting doors or gateways, as weU as opening gates. Improved safety guard or catch. See sketch.

1857. No. 2271. Aytoun. 10d.

Safety-Cage.—Four strong blade springs, with a tendency to grasp the guides, the lower portion attached to the cage and the upper attached to levers carried to the rope. See sketch.

1857. No. 2501. Brooman. (Provl.) 4d.

Lifting.—Employing atmospheric tubes, similar to railways, for carrying the cage. Extracts water in the same way. Cage having double bottom, and suitable valves.

1857. No. 3065. Normann and Henley. 1s. 2d.

Winding.—For preventing the overlapping of chains. Employs two barrels, one without grooves the other with grooves. The barrel a has a series of parallel grooves, sufficient in number to give the requisite grip or friction; the barrel b is without grooves, and merely acts as a guide to carry the rope or chain from one parallel groove on to another; the rope returns from the last groove at the opposite side to which it came on. See sketch.

1857. No. 3130. Rennie. (Peovl.) 4d.

Landing through Trap-Doors.—The passage through of the wagon opens and closes them.

1858. No. 215. Woodward and Percy. (Provl.) 4d.

Safety-Cage Brake.—To prevent the descent of the cage. When the chain is tight the levers are lifted. When it is broken the levers come against the guides. Also, a brake to prevent weights falling when the motion is communicated by a driving belt. When the belt is unbroken the lever is kept from the brake. Also, a brake actuated by a governor. 1858. No. 250. Aytoun.
8d.

Safety-Cage.—Levers with long and short arms, the long arms suspended to rope, the short arms grip the guides when the suspending power fails—India-rubber springs assist in bringing the grips into play. See sketch.

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1858. No. 375. Barns and Loach. 10d.

Safety-Cage.—A skip with a door in the side for ingress and egress, with a seat for the men. Employs a number of buffers pressed by springs to the outside of the shaft when the rope breaks. The springs are kept back by chains attached to the rope, and are released and allowed to press outwards when the suspending rope fails. See sketch. 1858. No. 385. Mackworth. (Provl.) 4d.

Lifting.—" I raise coal by endless bands, arranged so that the mineral is confined between them. Also, improved method of coking coal."

1858. No. 971. Demanet. (Peovl.) 4d.

Screwing Weights Up.—Two screws from top and bottom of shaft.

1858. No. 1531. Marland and Widdall. 10d.

Safety-Hooks.—Claims the employment of hooks made self-acting by means of lever catches, which give way when they strike against a bar. See sketch.

1858. No. 1532. Gidlow. 1s. 4d.

Brake.—Application to winding engines of a self-acting brake, connected to a shaft or pulley, so that the brake may be forced against the periphery, lifting eccentric rods off their pins by the same means.

1858. No: 1768. Tayloe. 1s. 4d.

Lifting.—Sort of compressed air engine. Also regaining part of the power expended in raising a load. Also throwing pumps out of work when the receivers are full.

1858. No. 1998. Robertson. 2s.

Driving Belts.—Making corrugated driving belts.

1858. No. 2280. Ridley. 10d.

Safety-Cage.—The application of a safety-cage as before described. Also of the use of coiled springs in combination with eccentrics and shafts. See sketch.

1859. No. 42. Corfield. 4d.

Chains.—" Instead of making chains of single links, I make them of double, one set being shorter than the others." 1859. No. 106. Bennetts. 8d.

Levers.—With their long arms attached to the lifting rope and their short arms made to press against the guides by means of springs. See sketch.

1859. No. 197. Newman. 10d.

Chains.—The chain, which is of the ordinary watchmaking class, has a

washer inserted on each side of the centre single link, this washer is received in recesses formed half in the centre link and half in the adjoining double links. See sketch.

1859. No. 426. Bailey. 1s.

Safety-Cage.—Claims arrangement. The toothed rack b1 is attached to the rope, and the other arrangements are attached to the cage, the levers cc keep the catches or grips bb in gear with b1, the triggers dd when struck by a ring at top first releases the catches cc, and then pulls bb out of gear with b1, thus disconnecting the cage. See sketch.

1859. No. 635. Calow. 10d.

Safety-Cage, Hook, &c.—A perforated shield—also compound action— also parallel motion of brakes or skids acting on the guides—also methods of adjusting—also detaching hooks. The whole will be sufficiently intelligible by reference to sketch.

1859. No. 857. Libotte. 8d.

Safety-Cage.—Method of constructing so that claws mounted on shafts turned by springs, such springs being inactive while the rope is working, are released when the rope is broken, and act upon the shafts, whereby the claws are put in motion.

1859. No. 987. Dutton and others. 8d.

Self-acting Brake.—The winding engine causes a wheel to rotate on a screw, which pushes it alternately into clutches on either side—these clutches causing the brake to be put into gear.

1859. No. 1068. Libotte. 8d.

Brake.—Instead of the brake being affixed to the edge of the wheel, it is affixed to the sides of the wheel—a lazy tongs action causing them to grip when the pressure of steam is admitted. See sketch.

1859. No. 1232. Evans. 8d.

Safety-Cage.—Consists of levers in a box, which push two bolts after the manner of a lock in and out of a slot attached to a pin connected with the rope. On the lock being withdrawn from the bolt it projects outwards and rests on the ring that disengaged it. See sketch.

1859. No. 1705. Gedge. (Provl.) 4d.

Safety-Cage.—Claws arranged to penetrate into guides, assisted by helicon springs.

1859. No. 1907. Jackson and Thorley. 6d.

Safety-Cage.—On the rope breaking the cage is wedged against the guides. See sketch.

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1859. No. 2212. Guibal. 10d.

Springs on Pulleys.—" I claim the introduction of springs beneath the pulleys of mining or other cables, or beneath the drum on which they roll, for the purpose of protecting them against sudden shocks."

1859. No. 2550. Spill. 4d.

Ropes.—Making ropes of covered strips of metal, in conjunction with cords of hemp.

1859. No. 2656. Knowles. (Provl.) 4d.

Overwinding. —A hinged pin withdrawn from a cotterhole when overwound, which disengages the apparatus.

1860. No. 113. Cope. (Provl.) 4d.

Landing.—The cage is upheld by folding flaps, which open upwards and prevent the cage from falling—a pair of hooks above keep hold of the chain by means of springs, which springs being released they disengage.

1860. No. 144. Timmins. 8d.

Safety-Cage and Hook.—Levers jambed into the guides in the usual way, and a detaching hook. See sketch.

1860. No. 497. Boissau. 1s. 8d.

Lifting.—Alternating racks which raise the cage up between them.

1860. No. 542. Walker. 6d.

Safety-Hooks.—Hook as shown. Claims application of an antifriction roller to the bridles of the disengaging hooks. See sketch.

1860. No. 544. Wright. 10d.

Safety-Cage.—The levers kept from the guides when the rope is whole, and press against them when broken. The disengaging apparatus consists of two sloping levers withdrawing two bolts.

1860. No. 616. Buxton. 6d.

Safety-Cage.—Lexers kept free from the guides by short chains attached to the main links. These slacken when the rope breaks and the levers press the guides, assisted by springs.

1860. No. 742. Crawshay. 6d.

Pulleys.—Construction of wrought iron pulleys. Pulleys with wrought iron rims.

1860. No. 915. Addenbrooke and Lewis. (Provl.) 4d.

To Prevent Overwinding.—The pulley is made to slide away from the mine shaft. On the further motion of the chain the pulley is made to move up an incline. Also radial levers which come against the guide in the usual way when the rope breaks.

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I860. No. 1264. Paton. 1s. 4d.

Winding, Lifting, and Boring.—Also mode of actuating a sinking tool by means of frictional gearing and a small steam engine.

1860. No. 1342. Farrell. (Provl.) 4d.

Safety-Hook.—The hook is suspended on a pivot which is canted on coming too high, and cross lever bars which when released push projecting pieces in contact with the upright guides.

1860. No. 1439. Fromont. (Provl.) 4d.

Safety-Cage.—A series of toothed wheels placed opposite to each other in frames let into the masonry. The cage is fitted with racks. When wheels rotate cage ascends.

1860. No. 1673. Davis. 1s. 8d.

Safety-Cage.—Toothed racks on each side of the pit a short way from the top which hold the cage when the hook is disengaged.

1860. No. 1758. Dickinson. 4d.

Self-Acting Bbake.—Makes engine put its own brake on, the attendant traversing a strap from a loose to a fast pulley. 1860. No. 2751. Rollinson. 8d.

Brake Apparatus.—A brake, the handle of which is wound up by a chain attached to the winding shaft.

1860. No. 2939. Perry. 1s.

Safety-Cage, Hook, &c.—Guides and racks from top to bottom, bolts are fixed into these racks on the breaking of the chain. Also a safety-hook. Also flaps on top of pit, made of wire. See sketch.

1861. No. 203. Law. 6d.

Brake.—A lever is made to traverse backwards and forwards by means of a screw on the engine shaft, acting on brake levers at either extremity.

1861. No. 265. Lemielle. (Provl.) 10d.

Safety-Cage.—The rope is balanced by connecting the bottoms of the ascending or descending cages with a rope running over a pulley at bottom of pit. Also the lever arrangement for gripping the guides.

1861. No. 388. Westhead. 6d.

Safety-Cage.—He applies a governor to an ascending cage, worked by a roller running up the guides, which gives a signal where the speed is in excess.

1861. No. 613. Spencer. (Peovl.) 4d.

Springs.—Uses alternate plates of metal and India-rubber, but does not allow the plates to project beyond the India-rubber.

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1861. No. 821. Wright. 8d.

Steam-Brake.—Puts a steam-cylinder on the brake skid, and the rod attached to a piston carried to another skid on the opposite side of a wheel. On applying steam the piston moves one way and the cylinder the other, compressing the respective skids on the wheel. See sketch.

1861. No. 1419. Bailey. (Provl.) 4d.

Safety-Cage.—Attaching to an ordinary cage a steam whistle for indicating dangerous speed.

1861. No. 1821. Savory. 10d.

Winding.—Winding by means of a barrel carried round the boiler of a locomobile.

1861. No. 2175. Copple. (Provl.) 4d.

Safety-Cage, Hook, &c.—Arms expanded by strings attached to the rope. Disengaging hook, and covering the pit mouth.

1861. No. 2579. Lister and Myers. 8d.

Safety-Cage.—Two guide rods and levers working inside guides which embrace these rods. These levers grip the guides in the usual way. A disconnecting hook of ordinary construction.

1862. No. 274. Deprez. (Provl.) 4d.

Lifting.—Placing two axles independent of each other; and at suitable angles, the cranks and connecting-rods intended to produce the reverse movement, and consequently the ascent and descent of the cages.

1862. No. 609. Farrimond. (Provl.) 4d.

Safety-Cage.—Two horizontal shafts, with eccentric levers, worked by a coupling-chain to the main-rope in the usual way.

1862. No. 648. Calow. 8d.

Safety-Cage.—Combining apparatus that grips, so that it may be brought into action by the gravitation of the cage. Also, the mode of detaching the rope. A weight balances a spring, the shock on which, when the rope breaks, causes the levers to work. See sketch.

1862. No. 1069. Hampshire. 1s.

Safety-Cage and Hook.—Levers actuated by the rope and springs in the usual way. Safety-hook. See sketch. 1862. No. 1240. Goodman. (Provl.) 4d.

Safety Apparatus.—Racks from top to bottom. Springs force the pauls out and chains connect the other ends to the rope.

1862. No. 1928. Johnson. (Provl.) 4d.

Adjusting the Length of the winding rope by having holes arranged

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on an iron plate at the end of the rope, arranged with holes in the drum after the manner of a vernier. See sketch,

1862. No. 2662. Gilchrist. (Provl.) 4d.

A steam boiler with winding details, actuated by a cylinder, together with a cylinder to give reciprocating motion to the boring tool.

1863. No. 71. Punshon. (Provl.) 8d.

Overwinding.—He counterbalances by means of a separate cylinder. When the weight gets past the half-way the steam in the counter cylinder will balance the extra weight of the descending rope, and at the end of the distance afford such resistance by pressure as to prevent overwinding.

1863. No. 113. Rock. 1s. 4d.

Lifting.—It is an endless Jacob's ladder. The platforms are made to project when rising, and fall vertical when descending, the whole surrounded by a tube, which it is proposed in a mine to make sufficiently strong to keep the pit open, no matter what accident has occurred.

1863. No. 166. Paul. (Provl.) 4d.

Compound slot link attached to an engine for obtaining a greater length of stroke than can be obtained by means of beams and cranks.

1863. No. 1745. Barton. (Provl.) 4d.

Landing.—A fence for coal pits, closed by self-acting gates.

1863. No. 2110. Newton. (Provl.) 4d.

Ropes.—Using several round cords instead of a flat cord. Using a furnace under the drum to counteract the injurious effects of humidity.

1863. No. 2814. Booth. 10d.

Guy-Cranes.—The application of double pulleys.

1864. No. 100.—Denton and Whitaker. 6d.

Safety-Cage.—A trigger-hook for preventing overwinding, and springs and levers for preventing falling by adhesion to the guide. Claims catches and springs and mode of arrangement. See sketch.

1864. No. 122. Balmforth and Robson. (Provl.) 4d.

Steam-Crane.—A portable steam-crane for quarry use.

1864. No. 160. Lebrun. (Provl.) 4d.

Safety-Cage.—Ratchet racks extending from top to bottom of shaft. Levers are attached in the usual way to the chain. Springs to force them on the racks when the chain breaks.

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1864. No. 744. Leak. (Provl.) 4d.

Signalling.—Transmitting signals. Tubes with mouth pieces for transmitting verbal messages.

1864. No. 1354. Eckersley. (Provl.) 4d.

Signalling in Mines.—Signals by means of symbols or indices, which shew and correspond to the number of knocks given.

1864. No. 1423. Bragg and Bridgeman. (Provl.) 4d.

Lifting.—Uses screws of great length fitted into each other with sockets, for lifting weights from mines and propelling through tunnels.

1864. No. 2007. Alison and Shaw. 8d.

Lifting.—Eaising minerals and workmen inside air-tight cylinders by means of air. Ventilation.—Also the ventilation of collieries by the use of an apparatus worked by a piston in an air-tight cylinder the whole length or depth of the shaft. 1864. No. 2293. Taylorson. (Provl.) 4d.

Self-Acting Valves.—Rendering the valves of steam engines self-acting by causing a rotatory motion to be given to a governor.

1864. No. 2492. Webster. 8d.

Manufacture of Flat Chain.—Manufacture of flat chain by interlacing or screwing together separate lengths of coil, metal rods, or wires.

1864. No. 3208. Taylor. 8d.

Safety-Cage.—Two racks running from top to bottom of the mines— wheels working in them—a weight falls down between the wheels and prevents them turning round when the suspension chain is broken. See sketch.

