NORTH OF ENGLAND INSTITUTE OF

MINING ENGINEERS.

TRANSACTIONS.

VOL. XVI.

1866-7.

NEWCASTLE-UPON-TYNE : A. REID, PRINTING COURT BUILDINGS, AKENSIDE HILL.

1867.

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NEWCASTLE-UPON-TYNE : A. REID, PRINTING COURT BUILDLNGS, AKENSIDE HILL.

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In drawing up and presenting to the members of the Institute their Report for the year just coming to a close, the Council have little else to do than to repeat the observations of the preceding year.

They have, as on that occasion, to report a large increase of members, and a generally prosperous and encouraging position of the Institution, with the difference, however, that this increase cannot exactly be attributed to the same causes. Much of it must be attributed to the junction of many and important members of the profession of Mechanical Engineers, which, whilst it adds to the numbers at the same time is largely augmenting the utility and importance of the Institution.

With the profession of Mechanical Engineers, that of Mining Engineers is of necessity partially connected; and by the junction of the two it is to be anticipated that an impetus will be given to that branch of mechanical science, without which mining, and more especially coal-mining, cannot now be successfully pursued. In saying this, the Council cannot conceal from themselves that this so desirable union has been, in part, caused by the prosperous state and growing influence of this Society, and the attention attracted to it by the information conveyed in its more voluminous Transactions.

The precise position of the Institution, as to increase of membership during the current year, now at its close, may be briefly summed up as follows:— gross increase of members, 70; deduct by death and other causes, 15; net increase, for 1806-7, 55.

Amongst the losses by death it would be unpardonable were the Council to omit to refer particularly to the death of the late Parker Jeffcock, Esquire, of Derby, for many years a member of this Society, and a partner of one of its Vice-Presidents, Mr. J. T. Woodhouse.

The appalling catastrophe at the Oaks Colliery, near Barnsley, is

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still too fresh in the memory, not only of those present, but of the public generally. Amongst those who perished on that melancholy occasion there are none whose loss will be more lamented than that of Mr. Jeffcock. Nobly exposing himself with his brave companions in the cause of humanity, and for the rescue of others from dangers hardly to be escaped, he fell a victim to a sense of duty of the highest order, and on which no euloguim can be passed which can be deemed extravagant.

The Council trust they may be excused in cherishing the hope that this respectful and affectionate momento of a good and brave man may help to keep his memory green, and prove, in some small degree, a consolation to those surviving relations and friends who admire his heroism whilst they continue to lament his loss.

From some of the striking incidents of the unfortunate catastrophe at Barnsley, it is yet possible to draw considerations of a consoling nature. It is impossible for a reflecting mind not to deduce, from the instances of daring courage and strong devotion there exhibited, this conclusion,— that no amount of risk can have deterred such men from the full performance of the dangerous duties of mine ventilation, or from any possible exertion of skill by which those dangers may have probably been diminished if not avoided. This conclusion is as sound as it is inevitable.

That coal-mining, especially in deep collieries, must long continue to be an insecure pursuit is only too evident. In this it is not singular, the same insecurity being shared in common with many other processes from which to all appearance it would be easier to exclude risk of life. The rate of mortality amongst those who follow the trade of saw-grinding is a striking proof of this. The Council, however, express their earnest hope and expectation that the continuous application of mechanical science will gradually diminish both the labour and the risk of the coal-mine. By the triumph of mechanical skill alone our deeper collieries have been made available. By the progress of mechanical science the toil and risks of reaching and extracting coal at great depths will, past a doubt, be gradually ameliorated, and possibly to a large extent avoided.

Adverting to the Volume of Transactions for the past year, the Council need not hesitate to say, that it will be found to embody the average quantity of papers of interest, as affording useful information and examples of well directed enquiry.

They may be allowed perhaps to particularise Mr. Lishman's paper

on the Long-Wall System of Working, and that by Mr. Cochrane, comparing the Guibal and Lemielle's Systems of Mechanical Ventilation.

There are also some important practical observations on the Conveyance of Coals Underground by Mr. J. Daglish and others, which ought not to be passed over without notice.

In making their Report for the preceding year, the Council briefly adverted to the Commission then recently appointed, for the purpose of ascertaining and estimating the supplies of coals applicable to future use in the United Kingdom. That Commission has not yet, as a matter of course, issued any report with respect to any portion of a subject at once so extended and so difficult as must necessarily be an enquiry of this nature. The Council advert to it a second time principally for the purpose of urging the members of the Institution generally to aid this investigation as far as it may be in their power so to do. That the President, and one of the most experienced members of this Societv, are placed upon the Commission is a matter for gratulation, but as far as relates to these counties, the whole labour ought not to be permitted to rest upon the Commissioners but every aid should be accorded that local members can give. That an approximately correct estimate of the available amount of coal remaining in known seams will be achieved the Council do not in the least doubt. They would, however, caution those who may be inclined to draw rash conclusions from such statements of the danger of doing so. It is premature in the extreme at this time to attempt to anticipate the march of adventure, the progress of mining science, and the geological discoveries still in store for the future. Had the steam-engine not being perfected the finest seams of this vicinity might have remained untouched; and the discovery of new forces, and new methods of overcoming mining difficulties may be destined in the far and distant future to unfold sources of supply as vet undreamed of.

Before concluding, the Council must be permitted to congratulate the Members on the general position of the Institution. The prosperous state, of which this Report has attempted an outline, will, they believe, be found to be borne out and corroborated by the Report of the Treasurer and Finance Committee, to which they would respectfully draw the attention of those present, as well as of the body of members.

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.

Finance Report

Your Committee are glad to have to report the healthy state of the Finances of your Institute during the past year.

There has been a very large increase of Members and Graduates. The arrears of subscribers paid up during the year contrasts favourably with the previous year, viz., £84 against £23. This favourable state is entirely due to the energetic exertions of your Treasurer, Mr. Boyd; and your Committee cannot allow this opportunity to pass without alluding to the great services received by your Institute from so valuable a Treasurer; but the arrears for the current year amount to a very large sum; this, however, arises from their having only recently been elected, and we have to draw the attention of the Council to the matter. The arrears amount this year to £95 against £92 last year.

A large number of members lose their membership this year in consequence of their being two years in arrears. As these gentlemen have received copies for two years of your valuable transactions, your Committee draw attention to this. The amount of these arrears is £58 against £27 of the previous year. It would greatly relieve your Treasurer, and secure the regular payment of the Subscription, if your members would, as in other similar Societies, give a general order on their Bankers to pay their Subscription when due.

The expense incurred by printing and publishing the Transactions is very similar to last year, viz., £450.

A new source of expenditure has been introduced during the past year, viz., grants to Committees appointed to investigate special and important questions. The amount granted to the Tail-Rope Committee during the past year has been £126. Your Committee feel sure that when the Report from this Committee is completed that it will fully repay this expenditure.

The total amount received and expended during the past year is very much the same as for the previous year, both slightly in excess, so that the balance for the year carried over is also very similar, viz., £323 against £252, making the entire capital £3308 against £2984.

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THE TREASURER IN ACCOUNT WITH THE NORTH OF ENGLAND INSTITUTE OF MINING ENGINEERS.

For the Year ending July 1st, 1867.

Dr.

1866.		£ s. d.	£ s. d.
July 1.—To Balance in hands of Treasurer from Fourteenth Year ...	£965 18 5		
„ Deposited in Messrs. Lambton's Bank	700 0 0		
	-------------		£265 18 5
„ Balance in hands of Liquidators of District Bank		18 10 10	
„ Bequest of the late R. Stephenson, Esq., invested on Mortgage of Northumberland Dock Bates		2000 0 0	

„ Deposited in Messrs. Lambton's Bank, New-

castle ... ... ,.. ... ... 700 0 0

-------------- 2984 9 3

1867.

July 1.—To Interest on R. Stephenson, Esq.'s bequest,

from June 30, 1866, to and with June 30,

1867 ... ... 95 0 0

Less Income Tax 1 11 8

------------- 93 8 4

„ Interest on £300 deposited in Messrs.

Lambton's Bank, from June 30, 1866,

to June 30, 1867 ... ... 15 9 4

„ Ditto on £400 deposited in Messrs.

Lambton's Bank, from September 5,

1866, to June 30, 1867 ... ...

„ Arrears of 1866, Subscriptions collected since balancing for

that year 56 14 0

„ Subscriptions received for this year from 337 Members ... 707 14 0

„ Ditto ditto from 19 Graduates 19 19 0

" Ditto ditto from Colliery Owners, viz.:—

Black Boy £4 4 0

Leasingthorne.. ... ... 2 2 0

Westerton 2 2 0

Hetton... ... ... 10 10 0

North Hetton... ... ... 6 6 0

Kepier Grange 2 2 0

Lambton 10 10 0

Londonderry 10 10 0

Haswell 4 4 0

Byhope 4 4 0

Whitworth 2 2 0

South Hetton and Murton 8 8 0

Stella... ... ... 2 2 0

----------- 69 6 0

To Sales of Publication, per A. Beid :—

From June 30, 1866, to June 30, 1867 ... 44 4 6

Less 10 per cent. Commission 4 8 6

----------- 39 16 0

£3986 15 11

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1867. Cr.

July 1.— By paid A. Reid for Printing, Advertising, and Publishing

Account—

From June 30, 1866,to Jan. 4,1867		£168 8 6		
„ Feb. 4,1867, to June 30,1867		168 6 6		
		------------		
		336 15 0		
Less by error in 1866 Account		4 17 6		
		------------	£331 17 6	
„ Ditto Covers for Parts, Circulars, &c. ...		30 17 6		
„ Ditto Binding and Sewing Vols... ...		31 7 0		
" Ditto Postage Stamps		30 1 7		
			------------	424 3 7
„ Secretary's Postage Stamps ...	12 3 0			
„ Ditto ditto	9 18 0			
		------------	22 1 0	
" Assistant Secretary's ditto ...	0 10 0			
„ Ditto ditto	0 10 0			
		------------	1 0 0	
„ Treasurer, ditto, etc			7 4 0	
			------------	30 5 0
„ Secretary's Salary for year ending June 30, 1867 ...				25 0 0
„ Assistant's ditto ditto ditto				35 0 0
" B. Curtice Reporting for ditto				12 12 0
„ Natural History Society's Subscriptions for year ending Oct. 2, 1866				20 0 0
„ Insurance on Property at Institute Rooms ...		0 12 0		
„ Ditto ditto called Stock, per A. Reid		1 16 0		
			------------	2 8 0
„ William Cochrane, Expenses connected with				

the Tail- Eope Enquiry		75 0 0	
„ Henry Watson, for Instruments	8 7 4		
„ Ditto ditto	2 1 0		
	------------	10 8 4	
„ Messrs. Elliott Brothers, ditto	11 9 6		
„ Ditto ditto ditto	30 0 0		
	------------	41 9 6	
		---------	126 17 10
" Messrs. Carter and Co., for engrossing Vote of Sympathy with the Family of the late Nicholas Wood, Esq. ...			1 5 6
„ B. Bobinson, for 1 gross of steel pens			0 1 6
" W. Heppell, for assistance in drawing this Balance Sheet			1 1 0
„ Balance in hands of Treasurer at this date	589 10 8		
„ Ditto Liquidators of District Bank, being proportion of deposit yet unpaid ...	18 10 10		
" R. Stephenson, Esq.'s Bequest invested on Mortgage of Northumberland Dock Rates	2000 0 0		
„ Invested in Messrs. Lambton's Bank, Newcastle	700 0 0		
		-------------	3308 1 6

			£3986 15 11

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General Statement, July, 1867.

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Patrons

His Grace the DUKE OF NORTHUMBERLAND.

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.

Honorary Members

WILLIAM ALEXANDER, Esq., Inspector of Mines, Glasgow.

JOHN J. ATKINSON, Esq., Inspector of Mines, Chilton Moor, Fence Houses.

LIONEL BROUGH, Esq., Inspector of Mines, Clifton, Bristol.

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

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

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

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T. RUTHERFORD, Inspector of Mines, Halifax, Nova Scotia.

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

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

* G. W. SOUTHERN, Esq., Inspector of Mines, Yorkshire.

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

JOHN HEDLEY, Esq., Ex-Inspector of Mines.

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

GOLDSWORTHY GURNEY, Esq., Bude Castle, Cornwall.

M. DE BOUREUILLE, Commander de la Legion d'Honneur, Conseiller d'etat

Inspector General of Mines, Paris.

DR. H. VON DECHEN, Berghauptmann, Ritter, etc., Bonn on the Rhine,

Prussia.

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

Prussia.

M. DE VAUX, Inspector General of Mines, Brussels, Belgium.

M. GONOT, Mining Engineer, Mons, Belgium.

Life Member

H. J. MORTON, Esq., Garforth House, Leeds, Yorkshire.

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

OFFICERS, 1867-8.

President

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

Vice-Presidents

JOHN TAYLOR, Earsdon, Newcastle-upon-Tyne.

GEORGE ELLIOT, Betley Hall, Crewe.

EDWARD POTTER, Cramlington, Newcastle-upon-Tyne.

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

ISAAC LOWTHIAN BELL, Washington, Washington Station, N.E. Railway.

J. T. WOODHOUSE, Midland Road, Derby.

Council

LINDSAY WOOD, Hetton Hall, Fence Houses.

JOHN DAGLISH, F.G.S., Belmont Hall, Durham.

T. DOUGLAS, Peases' West Collieries, Darlington.

G. B. FORSTER, Backworth, Newcastle-upon-Tyne.

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

Wm. COCHRANE, Seghill House, near Cramlington.

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

C. BERKLEY, Marley Hill Collieries, Gateshead.

JOHN MARLEY, Mining Offices, Darlington.

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R. S. NEWALL, Ferne Dene, Gateshead.

H. T. MORTON, Lambton, Fence Houses.

T. E. HARRISON, C.E., Central Station, Newcastle-upon-Tyne.

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

HUGH TAYLOR, Earsdon. ex-officio

WILLIAM ARMSTRONG, Wingate Grange, Ferry Hill. ex-officio

Treasurer

EDWARD F. BOYD, Moor House, Durham.

Secretary

THEO. WOOD BUNNING, Newcastle-upon-Tyne.

List of Members

AUGUST, 1867.

1 Ackroyd, Thomas, Berkenshaw, Leeds.

2 Adams, W., Severn House, Roath Road, Cardiff, Glamorganshire,

3 Aitken, Henry, Falkirk, North Britain.

4 Anderson, C. W., St. Hilda's Colliery, South Shields.

5 Anderson, Joseph. Solicitor, Neville Hall, Newcastle.

6 Anderson, William, Rainton Colliery, Fence Houses.

7 Appleby, Charles Edward, Reinshaw Iron Works, near Chesterfield.

8 Armstrong, W., Wingate Grange, Ferry Hill, County of Durham.

9 Armstrong', C.B., Sir W. G., Jesmond, Newcastle.

10 Ashwell, Hatfield, Anchor Colliery, Longton, North Staffordshire.

11 Asquith, Thomas, Harton Colliery, South Shields.

12 Attwood, Charles, Holywood House, Wolsingham, Darlington.

13 Aytoun, Robert, 3, Fettes Row, Edinburgh.

14 Bagnall, jun., Thomas, Whitby, Yorkshire.

15 Bailes, jun., Thos., 3, Queen's Terrace, Gateshead.

16 Bailey, W. W., Kilburn, near Derby.

17 Bailey, Samuel, The Pleck, Wallsall, Staffordshire.

18 Barkus, jun., Wm., Tynemouth.

19 Barklay, A., Engineer, Kilmarnock, North Britain.

20 Bartholomew, C, Doncaster, Yorkshire.

21 Bassett, A., Tredegar Mineral Estate Office, Cardiff, Glamorganshire.

22 Beacher, E., Thorncliffe and Chapeltown Collieries, Sheffield.

23 Beanlands, Arthur, University College, Durham.

24 Bell, John, Normanby Mines, Middlesbro'-on-Tees.

25 Bell, Isaac Lowthian,Washington,Washington Station, N.E. Railway.

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

27 Bell, jun., Thomas, Usworth Hall, Gateshead.

28 Benson, T. W., Cowpen Colliery, Blyth.

29 Berkley, C., Marley Hill Colliery, Gateshead, County of Durham.

30 Bewick, Thomas J., Neville Chambers, Newcastle-on-Tyne.

31 Bidder, B. P., Powell, Duffryn Collieries, Aberdare.

32 Bigland, J., Bedford Lodge, Bishop Auckland, County of Durham.

33 Binns, C, Claycross, Derbyshire.

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

35 Blackwell, J. Howard.

36 Bolckow, H. W. F., Middlesbro'-on-Tees, Yorkshire.

37 Bourne, P., Whitehaven, Cumberland.

38 Bourne, S., West Cumberland Hematite Iron Works, Workington.

39 Bourne, Thos. R., Rawcliff, Garstang, Lancashire.

40 Bowie, Alexander, Canonbie Colliery, Canonbie, Carlisle.

41 Boyd, Edward F., Moor House, Durham.

42 Boyd, M.E., Nelson, Belfast Foundry, Donegal Street, Belfast.

43 Boyd, William, Spring Gardens Engine Works, Newcastle-upon-Tyne.

44 Breckon, J. R., Darlington.

45 Brettle, Thomas, Mine Agent, Dudley, Worcestershire.

46 Broadbent, Jubal C, Drake Street, Rochdale, Lancashire.

47 Brogden, James, Tondu Iron and Coal Works, Bridgend, Glamorganshire.

48 Brown, J., Harbro' House, Barnsley, Yorkshire.

49 Brown, John N., 56, Union Passage, New Street, Birmingham.

50 Brown, Thos. Forster, Guildhall Chambers, Cardiff.

51 Brown, Ralph, Ryhope Colliery, Sunderland.

52 Bryden, John F., Hematite Iron Works, Whitehaven.

53 Bryham, William, Rose Bridge, &c, Collieries, Wigan, Lancashire.

54 Bryham, jun., Wm., Ince Hall, Wigan.

55 Burn, James, Rainton Colliery, Fence Houses.

56 Burrows, James, Douglas Bank, Wigan, Lancashire.

57 Buxton, William, Snibstone Collieries, near Leicester.

58 Cadwaladr, R., Broughton Colliery, Wrexham, Denbighshire.

59 Campbell, James, Staveley Works, Chesterfield.

60 Carr, Charles, Cramlington, Newcastle-upon-Tyne.

61 Carr, William Cochrane, Blaydon, Newcastle-upon-Tyne.

62 Carrington, jun., Thomas, Holywell House, Chesterfield.

63 Catron, Joseph, Wylam Colliery, Newcastle-upon-Tyne.

64 Chadborn, Beckit T., Pinxton Collieries, Alfreton, Derbyshire.

65 Childe, Rowland, Wakefield, Yorkshire.

66 Clark, William, Shotton and Haswell Collieries, Fence Houses.

67 Clark, Christopher Fisher, Garswood, Newton-le-Willows.

68 Clarke, Edmund, Colliery Guardian Office, Wigan.

69 Cochrane, W., Seghill House, Dudley, Northumberland.

70 Cochrane, C, The Ellowes, near Dudley.

71 Cochrane, B., Alden Grange, Durham.

72 Cockburn, William, Hutton Low Cross Mines, Guisbro', Yorkshire.

73 Cockburn, George, 8, Summerhill Grove, Newcastle-upon-Tyne.

74 Coke, Richard George, Tapton Grove, Chesterfield, Derbyshire.

75 Cole, W. R., Bebside Colliery, Morpeth.

76 Collis, William Blow, Amblecote, Stourbridge, Worcestershire.

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

78 Cooke, John, 4, Mulberry Street, Darlington.

79 Cookson, Norman, Newcastle-upon-Tyne.

80 Cooksey, Joseph, West Bromwich, Staffordshire.

81 Cooksey, J. H., West Bromwich, Staffordshire.

82 Cooper, Philip, Rotherham Colliery, Rotherham, Yorkshire.

83 Cooper, Thomas, Park Gate Colliery, Rotherham, Yorkshire.

84 Cope, J., Pensnett, Dudley, Worcester.

85 Cope, M.E., W. S., North Staffordshire.

86 Cossham, H., Hill House, Bristol, Somersetshire.

87 Coulson, W., Crossgate Foundry, Durham.

88 Cowen, jun., Joseph, Blaydon Burn, Newcastle-upon-Tyne.

89 Coxon, S. B., Usworth Colliery, Washington Station, Durham.

90 Coxon, Alfred, Bedlington Colliery, Morpeth.

91 Craig, W. Y., Harncastle Colliery, Stoke-upon-Trent.

92 Crawford, T., Little Town Colliery, Durham.

93 Crawhall, G. E., St. Ann's Rope Works, Newcastle-upon-Tyne.

94 Croften, J. G., Thornley Colliery Office, Ferry Hill.

95 Crone, S. C, Killingworth Colliery, Newcastle-upon-Tyne.

96 Crow, George, 2, Park Road, Newcastle-upon-Tyne.

97 Crudace, S. D., Willington, Durham.

98 Crudace, Thomas, Waratah, Australia.

99 Curry, James, Turston, Pontefract.

100 Daglish, F.G.S., J., Dene House, Seaham Harbour.

101 Dakers, jun., Thomas, Willington Colliery, Durham.

102 Dakers, W., Seaham Collieries, Sunderland.

103 Darlington, James, Springfield House, near Chorley, Lancashire.

104 Darlington, John, Moorgate Street Chambers, London, E.C.

105 Davison, A., Hastings Cottage, Seaton Delaval, Newcastle-upon-

Tyne.

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106 Davidson, James, Newbattle Colliery, Dalkeith.