1864. No. 3230. Edwards. 10d.

Lifting.—A piston is made to nearly fit the shaft. These pistons are packed with brushes or fibrous pads. An apparatus for compressing air by means of hollow screws or spirals working in water.

1865. No. 262. Gibson. 10d.

Lifting.—Putting the pulleys over the pit upon springs to relieve the strain.

1865. No. 937. Jamet. 8d.

Lifting.—A set of pulleys which jamb the rope when the end is let go.

1865. No. 1343. Elliott and Coxon. 10d.

Springs on Pulleys.—The pulleys are fitted in bearings supported by

steam cylinders. See sketch.

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1865. No. 1666. Gedge. 1s. 4d.

Lifting.—Double series of lazy tongs, moved upwards by a ratchet. See sketch.

1865. No. 2383. Broadbent. 10d.

Safety-Cage.—Long and short arm levers. The long arms connected to the chain—the short arms pressed into the guide by means of a spring when the chain breaks.

1865. No. 2663. Murray. 10d.

Load Lifting and Discharging.—The chain connected with the bottom of the tubs in such a way that the bottom will allow the contents to fall at any given position.

1865. No. 3176. Pickup and Heald. 4d.

Signalling.—By means of opening a cock and letting compressed air act on a whistle.

1866. No. 22. Buckley. 8d.

Signalling.—A bell is made to ring by means of a pulley, and a disc is made to rotate by means of a paul attached to the hammer working the bell, which shows the number of times the bell has rung.

1866. No. 71. Turner and Coughin. (Provl.) 4d.

Lifting.—By water power and attaching pulleys to the piston to increase the range of the lift. Similar to Armstrong's patent.

1866. No. 1562. Loader. 10d.

Lifting.—Machine for raising and lowering weights with pulleys. Pulleys of the same size are worked at different speeds by means of gearing.

1866. No. 1618. Bellhouse. 8d.

Safety-Cage.—The old levers to grip the guides. Weights are used at the long ends of the levers. A sliding grip is also attached to it, which is forced against the guide by an inclined plane or wedge. See sketch.

1866. No. 1672. Eades. 10d.

Pulley-Block.—A pulley is made to revolve slowly by means of another wheel mounted on an eccentric.

1866. No. 2193. Plimsoll. 10d.

Unloading Coals.—A mode of discharging coals at sidings, so that they may be less damaged.

1866. No. 2578. Clark. 1s.

Lifting.—Arranging a bucket elevator for ore or water in connection with guide-wheels or rods. Operated by means of a hoisting rope

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on a drum or windlass, so that the car shall be steadily supported and discharged by the deflection of the guide wheels.

1866. No. 2816. Scott. 10d.

Lifting.—Apparatus for raising and lowering weights.

1866. No. 3071. Johnson. 8d.

Lifting.—Travelling crane for raising heavy bodies, combining two windlasses in such a manner that they may be coupled or geared together, or one be made to work while the other is stationary.

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SECOND DIVISION.

MINING AND SINKING.

1805. No. 2822. Ryan. 10d.

Apparatus for boring coal, whereby small cylinders may be cut out, and brought to bank without being broken. The rock is cut out and nipped off at the bottom.

1806. No. 2926. Miller. 6d.

Sinking by means of raising a weight and letting it fall.

1830. No. 6018. Sir Thomas Cochrane. 10d.

Compressing atmospheric air and retaining it in mines, whereby it may counteract the tendency of superabundant water to flow by gravity into such mines. The men work in the high pressed air, and have antechambers for the purpose of going in and out.

1847. No. 11,548. Taylor. 10d.

Boring small holes. The passage h and valve e in the screwed head of the borer are for the escape of the borings into a receiver. (2) The application of a hollow tube receiver taking the place of a part or the whole of the ordinary lift and boring rods distinct from and above the top of the boring tool, to hold the said borings. See sketch.

1847. No. 11,913. Gard. 1s. 6d.

Apparatus for sinking, similar to No. 11,548. Uses a ball instead of a valve. Claims using concave bits with cross cutters attached to hollow shafts, and communicating internally and directly therewith, or with workable rope, chain, or other flexible substitute for rigid rods. (2) Claims the combination for boring and sinking purposes of concave bits aforesaid, with working machinery of either of the kinds hereinbefore described.

1851. No. 13,478. Kind and Wendel. 2s.

Apparatus for boring small holes, with peculiar apparatus for seizing the rods with forks or pincers, and enabling them to bring up small cylinders of soil without fracture. Also for boring larger holes by means of cutters at the extremity of a cylinder. Mode of lining the shafts by means of iron or wooden cylinders, the space between which and the side of the shaft is filled up with mortar or cement. See sketch.

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1852. No. 14,165. Dixon and Dobson. 4s. 6d.

Upon a turntable an apparatus is erected for jumping up and down a drill round the outside of a circle. A number of drills in a frame with a number of hammers striking them. A machine for shaping the slate after it is quarried. Round rods are used for rails here. The blocks of stone requiring to be cut are arranged on each side of a line of railway, and a locomotive, with a saw on each side, runs backwards and forwards and cuts them square. See sketch.

1852. No. 344. Perkes. 1s.

Boring earth, crushing, pulverising, dressing, mixing, grinding, pumping, washing, precipitating, and amalgamating ores, and an improved sublimating apparatus.

1854. No. 2275. Mather. 1s. 4d.

Improvements in machinery for boring and for actuating a hammer for driving tubes into the earth or other uses. Complicated apparatus, can hardly be described without an elaborate drawing. See sketch.

1855. No. 229. Fontainemoreau. 4d. Drilling and boring rock, tunnelling, and rock excavation. Specification not filed.

1856. No. 2288. Gard. 8d.

" I claim the forming of bits for boring and sinking in two separate and distinct parts." See sketch.

1857. No. 2189. Hughes. (Provl.) 6d.

Raising the jumper by eccentrics; making the jumper heavy by means of a moveable weight. Improved form of jumper.

1857. No. 2479. Newton. 6d.

A peculiar means for operating the drill longitudinally on giving it its reciprocating motion. Also in doing this intermittingly. Also a frame to work at different angles.

1858. No. 402. Greenley and Daft. (Provl.) 4d.

Applying direct action by steam to raise the boring rods between each blow of the tool. Also constructing the boring tool so that a metal cylinder with a valve at the bottom causes the debris to ascend.

1858. No. 1450. Erhard. 1s. 4d.

Causing water to flow past the boring tool by means of a pumping action. Connecting the cutting tools to the rods which pass up to the top of the well, so that after the rod has been lifted the tool may be released and allowed to fall independently.

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1858. No. 1920. Schrader. (Provl.) 4d.

For Boring.—A centre point projecting past side cutters.

1858. No. 2096. Allison. (Provl.) 4d.

Hollow boring head, furnished at the bottom with cutters. Inside and near the end of the tool a valve of gutta percha. For raising the debris I employ a pump. Also a hollow vessel of lead to contain muriatic acid, which is lowered to the point where the acid is required to operate, and is there let out.

1858. No. 2389. Luis. 10d.

Claims rotation of borer, cords being substituted for rods. Also guiding the tool. Also a sample borer. Also hooking and unhooking the borer.

1858. No. 2477. Schwartzkorf and Philippson. 10d.

Steam hammer striking a tool. Tool is lifted by springs or otherwise, and is turned round by a ratchet apparatus.

1859. No. 50. Johnson. 10d.

General arrangement of a hammer for boring. Also a striking piston independent of the action of the operating fluid. Also a constant pressure for bringing back the piston. Also self-acting advance.

1859. No. 638. Allison. 8d.

Inside the tool, at the bottom, is a valve of India-rubber. The top of the tube has a sling to connect the rope. I employ a pump to get out the debris, and a cylinder to contain muriatic acid.

1860. No. 514. Hughes. 6d.

Attaching to an ordinary borer a wire cable, a twirl, and a spring.

1860. No. 647. Luis. (Provl.) 4d.

In replacing "the small holes of mines, usually cylindrical, by mines variable in shape, size, and depth," according to the nature of the rock.

1860. No. 1264. Paton. 1s. 4d.

Winding, Lifting, and Boring.—Mode of actuating a sinking tool, by means of frictional gearing, and a small steam engine.

1860. No. 1892. Hunter. 10d.

Boring and Winding.—In which the boring rods are actuated by compouud adjustable levers. See sketch.

1860. No. 2178. Duverge. (Provl.)

Uses various drills in a framing for horizontal and vertical boring.

1861. No. 373. Poole and others. 6d.

Placing a small piston on a boring bar for boring rock, mounted in

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a suitable frame, which causes the borer to jump up and down. See sketch.

1861. No. 2813. Simpson. 10d.

Portable apparatus with a cylinder giving an up and down motion to the borer, direct at the end of a lever, and a winding apparatus. Applies counterbalance weights. Also a sludge pump with an air valve at the top end of the barrel.

1861. No. 2987. Barclay. (Provl.) 4d.

Boring for Water.—A combination of a locomobile, with levers for vertically jumping the rod and winding.

1862. No. 464. Crease. 8d.

Application of steam to a suitable hammer head attached to the boring tool. I give a jumping rotating motion to the drill, and a self-acting arrangement to cause the two to progress.

1862. No. 922. Harrison and Standly. 8d.

Drills for boring rock, supplying a continuous stream of water to the boring tool. We claim the supplying the cutter with water without interfering with the discharge of the debris.

1862. No. 2441. Brooman. 8d.

An apparatus mounted on wheels, with a drilling apparatus attached to it, which can be raised up and down. Claims boring tools formed of a metal tube with a ring or crown, armed with diamond cutters. Also imparting simultaneous rotatory and advancing motion to boring tools.

1862. No. 2505. Barclay. (Provl.) 4d.

A locomotive with apparatus for boring and winding attached.

1862. No. 2662. Gilchrist. (Provl.) 4d.

A steam boiler with winding details actuated by a cylinder, together with a cylinder to give reciprocating motion to boring tool.

1862. No. 3322. Clark. 1s. 4d.

For Boring, Winding, and Lifting.—Combined in one apparatus. An engine with a winding apparatus actuates a cam, which gives a vertical jumping motion to the tool. The rods are counterbalanced by two steam cylinders, with a valve to regulate the pressure. See sketch.

1863. No. 668. Barclay. 1s. 2d.

Claims use of a working beam coupled direct between the boring cylinders and boring rods. Also balancing the boring rods by means of a special cylinder, acted on by steam or air. Also combining two cylinders for winding. Also for making the locomotive

self-propelling. Also causing the reciprocating action to produce the rotation of the drill. Also introduction of an India-rubber spring between the engine and rods. See sketch.

1863. No. 1322. Munro and Scott. 1s. 4d.

For Boring.—Combination of the parts. Also a reciprocating tool actuated by pistons moving angularly. Also continued pressure chamber. Also a heavy ram or tool carrier. The whole is a boring apparatus, with winding apparatus, and means for giving reciprocating motion to boring tools.

1863. No. 2459. Gibson. 6d.

Cast Iron Tubbing.—Protecting the plates from corrosion by chill casting them.

1863. No. 2531. Polglase and Cox. 1s. 2d.

For Drilling Stone.—Working a number of jumpers in a row with tappets.

1863. No. 2600. Mitchell. (Provl.) 4d.

To sink with common boring tools, and for giving the force of the blasting powder the greatest effect. He also uses taper plugs.

1863. No. 3000. James. 10d.

Chiefly intended for boring obliquely. Consists of a boring rod having two water passages, one for the admission of water, and the other for the return of the drbris. See sketch.

1864. No. 1472. Tregay. 1s.

Boring rocks with Motional rotating tools, instead of by impact. Employs water through the tools, but acids may be employed with advantage. Claims a frictional rotating borer. Also the use of emery for boring.

1864. No. 1753. Maitland. (Provl.) 4d.

A boring tool composed of a number of tubes screwed into each other, open top and bottom, to receive a cylindrical vessel or bucket provided with a valve at the lower end, so that the debris may be forced up by the action of the cutting tool.

1864. No. 2914. Gay. 10d.

Forms discs of various metals, and wears away the rock by a biting substance such as sand or emery. Describes a machine with a number of such discs for boring tunnels.

1865. No. 981. Johnson. 1s.

Drills operated on by elastic fluid in combination with a hollow piston-rod, when used as a tool-holder. Also a momentum feed and 15 other claims, one of which is mounting, drilling, boring, or other

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machinery when arranged for the use of steam or compressed air, upon a columnal frame whether solid or tubular, and whether the steam is conveyed to them by independent pipes or through the columns.

1865. No. 1587. Haseltine. (Provl.) 4d.

Boring Tunnels.—Machinery arranged to cut annular grooves combined with means for splitting off the isolated portions remaining between the annular grooves by the boring tools.

1866. No. 655. Stevenson. 4d.

For Perforating Rocks.—An arrangement by which 20 men can work where only 2 can work now. It consists of a sheet iron cylinder 4 1/2 feet diameter, 3 feet long, supported by a round iron central bar or shaft. The boring is performed by means of men working inside the cylinder.

1866. No. 995. Scott. 4d.

Foundation Cylinder for Sinking Tubes.—By exhausting the air from the interior of the cylinders.

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THIRD DIVISION.

PUMPING.

1802. No. 2609. Charlton. 4d.

The substitution of cast-iron props instead of wood, stone, brick, or coal.

1830. No. 6018. Sir Thomas Cochrane. 10d.

Compressing atmospheric air, and retaining it in mines whereby it may counteract the tendency of superabundant water to flow by gravity into such mines. The workmen work in the high pressed air, and have antechambers for the purpose of going in and out.

1853. No. 672. Lucas. 8d.

"I introduce a tank underneath the cage, so that when the cross bar drops it lifts the valve, and allows the water to escape."

1856. No. 2133. Leaver. 4d.

An ordinary double-acting pump.

1856. No. 2985. Smith. 8d.

Placing the pump at the bottom of the mine, pulling the plunger up with a cord or chain, and letting it fall with a counterbalance weight.

1858. No. 1928. Dredge. 1s. 4d.

Lifting Water.—Applying confined cisterns with condensers. Forcing-water into such cisterns in the way described. Also said pumps for forcing.

1858. No. 1933. Black. 10d.

Curved paths on a revolving face for working pumps.

1859. No. 1996. Borrington. (Provl.) 4d.

To obviate the evil arising from the weight of the bucket in deep mines, "I substitute for the wooden pole or iron rod, a tube of gutta percha, and fix therein, or not, an iron tube." Also surrounding the rods with cork.

1859. No. 2234. Wright. 1s. 6d.

Raising Water.—Uses a steam cylinder the whole length of lift, with a long piston-rod.

1860. No. 509. Barclay. (Provl.) 4d.

Cylinder by the side of the mouth of the shaft. Piston-rod connected to the centre of an overhead beam. One end hangs over the shaft and pumps, and the other is fixed to a rocking axle.

1860. No. 2041. Barclay. 4d.

Cylinder arranged at side of shaft for pumping water. Piston-rod is

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connected at such a distance from the end of the beam as to allow the overhanging extremity to be joined to the pump rods, the other end being on a rocking axis.