107 Dawson, Thomas, Garmondsway Moor, Ferryhill.

108 Dees, J. Whitehaven, Cumberland.

109 Dennis, Henry, Brynyr Owen, Ruabon, Denbighshire.

110 Dickinson,W. R., South Derwent Colliery, Annfield Plain,Gateshead.

111 Dixon, George, Lowther Street, Whitehaven, Cumberland.

112 Dobson, S., Halswell Cottage, Cardiff, Glamorganshire.

113 Dorning, Elias, 41, John Dalton Street, Manchester.

114 Douglas, T., Peases' West Collieries, Darlington.

115 Dunn, C.E., Thomas, Windsor Bridge Iron Works, Manchester.

116 Dunne, D. G., Greenfield Colliery, Hamilton, North Britain.

117 Dyson, George, Britannia Iron Works, Fence Houses.

118 Easton, J., Nest House, Gateshead.

119 Elliot, G., Betley Hall, Crewe.

120 Elliott, W., Weardale Iron Works, Towlaw, Darlington.

121 Embleton, T. W., The Cedars, Methley, Leeds.

122 Evans, William, Ruabon Iron Works, Ruabon.

123 Feare, G., Camerton Coal Works, Bath.

124 Fenwick, Barnabas, Broomhill Colliery, Acklington.

125 Fidler, Edward, Piatt Lane Colliery, Wigan, Lancashire.

126 Firth, William, Birley Wood, Leeds.

127 Firth, S., 5, Port Street, Manchester.

128 Fletcher, C.E., Jos., 69, Lowther street, Whitehaven.

129 Fletcher, Isaac, Clifton Colliery, Workington.

130 Fletcher, Herbert, Ladyshire Colliery, Little Lever, Bolton, Lancashire.

131 Foord, J. B., General Mining Association Secretary, 52, Broad Street, London.

132 Forster, A.M., G. B., Backworth, Newcastle-upon-Tyne.

133 Forster, Thomas E., 7, Ellison Place, Newcastle-upon-Tyne.

134 Fothergill, Joseph, Cowpen and North Seaton Office, Quayside, Newcastle-upon-Tyne.

135 Fowler, Geo., Donisthorpe, Ashby-de-la-Zouch, Leicestershire.

136 Frazer, Benjamin, 28, Broad Chare, Newcastle-upon-Tyne.

137 Frazer, William, Rewcastle Chare, Newcastle-upon-Tyne.

138 Francis, W., Cliff Terrace, Marske, near Redcar.

139 Fryer, Mark, Team Colliery, Gateshead.

140 Gainsford, William Dunn, Darnall Hall, Sheffield.

141 Gainsford, Thos. R., Stafford Club, Burlington Gardens, London, W.

142 Gardner, M. B., Tondu Iron and Coal Works, Bridgend, Glamorganshire.

143 Garforth, W. G., Lord's Field Colliery, Ashton-under-Lyne.

144 Gillett, F. C, 5, Wardwick, Derby.

145 Gilroy, G., Ince Hall Colliery, Wigan, Lancashire.

146 Glover, B. B., Mining Engineer, Newton-le-Willows, Lancashire.

147 Goddard, C.E., William, Golden Hill Colliery, Longton, North Staffordshire.

148 Gooch, G. H. Lintz Colliery, Gateshead.

149 Gott, Wm. L., Shincliffe Collieries, Durham.

150 Greeves, J. 0., Roundwood Colliery, Horbury, Wakefield, Yorkshire.

151 Green, jun., Wm, 6, St. Mary's Terrace, Newcastle-upon-Tyne.

152 Greener, Thos., Etherley Colliery, Darlington.

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

154 Greenway, Edward, Brierly Hill, Dudley, Worcestershire.

155 Greig, D., Leeds.

156 Haggie, P., Gateshead.

157 Hales, Onas, Oakpits Colliery, Mold, Flintshire.

158 Hall, T. Y., 11, Eldon square, Newcastle-upon-Tyne.

159 Hall, William F., Shotton Colliery, Castle Eden, Ferryhill.

160 Hall, Henry, Haswell Colliery, Fence Houses.

161 Hanon, Jules, 91, Rue Herenthal, Antwerp.

162 Harden, J. W., Folshill Colliery, Coventry, Warwickshire.

163 Harper, Matthew, Whitehaven, Cumberland.

164 Harrison, C.E., T.E., Central Station, Newcastle-upon-Tyne.

165 Harrison, Robert, Eastwood Collieries, Nottingham.

166 Harrison, W. B., Norton Hall, Cannock, Staffordshire.

167 Harper, J. P., Regent Terrace, London Road, Derby.

168 Hawthorn, C.E., W., Engineer, Newcastle-upon-Tyne.

169 Hawthorn, Thomas, Engineer, 12, Elswick Villas, Newcastle-upon-Tyne.

170 Herdman, John, Park Crescent, Bridgend, Glamorganshire.

171 Heckels, R., Wearmouth Colliery, Sunderland.

172 Hedley, Edward, Osmaston Street, Derby.

173 Hedley, W. H., Consett Collieries, Medomsley, by Gateshead.

174 Heppell, Thomas, Pelaw Main Colliery, Birtley, Fence Houses.

175 Heslop, James, Peases' West Collieries, Darlington.

176 Hetherington, David, Netherton, Morpeth.

177 Hewlett, Alfred, Haigh Colliery, Wigan, Lancashire.

178 Hindhaugh, Thos. S., Moreton Hall Colliery, near Chirk, Denbighshire.

179 Higson, Jacob, 94, Cross Street, Manchester.

180 Higson, P., jun., Brookland, Swinton, Manchester.

181 Hill, Arthur.

182 Hilton, T. W., Haigh, Wigan.

183 Hodgson, R., Engineer, Whitburn, Sunderland.

184 Homer, Charles S., Chatterley Hall, Tunstall.

185 Hood, Archibald, Whitehill Colliery, Lasswade, Edinburgh.

186 Hopper, John, Britannia Iron Works, Houghton-le-Spring.

187 Horsley, W., Whitehill Point, Percy Main.

188 Horsfall, J. J., Fanbottom Colliery, Ashton-under-Lyne.

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

190 Howard, Wm Frederick, Rosemount, Taunton, Somersetshire.

191 Hudson, James, Albion Mines, Pictou, Nova Scotia.

192 Humble, jun., Joseph, Garesfield, Blaydon-on-Tyne.

193 Humble, W. J., Forth Banks West Factory, Newcastle-upon-Tyne.

194 Hunt, J. P., Corngreaves, Birmingham.

195 Hunt, A, H., Pelaw Main Office, Quayside, Newcastle-upon-Tyne.

196 Hunter, Wm., Moor Lodge, Newcastle-upon-Tyne.

197 Hunter, William, Morriston, Swansea, Glamorganshire.

198 Hunting, Charles, Fence Houses.

199 Huntsman, Benjamin, West Retford Hall, Retford.

200 Hurst, T. G., Backworth Colliery, Newcastle-upon-Tyne.

201 Jackson, Henry, Astley and Tyldesley Collieries, Tyldesley, Manchester.

202 Jackson, John, Clay Cross, Chesterfield.

203 Jenkins, M.E., William, 3, Brighton Terrace, Roath, Cardiff.

204 Jobling, T. W., Point Pleasant, Wallsend, Newcastle-upon-Tyne.

205 Johnson, John, Chilton Hall, Ferry Hill.

206 Johnson, R. S , Haswell, Fence Houses.

207 Joicey, John, Urpeth Hall, Fence Houses.

208 Jones, E., Granville Lodge, Wellington, Salop.

209 Kenrick, Wm. Wynn, Wynn Hall, near Ruabon, Denbighshire.

210 Kendall, W., Blyth and Tyne Railway, Percy Main.

211 Kimpster, W., Quay, Newcastle-upon-Tyne.

212 Knowles, A., High Bank, Pendlebury, Manchester.

213 Knowles, John, Pendlebury Colliery, Manchester.

214 Knowles, Thomas, Ince Hall, Wigan.

215 Knowles, jun., Andrew, Eagley Bank Colliery, Bolton, Lancashire.

216 Knowles, Kaye, Little Lever Colliery, near Bolton.

217 Knowles, R. M., Eagley Bank, Bolton.

218 Lamb, Robert, Cleator Moor Colliery, near Whitehaven.

219 Lamb, R. 0., Axwell Park, Gateshead.

220 Lancaster, John, Ashfield, Wigan.

221 Lancaster, jun., John, Hunwick and Newfield Collieries, Ferry Hill.

222 Lancaster, Joshua, Kirkless, near Wigan.

223 Lancaster, Samuel, Kirkless Hall Colliery, Wigan.

224 Landale, Andrew, Lochgelly Iron Works, Fifeshire, North Britain.

225 Laverick, George Wm., Zion House, Chesterton, near Newcastle-under-Lyne.

226 Laws, J., Blyth, Northumberland.

227 Lees, Samuel, Barrowshaw Colliery, Greenacres Moor, near Oldham.

228 Lever, Ellis, West Gorton Works, Manchester.

229 Levick, jun., F., Cwm Celyn and Blaina Iron Works, Newport, Monmouthshire.

230 Lewis, Henry, Swannington Colliery, near Ashby-de-la-Zouch, Leicestershire.

231 Lewis, T. Wm., Mardy, Aberdare, Glamorganshire.

232 Lewis, G. Coleorton Colliery, Ashby-de-la-Zouch.

233 Lewis, Wm. Thos., Mardy, Aberdare, Wales.

234 Liddell, J. R., Nedderton, Northumberland.

235 Liddell, M., Tynemouth.

236 Lindop, James, Bloxwich, Walsall, Staffordshire.

237 Lishman, Wm., Etherley Colliery, Darlington.

238 Lishman, Wm., Bunker Hill, Fence Houses.

239 Lishman, John, Ridsdale Iron Works, Bellingham.

240 Livesey, Thomas, Chamber Hall, Hollinwood, Manchester.

241 Livesey, Clegg, Bradford Colliery, Manchester.

242 Llewellin, David, Glanwern Offices, Pontypool, Monmouthshire.

243 Longridge, J., 3, Poet's Corner, Westminster, London, S.W.

244 Love, Joseph, Brancepeth Colliery, Durham.

245 Low, Wm , Vron Colliery, Wrexham, Denbighshire.

246 Low, jun., Wm., Wrexham, Denbighshire.

247 Lloyd, Thomas, Brierly Hill, Worcestershire.

248 Maddison, W. P., Thornhill Colliery, Dewsbury, Wakefield.

249 Maddison, J., Alexander Street, Newcastle-upon-Tyne.

250 Maddison, W., Coxlodge Colliery, Newcastle-upon-Tyne.

251 Mallett, C.E., F.R.S., Robert, 7,Westminster Chambers,Westminster, London, S.W.

252 Mammatt, C.E., John E., Barnsley, Yorkshire.

253 Manners, G. T., Birtley Iron Works, Gateshead.

254 Marley, John, Mining Offices, Darlington.

255 Marshall, Robert, 10, Three Indian Kings Court, Quayside, Newcastle-upon-Tyne.

256 Marshall, John, Smithfold Colliery, Little Halton, near Bolton.

257 Marshall, F. C, Jarrow, South Shields.

258 Matthews, Richd. P., South Hetton Colliery, Fence Houses.

259 Maurice, Arthur H., Vron Colliery, Wrexham, Denbighshire.

260 Maurice, Mortimer B., Haswell Colliery, Fence Houses.

261 May, George, North Hetton Colliery, Fence Houses.

262 Maynard, Charles, America.

263 McCulloch, H. J., East Mount, York.

264 McDonald, Hugh, Kirkless Hall Coal and Iron Works, Wigan.

265 McGhie, Thos., Cannock Chase Colliery, Walsall, Staffordshire.

266 McGill, Robert, St. Helen's Colliery, St. Helen's, Lancashire.

267 McMurtrie, J., Radstock Colliery, Bath.

268 Middleton, J., Davison's Hartley Office, Quay, Newcastle-on-Tyne.

269 Miller, Robt., Strafford Collieries, near Barnsley.

270 Mitchinson, jun., Robt., Kibblesworth Colliery, Gateshead.

271 Monkhouse, Joseph, Gilcrux Colliery, Cockermouth.

272 Moore, J. H., Smeaton Park, Musselburgh, Edinburgh.

273 Morison, David P., Pelton Colliery, Chester-le-Street.

274 Morris, William, Waldridge Colliery, Chester-le-Street.

275 Morrison, James, 34, Grey Street, Newcastle-on-Tyne.

276 Morrison, H. M., Rainton Colliery, Durham.

277 Morton, H., Lambton, Fence Houses.

278 Morton, H. T., Lambton, Fence Houses.

279 Muckle, John, Monk Bretton, Barnsley.

280 Mulcaster, H., Colliery Office, Whitehaven.

281 Mulcaster, Joshua, Crosby Colliery, Maryport.

282 Mulvany, Wm, Thos., 1335, Carls Thor, Dusseldorf on the Rhine,
Prussia.

283 Murray, B.

284 Murray, T. H., Chester-le-Street, Fence Houses.

285 Napier, Colin, Westminister Colliery, Wrexham, Denbighshire.

286 Naylor, Joshua T., 10, West Clayton Street, Newcastle-upon-Tyne.

287 Nelson, C.E., James, Bonner's Field, Sunderland.

288 Newall, Robert Stirling, Fern Dene, Gateshead.

289 Nicholson, William, Seghill Colliery, Newcastle-upon-Tyne.

290 Nicholson, Marshall, Middleton Hall, Leeds.

291 Noble, Captain, Jesmond, Newcastle-on-Tyne.

292 North, Frederick, Arleston House, Smithwick, Birmingham.

293 Ogden, John M., Solicitor, Sunderland.

294 Oliver, Wm., Stanhope Burn Offices, Stanhope, Darling-ton.

295 Oliver, John, Victoria Colliery, Coventry.

296 Oliver, Geo., Peases' West Collieries, Darlington.

297 Palmer, C. M., Quay, Newcastle-upon-Tyne.

298 Pearce, F. H., Bowling Iron Works, Bradford, Yorkshire.

299 Pease, J. W., Woodlands, Darlington.

300 Peel, John, Springwell Colliery, Gateshead.

301 Perrot, Sam. W., Hibernia and Shamrock Collieries, Gelsenkirchen,
Dusseldorf.

302 Piggford, Jonathan, Haswell Colliery, Fence Houses.

303 Pilkington, jun., Wm., St. Helen's Lancashire.

304 Potter, E., Cramlington, Newcastle-upon-Tyne.

305 Potter, W. A., Monk Bretton, Barnsley, Yorkshire.

306 Powell, T., Coldea, Newport, Monmouthshire.

307 Ramsay, J. T., Walbottle Colliery, Newcastle-upon-Tyne.

308 Reed, Robert, Felling Colliery, Gateshead.

309 Rees, Daniel, Lletty Shenkin Colliery, Aberdare, Glamorganshire.

310 Reskerne, J.

311 Richardson, Henry, Backworth Colliery, Newcastle.

312 Robson, J. S., Butterknowle Colliery, Staindrop, Darling-ton.

313 Robson, Neil, 127, St. Vincent Street, Glasgow.

314 Robson, Thomas, Lumley Colliery, Fence Houses.

315 Rockwell, Alfd. P., M.A., Norwich, Connecticut, United States, America.

316 Ronaldson, James, Clough Hall Coal and Iron Works, Stoke-upon-Trent.

317 Rosecamp, J., Acomb Colliery, Hexham.

318 Rose, Thomas, Millfield Iron Works, Bilston, Wolverhampton, Staffordshire.

319 Ross, A., Shipcote Colliery, Gateshead.

320 Rosser, Wm., Mineral Surveyor, Llanelly, Carmarthenshire.

321 Routledge, William (J.B.Foord), 52, Old Broad Street, London, E.C.

322 Russell, Robert, Gosforth Colliery, Newcastle-upon-Tyne.

323 Sanderson, R. B., West Jesmond, Newcastle-upon-Tyne.

324 Sanderson, Thomas, Seaton Delaval, Newcastle-upon-Tyne.

325 Seddon, Wm., Lower Moor Collieries, Oldham, Lancashire.

326 Shield, Hugh, Woodifield and Whitelee Collieries, Crook, Darlington.

327 Shortreed, Thos., Park House, Winstanley, Wigan.

328 Simpson, L., South America, per E. Simpson, Dipton, Gateshead.

329 Simpson, R., Ryton Moor House, Blaydon, Newcastle-on-Tyne.

330 Simpson, John Bell, Hedgefield House, Blaydon.

331 Smith, F., Bridgewater Offices, Manchester.

332 Smith, jun., J., Mining Engineer, Thornley Colliery, Sunderland.

333 Smith, Edmund J., 14, Whitehall Place, Westminster, London, S.W.

334 Smith, Thomas Taylor, Oxhill, Chester-le-Street.

335 Smith, H. Nelson, Albert Chambers, Corporation Street, Manchester.

336 Snowball, James, Stourbridge Fire Clay Works, Gateshead.

337 Sopwith, F.G.S.,etc., T., 103, Victoria Street, Westminster, London, S.W.

338 Southern, Robert, Cassop Colliery, Ferryhill.

339 Spark, H. K., Darlington, County of Durham.

340 Spencer, T., Ryton, Newcastle-upon-Tyne.

341 Spencer, J. F., North-Eastern Engine Works, Sunderland.

342 Spencer, W., West Staveley Colliery, Chesterfield.

343 Steavenson, A. L,, Crossgate, Durham.

344 Stephenson, W. H., Summerhill Grove, Newcastle-upon-Tyne.

345 Stephenson, George R, 24, Great George Street, Westminster, London, S.W.

346 Steel, Charles R., Ellenborough Colliery, Maryport, Cumberland.

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347 Stenson, W. T., Whitwick Colliery, Coalville, near Leicester.