1860. No. 2318. Barker. 1s. 4d.

Raising and Forcing Water.—Pumps by compressed air. Also by an archimedian screw going the whole depth of the mine.

1861. No. 14. Fuller and others. 8d.

A mixture of hard and soft rubber for valves in pumps.

1861 No. 453. Barclay. 10d.

Cylinder of the engine placed at the side of the mouth of the pit. The piston is not communicated to the centre of the beam, but so as to allow one end to hang over the shaft, the other end being in a rocking-frame.

1861. No. 2901. Smith. 8d.

Raising Liquids.—Forces air into the cask or chamber. In pumping water from the mines a continuous flow is obtained by having two pipes connected, with the place where the water is contained.

1862. No. 1170. Webster. (Provl.) 4d.

Raising water by the direct action of compressed air.

1862. No. 1692. Rydill. 2s. 6d.

A pumping apparatus in which two plungers are made to work one below the other.

1862. No. 2036. Johnson and Taylor. (Provl.) 4d.

Similar to No. 1928, Division 1.—When water is wound he passes an air pipe through the tub, to prevent a vacuum being left after leaving the water.

1862. No. 2843. Webster. (Provl. Refused.) 4d.

Self-acting fountains. Charges a reservoir with compressed air.

1863. No. 221. Clark. (Provl.) 4d.

The application of syphons. The application of a float which closes a cock for passing water out when there is no more water to remove, and opens it again on the return of water.

1863. No. 2448. Jones. (Provl.) 4d.

Pumping by the application of two sets of pipes, so that the columns of water in each series are alternately assisting each other in raising the water. Uses 3 pumps. The centre one is an equilibrium cylinder, and the upper and lower ones work in barrels. The equilibrium one communicates with the two columns of water, whereby the columns are balanced.

1864. No. 835. Briggs, Jun. (Provl.) 4d.

Uses two pipes connected to force pumps, so that the columns of water

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in each series are alternately assisting each other in raising the water from the bottom of the mine.

1864. No. 1273. Noble. (Provl.) 4d.

Raising Water.—" I use pipes, air-tight chambers, or reservoirs, into which I deliver the water at the top with a valve, to prevent the water returning. I raise the water out of the reservoir by another aperture near the bottom, which delivers into another chamber above, as before. My object is to break the column of water."

1864. No. 1493. Thomson. 8d.

Forcing water into water-tight bags, for the purpose of splitting rock and bringing down coal.

1864. No. 2523. Noble. (Provl.) 4d.

Air-tight chambers into which he delivers the water near the top, with a valve at the aperture to prevent it turning back. Raises the water out of the chamber by another aperture near the bottom, into another chamber above like the first. My object is to break the column of water.

1864. No. 2603. Gwynne. 1s.

Centrifugal Pumps.—A centrifugal pump. Has 12 claims.

1864. No. 2666. Laidlaw and Robertson. 2s. 6d.

A rotary compressing pump of a peculiar form. See sketch.

1864. No. 3005. Gray. (Provl.) 4d.

An improvement on Downton's pumps. (No. 5221—1825.)

1865. No. 1191. Bernard. 8d.

Apparatus for Raising Water.—Arranging clack doors so that the door can be removed without the bolts being taken out. (2) In packing it by means of a recess made in the pump, for the purpose of receiving elastic or other packing. See sketch.

1865. No. 1996. McEwan and Neilson. 1s.

They claim the application and use of high pressure steam in the form of circular jets, so that by the direct action and force of the steam, they raise or force the water through the full bore of the pipe.

1865. No. 2178. Newton. 6d.

Covering the snoreholes of a pump with a protecting shield.

1865. No. 2946. Easton. 6d.

Arranging a bucket with a plunger, so that half the contents of the pump are lifted at each alternation of the reciprocating motion. See sketch.

1865. No. 3074. Johnson. 6d.

A perforated pipe with a pointed end constructed as a drill, and united with a pump. See sketch.

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1865. No. 3330. Hoskold and Brain. 10d.

Improvements in Pumps.—A plunger working in two cylinders, whereby

the water is discharged from each alternately. See sketch.

1866. No. 385. Atwater. 8d.

A variation of Savory's engine. Steam is admitted into a vessel divided by a horizontal diaphragm, with a valve opening downwards. The water is partly driven up the stand pipe by the pressure of the steam; on that pressure being removed, it flows through the suction into the vessel.

1866. No. 435. Hargrave. (Provl.) 4d.

The use of a syphon in connection with a pump. One leg of the syphon is made to communicate with a pump above the piston. The pump having raised the water sufficiently high to set the syphon in operation, the discharge of the liquid is secured without the labour at present necessary to lift it to the level of the water outside the ship.

1866. No. 2927. Bonneville. 8d.

Pumping or Ventilating.—An elliptical box in which turn two parallel fluted rollers, with big rounded teeth geared together. See sketch.

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FOURTH DIVISION.

VENTILATING.

1826. No. 5348. Wood. 6d.

For Destroying Fire-Damp.—Sets a clock to fire the mine by means of phosphorus, when the men are out.

1830. No. 6018. Sir Thomas Cochrane. 10d.

Compressing atmospheric air and retaining it in mines, whereby it may counteract the tendency of superabundant water to flow by gravity into such mines. The workmen work in the high-pressed air and have antechambers for the purpose of going in and out.

1842. No. 9414. Booth. 10d.

For raising and lowering heavy bodies by which any ill consequence from the breaking of the rope will be prevented. (2) Raising the bodies by screwing them up, by having screws running down the mine from top to bottom, with rollers on the cages fitting into the threads. Also works a ventilator at the bottom of the mine, off the shaft, carrying the screw. Puts a rack down the whole depth of the mine. There is a lever which works in this rack, and has its long end attached to the lifting-rope which keeps it out of gear. On the rope breaking the lever falls and it goes into gear. Employs a small rope attached to the short end of the lever, which, when the large rope breaks, assists in keeping it in gear.

1852. No. 346. Perkes. 8d.

Puts pipes along the floor or ceiling of the mine with standard pipes, provided with bell mouths, for the free admission of foul air; he takes them to the surface and consumes the vitiated contents in a furnace—sometimes causes the pipes at the surface to be heated either by fire, steam, or gas. In other cases, chimney cowls are put on, and, when necessary, pumps or centrifugal apparatus. Rest of patent applies to sanitary (building) apparatus.

1853. No. 1381. Biram. 10d.

Claims mode of working drums for flat ropes by means of coupled winding-engines. (2) " The adoption of a link-motion for starting, stopping, or reversing coupled engines employed in working mines, hereinbefore described." Ventilating mines with a fan having tangential blades. See sketch.

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1853. No. 3027. Marlor. 8d.

Improvements in ascending mines by which the ventilation is increased. Specification not found.

1855. No. 2835. Rogers. 6d.

In connecting a pair of safety-doors by a cord, each door opening outwards from the space included between them, so that when one is open the other must be shut, and vice versa. See sketch.

1856. No. 488. Coats. 4d.

Uses sheet-metal instead of wood or canvas for brattice.

1856. No. 690. Heaton. 1s. 10d.

Invention for causing doors or gates to shut by the weight of the wagon going through.

1857. No. 551. Piaud. 4d.

Ventilating mines by a combination of pistons and fans.

1857. No. 1308. Heppell. 10d.

Pumping arrangement for ventilation. Arrangement of furnaces whereby the foul air does not come in contact with the ignited fuel. Combination of the two systems.

1857. No. 1642. Paule. 10d.

The fire in the furnace is supplied with air by means of heated pipes, by separate passages from those which supply the mine. 1857. No. 1720. Rennie. (Provl.) 4d.

Self-acting trap-door for wagonways.

1857. No. 1913. Delmas. 4d.

Ventilating.

1857. No. 1957. Kingsley. (Provl.) 6d.

Causes a vacuum in a vessel by means of water flowing in a river.

1857. No. 2345. Howard. (Provl.) 4d.

Putting pipes with trumpet mouths to catch and transmit air. Medicated air may be forced in by same means.

1857. No. 2419. Imhof. 1s. 2d.

The arrangement of bellows so as to be double-acting.

1857. No. 3130. Rennie. (Provl.) 4d.

Self-acting Trap-doors.—The passage of the wagon opens and closes them.

1858. No. 197. Dillage. 1s. 4d.

A number of bellows arranged round a square or an octagon shaft, with

connecting-rods leading at the different angles.

1858. No. 1105. Higgins. (Provl.) 4d.

Constructs a boiler and places it either at top or bottom, conveys the

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steam through the mine, mixes it with the gas, and destroys its explosive qualities.

1858. No. 1403. Scriven. 4d.

Circulating air and fluids by means of hollow axles and coils.

1858. No. 1583. Avril. (Provl.) 4d.

Produces a vacuum by letting the water run out of a pipe.

1858. No. 2768. Vasserot. 4d.

A cylinder of zinc with an air passage attached to its side. The cylinder has a piston-rod which works within it.

1859. No. 298. Lancaster. (Provl.) 4d.

Forces heated air down upcast shaft to required distance for producing the draught, instead of using a furnace.

1859. No. 347. Wilson. 8d.

Forces air down mine by means of a pipe, and attaches flexible hose at intervals to give off the air where requisite.

1860. No. 402. Newton. 8d.

Exhausting air by the draught caused by rapid motion.

1860. No. 557. Williams. 10d.

Large engine for pumping air, with peculiar culverts.

1860. No. 1935. Newton. 8d.

Employs a passage heated by a flue or steam pipe to rarefy and carry off impure air.

1860. No. 2228. Pantard. 8d.

Supplying air to persons under water. Forces air into receivers, to a pressure of 20 to 30 atmospheres.

1860. No. 3028. Hughes. 4d.

Uses apparatus like a gas-holder for forcing fresh air down mines by suitable pipes.

1860. No. 3082. Colwell. (Provl. refused.) 4d.

Neutralizes carburetted hydrogen by a limited supply of atmospheric air.

1860. No. 3087. Williams. 10d.

To convey a ramification of pipes into the several workings of the mine, and connecting such pipes with suitable appliances for exhausting such gases.

1861. No. 1435. Hewett. (Provl.) 4d.

Screw blades for ventilating. Puts them into chimneys or in top of upcast shaft.

1861. No. 1760. Rydill. (Provl.) 4d.

Smoke Consuming Apparatus.—Injects water into the flues.

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1861. No. 2875. Nixon. 1s. 2d.

Square ventilating pistons working horizontally in large air chambers, which pistons are supported on rollers.

1862. No. 30. Arundell. (Provl.) 4d.

Drives a fan by screw on the axis, by means of a wheel.

1862. No. 633. Gisborne and Wickens. (Provl.)

Indicating the pressure of destructive gases by employing their relative gravities to complete an electric currect and give a signal.

1862. No. 824. Guibal. 1s. 8d.

A rotatory fan with a spiral case and a flexible shutter for regulating the current.

1862. No. 1404. Moore. 10d.

Indicating the presence of explosive vapours. Uses a buoy and float to complete an electric current and give a signal. 1862. No. 1721. Giachosa. 10d.

A large description of organ bellows.

1862. No. 2027. Ridley and Jones. 1s. 4d.

Hollow rotatory apparatus on the top of a mine—horizontal. The air enters in at the centre and is forced out at the edges. See sketch.

1863. No. 291. Wilson. 4d.

He induces a current of air by a steam jet, after the manner of Giffard.

1863. No. 735. Lever. 4d.

Composition for coating and preserving canvas, consisting of a mixture of quicklime, glue, whiting, and sulphate of ammonia.

1863. No. 753. Evans and Griffiths. (Provl.) 4d.

Applies heated air and steam jets in a tower or structure contiguous to the upcast shaft.

1863. No. 2008. Schiele. 1s. 2d.

Centrifugal fans and centrifugal pumps. See sketch.

1863. No. 2049. Dobb. 8d.

Chimney tops. Also as to covering ventilating shaft.

1863. No. 2726. Hughes. 10d.

Fans for forcing air.—" I claim, in fans for forcing and exhausting air, the system of causing an archimedian screw, formed of any suitable number of segments fixed to a horizontal shaft, to revolve in a case containing water, and covering the screw with an air-tight cover, with apertures at the top or ends for the entrance and exit of the blast."

1864. No. 89. Welch.

Propelling ships, part of system useful for ventilation. A peculiar form of screw.

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1864. No. 762. Lever. 4d.

Places hoops of steel in flexible tubing employed for the ventilation of mines.

1864. No. 786. Lang. 4d.

Extracting impure air. In contradistinction to forcing pure air into the passages. May be done in various ways, one means being to arrange pipes or tubes throughout the workings.

1864. No. 1701. Rogers. 4d.

Supplying fuel to furnaces. Applying to an ordinary furnace a coke oven, so that the products of combustion may pass from the coke oven to the ordinary furnace. May be useful for ventilating purposes.

1864. No. 1925. Johnson. (Provl.) 4d.

Apparatus resembling a feathering paddle-wheel, applied as regards mines to ventilating purposes.

1864. No. 2007. Allison and Shaw. 8d.

Raising minerals and workmen inside air-tight cylinders by means of air. Also the ventilation of collieries by the use of an apparatus worked by a piston in an air-tight cylinder the whole length or depth of the shaft.

1864. No. 2593. Shaw. 10d.

Coffer-Dams.—For sinking coffer-dams and caissons and supplying them with air.

1864. No. 2666. Laidlaw and Robertson. 2s. 6d.

A rotatory compressing pump of a peculiar form.

1864. No. 3133. Brookes. 8d.

Claims supplying commingled air and steam to ignited fuel in furnaces. In mines the system is applied to ventilation.

1865. No. 392. West. (Provl.) 4d.

An alarm, by means of a galvanic battery.

1865. No. 668. Ansell. 10d.

Indicating the presence of explosive gases by means of the endosmosis action of the gas whose presence it is desired to make known. Employs a small cylinder with a piston—the bottom of the cylinder being closed with porous earthenware. In the presence of gas the endosmosis action causes the pressure below the piston to be increased or diminished according to the nature of the gas. This motion may be made to break or connect a galvanic current, and thus give alarm.

1865. No. 1780. Beigel. (Provl.) 4d.

Generating Oxygen Gas. — To purify air in hospitals, mines, ships,

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and elsewhere. To 100 lbs. of chloride of lime, he adds half-an-ounce of oxide or salt of nickle. The chloride of lime is decomposed and the oxygen eliminated and set free from the lime. The oxygen is guided to where it is wanted. 1865. No. 3153. Mondesir and others. 8d.

Compressing air by a forcing pump in an air-tight chamber. Using a jet to expel foul airs.

1865. No. 3247. Warriner. 10d.

Admitting heated air into fire-places for ventilating purposes.

1865. No. 3287. Harrison. (Provl.) 4d.

Passes the air for ventilating buildings into receptacles filled with charcoal.

1866. No. 363. Gatley. (Provl.) 4d.

Blast Engines.—Makes the valve similar to those used for steam engines of iron—self-moving.

1866. No. 2927. Bonneville. 8d.

Pumping or Ventilating.—An elliptical box in which turn two parallel fluted rollers with big rounded teeth geared together.

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FIFTH DIVISION.

SAFETY-LAMPS.

The following lamps, the description of which has been condensed from Dr. Ure's Dictionary of Arts, have not formed subjects for letters patent, they are inserted to show what has been done.

In 1813, Dr. Clanny, of Sunderland, was the first to contrive a lamp which might burn in explosive air without conveying flame to the gas in which it was plunged, by means of an air-tight lamp, with a glass front; the flame of which was supported by blowing fresh air from a small pair of bellows through a stratum of water in the bottom of the lamp, while the heated air passed out through water by a recurved tube at the top.

Dr. Clanny made another lamp, by introducing into it the steam of water, generated in a small vessel at the top of the lamp, heated by the flame.

In 1816, Davy published an account of his lamp, which consists of a common oil lamp surmounted with a covered cylinder of wire gauze.

The Stephenson Lamp consists of a wire gauze cylinder, with a glass shield inside. The air, from combustion, is admitted through a series of perforations in the bottom, and a metal chimney full of small holes is fixed inside, on the top of the glass cylinder.

Mr. Smith, of Newcastle, improved this by covering all the perforations with a wire gauze.

Newman, to meet the objection that strong currents of air could be forced through the gauze, made a lamp with a double wire gauze, commencing from nearly the top of the flame of the lamp, leaving the lower portions with one gauze only.

Upton and Roberts.—This lamp consists of a wire gauze cylinder. The lower half is protected by a thick glass cylinder, and the remaining portion by a cylinder of copper. The air, for combustion, passes through a range of small openings, in the upper part of the cistern, into a space protected by a double shield of closely compressed wire gauze.

Martin's Lamp is similar to the above, but the flame is extinguished as soon as an explosive mixture is within the glass cylinder.

Dumesnil used a carefully annealed glass shield surrounding the flame, protected by bars. A chimney of sheet metal being above the glass, and all the air being compelled to pass through apertures rendered safe by the use of wire gauze.

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Clanny's New Lamp.—An impervious metal shield, having glass and lenses in its sides. Only open at the highest part of the gauze cylinder, for about 1 1/2 inches. Thus there is no admission of air to the lamp, or emission of the products of combustion from the lamp, except over the top of the shield. This, in many respects, resembles Mueseler's lamp, to be next described.

Mueseler's Lamp.—The cistern opening for the wick is precisely the same as we find in the Davy. A glass shield occupies about two-fifths of the entire height, the lower edge resting on an annular recess on the upper part of the cistern. A conical tube of metal carries off the products of combustion. Upon the bars which protect the glass rests the gauze cylinder above it.

Combe and Boty's are modifications of the preceding.

Parish's, Fyfe's, and Hewitson's all involve the use of talc in the place of glass.

Eloyn's Lamp consists of a cylinder fixed upon the upper surface of the glass shield, which is pierced with several holes, covered with wire gauze through which the air enters.

Glover, Cail, and T. Y. Hall have introduced lamps similar to those above-named.

Mackworth.—An inner glass tube standing on a frame covered with gauze, and an outer and thicker glass tube standing on the lamp cistern. The top annular space between the glass cylinders is also protected with wire gauze, which supports a gauze cylinder above. The air enters through the top gauze cylinder, then passes the annular space protected by gauze at the top of the glass cylinders, through the gauze at the bottom of the smaller cylinder, reaches the flame, and the products of combustion pass through the top gauze cylinder.

The Miners' Safety-Lamp by Struve.—A gauze cone instead of a gauze cylinder is used, and the oil-box made so as to project well up into the cone.

1864. No. 232. Wyndtjs. 4d.

Dispersing light in mines.—No description.

1827. No. 5571. Bonner. 6d.

Employs several small wicks round a centre tube for increasing the light —while unscrewing the gauze two flaps extinguish the flame.

1849. No. 12,458. Parish. 6d.

The air is admitted through a perforated plate at bottom, and passed

through gauze; a glass cylinder protected with gauze about two inches high; then a metal chimney, with two openings, protected with gauze at the lower part.

1849. No. 12,489. Biram. 8d.

The lower part of this lamp is half round, with a flat front of talc or glass, and a circular chimney covered with gauze. The air is admitted at the bottom through an opening covered with gauze. A pricker revolving on an universal joint. A flexible tube leading from the lamp to the open air.

1852. No 262. Glover and Cail. 6d.

Employ an inner and an outer cylinder of glass. The air for supporting combustion passing between and through gauze at the bottom; the products pass through the inner glass and through a wire gauze chimney, the bottom of which has a short conical funnel.

1852. No. 541. Lord. 6d.

Safety and other lamps.—No specification found.

1852. No. 1099. T. Y. Hall. (Provl. only.) 4d.

About three-parts of the cylinder that constitutes the chamber is formed of a disc of glass, and the rest of the circumference is made up of double wire gauze. The glass portion is protected from fracture by a covering of wire gauze or talc.

1854. No. 1595. Whitehead. 10d.

Attaches a pipe to admit air. Uses a bull's-eye to give light. The apertures are protected with gauze.

1854. No. 2003. Purdon. 8d.

Protecting glasses of safety-lamps by sheets of talc. The application of a reflector in connection with a double gauze diaphragm, and the use of a diaphragm with a coarsely perforated chimney.

1855. No. 1880. Dubrulle. 1s.

Safety-lamps.—No specification found.

1856. No. 944. Longbottom. (Provl.) 4d.

Generates illuminating gas by means of the heat employed in creating a draught.

1856. No. 1838. Wright. 8d.

Lights mines with gas by giving it a suitable pressure to make it descend.

1856. No. 2048. Mozard. (Provl.) 8d.

Arranging the miner's lamp so that the gauze cannot be removed without extinguishing the flame. A metal chimney and a wire gauze closed at top and bottom.

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1857. No. 850. Clark. (Provl.) 4d.

Lighting mines by causing a current of air to pass through the lamp. Connected by flexible tubes to a pump.

1857. No. 867. Beaumont. (Provl.) 4d.

Instead of surrounding the lamps with wire gauze, employs a lens, consisting of glass and water, which, on breaking, puts out the light. Attached to it is a float containing gas which falls when the mine is unsafe.

1857. No. 1194. Sutherland. (Provl.) 4d.

Safety-candle lantern.

1857. No. 1442. Samuelson. (Provl.) 4d.

Candle lanterns, which do not require to be snuffed. Closed with gauze, same as Davy-lamps.

1857. No. 1784. Arthington and Smith. 4d.

Use of naphtha, or mineral spirit, with a Davy-lamp.

1857. No. 1789. Struve. 6d.

Wire gauze is made into the form of a cone, and the apparatus closes with a cap. Around the burner is a glass chimney; a conical glass may be used instead of the conical wire gauze.

1857. No. 1845. Orphin and Lyons. 10d.

A brilliant light from a cheap and economical oil, extracted from peat. Uses a metallic cap impinging on the base of the flame. Peculiar lamp for burning volatile oil.

1857. No. 1867. Cooper. 8d.

Modification of Argand burner and Davy-lamp.

1858. No. 121. Sterry. 10d.

Surrounds the flame with a cylindrical gauze. The oil is forced up to the wick by a piston.

1858. No. 558. Sutton. 4d.

Constructing miners' lamps that do not require snuffing.

1858. No. 1109. Higgs. 6d.

Air is compressed and supplied to the wick of the lamp, whereby the lamp may be kept burning when surrounded by bad air.

1858. No. 1308. Robinson and Ogden. 6d.

Gauze is attached to a ring having inclined planes and stops. Projections go into stops by means of springs, which can only be screwed out by a peculiar key acting on the stem of the projection. See sketch.

1858. No. 1398. Wilkins. 8d.

Passes the air through his lamp by means of tubes, protected by gauze, through the oil holder. The lower part of the lamp is protected with thick glass; the upper part with gauze. See sketch.

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1859. No. 653. Clark. 10d.

An electric light.

1859. No. 1066. Jones. (Provl.) 4d.

Provided with an extinguishing apparatus, secured to a moveable head, so arranged that if tampered with two metallic surfaces come in contact with the wick and put it out.

1859. No. 1447. Waring. 8d.

Constructing safety-lamps with an extinguisher and a spring, so arranged that the spring can only be released by bringing down the extinguisher.

1859. No. 2861. King. (Provl.) 4d.

Submarine Lantern.—The upper part fitted with two tubes of unequal length, the longest placed over the flame.

1859. No. 2901. Howden and Thresh. 6d.

We provide below the oil chamber a receiver for the air, giving the air access thereto by holes at the foot, provided with gauze diaphragms, upper part provided with gauze as usual.

1860. No. 18. Blacet. (Provl.) 4d.

This lamp cannot be opened without a screw-key. The upper part which is fixed inside the metallic frame made is higher, so that the flame gives more light.

1860. No. 885. Howat. (Provl.) 4d.

Reflector and glass tube for increasing the combustion of the oil and radiating the rays to a focus.

1860. No. 1242. Copcutt. 6d.

Manufacture of Gas.—Forces gas at a pressure of several atmospheres, &c. Also employs gauze.

1860. No. 2207. Wright. 8d.

A flexible disc on which is placed a wick holder. Pneumatic means of pressure to move a flexible partition. Also means of using the chimney to act on the wick without opening the lamp. Also fastening the lid by means of teeth. Also a pneumatic fastening specially applied to Davy-lamps. Also using alcohol, &c, with lamps so fastened.

1860. No. 2975. Michaux. (Provl.) 4d.

Hollow piston to bottom of lamp. The apparatus for withdrawing the lamp is a cast iron framing, supporting a pneumatic apparatus of copper.

1860. No. 3080. Barber. 6d.

An arrangement for putting out the light by means of springs and catches when the cover is withdrawn.

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1861. No. 239. Crawley and Schneider. 10d.

Employs an Argand burner with a convenient arrangement for raising and lowering the wick.

1861. No. 438. Ribton. (Provl.) 4d.

Employs a peculiar gas or candle lamp on the Argand principle, protected by a glass cylinder and stout wire cage. The lamp is entirely shut from the surrounding atmosphere, receiving air from a special pipe, another pipe being required to remove the products of combustion. When the lamp is tampered with it is extinguished by means of spring levers. 1861. No. 1002. Hall.
6d.

Using petroleum with a suitable chimney. Superior light. Can use a finer gauze. Also for consumption of smoke. 1861. No. 1248. Bowditch. 8d.

Uses two flat wicks which allow the flames to impinge against each other. Also an apparatus to put out the light when the gauze is removed.

1861. No. 1789. Jones. 10d.

Apparatus for extinguishing the light when the gauze is tampered with.

1861. No. 2512. Evans. 8d.

An outer and inner cylinder of glass. An annular space which keeps it cool. The air passes through apertures at the bottom covered with wire gauze. On the top are two gauze caps.

1861. No. 2829. Clark. 4d.

To be extinguished (when the gauze is removed) by mechanical action

1861. No. 2922. Parkinson and Minchin. 4d.

An extinguisher supported by solder, which fuses when too hot and puts the light out. Also connected with a second extinguisher which puts the light out when the gauze is taken off. Has a small hole in the base of the chimney for lifting, which can be closed with a plug.

1862. No. 69. Barber. (Provl.) 4d.

Cannot remove the lower part of the lamp without breaking a brittle substance which the miner is unable to replace. Also an extinguishing tube worked by a spring.

1862. No. 1043. Gedge. 6d.

A box of galvanized iron, containing an induction bobbin, with the elements of a generating pile. A hollow glass rod with a vacuum inside, closed at each end with conducting rods, and charged with non-metallic fluoric matter. The generating pile being charged, produces light in the glass tube.

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1862. No. 1271. Maiden. 8d.

Self-locking and self-extinguishing by a thimble turning on a spring when the gauze is removed.

1862. No. 1516. Morris and others. 4d.

Obtaining light by electricity.

1862. No. 1671. Hall. (Provl.) 4d.

A safety-lamp with a spring lock. A bolt with a spring to force it up into the body of the lamp. Has a screwed tail which, with a suitable key, enables you to draw it out of the groove. A superior wire gauze is made by tinning or galvanising it.

1862. No. 2034. Crawley and Foster. 8d.

Combining a lock and bolt with the apparatus which raises and lowers the wick.

1862. No. 3213. Bourne. (Provl.) 4d.

The action of suitable springs which are kept out of the way as long as the gauze covers the lamp, but extinguish the lamp when it is removed.

1863. No. 1140. Bourne. (Provl.) 4d.

An apparatus attached to the lamp so that the wick is pressed out when the gauze is removed.

1863. No. 1444. Brooke. (Provl.) 4d.

For imparting a better light. He burns mineral oils and dispenses with the gauze.

1863. No. 2256. Gedge. (Provl.) 8d.

Causing an ordinary Davy-lamp to become extinguished in fire-damp. A small flap to put out the flame by means of a spring, it is prevented from doing so by a fine wire which melts with the extra heat caused by the fire-damp.

1863. No. 3265. Bowditch. (Provl.) 4d.

I pump air to a receiver and thence to the light to be supplied—the air being supplied to the lantern under pressure prevents the entry of fire-damp. Also uses the waste air blown off from engines.

1864. No. 54. Rees. (Provl.)

Employs a cylinder of wire gauze, and uses an apparatus lor letting out the oil when the gauze is tampered with.

1864. No. 620. Foster. 8d.

I cause the ring or frame of the wire gauze to engage with a disc or instrument, which, when turned, raises or lowers the wick, and I put a spring catch on the gauze frame which puts the lamp out when the frame is removed. Claims the combined arrangement for securing the wire gauze.

1864. No. 1121. Hammerton. (Provl.) 4d.

Extinguishes the light before the top can be removed.

1864. No. 2100. Brooman. 8d.

Firing charges and obtaining light by means of an electrical apparatus.

1865. No. 353. Thorp and Young. (Provl.) 4d.

Extinguishes the wick when the gauze is taken off. Prevents current of air acting on the flame by means of a glass shield.

1865. No. 1274. Johnson. 8d.

Constructed so that when opened it will extinguish the light. Making portions of a brittle or fusible material for the purpose of extinguishing the light when the lamp is too hot.

1865. No. 2370. Bonneville. 6d.

To prevent removing the wire gauze without extinguishing the flame.

1865. No. 3070. Hall. 10d.

Lamp for Burning Petroleum.—For railway carriages, mines, &c.

1866. No. 113. Lake. 8d.

A lamp arranged for using a flat wick, or two curved wicks for burning petroleum.

1866. No. 1610. Hall and Cooke. 8d.

A lamp that cannot be opened without being extinguished. Also uses a fluted glass and a seamless gauze.