348 Stobart, H. S., Witton-le-W ear, Darling-ton.

349 Stott, James, Basford Hall, Stoke-on-Trent.

350 Straker, John, West House, Tynemouth.

351 Sutcliffe, John C, North Gawber Colliery, Barnsley.

352 Swallow, R. T., Pontop Colliery, Gateshead.

353 Swallow, John, Harton Colliery, South Shields.

354 Taylor, H., Earsdon, Newcastle-upon-Tyne.

355 Taylor, H., Tynemouth.

356 Taylor, J., Earsdon, Newcastle-upon-Tyne.

357 Telford, W., Cramlington, Newcastle-upon-Tyne.

358 Thomas, William, Towlaw Iron Works, Darlington.

359 Thompson, John, Norley Colliery, Wigan, Lancashire.

360 Thompson, Joseph, Seaham Colliery, Sunderland.

361 Thompson, John, Marley Hill Colliery, Gateshead.

362 Thompson, John, Field House, Hoole, Chester.

363 Thompson, T. C, Milton Hall, Carlisle, Cumberland.

364 Thompson, Astley, Kedwelly, Carmarthenshire.

365 Thompson, James, Bishop Auckland.

366 Thorman, John, Ripley, Derbyshire.

367 Tone, C.E., John F., Westgate Street, Newcastle-upon-Tyne.

368 Trotter, J., Newnham, Gloucestershire.

369 Truran, Matthew, Dowlais Iron Works, Merthyr Tydvil, Glamorganshire.

370 Vaughan, John, Middlesbro'-on-Tees.

371 Vaughan, Thomas, Middlesbro'-on-Tees.

372 Varley, James, Waterloo Foundry, St. Helen's, Lancashire.

373 Waddington, C. L. Burnley, Lancashire.

374 Waller, William, 82, Northgate, Darlington.

375 Ward, Henry, Priestfield Iron Works, Oaklands, Wolverhampton.

376 Wardell, Frank N., Plashetts Colliery, Falstone, Hexham.

377 Warrington, John, Kippax, near Leeds.

378 Watkin, Wm. J. L., Pemberton Colliery, Wigan.

379 Watson, W., High Bridge, Newcastle-upon-Tyne.

380 Webster, R. C, Ruabon Collieries, Ruabon, Denbighshire.

381 Weeks, John G., Ryton, near Blaydon-on-Tyne.

382 Westmacott, Percy G. B., Elswick Iron Works, Newcastle.

383 Whalley, Thomas, Orrell Mount, Wigan.

384 White, Jos., T. 68, Westgate, Wakefield.

385 Williams, E. (Bolckow, Vaughan, and Co., Middlesbro'.)

386 Willis, James, Washington Colliery, Washington Station, County of Durham.

387 Wilmer, F. B., Duffryn Collieries, Aberdare, Wales.

388 Wilson, J. B., Haydock, near St. Helen's, Lancashire.

389 Wilson, R., Flimby Colliery, Maryport, Cumberland.

390 Wilson, J. Straker, Tynemouth.

891 Wood, C. L., Black Boy Colliery, Bishop Auckland.

392 Wood, Lindsay, Hetton Colliery, Fence Houses.

393 Wood, W. H., West Hetton, Ferry Hill.

394 Wood, John, Flockton Collieries, Wakefield, Yorkshire.

395 Wood, William O., Brancepeth Colliery, Durham.

396 Woodhouse, J. T., Midland Road, Derby.

397 Wright, C, Tylden, Shireoak Colliery, Worksop, Nottinghamshire.

398 Yardley, John, Burnttree, Tipton.

Graduates

1 Armstrong, L., Cowpen Colliery, Blyth, Northumberland.

2 Armstrong, jun., William, Seaham Colliery, Sunderland.

3 Auberey, jun., William.

4 Bainbridge, Emerson, Londonderry Collieries, Durham.

5 Booth, R. L., Medomsley, by Gateshead.

6 Coates, C. N., Skelton Mines, Guisbro'.

7 Cowlishaw, John, 74, Osmaston Street, Derby.

8 Crawford, Thos., Howlish Offices, Bishop Auckland.

9 Dodd, Benj., Seaton Delaval Colliery, Newcastle.

10 Embleton, jun., T. W., The Cedars, Methley, Leeds.

11 Gilchrist, Thos., Newbottle Colliery, Fence Houses.

12 Griffith, N. G., Cowpen Collieries, Blyth.

13 Harrison, John G.

14 Maughan, James A., Benwell Colliery, Newcastle.

15 Parrington, Matthew, Normanby Mines, Middlesbro'-on-Tees.

16 Peile, William, Corkickle Forge, Whitehaven, Cumberland.

17 Ramsay, Thomas Dunlop, Trimdon Colliery, Ferry Hill.

18 Ridley, George, Cowpen Colliery, Blyth, Northumberland.

19 Simpson, J., Towneley Colliery, Blaydon-on-Tyne.

20 Siddon, Frederick, Wigan, Lancashire.

21 Sopwith, Arthur, 103, Victoria Street, Westminster, London, S.W.

22 Taylor, W. N., Ryhope Colliery, Sunderland.

23 Wardell, Stuart C, Towneley Colliery, Blaydon, Newcastle.

24 White, H., Moorhouse, Durham.

25 Wright, George H., Rainton Colliery, Fence Houses.

26 Verner, Frederick, Cowpen Colliery, Blyth.

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.

,, Earl Durham, Lambton Collieries, Fence Houses.

„ Hetton Collieries, Fence Houses.

„ Whitworth Colliery, Ferry Hill.

„ Ryhope Colliery.

„ Rainton Collieries. (Earl Vane.)

ERRATA.

Page 24, 14th line from bottom. For March 10th, 1866, read March 10th, 1862.

Page 24, 10th line from bottom. For my safety-cages, read many safety-cages.

Page 26, 7th line from bottom. For over the pulleys, read up to the pulleys.

NORTH OF ENGLAND INSTITUTE

OF

MINING ENGINEERS.

GENERAL MEETING, SATURDAY, SEPTEMBER 1, 1866, IN THE ROOMS OF THE INSTITUTE, NEVILLE HALL, WESTGATE STREET, NEWCASTLE-UPON-TYNE.

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

The following gentlemen were elected members of the Institute:—

Edward Fidler, Piatt Lane Colliery, Wigan; Arthur Hill Maurice, Vron Collieries, Wrexham, Denbighshire; Mortimer B. Maurice, Haswell Colliery Office, Fence Houses; W. Kendall, Blyth and Tyne

Railway, Percy Main ; J. Humble, Forth Banks West Factory, Newcastle-upon-Tyne.

The Secretary read the minutes of the council meetings ; after which it was agreed that the sum of £50 each, as recommended by the Council, should be granted to the Tail-rope and Endless-chain Committee, and also to the committee appointed to investigate the subject of Coal-cutting Machines, in order to defray any necessary expense those committees might incur.

Mr. J. J. Atkinson requested permission for the papers that had been read by him on the Ventilation of Mines to be translated into French. After some conversation on the subject, the motion that this request be granted was acceded to.

Mr. A. L. Steavenson said, that Mr. Atkinson's request induced him to ask whether, in case a member of the Institute met with information or a paper in another language which seemed likely to be useful to the

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members of tins Institute lie would be allowed to give a translation or abstract of such paper ?

The meeting having decided that this might be done, Mr. Steaven-son promised a translation of a paper on Guibal's Ventilating Fan.

DISCUSSION OF MR. G. F. ANSELL'S * PAPER " ON THE NEW METHOD OF INDICATING THE PRESENCE OF FIRE-AND CHOKE-DAMP IN COAL-MINES.

The President inquired if Mr. Ansell had any matter he wished to add to his former paper ?

Mr. Ansell said, that since reading the paper, he had modified his proposition by using white Sicilian marble for the purpose of making known the presence of fire-damp. He reminded the President of Mr. L. Wood's proposition, that if a man left his working place during the dinner hour, how would he tell if gas accumulated while he was absent, say by the removal of a brattice or a fault in the ventilation ? To meet this case he had originally proposed to use a diaphragm of cast-iron, but he had found this too slow in its operation, and had determined to use white Sicilian marble, which answers the purpose exactly. He now exhibited two instruments constructed with marble, and intended to displace the original India-rubber balloon apparatus. These instruments were of simple construction. An iron funnel was fitted with a U-shaped tube of iron, upon one end of which was fixed a small glass globe, into which was passed a platinum-pointed copper wire, capable of being adjusted at will. The other end of the U-shaped tube passed into the thin end of the iron funnel, while the broad open end of the funnel was closed by means of a piece of white marble. When gas impinged on the marble, it passed hj diffusion rapidly through it, and caused the mercury to rise into the glass globe, and so to complete a battery circuit, by which a telegraph needle received motion and a bell was set ringing. The two instruments exhibited were similar, but he said he had provided one with marble one-quarter inch thick, and the other with marble one-half inch thick, and that he preferred the one-half inch thickness, because it admitted of very little effusion; indeed, if gas required two hours to accumulate from zero (pure atmosphere) to the explosive point, this thicker marble would suit best, but if it took half an hour, then the thinner marble was preferable. He again referred to the fragile nature of the India-rubber balloon, and

* The words " Chemist to the Royal Mint," reported in Vol. XV., p. 163, should be cancelled, as there is no such office.

said that the marble would now replace it for indicating fire-damp. Indeed, for carbonic-acid the marble might be used, only that the telegraphic communication would require to be made from the other end of the U-shaped tube.

After the reading of Mr. AnselPs additional remarks, a long and interesting conversation ensued, in which Mr. J. J. Atkinson, Mr. Booth, the President, and other gentlemen took part.

Mr. Steavenson, having- asked whether it was the intention of the Institute to express an opinion unitedly on the merits of Mr. AnselPs invention, proceeded to say that, as an individual member, he was very sanguine of its ultimate success. All present knew that what had proved to be most valuable inventions, in their first introduction were very different from what time and practice ultimately produced, such, for instance, as photography and telegraphy, which were at first in what might be called the crude state. He thought they were all deeply indebted to Mr. Ansell for having brought under their notice his propositions with regard to certain natural laws, which members of the Institute could apply in practice, and, no doubt, in so doing, would be able to see where improvements might be made. He was quite sure that in this invention they had met with a new and valuable aid to coalmining, and, as in the case of Sir Humphrey Davy, so also Mr. Ansell would become valued as a great benefactor to the whole mining community.

The President communicated to Mr. Ansell the thanks of the meeting for his excellent paper, and the interesting experiments he had exhibited to them.

Mr. W. Green exhibited some specimens of coal and bituminous shale from the Pictou Coal-field, Nova Scotia, which he desired to present to the Institute.

The President, in thanking Mr. Green, proposed that a vote of thanks should be presented to him for the specimens, after which the meeting separated.

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NORTH OF ENGLAND INSTITUTE

OF

MINING ENGINEERS.

GENERAL MEETING, THURSDAY, OCTOBER 4, 1866, IN THE ROOMS

OF THE INSTITUTE, NEVILLE HALL, WESTGATE STREET,

NEWCASTLE-UPON-TYNE.

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

The following new Members were elected, viz. : Mr. James Nelson, Bonner's Field, Sunderland; Mr. Benjamin Frazer, 28, Broad Chare; and Mr. William Frazer, Rewcastle Chare, Newcastle.

A letter was read from Mr. Daglish, calling attention to a new form of safety-lamp, a specimen of which was shown, the object of which was the extinction of the light either by a fall or any attempt at opening it.

A recommendation by the Council, that a Steam-indicator and Dynamometer should be purchased for the use of the Institute, both instruments being required immediately to carry out some experiments, was put to the meeting and carried unanimously.

CHRONICLES OF THE COAL-TRADE.