1866. No. 3045. Thomas. 6d.

To prevent the glass from becoming loose, and preventing the entry of foul gases. At present the glass is kept in its place by a flat metal ring which bears direct against the bottom glass without any allowance for expansion. " I form an annular groove in such surface, and cause the glass to fit into such annular groove, and, in order to prevent the ingress of foul air, I introduce at those parts a ring of India-rubber."

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SIXTH DIVISION.

COAL GETTING.

1761. No. 762. Meinzies. 10d.

Moved by a fire engine, a water wheel, or a horse gin, and the force is communicated by spears going down the pit. To the lower end of each spear is fixed a chain, which goes round a vertical wheel at the bottom, and the other end of the chain is fixed to a spear, which moves horizontally on rollers till it comes opposite to the boards where the coals are to be hewed. At that part of the roller a peg is fixed, and by means of a chain a wheel is turned round in the board, to which a heavy pick is attached. The other portion of the patent applies to raising water and feeding the furnaces of steam engines by machinery.

1762. No. 775. Walkenshaw. 4d.

A catapult for working mines. A frame of wood (oblong square) with a number of small cords twisted into one large cable by a number of iron wheels, one at each end to give it the necessary tension. At the other end of this frame of wood is a windlass with an iron wheel on one end, which is turned by a pinion and handle. This windlass raises the head of a large hammer which has the end of its shaft twisted into the cable. When the windlass has raised the hammer an angle of ninety inches, a pair of forceps open, and the hammer falls with an immense force on the ends of wedges. 1783. No. 1366. Driver. 4d.

An engine like a common plough is placed on a three-wheeled cart, the plough is drawn backwards and forwards, the stuff cut being put into a loading wheel and carried to the carriage.

1818. No. 4236. Bead and Howell. 6d.

New system of working, particularly adapted to the thick main bed or ten-yard coal of Staffordshire.

1830. No. 6056. Wood. 6d.

Battering Ram.—The ram slides on wooden guides at top and bottom. Claims application of a battering ram supported on a frame and rail, and acting on a large wedge, passing through a guide box, for the purpose of working coal. See sketch.

1843. No. 9638. Newton. 2s. 2d.

(1) Mode of cutting blocks of coal from their beds, by means of saws,

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rasps, or other rotatory cutters, whether worked by manual labour or motive power. (2) The peculiar construction shewn in drawing. (3) The mode of withdrawing the blocks. See sketch.

1846. No. 11,174. Bell. 8d.

Uses a battering ram. See sketch.

1851. No. 13,754. Roberts. 1s. 8d.

Detaches portions of slate or rock by drilling a number of holes down the line of cleavage desired, and inserts wedges. He makes use of a machine like a carpenter's ordinary hand mortice machine for cutting slots.

1852. No. 14,165. Dixon and Dobson. 4s. 6d.

Upon a turntable an apparatus is erected for jumping up and down a drill, round the outside of a circle. A number of drills in a frame with a number of hammers striking them. A machine for shaping the slate after it is quarried. Round rods are used for rails here. He arranges the blocks of stone requiring to be cut on each side of a line of railway, and has a locomotive with a saw on each side, which runs backwards and forwards and cuts them to required shape. See sketch.

1852. No. 42. Hedley. 6d.

Applying a cutting tool, projecting from the side of a carriage running on a railway, so that the cutter may be caused to pass more and more deeply into the side of the mine by the repeated passing of the carriage, and the setting of the tool more and more beyond the side of the carriage. See sketch.

1852. No. 407. Waring. 1s. 4d.

Rotatory cutter wheels mounted on a carriage running on a tramway, so arranged that its position and the plane in which it works may be varied (Fig. I). Also the mode of constructing machinery, with cutters fixed on cutter frames slotting, to which a reciprocating motion is given by a crank or lever, and adapting the same to horizontal, vertical, and diagonal cuts (Fig. 2). The above, in conjunction with a bellows or pump to remove the dust, combining an air, water, or steam engine on the same frame with the above. Screw pillars and bird mouthed cutters of chilled iron (Fig. 3). Working coal by making two series of diagonal cuts, so as to separate the coal into rhomboids. See sketch.

1852. No. 423. Cottam. 6d.

" I claim the application of the power obtained from a hydraulic press or hydraulic presses, for the purpose of quarrying slate." See sketch.

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1852. No. 698. Hedley. 6d.

Construction of a carriage running along a railway and carrying a rotatory saw or cutter in such a manner as to be capable of making cuts or incisions into the face of the coal as the carriage passes along (Fig. 1). Driving the saw from the axle of the carriage (Fig. 2). See sketch.

1852. No. 1193. Bbown. 4d.

Steam or pneumatic hammer for driving boring tools or working irons. The steam is supplied through the fixed piston.

1853. No. 2262. Peace. 1s.

I claim the combination of a moveable lever and wheels, with an endless chain band or strap furnished with suitable cutters, the whole being mounted on any convenient frame, and receiving motion in any convenient manner for the purpose of hewing, cutting, or excavating coals and other minerals. See sketch.

1854. No. 1103. Worthington and Allman. 4d.

Makes drills, partly of iron and partly of steel, to keep sharp. Employs also a crown saw, or saw on the edge of a cylinder, for cutting out cylinders of coal.

1855. No. 2751. Chaffer and Ellis. 10d.

A slide or bed-plate with a travelling rest (like a lathe) for carrying the saw or cutter. This is moved by a screw or by a worm rack and pinion or chain. Use of an oscillating double pointed cutter (like a planing machine).

1856. No. 55. Brooman. 8d.

Arrangements of machinery driven by steam, or otherwise, the parts dug out and deposited in wagons at side of the machine. See sketch.

1856. No. 439. Johnston and Dixon. 1s. 10d.

Method of cutting the coal by the sideway motion of a revolving cutter. (2) Mounting the engine on the same carriage as the cutter to which it is to give motion. See sketch.

1858. No. 141. Newton. (Provl.) 4d.

A rotatory cutter-wheel arranged to cut in a direction at right angles to its axis, mounted on wheels—cuts a paralled groove.

1858. No. 2481. Penrice. 1s.

A large cutter-holder driven against the face of the rock by means of the expansive power of the steam which drives it. By causing the steam in the holding-up cylinder to be rapidly withdrawn and admitted, a series of rapid sharp blows can be maintained.

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1859. No. 285. Plimsoll. (Pbovl.) 4d.

Substitutes a circular saw for a pick. Uses steam direct for washing coal.

1859. No. 2272. Scott. (Provl.) 4d.

Boring.—A centre portion which is wedge shaped, or slightly curved, or two cutting edges, the centre portion projecting beyond the cutting edges, must be struck by a hammer and partly turned round.

1860. No. 29. St. Just. (Provl.) 4d.

Moves on iron rails, cuts by means of twelve pickaxes. Boilers tubular. Runs from one end of the quarry to the other, cutting the stone in a straight line.

1861. No. 795. Ridley and Rotherey. 1s. 4d.

Coal Getting.—Picks mounted on wheels actuated by a spring. The ratched wheels coil the spring and are set free, the spring then works the pick. See sketch.

1861. No. 1302. Donisthorpe. 6d.

A slotting tool mounted on rollers on a carriage. The tool is struck by hand and a slot knocked in the coal. See sketch.

1861. No. 2902. Hemingway. 6d.

Revolving cutters or saws for cutting coal, and reciprocating straight saws. See sketch.

1861. No. 2975. Firth and Ridley. 1s.

A steam hammer, mounted on wheels, striking the tool for entering the coal. See sketch.

1861. No. 2977. Donisthorpe and others. 1s. 6d.

Claim picks with lever handles, actuated by compressed air engines. Also cutters connected with and moved to and fro by the piston-rods of air engines. See sketch.

1861. No. 3025. Treeby. 1s.

Claims a combined arrangement as described only, in which a number of spindles on a frame are driven by a series of wheels geared with one another, and forced against the rock by means of worms, also worked with wheels.

1861. No. 3271. Newton. 10d.

A rectangular frame like a pit prop, jambed at the top and bottom, and made to hold a drilling apparatus at any convenient height.

1862. No. 1831. Simpson. 1s. 4d.

For working mine and other pumps, by means of a steam cylinder to the piston-rod of which they are connected, the bottom of the

cylinder is always connected with the boiler. Also a reciprocating motion given to a series of chisels. See sketch. 1862. No. 2441. Brooman. 8d.

An apparatus like a clock mounted on wheels, with a drilling apparatus attached to it, which can be raised up and down. Claims boring tools of a metal tube, made with a ring or crown armed with diamond cutters. Also imparting simultaneous rotatory and advancing motion to boring tools.

1862. No. 2952. Jenkins. 1s. 6d.

" I first drill holes for the purpose of making an opening for the introduction of my cutting instrument, I then either give a rotatory motion to a peculiar grinding cutter, or a reciprocating motion to a saw, I then move the machine along the face of the coal by endless ropes."

1862. No. 2662. Gilchrist. (Provl.) 4d.

A steam boiler with winding details, actuated by a cylinder, together with a cylinder to give a reciprocating motion to the boring tool.

1863. No. 560. Delahaye. 10d.

An apparatus supported and guided by two pit props whereby holes can be drilled and coals can be chipped by means of a tool moved by hand.

1863. No. 903. Low. 2s. 6d.

Small portable cylinder for giving a rapid succession of blows to a drill. The tool is made hollow and the exhaust steam and condensed water help to get rid of the debris. A self-acting axle motion is also given to the tool. The mode of mounting on wheels, exhausting through the tool, working valves, &c. See sketch.

1863. No. 1072. Donisthorpe. 1s. 2d.

Obtains the requisite stability by applying a wheel or wheels to act against the roof. Such wheel or wheels to be pressed elastically against the top of the mine by means of a piston in a cylinder containing compressed air, acting directly, or by interposed levers on the axis of the wheel or wheels in contact with the roof. See sketch.

1863. No. 1095. Gray. 2s.

A portable hammer for rivetting, or caulking in ship building, to be held by hand to its work. Steam or air brought to it by flexible pipes. See No. 903.

1863. No. 1319. Burton and others. (Provl.) 4d.

Piercing the coal by one or more cutters having a reciprocating motion,

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by slide sockets, which are actuated by links attached to a bell crank lever, actuated by a cam.

1863. No. 1420. Jones and Eidley. 1s.

A combination of a pick, with a trunk engine on a truck (Fig. 1). Also a trunk engine working a slotting tool by means of a lever and connecting link (Pig. 2). See sketch.

1863. No. 1857. Gay. 8d.

Claims a machine having a drum or cylindrical tube furnished with cutting tools. Also a secondary machine for opening a centre hole when the outer cutting is sufficiently advanced. See sketch.

1863. No. 1888. Firth. 10d.

An oscillating cylinder connected direct to a pick. Also a direct action from the piston rod to a link which connects two cranks, one driving a picker and the other a counterbalance. (Similar to Crowther's parellel motion.) Also, a truck raised by two hydraulic cylinders, which allow it to fall as it gets filled from the inclined riddles. See sketch.

1863. No. 2327. Ridley and Jones. 1s. 4d.

A reciprocating motion is given to a pick from a central axis by means of a crank and connecting-rod, the motive power being electromagnetic.

1863. No. 2357. Sturgeon. 1s. 4d.

Causing the pick to penetrate to a certain depth before it can set in motion the gear which advances the tool. Seems to be an ordinary pick on wheels, and a short arm worked direct, and a ratchet wheel worked by the action of the pick itself. See sketch.

1863. No. 2398. Elliot. 6d.

Props for Mines.—Claims making them of wrought iron ; also using shoes of metal or wood to support them.

1863. No. 2531. Polglase and Cox. 1s. 2d.

For Drilling Stone..—Working a number of jumpers in a row with tappets.

1863. No. 2624. Crease. 8d.

Portable steam hammer to which a borer can be attached and turned by hand, or by a self-acting apparatus attached. The valves for working the hammer are worked by means of orifices leading to the main cylinder over which the piston passes.

1863. No. 2630. Locke and others. 1s. 6d.

Hydraulic slotter, actuating cutting tools, for working coal by the direct pressure of water so as to produce a steady slotting motion. Also,

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a holding on head being pressed against the roof during the cutting of the tools, and released therefrom to allow the machine to move forward. Also, causing the holding on head to reciprocate by the action of the elastic medium, acting on a non-elastic fluid, for the purpose of securing the machine non-elastically during the cutting stroke.

1863. No. 2659. Firth and Sturgeon. 2s.

Various modifications of picks, attaching them direct to an oscillating cylinder, or to a semi-rotatory engine. Too many variations to be described. The above are the principal. See sketch.

1863. No. 2671. Donisthorpe. 10d.

Slots, and claims securing the carriage by wedges to the rails, and the application of clearers or clearing instruments. See sketch.

1863. No. 2786. Philipson and Dees. (Provl.) 4d.

A large screw works through a screwed nut moving in guides. To this nut a pick is affixed, and the screw made to revolve.

1863. No. 2887. Harrison. 8d.

Combination of a turbine for working picks, mounted on a truck, trolley, or other carriage. See sketch.

1863. No. 3034. Harrison. ' 1s. 4d.

For combination with a truck, rolley, or other carriage, a turbine for driving a rotating cutting tool, the carriage being so arranged that it can be caused to travel gradually. (See last No.) See sketch.

1863. No. 3066. Firth and Sturgeon. 1s. 4d.

Applying hydraulic power, by pumping, for the purpose of splitting the coal, by driving a wedge or suitable tool into the coal by the power of the ram, either for the purpose of undercutting or after that operation has been effected, by boring a hole into which a ram can be introduced. Employing vibrating piston engines for driving picks either direct on the same axis or by means of a slot and link.

1864. No. 90. Bartholomew. 1s. 8d.

For bringing out the coal by introducing a solid steel rod, the end being made like a flustrum of a cone, ramming it with coal dust and pulling it out with hydraulic power or a screw. The hole may be drilled with an enlargement at the far end ; and the rod may also have an enlargement.

1864. No. 158. Donisthorpe.

A double-acting slotting machine, worked by compressed air or other

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fluids, mounted on a suitable frame, and pressed down to the rails by rollers jambed against the roof. See sketch. 1864. No. 267. Jones. 1s. 6d.

The axis of a pick is mounted on a cylinder, so as to be capable of adjustment. See sketch.

1864. No. 607. Burdon. (Provl.) 4d.

Employs a piston or hammer driven by steam or air, working on a jemmy held by a man or attached to the piston. 1864. No. 795. Newton. 10d.

Boring apparatus intended to be worked by hand. The principal object of the invention is to support the boring tool in the required position. Made of two frames working one on the other, so that they may be lengthened or shortened. See sketch.

1864. No. 895. Nisbet. 10d.

Working picks with cylinders and pistons by compressed air or other suitable fluid. See sketch.

1864. No. 1050. Russell, Jun. (Provl.) 4d.

The apparatus resembles a pickaxe working in an upright axis with a reciprocating motion. Also of tooth-shaped revolving cutters.

1864. No. 1244. Hunter. 8d.

Cutting marble, stone, slate, and coal, with a solid bar, with an enlarged or trumpet mouth. " For cutting or boring tunnels I mount these tools on the end of a cylinder. I place a screw or angular grooves on the outside for the purpose of leading out the debris."

1864. No. 1352. Firth. 10d.

A new form of pick so as to cut the coal at two or more points, placing sleepers for spanning the rails to prevent the jerking motion. Placing rollers to prevent the machine dipping when at work. Spring arranged to be acted upon by the pick cutter or balance weight. Coupling the wheels together.

1864. No. 1797. Westmacott. 2s. 2d.

For driving galleries or tunnels in stone. Arranged so that each time a cutter has been struck by a hammer, the cutter is slightly moved from the surface of the work, and the tool is always kept steadily against the surface before striking the blow. Claims moving the tool in contact with the work, after it has made a cut.

1864. No. 1904. Beaumont. 2s. 4d.

For driving circular drifts. " I employ a strong disc with chisels or jumpers fixed around its periphery. This disc is mounted on a strong axis which is carried on a carriage. A slow rotatory motion

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is given to the disc and cutter. The chisels or jumpers are caused to act by concussion, and to move step by step forward between the blows, so as to cut a continuous chase." See sketch.

1864. No. 2121. Armitage. 8d.

An arrangement to enable the picks of coal-cutting machines to make a complete revolution. Claims also constructing the foundation plates in two parts, for the facility of transport. See sketch.

1864. No. 2162. Burdon. 8d.

In employing a hammer or piston driven by steam or air to work upon a jemmy by blows on the head, while the jemmy is held loose by a man, or attached to the piston. Also a circular saw, which I work by steam or air. See sketch. 1864. No. 2612. Donsthorpe. 10d.

Securing rails, used when getting coal by posts or pillars, held or wedged between the floor and the roof of the mine. 1864. No. 2613. Jones. 8d.

The application of a rolling weight to the after part of a carriage, upon which picks are worked, for the purpose of keeping the pick carriage steady.

1864. No. 2914. Gay. 10d.

Forms discs of various materials, and wears away the rock by a biting substance, such as sand or emery. Describes a complicated machine with a number of such discs for boring tunnels.

1864. No. 2929. Haggie and Gledhill. 1s. 8d.

A pick, the short arm of which is driven either by a rack off' a moveable cylinder, the piston rod of which is held (Fig. 1) or by a rack on a piston rod (Fig. 2). Also by a semi-rotatory engine (Fig. 8). Also by annular piston engine (Fig. 4). See sketch.

1864. No. 2962. Carrett and others. 10d.

Imparting to picks a compound vibratory action. Embodying a twofold movement with every vibration of the pick, whereby it is made to clear itself. Also combining the several parts where picks are used, whereby a separate trunk is dispensed with. Also carrying the axis of the pick upon the motive power cylinder. Also employing a moveable support or girder.

1865. No. 558. Lauder. 8d.

Gets coal by means of a number of bits, augers, or drills placed on a truck.

1865. No. 737. Farrar and Booth. 10d.

Slotting by steam, compressed air, or other elastic fluid. See sketch.

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1865. No. 1203. Leatham. 1s. 6d.

A self-acting anchor gripping the coal. A peculiar way of fixing the picks, whereby the pick relieves itself when coming out. Increasing the momentum of the pick by an additional cylinder. Also making the carriage rise and fall to the height to accommodate the pick where the groove is required. See sketch.

1865. No. 1587. Haseltine. (Provl.) 4d.

Boring Tunnels.—Machinery arranged to cut annular grooves, combined with means for splitting off the isolated portions remaining between the annular grooves, formed by the boring tools.

1865. No. 1778. Low. 3s. 4d.

Impossible to describe it without a more complicated drawing than suits the nature of this extract. Amongst other things claims a cushion of air behind the boring or cutting tool, for the purpose of lessening the effects of the concussion on the boring tool. Also the mode or modes for causing the rotation of the boring tool. Also in coal cutting, mounting and arranging the mechanism to enable the tool to cut forward a considerable distance without too frequently removing the machine. 1865. No. 2363. Newton. 1s.

Stone-cutting.—Requires a full drawing to explain it, has no salient feature or particular principle involved, and has twelve claims.

1865. No. 2796. Newton. 8d.

A new shaped pick with an ellipitical socket for receiving the wooden shaft.

1865. No. 2940. Alison and Hoskings. (Refused.) 4d.

A combination of discs and chisels.

1865. No. 3127. Donisthorpe. 1s. 2d.

Improvements, by means of which a coal getting machine is made to traverse by means of a screw. See sketch. 1865. No. 3218. Doering. 2s. 4d.

Between two horizontal shafts, forming side supports, I fit horizontally a steam or air cylinder—one of the shafts is threaded—a piston works in the cylinder and passes through the front end, which has a drill or boring tool fixed on it.

1865. No. 3297. Cooke and Hunter. 1s. 2d.

Segments to two cylinders with cutting tools on their edges, fixed on a stand frame, and driven by rotatory gearing. See sketch.

1866. No. 58. Penrice 1s. 2d.

A cylindrical cutter with projecting tools on the edge, the axis of which

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is provided with a piston which has a reciprocating motion given to it. The cutters also made to rotate. See sketch. 1866. No. 94. Bartholomew. 8d.

Improvements on No. 90, 1864.—A mode of forcing out lewises or side pieces at the end of a rod for insertion into a hole previously bored, for pulling out the coal.

1866. No. 483. Cooke. 1s. 4d.

Circular rotating discs formed to receive cutters projecting forward on a framing. The mode of mounting the cutters described in No. 1244, 1864. See sketch.

1866. No. 477. Rothery. 1s. 4d

Working a pick, the striking blow of which is given by a spring, the return being made by a wiper and cam. Claims also the application of horse-power to machines for compressing air. See sketch.

1866. No. 703. Donisthorpe. 8d.

He forms a slotting machine and employs the roof or floor as a guide for the cutter by mounting on the carriage an air cylinder with a piston with a roller to press against the roof. But in place of mounting the cutting apparatus on the carriage, which is guided by the rails, he fixes it to or connects it with the rising and falling piston or plunger. See also No. 2612, 1864.

1866. No. 807. Gillott. 2s.

A slotting machine composed of a number of cylinders, the return stroke of the cylinders being effected by the waste air coining from the forward stroke of the other cylinders. Claims the arrangement. Also, having tools connected with one cylinder cutting deeper than those connected with the preceding cylinder. Also, utilization of the waste steam or air as above described. Also, the employment of India-rubber or elastic rings fitted in the hollowed-out portions of the pistons.

1866. No. 832. Dalby. 10d.

I impart a rotatory motion to a vertical shaft, having upon one of its extremities two or more arms of any diameter, to the extremities of which are fixed adjustable cutters. See sketch.

1866. No. 974. Richards. 10d.

Bores rock with a hand-brace, same as boring a hole in iron.

1866. No. 1091. Jones. 10d.

An Improvement on his Patent, No. 267, 1864.—This is for giving a self-acting back and forward motion, which is done by a small working cylinder, combined with a large one, and connected at

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each end to it by small pipes. A piston rod runs through the small cylinder and communicates motion to grips passing round the wheels, which gives an alternate back and forward motion to the machine when at work.

1866. No. 1186. Donisthorpe. 10d.

He cuts in the roof of the mine a shallow groove at a short distance from the face of the coal that is being worked, by which the machine may be steadied. Uses a little slot engine. See sketch.

1866. No. 1224. Nisbet. 10d.

Actuates a lever, having a cutting tool on the end of it, by means of a segmental rack, acted upon by a revolving pinion, whereby the cutting tool is pulled steadily round. See sketch.

1866. No. 1299. Fidler. 1s. 2d.

He cuts a slot by means of a rotatory cutting bar, either fluted or containing knives, nibs, or teeth, on a frame containing the motive power. He drills down first the usual depth, about three feet, and then prolongs the cut by moving the machine. See sketch.

1866. No. 1784. Brunton. 1s. 4d

Sinking Shafts and Drilling Tunnels.—A cutter is caused to revolve round an axis, which I call the planetary axis, parallel to the true axis of the machine, which I call the central axis. See sketch.

1866. No. 2192. Hunter and Cooke. 1s. 6d.

A sort of planing machine for shaping coal and slate by means of disc cutters.

1866. No. 2238. Gall. 10d.

A machine for cutting mouldings in stone. A steam hammer strikes the chisels, the stone being fixed on a carriage. 1866. No. 2708. Jones. 10d.

Arranging slotting cutters, so that they will plane both ways. A peculiar slot crank in a box for giving the necessary reciprocating action. Turning the shaft, working the slot by means of a worm wheel and worm. Making rails with double flanges. Holding the machine to its work by means of the double flanges.

1866. No. 2797. Hunter. 10d.

Excavating and Mining.—A semi-rotatory engine, the piston of which is stationary. The pick is attached to the cylinder which gives motion by means of tappets to a central cock which regulates the admission of the air. See sketch.

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1866. No. 2922. Doering. 2s.

Boring Rock.—It refers to No 3218, 1865.—Requires a full size drawing to explain. Has ten claims.

1866. No. 2954. Routledge and Ommaney. (Provl.) 4d.

Obtaining coal by a succession of rapid blows instead of by the long and powerful strokes of most other machines. To be held up to its work by the workman.

1866. No. 3063. Gledhill. 2s.

Claims cutting coal by means of cutters carried by an endless chain and jib projecting from the side of the machine, and forced through the coal by the forward motion of the carriage. Also arranging a machine in such a manner that the cut may be produced by a segmental arm. Also for cutting coal with a machine on three wheels, with a pick immediately alongside of the cylinder and receiving its motion from a connecting-rod. Also from the outer end of the piston-rod. Also working the pit by expanding the air or fluid out of the smaller into the larger area of the cylinder. Also combining the machine with an apparatus consisting of a light and stiff girder in such a manner that the machine may traverse parallel to the face.

1866. No. 3065 Haseltine. 1s.

Drilling Rocks.—A drill bar with a piston on it working in a cylinder, the valves of which are worked by an annular cam. The piston-bar is made to rotate with a ratchet ring. A peculiar valve clamp and clasp are also claimed.

1866. No. 3395. Jordan and Darlington. 2s.

Claims the application of a turbine in conjunction with a pressure of water to lift a rock-cutting or boring tool. Secondly, the application of a turbine, ram, or piston to produce a vacuum to give the required blow by atmospheric pressure. Thirdly, the application of hydraulic pressure for boring rocks when the valve or cock for alternating the pressure is moved by hand or by a turbine. Also the application of hydraulic pressure admitted by suitable valves to produce rapid percussion and rotatory action.

SEVENTH DIVISION.

EXPLOSIVE COMPOUNDS.

1807. No. 3032. Forsyth. 6d.

Firing Mines.

1823. No. 4853. Congreve. 4d.

Fireworks.—Application to firing trains in mines.

1831. No. 6159. Bickford. 1s. 2d.

Manufacture of Safety-Fuses.

1844. No. 10,364. Caorbines. 8d.

Improvements in Miners' Fuses.—Covers them with lead, India-rubber, and other sheathing.

1845. No. 10,579. Liebhaber. 6d.

For making Holes for Blasting.—The hole is made in the usual way, and is enlarged by means of muriatic or other acids which are conveyed down by pipes; proper means being taken to allow the means of escape of the gases. The acid is to be removed by syphons or pumps.

1845. No. 10,928. Pickford and others. 6d.

Miners' Fuses.—(1) Firing three or more at one time. (2) Spinning a central thread with the gunpowder. (3) Covering them with varnish. (4) Putting a second covering of tar.

1846. No. 11,407. Taylor. 4d.

Manufacture of Explosive Compounds.—Gun cotton. Claims " the manufacture of explosive compounds from matters of vegetable origin by means of nitric acid, or nitric and sulphuric acid."

1846. No. 11,447. Smith. 6d.

Safety-fuse coated with gutta-percha, as above described.

1849. No. 12,406. Loam. 8d.

Fuses.—Employs calico for forming interior tube of fuses.

1850. No. 13,215 Melville and Callow. 1s. 6d.

Improvements in guns, gun-shells, and explosive compounds.

1850. No. 13,344. Liebhaber. 1s.

Bores holes and enlarges by acid in same way as described in previous patent, and prepares products therefrom. 1852. No. 14,014. Pidding. 8d.

Apparatus for Drilling Holes.—Chemical application of explosive compounds for blasting, and the application of heat and cold.

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1852. No. 14,065. Davey and Chann. 8d.

Explosive Composition.—Making fuses with an internal thread. Employing a tube or holder to contain the explosive compound.

1852. No. 543. Norton. 6d.

Employment of cartridges charged with fulminating mercury. The cartridge, having a bar of metal projecting, is put into a hole; by striking the bar of metal the cartridge is exploded.

1858. No. 376. Pidding. 4d.

" I drill quartz, previous to blasting, by rammers acted upon by gunpowder, or other detonating force, or steam. I fit the hammer into a frame like a pile driver, horizontally, bringing the tail close to the mouth of a common cannon which drives it forcibly against the object to be drilled. I bring the hammer back by means of springs."

1853. No. 1500. Newton. 4d.

Drilling rocks at any angle by apparatus attached to a foundation plate. An impact blow is given to the drill by a spring of metal or rubber, and the spring is driven back by the power of a small engine.

1853. No. 2143. Kraut. 6d.

For Cutting Bock for the purpose of Blasting.—A round bar with a recess for receiving a cutter. The cutter projects out at the side, and forms a chamber at the bottom of the hole. See sketch.

1853. No. 2264. Norton. 4d.

Firing Explosive Compounds.—Two pieces of cord are attached to each other with lucifer match composition, and when pulled, explode the cartridge.

1853. No. 2854. Newton. 1s.

Similar to 1506, 1853.—Claims swinging frame, inclined planes, and the application of India-rubber for springs combined with drills.

1853. No. 2910. Bellford. 4d.

Heating a granulated composition of charcoal, sulphur, and nitre with a strong solution of chlorate of potash, and employing the powder in an unglazed state.

1855. No. 1475. Davey. 10d.

Safety-Fuses.—Passing threads through the centre of the gunpowder of an ordinary miner's fuse, and coating it with gutta-percha.

1855. No. 2617. Whitehouse. 1s.

Blasting by electro-magnetism.

1856. No. 196. Tolhausen. 8d.

Is intended for use within a hole previously bored, and for producing a large chamber at the bottom of a small hole.

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1856. No. 1759. Copeland. 6d.

Safety-Cartridge.—Part of the cartridge being filled with horse hair.

1856. No. 2403. Brooman. 4d.

Blasting by means of sulphur, saltpetre, salt, sawdust, and dung.