Mr. Green's paper on this subject came on for discussion.

Mr. Boyd enquired if Mr. Green had entered on the subject of the registration of colliery plans as well as of colliery documents?

Mr. Green said, he had nothing' to mention further than what was contained in Mr. Thomas' pamphlet.

Mr. Boyd said, the object of having a registration of colliery plans was to prevent accidents through entering seams which had been drowned out. The difficulty was, that proprietors of mines might possibly object to their private plans being published. It would very much enlarge the scope of Mr. Green's paper if plans as well as memoranda were registered. It seemed to him that the Institute was the very place where such a record should be kept.

Mr. Green said, that members might be solicited to give papers, books, or plans for that purpose.

Mr. Boyd said, the Council should propose a measure, if agreed to by all parties, by which application should be made to proprietors of collieries for any plans they might be willing to contribute.

Mr. Green said, that some time ago it was proposed that there should be a record of borings.

Mr. G. B. Forster— Alluvial borings.

The President said, Mr. Thomas was very strongly in favour of it, and Mr. Buddle also; but there was a jealousy on the part of the coalowners. He did not think, however, that in these enlightened times coalowners could feel so much objection as they did at that time.

A Member remarked that there would be a difficulty in keeping the plans up.

The President did not think there would be any difficulty. They might send their graduates to copy the plans recorded.

Mr. Green said, he thought Mr. Buddle's idea was to have the plans of exhausted seams, not working plans, recorded.

Mr. A. L. Steavenson said, if it was only the plans of seams worked out there would be no objection, and those were the most important.

M. GUIBAL'S VENTILATOR.

Mr. A. L. Steavenson read a paper " On some Experiments with the Covered Ventilator of M. Guibal, at the Colliery of Crachet and Picquery, at Frameries." The paper was illustrated with a diagram and plans.

Mr. Tone said, there was a remarkable circumstance connected with the diagram which he had noticed along with Mr. Wood and Mr. Simpson. Immediately on the admission of steam there was an immense increase of pressure in the cylinder, followed immediately by great exhaustion. There was first an increase, and then a decrease. Mr. Wood and Mr. Simpson suggested that this might be due to some dynamical question. As far as his experience went, that opinion seemed correct. He had found the same thing in the construction of hydraulic rams. It will be found in accordance with what is expected. You let in the first opening a large quantity of steam. This passes through a long channel with the ordinary pressure on the innermost circle. There is great speed, and the pressure is not statical, but dynamical. There is an impact on the cylinder which drives it suddenly, and it goes faster than the steam would drive it statically; but there is not sufficient to follow it up. This agreed with what his experience had shown him in the action of water. Other gentlemen would give him their experience with regard to other fluids.

Mr. Easton said, the lead of the slide would have something to do with it.

Mr. Tone — Still the dynamical question remains.

Mr. Easton — The lead of the slide would have a great deal to do with the form of the diagram.

Mr. J. B. Simpson said, he had noticed the same curious diagram in a fan-engine; but, in his case, the slow velocities gave a better diagram than quick ones. When the revolutions were great, the steam being admitted at a great pressure, gave the piston such a velocity that the steam could not follow it fast enough, and hence the irregularity of the diagram; in other words, the steam was wire-drawn.

Mr. A. L. Steavenson said, he should attribute it to the steam being applied too quick before it got over the centre.

Mr. Daglish said, that might be so in the first rise. After that it was due to the spring of the indicator.

Mr. Tone said, the faster the steam was passing along the cylinder there was less pressure. He had had some experience of water pipes, and had known them burst by the opening or shutting of a valve. For a length of four or five miles it would burst the pipe in several places.

Mr. Easton said, the same effect was produced in shutting off the steam in engines, and especially in one attached to these ventilating machines.

Mr. Wm. Wood remarked that, in all the experiments he had heard of in England made with Guibal's ventilator, the effect of the shutter had not been carried out the same as in Belgium.

Mr. Cochrane said, if the shutter is badly regulated, and at the top of the chimney, where the air is discharged from the mine, there is let fall eider-down or small bits of paper, you can observe currents going down the chimney though 100,000 cubic feet of air per minute is being discharged from it; but if the shutter is properly regulated no such thing occurs. The currents are steady up the whole area. This shows that there is some effect in the shutter. M. Guibal urges that this is a detail which cannot, except by experiment, be regulated. There is no mathematical formula which will fix the proper area of the discharge. It requires experiment. The shutter affords you the means of regulation, and, once regulated, you never vary the shutter unless you vary the conditions.

Mr. Boyd inquired if there was sufficient weight laid on the question of exhaustion ? If these large segments were to be filled with air from the mine, there should be some means of making a vacuum previously. They must fill with external air in the first instance, unless they are made air-tight.

Mr. Cochrane said, that the casing was perfectly air-tight, except from the outlet.

Mr. Daglish said, the fan was not air-tight to the cover.

Mr. Cochrane said, no ; there is a clearance of about one inch between the circumference of the fan and the inside of the casing; and this clearance is increased towards the chimney.

Mr. Tone said, as soon as you set the fan in motion it clears itself. There is a centrifugal motion established.

Mr. Cochrane said, the fan was filled from the centre. As fast as the discharged air was removed fresh air rushed in from the centre to supply its place.

Mr. Morison said, he would give the meeting one or two experiments which he had made the day before at Pelton Colliery. The first experiment was made with the shutter fully open, the water-gauge being 1.85, and the discharge of air from the mine 59,911 cubic feet per minute. At three-quarters open the discharge was 61,064 cubic feet per minute. At half-open both water-gauge and air decreased sensibly. When the shutter was put down as close as the chimney would allow, the water-gauge, instead of being 1•85, was only 1•43, and the discharged air was only 54,074 cubic feet. It was suggested to him that there was not so good an effect obtained as M. Guibal expected, the shutter not coming down to the full extent. A board was then inserted at the bottom of the shutter, and the shutter placed in each of its positions; but, instead of a better result, a much worse result was obtained. In the first experiment, with the shutter open, they got 51,463 cubic feet instead of 59,911; at three-quarters they got only

50,311; at half open, 49,542; and at a quarter open only 36,809. The following is a tabular view of the experiments :—

[table: Experiments on Sliding Shutter (Vanne Regulatrice of Guibal's Ventilator.—Pelton Colliery, 3rd Oct., I860.]

Mr. Cochrane said, these experiments were conclusive as to the proper adjustment of the shutter. A point between three-quarters and full open gave the best results. They were also conclusive on the shape of the chimney. A mere ten-inch board placed in the chimney as described interfered with the ventilation to the extent of 10,000 feet per minute. At Elswick he found the most effective opening was three-quarters, above and below that there was less volume and less water gauge.

Mr. Morison said, it might be interesting to hear one or two figures as to the comparative power of the furnace and fan at Pelton Colliery. With the furnace — the average temperature of the upcast being 235 degrees — the utmost quantity of air obtained was 48,860 cubic feet per minute. On October 18th, 1865, they set the furnace to work for both seams, and the result was 31,800 cubic feet in the upper seam, and 17,000 in the lower seam, giving a total of 48,800 cubic feet. On

* In experiments Nos. 6 to 9 the ten inches of aperture with the shutter at 0 were boarded up. The board, however, being a direct impediment to the exhaust of the air, the useful effect greatly decreased; and at experiment No. 9, where the shutter was lowered to quarter open, or within twelve inches of the board, the water-gauge fell immediately, and the speed of the fan increased to such an extent that nearly one-half of the steam had to be shut off to keep the revolutions down to about 55. [note: this is a footnote to table above]

October 23rd, they set the fan to work in both seams. The water-gauge, which, by the furnace alone was 0•9, rose to 2•15, and the quantity of air was 82,377 cubic feet. This, he believed, was with one -quarter or one-third the coal consumed in the furnace. They got the water-gauge to 3•35 inches, and the total quantity of air was 142,362 cubic feet. This was at the greatest speed they had tried so far, seventy strokes per minute.

The President—What was the depth?

Mr. Morison—320 and 540 feet in depth.

Mr. J. B. Simpson said, he could speak of the efficiency of Guibal's ventilator for shallow depths. He had recently put up one, the engine cylinder of which was eight inches diameter. The fan was sixteen feet diameter, and, with the water-gauge at •6, with fifty revolutions per minute, they got 30,000 cubic feet of air per minute. At seventy-four strokes they got 45,000 feet with the water-gauge 1•0. He could also speak of the great economy of the ventilator. They required, in this case, no extra labour, and no more coals. The waste steam of the boilers drives the fan. The pit was only forty-four fathoms in depth, with two seams working each 600 yards from the shaft, and the workings extending on each side.

Mr. A. L. Steavenson said, that as some gentlemen had referred to other fans, he hoped they would bring the quantity of coals used in comparison with the coals used in the furnace.

Mr. J. Daglish said, they could not work the fan where they had underground boilers. These would destroy the fan.

Mr. A. L. Steavenson thought they might protect the fan by putting it in galvanised iron.

Mr. J. Daglish thought this would be only a temporary protection.

The President said, hitherto they had heard only one side. At shallow depths it did well; but when they came to 250 or 260 fathoms, the question was, whether the furnace or the ventilator would be best ?

Mr. Easton said, he thought the furnace at great depths was decidedly more economical.

Mr. A. L. Steavenson said, he had given, from Mr. Atkinson's paper, the depths at which the furnace was equal to the ventilating machine.

The President said, they were very much indebted to Mr. Steavenson for his paper, and he would propose that they give him a vote of thanks, and that the paper be printed. It would be further discussed at the next monthly meeting.

The motion was carried unanimously.

ON SOME EXPERIMENTS
WITH THE
COVERED VENTILATOR OF M. GUIBAL,
AT THE
C0LLIERY OF CRACHET & PICQUERY, AT FRAMERIES.

Br MM. GILLE et FRANEAU, Mining Engineers.

TRANSLATED, AND READ OCTOBER 4th, 1866,

By A.L. STEAVENSON.

INTRODUCTION.

So long as I bring under your notice any new facts connected with a subject of such great importance as that of ventilation, I offer no apology for their not having been obtained by my own experiments.

The entire theory of ventilation has been supplied to us by Mr. Atkinson, in his paper contained in the third volume of our "Transactions;" and he has further elucidated the subject which we have especially before us to-day, in the paper contained in the sixth volume, "On the Comparative Consumption of Fuel by Furnaces and Machines," so that it only remains for us to examine any new system, and to make its merits thoroughly apparent, and, with this view, I have the pleasure of calling your attention to a large number of experiments made with a ventilating machine, which has already been described by Mr. W.

Cochrane, in the fourteenth volume of " Transactions of the Mining Institute." I have been promised that, in the discussion of this paper, further facts will be brought forward, and, I believe, they will all tend to lead to the entire discontinuance of the furnace as a ventilating agent. There are, of course, extreme depths at which a furnace can do effective work, but the objections peculiar to itself will serve to turn the scale against it under all circumstances. I will briefly call your attention to

a table, given at page 142, Vol. VI., by Mr. Atkinson, showing the depths at which furnaces become equal to ventilating machines under an average state of circumstances, viz.:—

[table]

And if there is taken an average loss of heat from furnaces before reaching the average prevailing temperature of the upcast of forty per cent., and which is shown to be a fair allowance, then the above depths will answer to the conditions afforded by a ventilating machine, utilising sixty per cent. of the engine-power and to those of the machine at present before us.

I originally prepared this translation for my own use, but finding the subject so thoroughly treated, it appeared to be very desirable that the information contained in it should be made readily and generally available, at a time like the present when mechanical ventilation is becoming commonly applied. I have endeavoured, as far as possible, to give the literal meaning of the text, and with little if any curtailment.

TRANSLATION.

Several members of this Association have requested, at different times, that I should make known the results of the experiments which have been made, recently, with my ventilator (Plate I.), at the Colliery of Crachet and Picquery, at Frameries (Belgium). Not having been able to answer directly many of these requests, I think it best to reply generally, by communicating the results of these experiments to you.

I shall state hereafter with what object, and under what conditions, these experiments have been made. There is not, as you know, a machine, the laws of which are still more obscure than the fan-ventilator, working by the effects of centrifugal force. Also, the results of the apparatus, based on this principle, which I have applied to the ventilation of mines, appear inexplicable to engineers who have proved it, and altogether inadmissible to those who have not seen it to realise with their own eyes. But there should be nothing surprising in the presence of theories, the insufficiency of which is generally admitted. These theories demonstrate in fact, that without treating the resistances in the same

manner, the centrifugal-force ventilators working by suction, cannot utilise more than a fraction of the work transmitted to their axis.

However, I believe from this time, that a machine of the same kind can reach, and itself draw out, a result practically of sixty per cent, of the work of the steam on the piston of the machine employed to move it.

Since there cannot be a false theory (because that has not truth which is not true), we shall comprehend that there exists between the old machine and the new some differences of condition of action, which, in themselves, were due to the apparent contradiction between the indications of science and the facts furnished by practice. But these differences were so visible, that one could perceive them without effort, since the old ventilator was designed to throw off the air at all points of its circumference (an arrangement specially patented in each design every time by the inventors), whilst the new machine, in a covering, throws out the air by a tangential opening, in which the size regulates itself practically according to the volume which it exhausts under the depression produced, and discharges into the atmosphere by a chimney, of a section progressively increasing, by which means the air is given off with the most feeble speed possible.

But in these arrangements, apparently more adapted to constitute a ventilator for blowing than exhausting, the blowing machines are found in effect very advantageous. Some have seen in the covering a cause of resistance, in the shutter which regulates the outlet only an obstacle to the exhaustion of the air, and in the chimney a superfluity. In consequence, some have denied any advantage.

However, all mechanics know well that force itself is not lost; that a machine of the theoretical power of twenty horses, which does not produce more than five usefully, gives off fifteen to produce no effect. They can then comprehend that there is something to gain in a machine which renders in labour 25 per cent. of the work consumed.

But erroneous principles are difficult to detect when they have had free course for a long time, so that many of those who themselves admit the results furnished by the new ventilator, cannot explain the effects of the arrangements which are special to it, suspecting its superiority, and attributing it to the greatness of the diameter which it presents in very many of its applications, or to conditions (which they think exceptional) of some mines in which it is established; whilst others, more logical, admit that the new results are due to modifications in the appliance, yet they impute it most frequently, some to the covering-, some to the shutter, and others to the chimney.

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In the meantime, I am able to publish the theory (much more simple than some had thought) of the new ventilator, and give the measure of the effect of the covering, of the chimney, and of the slide, which have been furnished me. It appears that these experiments have furnished complete warrants and safe guides, and will be better assistance than the stated opinion of the greatest number. These experiments, to be entirely convincing, should be made on the same machine. First without the envelope, then they should be arranged according to the old system of ventilators at our mines, afterwards with a cover without the slide, then with the cover and slide, and at length with cover, slide, and chimney.

To MM. Gille and Franeau, engineers of the Mining Association, being in the habit of judging of the currents of air, and of measuring the work of machinery, thanks are due, having been kind enough to take charge of the carrying out of this programme. And I have also to give, without name, the thanks of the society to the managers of the collieries of Crachet and Picquery, having been the means of realising the results during the construction of the apparatus which I have furnished to them.

In all the experiments which have been made, there has been kept—

1st. The measure of the depression obtained, by measurements of the column of water, simple or multiplied, tried in many different places in the chamber, so as to control the indications one by the other.

2nd. The currents of air have been measured by the anemometrical system of Combes, and by the English system, carefully examining beforehand, during the observation, all points in the section of the gallery.

3rd. The work of the engine has been measured with one of Watt's indicators (which we had tested on many occasions), placed alternately on the top and bottom of the cylinder.

We measured the time by means of a second-pointer.

I lay before you the result of fifty-three experiments which we have made, and in which you will find all the indications which have been got. The diagrams are with them, so that you can test the accuracy of the calculations.

It is not necessary for me to give you an account of the numerous figures which compose their tables; it would be useless. I find it more important to give a resume of the results which proceed from them, at least to save you the trouble of the research. All that remains is to assure you of their accuracy, when these documents are placed in your hands.

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Although it has not been considered necessary, in the course of these experiments, to measure the work given off by the machine to overcome its own resistance—that is to say, in making it work the ventilator without the vanes—the results furnished by the machine, under these conditions, should be examined.

Four experiments (Nos. 15 to 18) have been made on the ventilator without vanes and without covering, and we have made eight (Nos. 19 to 26) also without vanes, but the envelope was constructed, altogether twelve experiments, in which the speed varied from 18•75 to 84•50 revolutions per minute. The object proposed to be reached was to know the force disposable on the axis of the ventilator in the latter experiments, a knowledge of extreme importance in studying the theory of the machine.

Observe the speeds of the machine, and their separation into two columns, according as they have been obtained without the cover and with the cover; the quantities of work yielded by the machine, of which care had been taken to have it well oiled.

[table]

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It is easy to see, on an inspection of the numbers, that the work of the machine increases very rapidly with the speed, nearly as the square of it. And, indeed, if we compare the experiment No. 20 with that of No. 18, for example, we find that the first has absorbed 3•52 horse-power ; the second should have absorbed (according to the law of the square of the speed) 22 horse-power, and it has required 24-80.

In tracing a curve, with the number of revolutions for abscissae, and the force in horse-power for the ordinates, we obtain obviously a parabola; and the curve so obtained can afford the work absorbed at other speeds than those at which the observations had been recorded. (See Plate II.).

These results are very surprising in themselves, so that they struck my attention forcibly. In the actual study of them there is nothing I need note, but I think I ought to add that they are found to be confirmed by the experiments of the same kind made on another machine, constructed in a different manufactory.

In the two cases the machines were working for the first time.

If we find the work occasionally less at the same speed, when the machine is not covered than when it is provided with a cover, I think that that gives reason to believe in some special cause, for evidently the cover cannot be the cause. It will be sufficient if some bolt is more tight one day than another, or less properly oiled, may occasion the difference.

The fan, provided with vanes, has been tried without the cover, and with it -— first, in hindering the air of the mine from coming in; second, in allowing it access.

When the machine was not acting on the air of the mine, it had not to overcome anything but the passive resistance, so that it could not produce any useful effect.

Here I append a table of the results of thirteen experiments made in preventing the air of the mine from communicating with the fan.

[Plate I: Interior of Ventilator]

[Plate II: Diagram of the results furnished by the experiments of Messrs Gill and Francau]

[PLate III: Diagrams from the engine by which the work has been calculated.]

[Table of experiments on ventilation]

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[table]

There are here two comparisons to be made; the one relative to depressions, the other concerning the work absorbed.

From the depressions, we determine easily that they increase sensibly as the square of the velocity (which is conformable to theory), whether the machine is or is not covered; only they are generally a little higher when the machine is covered. In the two cases, the depressions are higher than the centrifugal force should afford. The curves drawn on these conditions and compared with the theoretic parabola of depressions, furnishes a means of comparison very significant. (See Plate II.)

Relative to the work available, the figures in the table determine a difference very considerably in favour of the machine when covered. Thus, at the speed of seventy-two revolutions, the force absorbed by the fan without the cover has been 31•06 H.P., whilst, at the same speed and with the cover, it has not required more than 21•34 H.P.; the difference 9•72 is doubtless employed in moving the surrounding air, to create the eddies which are, under these circumstances, great, it is true, but which they produce always around the fans without a cover, and the same

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round those which are not suitably covered. To compare the result of the two arrangements at other speeds, it is necessary to have recourse to the line of curve, similar to those which I have shown; we then see the differences in a manner very clear and decided. I should have remarked that the ventilator when covered had absorbed still less work in those experiments when we made use of the slide to close totally the orifice of outlet, for then the resistance had been reduced to the friction of the machinery and to that of the air in the fan, in the absence of the slide permitting the extreme air which has access by the fourth of the circumference to form eddies.

The trial of the fan working- from the mine has been recorded without the cover, with the cover, with cover and chimney (but without the slide), and at last with cover, chimney, and slide regulated.

Unfortunately, as we found great difficulty in reproducing exactly the same speed, the elements for direct comparison fail. The curve line is, therefore, here an absolute necessity. However, in bringing together the experiments made at extreme speeds, we are able to draw up the following table:—

[table]

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The influence of the slide on the useful effect would have been better seen if the requirement of the mine had been less near to that for which the ventilator had been proportioned (63,558 c. f. of air per min. under the depression of 3•14 inches). The results consequent on this arrangement are as follows:— 1st. The cover is useless below a certain speed (fifty-two revolutions for the machine which we have in hands as well as that, the results of which are traced in the curve), and becomes so much the more advantageous as the speed is increased up to a certain limit, about seventy-five revolutions, where the benefit appears to remain constant.

2nd. The action of the chimney makes itself felt at all speeds, but its effects are so much the more decided as the speed increases.

3rd. The slide, suitably regulated, increases the useful effect of the fan. The experiments Nos. 43 and 44, which have been arranged at the same speed (68 revolutions), prove that the useful effect is raised in the proportion of 1•064 to 1, since it has reduced the work done, for the same result obtained, from 21•38 horse-power to 20•10 horse-power.

The general conclusion, resulting from all these facts, is, that the fan uncovered is a very bad machine. That the cover badly arranged can be more useless than useful. That the chimney affords incontestably the greater part of the benefit obtained in the new arrangements. And that the sliding shutter, which completes the arrangement in allowing of the adjusting of the machine according to the requirements of the mine upon which it is established, furnishes the means for obtaining, under all these circumstances, the highest useful effect.

In what precedes I have shown, at different occasions, the line of curves as a means by which all the results which the experiments afford are rendered intelligible. I conclude by placing before you a table of these curves, the one relative to the depressions, the other to the work. (See Plate II.) I think the accompanying explanation will enable you completely to understand the indications. You will find easily, for any speed whatever, according to the depressions, what would be the corresponding work of the fan without the cover, covered with the chimney, and lastly, covered with chimney and slide regulated. Take, for example, the speed of 75 revolutions. The perpendicular to the scale of speeds shows the point on this scale which corresponds to this speed (on the curves of depression) in cutting the curve A at the point a, shows that at this speed the depression produced, by the machine complete, would be 2•40 inches. The meeting of curve B at b shows that the fan without the c over does not give more than 1•90 inches. We see, in the same way,

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that the machine covered without a slide, and without a chimney, would not give more than 1•70 inches of depression.

In the same manner, the perpendicular to the scale of speeds on the curves of work raised to point 75, indicates, by its intersection with the different curves, the work required to be done by the machine, which corresponds to that working in the mine of Picquery. Thus, the machine, without the cover, absorbs 42 horse-power; provided with the cover, but without the chimney and slide, it does not require more than 37; with cover and chimney, it does not require more than 31; and complete, that is to say, with the cover, the chimney, and the slide, from 26 to 27 horse-power is sufficient to move it.

If you remark, that the least force spent corresponds exactly with the greatest depression obtained, and, in consequence, the overflow of the greater volume of air, you understand how the useful effect of the new ventilator is superior to that which was furnished by the old one, applied to produce the same current in the same mine.

Although the hour at which we generally break up our seances has already passed, permit me, before we separate, to call your attention to two orders of facts, very interesting, and inseparable from those which precede.

It is, in the first place, the manifestation of the action of the chimney, rendered visible by the vacuum which is produced at its base.

This vacuum has been measured by MM. Gille and Franeau, by placing a water-gauge in the partition of the chimney, opposite to the slide at three different heights. Six observations were taken while the fan was making 72 revolutions, and producing a depression in the air measured by a water column of 2•28 inches. The result which they have furnished are recorded in the Nos. 48 to 53 of the general tables.

The circumstances in which the current of air is placed in the chimney authorises us to take, for the effective depression, the least depression which there has been on the face of the opening of the slide, from 1•35 inches at 11•81 inches higher, of 1•04 inches; and at 19•68 inches higher again of 0•70 inches.

The rapid decrease of vacuum in the middle of the chimney, measured at the increased section, is the confirmation of the principle which has prompted the adoption of this important addition; and the greatest value of this vacuum, which in the experiment is 1•35 inches, proves how much the machine is found advantageous when, without the chimney, there was to overcome a pressure of 1•35 inches greater to force into the atmosphere the air which it drew from the mine. In other

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terms, it is evident that, if the chimney did not exist, the depression or vacuum in the air-chamber would be reduced from 2•28 inches to 0•92 inches, an abstraction to be added to the resistances of the air in the ventilator. The principal character of the machine is proved when placed in the same light by the experiments on the vacuum produced at the base of the chimney. And it appears to me impossible that any person can be mistaken hereafter. The last result of observations made on the ventilator of Crachet and Picquery which I have to communicate to you is relating to the considerable volume of air which this kind of machine can displace. In the preceding experiments we operated at the mine in such a manner that the volume of air, displaced at the different depressions obtained, depends on the conditions of the work which it was obliged to perform, not having surpassed in these conditions 50,328 cubic feet per minute (experiments 39 and 47). By opening a small trap-door to the day the volumes of 44,100 cubic feet and 62,432 cubic feet were obtained; but these volumes were very far from representing that which one would have obtained if the access had been made easier. In order to come to a definite result on this subject an experiment was made, on the 6th August, by MM. Raux and Frauquet, in the presence of M. Stoesser and other persons, in which as many communications as possible were opened between the down-cast pit and that of extraction (up-cast shaft), and also between the surface and the air-chamber. The ventilator, when the slide had been entirely raised, was going at the speed of 87 revolutions. The depression in the air-chamber was 1•99 inches, and the volume of the current was found 175,620 cubic feet per minute. The experimenters had great difficulty in remaining in the current when the speed of the air coming from the mine was 24•92 feet, and 139•95 feet for the air taken directly at the surface. When the ventilator was going at this speed it was found impossible to pass the trap-door of communication with the interior. A man would most certainly have been knocked down.