1857. No. 1431. Fontainemoreau. 4d.

Working on calcareous rocks by hydrochloric acid, forming at the base of the hole a cavity to put the powder in.

1857. No. 2031. Bennett. (Provl.) 4d.

Screw Auger.—The material bored is collected on the threads and brought to surface by sliding it on the rods.

1857. No. 2044. Anderson. (Provl.) 4d.

An ordinary watch discharges the fuse.

1857. No. 2479. Newton. 6d.

A peculiar means for operating the drill longitudinally, or giving it its reciprocating motion. Also in doing this intermittingly. Also a frame to work at different angles.

1857. No. 2727. Addison. 4d.

Anchors small balloons to the floor of the mine. If the mine is clear of hydrogen or carbonic hydrogen the balloons will be in contact with the roof; destroys gas where found by exploding by electric spark. Also sets fire to a rocket and fires it into the dangerous part.

1858. No. 575. Mennons. (Provl.) 6d.

Piercing Tunnels.—Forming a manhole at the axis of the tunnel, which hole when it has attained a certain length is mined with gunpowder to blow out the earth.

1858. No. 2478. Davey. 4d.

Blasting Powder.—Nitrate of potash, sulphur, charcoal, and flour.

1859. No. 1226. Trets. 4d.

Composition for Splitting Rock.—Soda tan and sulphur.

1859. No. 2173. Opie. (Provl.) 4d.

Charging holes in blasting.

1859. No. 2649. Hughes. 4d.

Blasting Powder.—Carbonate of potash, ground straw, and anthracite.

1859. No. 2651. Hughes. 4d.

Blasting Powder.—Chlorate of potash, carbonic acid, and charcoal.

1860. No. 888. Biehler. (Provl.) 6d.

For Blasting Cartridge.

1860. No. 913. Webb. 4d.

Cartridges employed in Blasting.—In using for the case of the cartridge waterproof cloth, the seams being made waterproof, and providing

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at the junction of the fuse and the cartridge a material which will not smoulder should the fuse not explode the cartridge.

1860. No. 2178. Duverge. (Provl.) 4d.

Uses various drills in a framing for horizontal and vertical boring.

1861. No. 719. Victor and Polglase. 4d.

Safety-Fuses,—Enclosing the powder in metallic tubes.

1861. No. 2438. Bickford and Smith. (Provl.) 4d.

Safety-Fuse.—Uses metal tubes covered with yarn and varnished.

1861. No. 2679. Lobb. (Provl.) 4d.

Substitutes sawdust for charcoal in gunpowder.

1861. No. 3271. Newton. 10d.

A rectangular frame, like a pit prop, jambed at the top and bottom, and made to hold a drilling apparatus at any convenient height.

1862. No. 1084. Newton. 4d.

Blasting Powder.—Substitutes nitrate of barita for saltpetre.

1862. No. 1334. Victor and others. 4d.

Safety-Fuses.—Covering and protecting soft metal fuses ; also making hard metal fuses

1862. No. 1796. Kellow and Short. 4d.

Blasting Powder.—Nitrate of potash, nitrate of soda, and the chlorate in a state of solution, with sawdust, tar, and sulphur.

1862. No. 2071. Gedge. 1s.

Boring Apparatus.—To bore an interior cavity of superior diameter to one already made by ordinary means.

1862. No. 2640. Lord and Gilbart.

A new mode of loading guns, partly applicable to mining.

1862. No. 3173. Austin. (Provl.) 4d.

Material for manufacture of cartridge cases. Uses paper pulp.

1862. No. 3297. Benton. (Provl.) 4d.

Charcoal, chlorate of potash, sea grass, and stone-coal. Sundry other mixtures.

1863. No. 30. Newton. 6d.

Mode of discharging cartridges, for exploding cannons without touch-holes, by electrical apparatus.

1863. No. 560. Delahaye. 10d.

An apparatus supported and guided by two pit props, whereby holes can be drilled and coals can be chipped by means of a tool moved by hand.

1863. No. 949. Spence. 4d.

Manufacture of Gunpowder.—Water, chlorate of potash, charcoal, sea grass, stone, coal, and sawdust.

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1863. No. 1971. Cunnack. (Provl.) 4d.

Cartridges,—By exposing the explosive material to great pressure.

1863. No. 2251. Sutherland. 6d.

Blasting Bocks.—Applying a wedge above the powder in blasting. See sketch.

1863. No. 2353. Dronke. (Provl.) 4d.

Gunpowder.—Cutting trunks of trees in slices, and afterwards into grains. Made porous by alkalis, made flammable by chloride and nitrous acid, and made explosive by nitrate of potash.

1863. No. 2359. Newton. 4d.

Gunpowder.—The employment of explosive liquids mixed with ordinary gunpowder or guncotton. Nitro-glycerine is preferred.

1863. No. 2555. Budenberg. 4d.

Blasting Powder.—Nitrate of potash, nitrate of soda, sulphur, wood charcoal, common coal, and potassio tartrate of soda.

1863. No. 2600. Mitchell. (Provl.) 4d.

To sink with common boring tools, and to give the force of the blasting powder the greatest effect. He also uses taper plugs.

1863. No. 2888. Wigfall and Jolly. (Provl.) 4d.

An explosive compound called " Prussian fire," formed into a needle cartridge.

1863. No. 8000. James. 10d.

Chiefly intended for boring obliquely. Consists of a boring rod or tube having two water passages, one for the admission of water and the other for the return of the debris.

1864. No. 837. Cunnack. 4d.

Cartridges for Blasting.—Claims concentration of the charge in cartridges. Also flexible cartridge cases of metal. Also mixing the explosive mixture with resinous, gummy, or adhesive materials to avoid using an external case.

1864. No. 575. Symes. 4d.

Improvements in Pontoons, or Caissons.—Applicable to building structures in water. Useful for blasting rocks.

1864. No. 775. Evans. (Provl.) 4d.

Improvements in Blasting.—Charges tin or metal tubes with carburetted or pure hydrogen gas for the use of blasting or cannon.

1864. No. 900. Dronke. 4d.

Gunpowder.—Of granulated woody material. Removes acids and colouring matters. Submits the grains to the action of nitric acid, and saturates them with salt, containing oxygen and nitrogen.

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1864. No. 1493. Thomson. 8d.

Forcing water into water-tight bags for the purpose of splitting rock and bringing down coal.

1864, No. 1694. Ehrhardt.

Gunpowder.—He uses tannic gallic acid, or the resin of commerce, and chlorate or nitrate of potash.

1864. No. 1813. Newton. 4d.

A mode of igniting nitroglycerine.

1864. No. 2566. Newton. 4d.

Safety-Fuse.—By putting a train of gun-cotton in a groove cut in wood, and laying over it any waterproof material.

1864. No. 2816. Sutherland. 8d.

Compressing Gunpowder for Blasting.—Combined with conical or folding wedges in the tamping. Claims making a blasting cartridge with a split cylinder or wedges. Also with gravel or an expanding wad. See sketch.

1865. No. 136. Cotter. (Provl.) 4d.

The construction of shells and the explosive powder. The powder is made of chlorate of potash and realgar in equal parts.

1865. No. 1192. Bernard. 10d.

A novel cartridge, rendered waterproof. Also a peculiar tool used for blasting. Also a peculiar mode of serrating the cutting edge of tools, causing the serrations of one part of the tool to cut in a different direction than those of the other. 1865. No. 1636. Klein.
4d.

Gunpowder.—A new way of combining the old ingredients.

1865. No. 2266. Reichen. 4d.

Preparing charges for fire arms and blasting. Chlorate of potash, nitrate prussiate, charcoal, powder, starch, chromate of potash, and water.

1865. No. 2363. Newton. 1s.

Requires a full drawing to explain it. Has twelve claims. No salient features or peculiar principle involved.

1865. No. 2774. Bernard. 8d.

Exploding charges grouped in recesses cut in a round rod. A peculiar form of boring tool. See sketch.

1865. No. 3206. Budenberg. 4d.

Blasting Powder.—Potassio, tartrate of soda, nitrate of potash, sulphur, and wood charcoal.

1865. No. 3218. Doering. 2s. 4d.

" Between two horizontal shafts, forming side supports, I fit horizontally

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a steam or air cylinder—one of the shafts is threaded—a piston works in the cylinder and passes through the front end, and has a drill or boring tool fixed on its front end."

1866. No. 974. Richards. 10d.

Boring Rock.—Bores rock with a hand-brace, same as boring a hole in iron.

1866. No. 3301. Rollason. 4d.

Blasting Cartridges.—Cases made of paper placed in a mould, and a fuse inserted filled with gun cotton, rammed by hydraulic pressure. Claims the manufacture of cartridges and fuses of gun cotton or pyroxyline. Compounds in the manner above described.

1866. No. 3310. Neumeyer. (Provl.) 4d.

Gunpowder.—Made of saltpetre, charcoal, and sulphur, not incorporated in the usual way. Mixes it with water, and stirs it about with revolving arms for fifteen minutes. It is then dried and is fit for use without being granulated.

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EIGHTH DIVISION.

MISCELLANEOUS.

1638. No. 117. Ramsay and others. 6d.

Making iron into any sort of cast work with sea or pit coal, peat, or turf.

1692. No. 288. Morton and Weale. 4d.

Engine partly applicable to the working of mines and coal pits. An engine for beating, pounding, or stamping.

1734. No. 547. Parsons. 4d.

For raising water and ore out of pits, first by a water-wheel, second by men, third by horses, fourth by wind, whereby large beams are moved, and also for clearing mines of damp by three newly invented bellows.

1744. No. 609. Perkins. 4d.

Sort of windmill, both horizontal and vertical, in which the sails on one side offer less resistance to the wind than those on the other. Used for raising coals.

1749. No. 643. Langworthy. 6d.

Horizontal windmill, somewhat similar to the above, for the purpose of raising weights.

1749. No. 648. Stokoe and Newton. 4d.

Using a treadmill worked by horses.

1750. No. 653. Meinzies. 10d.

Tail-Rope.—Double wagonway in the drift, with a pulley at each end, and an endless rope running round them, the heavy ones draw the light ones up. In the sloping wagonways below ground one rope may do instead of two. Hooks hanging down to take hold of the boxes in ascending and descending.

1787. No. 1588. Heame. 10d.

For regulating the sails of mills.

1796. No. 2092. Clay. 8d.

Double tip wagon. See sketch.

1799. No. 2294. Jeffreys. 1s. 10d.

Lifts coals with endless chains. The endless chains are at the bottom, giving motion to other endless chains leading into the workings, which draw the curves along, they being suspended from a pulley in a sort of overhead railway.

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1800. No. 2878. Crowther. 10d.

Engine commonly known as Crowther's engine.

1802. No. 2632. Murray. 10d.

Variety of steam engine.

1808. No. 3126. Chapman. 10d.

Conveying coals below ground. Endless chain or rope, which, by causing the rope to go always the same way, in place of reciprocating, laden carriages may be put on anywhere and light carriages taken off.

1810. No. 3336. Bosworth. 4d.

Improvements in Carriages.—The bottom is formed of drops fastened to the sides, and removing the lever which keeps the bottom in, lets down the load by either lever, pulley, screw, or wheel.

1811. No. 3431. Blenkinsopp. 4d.

Application of racks to rails.

1813. No. 3645. Dunkin. 10d.

Lessening the consumption of steam.

1826. No. 5428. Harsleben. 1s.

Drives a mixture round in a tub and separates by washing.

1845. No. 10,941. Palmer. 6d.

Improvements in lifting machinery where a continuous rotatory motion is produced by means of racks acting on a wheel. See sketch.

1846. No. 11,129. Bovil and Griffiths. 2s.

For Raising Weights in Mines.—Two pipes with slots go from top to bottom of pit, the pistons are attached to the cage, and the load is lifted after the manner of an atmospheric railway. Claims application of the force of the atmosphere when employed as a propelling power on railways or canals, whether applied to tubes with longitudinal or other valves, or whether applied to cylinders or vacuum engines for the like purpose. (2) Propelling carriages by means of draw bars. (3) Application of atmospheric mains having their longitudinal slots covered, as before described, to mining purposes.

1852. No. 344. Perkes. 1s.

Boring earth, crushing, pulverising, dressing, mixing, grinding, pumping, washing, precipitating, and amalgamating ores, and an improved sublimated apparatus.

1852. No. 679. Hoga. 4d.

Ascertains the existence of gold by making use of a rod made of some conductor of electricity. Wherever gold is supposed to exist the rod is inserted, and the presence of gold is indicated by the completion of the circuit.

1851, No. 1371. Hackworth. 1s. 2d.

Double cylinder expansive engine. 9th claim. Mode of reversing motion of mine shaft winding without reversing the motion of the driving-engine itself, by means of friction clutches and a well-known apparatus in use for planing machines.

1854. No. 2695. Smith and Mackenzie. (Provl.) 4d.

They form steam by injecting water on molten lead, and use it either for blasting purposes or for firing guns.

1856. No. 1470. Longridge. 10d.

Storing compressed air in reservoirs, applying heat to the air previous to its going into the cylinders, using air so heated in locomotives for mines, and a peculiar regulating valve.

1857. No. 1456. Travis and Casartelli. 1s.

Peculiar construction of steam-pipe—an expanding tube.

1857. No. 1868. Royds and others. 1s. 4d.

Lifting Minerals.

1858. No. 1392. Anderson. 6d.

A combination of racks to enable locomotives to ascend inclined planes.

1858. No. 1768. Taylor. 1s. 4d.

Sort of compressed air engine. Also regaining part of the power expended in raising a load. Also throwing pumps out of work when the receivers are full.

1859. No. 151. Archibald. 8d.

A bivalve piston for generating force.

1859. No. 487. Seguln. 1s.

Application of tidal power to manufacturing purposes.

1859. No. 2671. Lindon. (Provl.) 4d.

Uses the direct force of water conveyed from a high level into a cylinder and piston.

1860. No. 2889. Fowler and others. 1s. 4d.

Clip-pulley.

1861. No. 1432. Johnston. 6d.

Mine Props.—Made in two pieces, with a splice and a ring to go over to keep them together. Also hinged. Also telescopic. Claims making pillars in two parts. See sketch.

1861. No. 2377. Jacob. 6d.

Forming the joints of flat-bottomed rails.

1861. No. 3029. Burrows and Dougan. 10d.

Clip-Pulley.—Small levers are forced on to the rope by an eccentric. There is an arrangement for doing this also with levers. See sketch.

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1861. No. 3092. Stanley. 4d.

Application of aluminium to mining dials.

1862. No. 143. Jobling. 6d.

Applying Locomotives to Mines.—Passes the exhaust to a tank of cold water, thence through a coiled pipe to the outside.

1862. No. 1786. Crestadoro. 6d.

Obtaining motive power from rarefied air.

1862. No. 1800. Coltman. (Provl.) 4d.

To diminish the breaking of coals by causing them to be discharged towards the higher part of the shoot instead of towards the lower part thereof.