In this experiment no measure was taken of the work given off.

With respect to the work taken in moving the air, it was seen that it was raised to 1,860,540 pounds per minute, or 56•38 horse-power.

Plate I. is a Plan and Section of the Ventilator.

„ II. is a Diagram giving results at different Speeds.

„ III. is the Indicator Diagrams.

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NORTH OF ENGLAND INSTITUTE

OF

MINING ENGINEERS.

GENERAL MEETING, SATURDAY, NOVEMBER 3, 1866, IN THE ROOMS OF THE INSTITUTE, NEVILLE HALL, WESTGATE STREET, NEWCASTLE-UPON-TYNE.

JOHN TAYLOR, Esq., Vice-President of the Institute, in the Chair.

The Secretary read the minutes of the Council meetings, after which the following new members were elected, viz.:— Mr. James Turnbull, Gateshead; Mr. Jos. Catran, Wylam Colliery; Mr. J. M. Ogden, Sunderland; Mr. John Yardley, Burnt Tree, Tipton; Mr. W. Y. Craig, Harecastle Colliery, Stoke-upon-Trent; Mr. Thomas Brettell, Agent, Dudley; Mr. John J. Bryden, Hematite Iron Works, Whitehaven.

A letter was read from Mr. W. Cochrane on the duties of the Secretary, and a committee was appointed to take the subject into consideration.

CALOW'S SAFETY-CAGE.

Mr. Marley's paper on Calow's Safety-cage came on for discussion.

Mr. Marley said, that by permission of the Council, Mr. Calow was in the room, and he would be glad to illustrate the paper further than he (Mr. M.) was able to do at the Manchester meeting, by exhibiting a model of his safety-cage. He would only now bring forward the points which might require fuller consideration with regard to safety-cages generally, and to this one in particular. He would touch on a few par-

ticulars, which might be said to be prominent points, and more especially as they would hear another paper read to day on another patentee's safety-cage. He might premise that he had no interest whatever in connection with this or any other safety-cage, beyond what he had already stated at Manchester, and that was to lessen the danger to which their own and their workmen's lives were exposed whenever they went up or down a coal or other mine. The object of his paper would be lost, unless Mr. Dickinson, or some other gentleman, would give statistics as to how long the various apparatuses had been used. Calow's was the best safety-cage he (Mr. M.) had seen, and he wished to have the matter fully discussed. Mr. Calow wrote him a long letter on the subject, a few days ago, in connection with this paper. Although he had not much that was new to add since he read the paper in July, 1865, there was this additional advantage, that since that time he had had the cage constantly at work at Shildon Lodge Colliery, and at Eston Mines, in Cleveland; also, for a few weeks, at Byers Green Colliery; and during that time these cages had continued to give satisfaction, requiring no repairs, or next to none, and showing, by their continued use, that they were equal to the general objects proposed by the use of safety-cages. When the cage was applied to wood guides, its constant use caused no great expense for repairs, and it had not yet been practically tried on wire or iron rods. One advantage of Calow's cage was the simplicity of the machinery connected with it. They were all aware that it was not connected with the rope, and hence it did not come into play when the cage came to bank, nor at the bottom, but only when required, with actually broken or dissevered ropes, following the natural law of gravitation. The present patent is dated March 10th, 1866. Another point to which Mr. Calow wished to have their attention specially called was one of the objections about great speed. He would read a short part of Mr. Calow's letter:—

"The one chief objection to my safety-cages now is, if I mistake not, the great speed some of the winding-engines travel at in modern collieries. I beg to say that this has been an item whereon I have spent much time and thought. I do know that from the construction of certain safety-cages, they are, as it were, hung in springs, so that, at the time when the engineman cuts off or reverses his engine, it has a very great tendency to bring the grips into play, thereby doing serious mischief ; and I know parties who will not run the risk of trying them on that account. Well, but in my case, I have a method whereby I can test the effect of the cutting off of the steam or reversing the engine would have upon the apparatus, without the apparatus being on, so that the risk is done away."

Mr. Calow has a method by which he tries the effect of cutting off the steam, and to meet the greater speed at which the engine was likely to run. Thus—

"I simply fix in a box a spring of a given length and strength, such a one as would be suitable for the cage tried on. I would subject the spring to a certain pressure — say fifty per cent, more than necessary to shut it. Above the spring I would place, say a bit of straw, or anything that the spring through the action (if any) of the cutting off the steam, etc., would easily displace ; therefore, it would at once show the effect of the speed being checked, etc. This would be proved without the grips being attached to the spring, thereby no risk whatever would arise as in other cases ; but to obviate this effect, I could overcome that by putting on extra weight and fixing the grips further from the guides. This I have ascertained by actual experiments, extending over four years, and it is a fact I shall wish the meeting to be specially acquainted with."

The principal thing which Mr. Calow claims as an advantage for this invention is the apparatus not being connected with the rope as in other cages :—

"There is, amongst others, another thing in its favour. The old system being connected to the rope, thereby getting the motion from the rope, has a great difficulty to overcome, and one which has not been lost sight of before now, viz.:— When a cage is some 300 or 400 yards down a shaft, and the rope breaks near the drum, and the drum is a considerable distance from the pulley, those springs have actually to drag all that rope quicker than the cage falls, in order for the grips to get hold of the guides. Cases have been known where the great amount of rope has prevented them from acting; besides, they must have only one strength of spring to effect it, for if the spring be too strong, the cage could not shut it sufficiently when the rope got the weight, so that the grips would not be clear of the slides; but, in mine, the spring is immediately at liberty to act on the instant of the breakage, without being trammelled by the tail or broken rope above. Besides, I am not confined to the strength of spring, it is only increasing the pressure upon it, which pressure is as nothing in time of accident. Again, some have made objections that if the apparatus were required to be brought into play in case of rapid descent, or if the rope broke when the engine was at full descending speed (a case of very great rarity), it would do as much damage as letting it go to the bottom. This I can deny with regard to my mode of grips, they being so con= structed (curved wedges) that if they are required to act as stated, they will not stop the cage instantly, but arrest its downward tendency gradually or by degrees according to the speed at which the cage was travelling at the time of accident, but in case of ascending it would arrest the cage on the instant. This has been proved practically. Since the discussion on my safety-cages, which took place at Manchester last year, I have been very much interested in reading a copy or report of the dis- cussion, from which I gather how little is known of the nature of it, which is a source of encouragement to me, believing, as I do, that when it becomes more

known, it will be more appreciated. I hope the models will be easily understood. I have made them myself, and have been anxious that they should show the prin- ciple of my invention, because no one will have faith in a thing they know nothing of ; and although I have shown two ways of applying it, I do not confine myself to them, but to the principle of action, viz., gravitation. At the Manchester meeting, a question was asked whether it would act on wire guides? Since then I have made a model to act, not on wire guides (which are twisted, therefore producing an uneven surface to the advantage of the apparatus), but to act on a smooth iron rod, and without even serrating the surface of the grips employed. What more may be required I know not. I am not aware, and my experience has extended over a series of years, that any other objection has been raised, but I am prepared to meet it if any should arise. I have it upon the best authority that the principle cannot be beaten, and as regards the machinery employed for wood guides, there is none so simple, and none that has run half the time without requiring expensive repairs."

In Calow's cage you will see the spring is in a condition to act without being trammelled by the tail or broken rope. Again, some had made objections that if brought into play in case of rapid descent, it would do as much damage as letting it go to the bottom. This had been found by experience not to be the case. They would have an opportunity of putting any questions they pleased to Mr. Calow, and, by leave of the Chairman, he would be allowed to answer them.

Mr. Calow said, this was the most simple method that he knew of applying safety apparatus. The first time he took out a patent (in 1859) it had its motion from the rope; and all other safety-cages had, he believed, except the present one. Indeed, if there was another like this in that respect, it was unknown to him. In this cage the motion was got by the law of gravitation, and he had never known it to fail. The great defect in other safety-cages was, that the instant they were let down to the bottom, the apparatus was set at liberty, and there was unnecessary wear and tear of the machinery employed. In this case it never worked unless it became a falling body.

The Chairman (to Mr. Marley)—Have you ever had a broken rope? Mr. Marley said, the engineman, in two cases, had drawn the cage over the pulleys. Thus there were two cases in which the apparatus was brought into play through the detaching hook; one was with a full tub, and another with an empty tub. They were not testing for amusement, and the apparatus acted perfectly in both cases.

Mr. Calow — The instant the rope breaks it is perfectly at liberty to act.

Mr. J. B. Simpson — How far would the cage fall in the event of the rope breaking ?

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Mr. Calow — Ten inches.

Mr. Marley said, it varied from seven to fourteen inches. You can set the apparatus and adjust it so as to give it a certain time to fall. The actual fall, in one of the cases mentioned, measured off ten inches. Mr. Watkin, who was in charge of the colliery, stated that the guides were very little damaged, and the work was resumed thirty minutes after the accident. Mr. Higson, at the Manchester meeting, asked if it could be used with round wire ropes (see Report of Manchester meeting, Vol. XV., page 111). He (Mr. Marley) used the ordinary wooden slides, but the models now show it can be used with wire-rope.

Mr. Calow — In other cages you must get hold of the rope to set the grips at liberty.

Mr. Marley — Mr. Dickinson said one of the good things of a safety-cage was, that it was connected with the rope, and so came into play at top and bottom of the shaft. Mr. Dickinson and myself joined issue upon that point. The advantage of this safety-cage is, that it is not connected with the rope. I have not tried it with wire-rope slides.

Mr. Calow, in answer to questions asked, said, the grips are so arranged that no damage is done to the slide. There are no serrated edges. It is merely a chain or chains acting on the eccentric. There is no connection between the rope and the mechanism.

Mr. Simpson inquired if there was no danger of the cage catching with a great velocity? Suppose a case where the usual velocity of the cage was at the rate of ten feet per second, would there be any fear of the cage being stopped should the engineman inadvertently increase this velocity ?

Mr. Marley explained that by properly adjusting the weight they might maintain any rate of speed that might be required.

Mr. Easton — You will have to calculate the exact weight due to your momentum. If you make it a little too light it will not act. Make it a little too heavy and if the engineman suddenly increases the speed it will be sure to stop.

Mr. Calow — The first principle is simply this, namely, no matter what the momentum may be when the weight required is fixed on the spring, action can only take place when the cage gravitates.

Mr. Steavenson said, the only limit was, they must have a surplus of weight. If they could run to the speed of a falling weight then it must stop. All that they had to see was that they had more weight than

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they wanted. In the Exhibition of 1862, Mr. Calow's safety-cage was the only one he (Mr. S.) thought worthy of attention.

Mr. Coxon inquired what was the weight of the whole machinery at Shildon Lodge ?

Mr. Marley said, the large tubs of coals, cage, and apparatus weighed one ton nineteen cwts.

The Chairman asked if there had ever been an instance where it acted improperly, or acted when they did not wish it to act?

Mr. Marley said, for the first six months from their putting it down at Shildon, there were several instances where it acted improperly, but they found they had not got the proper weight upon it. This was also the case at Byers' Green. They put the necessary additional weight on, and since that time, not by any checks whatever, had they the slightest motion.

Mr. Calow said, the weight of the machinery was about 112 lbs.

Mr. Easton asked if it bore any ratio to the whole weight of the coals ?

Mr. Marley said, he could not give the weight of the apparatus separately without reference. They had had it three years in use and it had not cost them 5s. for repairs.

Mr. Easton said, that a cage moving five or six feet per second, every part was more or less shaken on striking the bottom of the pit-shaft; and the more weight they added to the cage, the more complicated it was, and the greater the difficulty of keeping it in working condition.

Mr. Marley — This is just the advantage. It does not grip every time it comes to the top and bottom.

Mr. Easton — From the constant beating of the cage at the bottom of the pit there must be a difficulty of keeping it in working condition.

Mr. Marley said, in answer, that he had only to repeat what he had just now said, that they had had it in use three years; and they were drawing two tubs, with eleven cwts. of coals in each tub. At Eston Mines, in Cleveland, they were drawing a ton and a-half of ironstone each time.

Mr. Daglish said, the large and long cages, now in use carrying four tubs, get very much damaged themselves, without reference to any particular mode of mechanism.

Mr. G. B. Forster — The working load in some of our shafts is six tons without the rope.

[Plate IV]

Mr. Marley said, at Shildon Lodge they were drawing two tubs weighing from six to six and a-half cwts., with ten to eleven cwts. of coal in each tub, with a cage in proportion. These large cages had been in use twelve months, and they had not found any difficulty. In Cleveland they drew ironstone in large wagons, each containing one and a-half tons of ironstone. The wagons were made of iron, and weighed from fifteen to eighteen cwts.