1862. No. 2185. Slevins and Rider. 10d.

Improvements in Colliery Wagons.

1862. No. 3189. Johnson. 8d.

Indicating the Presence of Hidden Metallic Bodies.—He claims the construction of apparatus for indicating the presence of electric conductors in foreign bodies. Also, the application of an electric testing apparatus for metals.

1863. No. 169. Mawson and Whitehead. (Provl.) 4d.

To dispense with stuffing boxes in hydraulic machines.

1863. No. 2021. Yates. 10d.

Indicating quantities drawn from a mine.

1863. No. 2241. Meyer. (Provl.) 6d.

Utilizing Vapours.—He adapts to ordinary machines a supplementary apparatus, receiving the waste steam from an ordinary engine. Re-condenses and forces into a boiler.

1864. No. 1500. Jones. 10d.

" I employ machinery in such a way, that the wrater descending in a mine, may give motion to a piston-plunger of a hydraulic engine and actuate an air-pump.

1864. No. 2258. Hey. 10d.

The lubrication of the axis of corves. Makes the bosses hollow, filling the hollow part with oil. See sketch.

1865. No. 96. Jones. 1s. 4d.

An engine for compressing air, the piston-rod of the steam cylinder working the air piston direct, and giving motion to the valve by means of a tappet. Claims the arrangement. Also the application of air vessels at intervals between the air pump and the workings. Also picks which commence at the back and move outwards.

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1865. No. 982. Jones. 8d.

An Apparatus for actuating Valves.—The piston has a hollow rod, in which works another rod connected with the valve in such a way that the valve is reversed by the motion of the piston. Should the piston not have made a sufficient stroke to reverse the valve, a sliding shuttle is put round the rod, the momentum of which acts on the valve after the piston is stopped.

1866. No. 2103. Bonneville. (Provl.) 4d.

Forming the wheels of mine carriages with the grease boxes in one

piece.

1866. No. 2193. Plimsoll. 10d.

Unloading Coals.—A mode of discharging coals at sidings, so that they may be less damaged.

1866. No. 3373. Sloper. (Provl.) 4d.

New Motive Power.—Produces powerful currents of air by means of one or more shafts built in the usual way of brick, stone, or metal, and causing the currents to operate on vanes or fans.

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Catalogue of Institute Library

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CATALOGUE.

A

Accum, Fred., A Practical Treatise on Gas Light. 1815.

Agricolae, Georgii, Kempnicensis Medici Ac Philosophi Clariss, De Re Metallica, libri XII. 1657.

Annales des Travaux Publics de Belgique. Vol. XII. 1853-4.

Ansted, David T., an Elementary Course of Geology, Mineralogy, and Physical Geography. 1850.

Arts et Metiers. Vol. X., 1768 ; Vol. XL, 1774 ; Vol. XII., 1777. (L'Art d'exploiter les Mines de Charbon de Terre.) Atlas de la Richesse Minerale. Par M. le Baron Heron de Villefosse. Nouveau Tirage. 1838.

B

Bainbridge, Wm., A Treatise on the Law of Mines and Minerals. 1856.

Bakewell, R., An Introduction to Mineralogy. 1819.

Ditto, An Introduction to Geology. 1833.

Bell, John, Collections relating to the History of Coal and Mining. 21 vols. Presented by T. J. Taylor, Esq.

Belt, Thomas, on Mineral Veins : an Enquiry into their Origin, founded on a Study of the Auriferous Quartz Veins of Australia. 1861. Presented by Thomas Belt, Esq.

Binney, E. W., Observations on the Carboniferous Permian and Triassic Strata of Cumberland and Dumfriesshire. Birmingham Institute of Mechanical Engineers, Transactions of. 15 vols.

Bourne, John, C.E., A Treatise on the Steam Engine. 1855.

Brard, C. P., Elemens Pratiques d'Exploitation. 1829.

Brongniart, Alex., Tableau des Terrains, qui Composent l'Ecorce du Globe. 1829.

Ditto, Traite Elementaire de Mineralogie. 2 vols. 1807.

Buddle, John, First Report of a Society for Preventing Accidents in Coal Mines. 1814. Presented by P. S. Reid, Esq.

[xix]

C

Carnall, R. von M. Geognostiche Karte von Ober Schlesien.

Ditto, Zeitschrift fur das Berg-Hiitten und Salinenwesen in dem Preussischen Staate. 3 vols. 1854-5-6. Catalogue of the Geological, Mining, and Metallurgical Models in the Museum of Practical Geology. 1865.

Catalogue of the Minerals and Fossil Organic Remains of Scarborough. 1816.

Chabannes, Marquis de, on Conducting Air by Forced Ventilation, &c. 1818.

Chalmers, James, C.E., The Channel Railway. 1861.

Civil Engineers, Proceedings of. 26 vols. 1842 to 1867.

Ditto, General Index to vols. 1 to 20. 2 Copies.

Ditto, Catalogue of Books in Library of.

Clegg, Samuel, Jun., A Practical Treatise on the Manufacture and Distribution of Coal Gas. 1841.

Combes, M. Ch., Traite de l'Exploitation des Mines. 3 vols. 1844-5.

Ditto, Ditto Ditto, Atlas. 1847.

Combustion of Fuel: Abstract of Specification of Patents.

Conybeare and Phillips, Outlines of the Geology of England and Wales. 1st vol. 1822.

D

Dalton, John, Meteorological Observations and Essays. 1834.

Ditto, A New System of Chemical Philosophy, Part 1, vol. II. 1827.

Ditto, Ditto Ditto. Part 1., 2nd edition. 1842.

Davy, Sir H., on the Fire Damp of Coal Mines. 1816.

De la Beche, H. T., Report on the Geology of Cornwall, Devon, and West Somerset. 1839.

Ditto, A Geological Manual. 1833.

Doursther, H., Dictionnaire Universelle des Poids et Mesures. 1840.

Dudley and Midland Geological Society, Transactions of (some odd parts only).

Dunn, M., View of the Coal Trade and History of the Steam Jet. 1844. Presented by M. Dunn, Esq.

Ditto, A Treatise on the Winning and Working of Collieries. 1852.

Ditto, How to prevent Accidents in Collieries. 1862.

E

Explosion at Hetton Colliery, Account of. 1860.

[xx]

Explosion of Fire Damp at Eaglesbush or Eskyn Colliery, South Wales, March 29, 1848.

F

Faujas-Saint-Fond, B., Voyage en Angleterre, Ecosse et aux Iles Hebrides. 2 vols. 1797.

Feier, die, des Zehnjaehrigen Stiflungsfestes des Architecten und Ingenieur-Vereins fur das Konigreich Hannover, 1841.

Fenwick, Thomas, Essays on Practical Mechanics. 1824.

Flotz-Karte des Oberschlesischen Steinkohlengebirges. 1860.

Forster, Westgarth, A Treatise on a Section of the Strata from Newcastle to Cross Fell in Cumberland. 1821.

Fossil Fuel and Collieries, History of. 1841.

G

Geological Society, Quarterly Journal of, Nos. 1 to 89 (except No. 7, which is out of print).

Geological Enquiry, present Position and future Prospects of. 1864-5.

Geological Survey of the United Kingdom. 1849. Presented by Sir R. I. Murchison.

Geological Survey of Great Britain, &c. 1856. Presented by Sir R. I. Murchison.

Ditto Ditto. 1858. Part 1.

Ditto Ditto. Maps.

Girardin and Burel, Rapport sur l'Exposition Universelle de 1855.

Glossary of Terms used in the Coal Trade.

Glynn, Joseph, Memoir of. 1863-4.

Greenwell, G. C, A Practical Treatise on Mine Engineering.

Guerin's Self-acting Railway Brake, Report on. 1857. 2 copies.

H

Hainault Societe des anciens Eleves. 11 Parts and Rules.

Hales, Stephen, A Description of Ventilators, whereby great quantities of Fresh Air may be conveyed into Mines, &c. 1743.

Hall, T. Y., Treatises on various British and Foreign Coal and Iron Mines and Mining. 1854.

Henckel, J. F., Pyritologia ; or a History of the Pyrites. 1757.

I J

Ireland, Proceedings of Civil Engineers of. 6 vols., and vol. 7, part I.

Jars, M. G., Voyages Metallurgiques. 3 vols. 1774, 1778, and 1780.

[xxi]

Jars, M. G., Voyages Metallurgiques, 1st vol. (Angleterre). 1774.

Johnstone, Alex. Keith, Physical Atlas of Natural Phenomena.

K

Keilhan, B. M., Gasd Norwegica von mehreren Verfassern herausgegeben. 1838.

Kirwan, Richard, Elements of Mineralogy, 2 vols. 1794.

L

Lectures Delivered at the Bristol Mining School. 1857. 15 copies.

Leithart, John, Practical Observations on Mineral Veins. 1838.

Lesley, J. P., Manual of Coal and its Topography. 1856.

Literary and Philosophical Society of Newcastle, Transactions of, 6 vols. 1793 to 1845. Presented by E. F. Boyd, Esq.

Ditto Ditto, Catalogue. 1829.

Ditto Ditto, Supplementary Catalogue. 1829.

Ditto Ditto, Catalogue. 1848.

Literary and Philosophical Society of Manchester, Memoirs of, 17 vols.

Ditto Ditto, Proceedings, Vol. II., 1860-1, and 1861-2, and Rules.

Ditto Ditto, „ Vol. III., 1862-3, and 1863-4.

Ditto Ditto, „ Vol. IV., 1864-5.

Lyell and Faraday, Report on the Explosion at Haswell Colliery. 1844.

M

Machines a Vapeur, Reglement de Police et Instructions. 1854.

Mammatt, E., Geological Facts and Practical Observations intended to elucidate the Formation of the Ashby Coal Field. 1834.

Manchester Geological Society, Transactions of, 6 vols. Imperfect.

Meteorological Tables, from the Register of the Literary and Philosophical Society of Newcastle, 1849 to 1851. Presented by P. S. Reid, Esq.

Metropolitan School of Science, Prospectus of, 7th Session. 1857-8. 3 copies.

Miner's Safety Rod, or Safety Fuze, for Blasting Rocks. 1832.

Mining Journal, 11 vols. 1847 to 1858. Presented by William Anderson, Esq.

Mining and Smelting Magazine. Odd parts.

Miner's Friend. 1702.

Moore, Ralph, On the Ventilation of Mines. 1859.

Ditto, Black Band Ironstones of the Edinburgh and East Lothian Coal Fields. 1861.

[xxii]

N

Natural History Society of Newcastle, Transactions of, 2 vols. 1831-38.

New Zealand Government Gazette, Vol. X., No. 21.

North of England Institute of Mining Engineers, Transactions of, 17 vols.

O

Oaks Colliery Explosions, Narrative of, and diagrams. 1866. Presented by W. A. Potter, Esq.

P

Pambour, Comte de, Theory of the Steam Engine. 1839.

Ditto, Practical Treatise on Locomotive Engines. 1840.

Pamphlets (various). Presented by W. Green, Esq.

Parachute a Friction pour Cages des Mines. 1862.

Peclet, E., Traite de la Chaleur consideree dans ses applications. 1844.

Ditto, Ditto, Ditto, (planches). 1843.

Ditto, Nouveaux Documents relatifs au Chauffage et a la Ventilation, &c. (Supplement). 1854.

Phillips, John, Illustrations of the Geology of Yorkshire :—

Part 1.—Yorkshire Coast. 1835

Part 2.—Mountain Limestone District. 1836.

Phillips, John, Figures and Descriptions of the Palaeozoic Fossils of Cornwall, Devon, and West Somerset. 1841. Playfair, Prof., A Comparative View of the Huttonian and Neptunian Systems of Geology. 1802

Practical Mechanics' Journal, 4 vols. 1860 to 1864.

Proceedings and Resolutions at a Meeting of Deputations from the Coal Mining Interests of the Kingdom. 1854.

R

Receuil de Memoires et de Rapports des moyens de soustraire l'Exploitation des Mines de Houille, aux chances d'Explosion. 1840.

Report on Accidents in Coal Mines. 1835.

Report on the Important Mining Case, Regina v. Cope.

Report of the Commission on the Operation of the Act 5 and 6 Vic. cap. 99, and State of Population in the Mining Districts. 1848.

Ditto, Ditto, Ditto, 1853.

Report of the Chief Commissioner of Mines for the Province of Nova Scotia, 1866.

Revue Universelle des Mines, &c, 2 vols. 1864.

Ditto, odd part.

Rogers, Ebenezer, Description of a Ventilating Fan at Abercom Collieries, &c. 1857.

Ronalds and Richardson, Chemical Technology, 2 vols. 1855.

Royal Dublin Society, Transactions of, parts 1 to 36.

Royal Institution of Great Britain, Notices of Proceedings, vol. I. 1851 to 1854. List of Members, &c.

Ditto, 5 vols. Imperfect. :

Ditto, List of Members. 1862.

Ditto, Ditto, 1863.

Royal Scottish Society, Transactions of, 3 odd parts.

Royal Society of London, Proceedings of, 15 vols.

Ditto, List of Members. 1862.

S

School of Mines, Records of. Parts 1, 3, and 4 of vol. I.

Scientific Instruction, Report on. 1868.

Scotland Institute of Engineers, Transactions of Vols. VI. to XI.

Scrivenor, Harry, History of the Iron Trade. 1854.

Seaham, Description of Port of. 1854.

Sinking at Annesley Colliery. E. Hedley. 1866.

Smeaton, John, F.R.S., Reports on Civil Engineering, 2 vols, in 1. 1837.

Sopwith, T., An Account of the Mining Districts of Alston Moor, &c, 1833.

Ditto, Award of the Dean Forest Commissioners. 1841.

South Wales Institute of Civil Engineers, Transactions of, 5 vols. 1857 to 1865.

Statistiques de la Belgique, Mines, Usines, Mineralurgiques, Machines a Vapeur, &c. 1842, 1846, 1852, and 2 copies of 1855.

Statistiques de l'Administration des Mines, Resume des Travaux. 1847 to 1852.

Steam Boiler Assurance Company, Engineer's Reports. 1863 to 1867.

Stephenson, George, Report on his Claims to the Invention of the Safety-lamp. 1817.

T

Taylor, R. C, Statistics of Coal. 1848.

Tredgold on the Steam Engine, Stationary, Locomotive, and Marine, 4 vols. 1852-53.

Ditto, Ditto, Revised by W. S. B. Woolhouse, 2 vols. 1838.

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U

Uebersicht von der Production der Bergwerke Huetten und Salinen in dem Preussischen Staate im Jahren. 1855-59.

W

Werner's New Theory on the Formation of Veins. 1809.

Williams, John, Natural History of the Mineral Kingdom, 2 vols. 1789.

Y

Young and Bird's Geological Survey of the Yorkshire Coast. 1832.

Z

Zeitschrift des Architecten und Ingenieur-Vereins fur das Koenigreich Hannover. 1861. 10 parts.