Mr. Easton said, if they had a velocity of five or six feet per second, when they arrived at the bottom there was a blow given which would be heavier in proportion to the weight of the cage. He did not see how they could obviate this, and if they added to the parts they increased the liability to derangement.

Mr. Marley — On the same principle a double cage would require double the amount of repair?

Mr. Daglish — A much greater proportion than that.

The Chairman — Can your principle be applied to iron slides?

Mr. Calow said yes, this is an iron slide (referring to the model). There are no teeth whatever, so that it can do no possible injury. Mr. Calow exhibited a spring and said, that was the spring which had been at work at Shildon Lodge two and a-half years. There was a great deal of elasticity in it yet, and it would wear much longer.

Mr. Calow said, he had drawn up a rough paper to show how it could be applied at quick winding collieries without the grips.

" Staveley, November 2nd, 1866.

" Gentlemen, — I beg to forward a rough sketch (Plate IV.), of an apparatus for trying the effect of rapid descent, or any sudden reverse of the engine, etc., produced upon Calow's system of safety-cage. The apparatus is arranged so as to be experimented upon at any colliery, regardless of speed, without running the least risk, as the gripping machinery is removed and a weight used as an equivalent. Explanation: a a is a box with front removed, containing the simple apparatus employed; b is a foundation fixed in the box and made secure to the sides a a. Upon the foundation is fixed a spring such as might be employed for the cage tried upon ; the spring is weighted according to a fixed rule established by the patentee. The weight may be fixed on the top of, or suspended underneath, the spring, as shown at c c ; if the former, the weight at the top would require to work in a slide or slides as shown at d d. If the engine proves to have too much power over the spring, it will be shown by the removal of the straw or any similar material, as shown at the top of the weight (see straw e). This being the case, an extra weight must be used until the proper weight required be ascertained. To prove this, I would recommend that the box be fixed on the top of the cage, and made secure thereto, and the door of the box locked up, and allow it to remain in that

position for one month. The utility of this arrangement will be clear to all. It does away with all risk as to whether the apparatus, if applied, would grip through any sudden reverse of the engine, a doubt which so many entertain.

" I remain, gentlemen,

" Yours respectfully,

"J. T. CALOW."

LEMIELLE'S VENTILATOR.

The model of a Ventilating Fan, by M. Lemielle, was exhibited, and its working explained by Mr. Marshall and Mr. Ellis Lever, of Manchester.

Mr. Cochrane remarked, that there was a paper on M. Lemielle's ventilating fan in the Transactions of the Institute (Vol. VI., p. 130), and it seemed to him that this was exactly the same machine.

Mr. Lever said, two or three improvements had been made in it since it was introduced six or seven years ago.

Mr. Steavenson said, it gave eight inches of water-gauge, whilst Guibal's gave only four or five inches at the outside.

The Chairman suggested that Mr. Lever or Mr. Marshall should read a paper upon it.

Mr. Lever said, he thought Mr. Higson, of Manchester, would write a paper on this machine.

HARRISON'S CAST-IRON BOILER.

Mr. Cochrane read a paper on " Harrison's Cast-iron Boiler."

Mr. Willis inquired if there were any tables as to the time spent in getting steam, the coals used, and water evaporated. He had had some experiments with cast-iron boilers, and he would be glad to put them together, and compare them with Mr. Cochrane's. There was a remark in one of the papers that these boilers leaked considerably.

Mr. Cochrane understood they were successful as regarded leakages.

Mr. Willis said, notwithstanding the success that was said to have attended them in America, a statement had appeared in a work entitled "Engineering" that the Editor had received a letter from that country in which it was reported that "they leaked considerably."

Mr. Cochrane said, he had broken his up, and put them into the cupola. He had given them a fair trial.

Mr. Marley suggested that Mr. Willis should favour the Institute with his experiments at the adjourned discussion.

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BROADBENT'S SAFETY-CAGE.

Mr. Daglish read a paper on "Broadbent's Patent Safety-Cage." He said, the gentleman was present to whom the invention belonged, and, perhaps, they would allow him to exhibit it to the members. There are no springs attached to the apparatus. It is similar to others in being attached to the rope, but dissimilar, inasmuch as the weight of the catches themselves throws it into gear.

Mr. Nelson Smith, the exhibitor, produced a model of the invention. He said, the first action was not dependent on a spring, but they attached springs as accelerators. There was no fall whatever; but even without the springs it would stop. The eccentrics were chained back behind it. It would run as fast as they pleased, and when the rope snapped it would stop.

Mr. Marley — What is the difference between yours and Owen's?

Mr. Smith — In Owen's the first action is dependent on the spring, but our first action is not dependent on a spring. We put springs in as accelerators, and there is no necessity for heavy weights.

Mr. Marley said, suppose the engine should give jerks, or suppose it went at extraordinary speed, what provision was there to prevent its coming into play when it should not ?

Mr. Smith said, it was working very satisfactorily at Kirkless Pit.

The Chairman inquired if any accident had occurred with it in use?

Mr. Smith said, it had not caused any accident; no accident had been reported.

Mr. Daglish — Has it ever been in use when a rope has been broken?

Mr. Smith — No; except as an experiment.

Mr. G. B. Forster — If there was a weight of six tons, do you not think it would cut the guide in two?

Mr. Smith — We assume it would not, because of the broad surface.

Mr. Marley — What is the weight of the apparatus alone?

Mr. Smith — A plan such as this would be one cwt.

Mr. Willis — You say on account of the width of the slide, but in most pits you have not a slide of great width.

Mr. Smith — We only require two and a quarter inches ; and in the slides where the experiments have been tried, the mark is hardly perceptible.

Mr. G. B. Forster — You have not tried it with very great weights?

Mr. Smith — It was shown to Mr. Lancaster. At some of the Wigan collieries they have great weights.

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Mr. Marlby said, the objection he had in connection with this was, the constant coming into play, and knocking the slides to pieces at the top and bottom, and being connected with the rope.

Mr. Smith said, if they consulted the Wigan Colliery owners, they would find the wear and tear was less than with Owen's, or White and Grant's.

Mr. Smith also exhibited machines for calculating workmen's wages.

At the close of the discussion, votes of thanks were accorded to the gentlemen who had exhibited the various machines, and the Secretary was instructed to communicate these votes to the parties concerned.

[page with plate V]

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ON BROADBENT'S PATENT SAFETY-CAGE.

By JOHN DAGLISH, F.G.S.

I have been requested to draw your attention to an invention recently patented by Mr. Jubal C. Broadbent, of Rochdale, Lancashire, which was recently brought under my notice by his agent, Mr. Nelson Smith, of the firm of Ashwood, Smith, and Co., Manchester. It is stated to have stood, successfully, several tests on both wood and wire rope conductors at several large collieries.

I understand that the Wigan Coal and Iron Company were the first to adopt it, on the wire rope conductors and then on wood, at the

California Pits, where, previously, an accident had occurred in September last year, when seven men were killed by the breakage of a nearly new wire-rope. It is not my intention to commend or recommend the use of this or any other apparatus, or do more than draw your attention to it.

Plate V., fig. 1, represents a cage of ordinary construction, with safety apparatus attached immediately under the rim or top, and held out of action by the tension of the winding rope, as when the cage is at work ascending or descending.

At A are represented the weighted eccentrics or tumblers, supported and working on studs or fulcra rivetted to plates B, and held up by the small chains C, which are attached to the ordinary winding chains of the cage. D is a spiral or vulcanised rubber spring tie, which (though not essential to the working of the apparatus), may, at discretion, be fixed at the back of the eccentrics so as to quicken their action, thereby preventing the cage attaining the least possible momentum in case of accident. E is the conductor, which may be of wood or wire-rope.

Plate V., fig. 2, represents the position the "apparatus" would assume in case of accident by the breaking of the winding rope. The

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actions being unsupported fall on their fulcra, the serrated surface of the eccentrics being thus brought in contact with the conductors have their larger radii run in until the cage is gently but inevitably arrested. This is accomplished without occasioning the slightest damage to the conductors by reason of the large surface brought to bear the resistance.

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[Plate V: A pair of 18 HP Harrison Boilers]

ON HARRISON'S CAST-IRON STEAM BOILER.

By WILLIAM COCHRANE.

In May, 1864, a paper on this subject was read before the Society of Mechanical Engineers, at Birmingham. The results were stated to be entirely satisfactory, and the system was in operation at Messrs. Hetherington's of Manchester, and elsewhere, so that, after a careful examination of the boilers at Messrs. Hetherington's, and the fullest inquiry that could be made, there seemed every inducement for its adoption in preference to the ordinary wrought-iron boiler. A plant was, therefore, erected at the Elswick Colliery to thoroughly test the system with the view of extending its use. It has proved, in my opinion, a failure; but with some variations may probably still be made useful; and it is with this object that I bring the subject before this Society, so that the difficulties so far as experienced may be known, and perhaps remedies applied; for the adoption of cast-iron, in some such form as this system, promises very great advantages. The description of the plant at Elswick is as follows :—

Two boilers were fixed alongside of each other, each composed of six slabs, enclosed and covered in with brickwork, as shown on the accompanying drawing (Plate VI.), built up of cast-iron spheres fitted together accurately with faced joints, these spheres being threaded on wrought-iron bolts, one inch-and-a-quarter diameter, which are furnished with screw nuts at each end, so that the joints of each string of globes can be well tightened; suitable caps close the top and bottom of each line of spheres, and the joint is formed as shown at A, B, metal to metal. The whole slab is composed of castings similar to those detailed on the plan, which shows sufficiently the mode of fixing them together. The spheres have an external diameter of eight inches and are three-eighths thick, being connected by passages of three inches and one-eighth internal diameter; each sphere weighs about twenty-two-and-a-half pounds, so there are about 100 to the ton : its contents are about seven pints; the external surface about one-and-a-quarter square feet, and internal about one-and-one-eighth square feet. Experiments had shown that each ton of slabs represented about three

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horse-power, so that in the comparison of weight to power it was about on a par with the ordinary internal-flued Lancashire wrought-iron boiler.

The strength of these spheres had been carefully tested, and as might be expected from their spherical shape, afforded most satisfactory results; indeed this was one of the chief recommendations of the system that under enormous pressure there would be no bursting of the spheres. The metal was selected, and the manufacture was very carefully carried out, so as to secure uniform thickness and accurately similar castings. The spheres did not burst at a pressure of 1200 lbs. to the square inch : the bursting pressure, indeed, could not be exactly ascertained in consequence, at these high pressures, of imperfect gauges, but it was considered to be about 1500 lbs. per square inch. In these experiments a sphere was closed with the caps and a bolt nine inches long. In the case of a slab where the bolt is nine feet long, the expansion of this length at a much lower pressure than above-mentioned would cause all the joints of the spheres to open, and thus avoid violent explosion. The risk of injury from violent explosion is therefore entirely removed.

The drawing (Plate VII.) shows the manner in which each slab is built up. One, two, and four globes being cast in one piece in order to get cross joints and thus build the slab firmly; the top and bottom of one of each pair of slabs, when fixed in place, consisting of a single sphere, S and W. On each terminal sphere a cap is accurately fitted as a washer plate, against which the nut is screwed (a sample one is shown), and to each alternate top and bottom single sphere a wrought-iron quarter bend is fixed for steam and water connection respectively; such quarter bend is connected with the straight steam-pipe at the top, and the water feed at the bottom, as shown in the drawing at S and W: these bends provide for expansion.

The system of water supply was a Giffard's Injector. Six slabs placed side by side, in the form of three pairs, formed a boiler; a cast-iron chair C, built in the fire-brick bridge, supporting each slab along one of the lower lines of spheres; the upper line of spheres at F resting on a suitable fire-brick arch over the fire-door; the general angle of the slabs being about forty-five degrees, which is provided for the emptying of the spheres when the water is blown off.

A T-shaped casting is run horizontally in the line T from front to back between the slabs to prevent the flame playing on the steam space, which consists of about one-third the number of spheres in each slab, and therefore two-thirds would be water space. The steam-filled slabs are thus in a highly heated chamber, and the steam should be, consequently, well dried.

[Plate VII: A pair of 18 HP Harrison Boilers - Longitudinal section]

[Plate VIII: A pair of 18 HP Harrison Boilers - plan]

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The cost of each boiler, iron work and all fittings complete, as shown on the drawing-, was £135, including patent right; the total weight about six and a-half tons; the cost of fixing and of masonry, including proportion of chimney, was £67; the area of ground covered by each boiler, with flues, is about 280 square feet.

The two boilers were set to work 24th May, 1865, and were used to drive an underground engine.

The raising of steam was very rapid; in half-an-hour from commencing to light the fires on a Monday morning, with cold water in the boiler, steam was raised to thirty pounds pressure; and when the boilers were new, each yielded as much steam as a thirty-feet by five-feet-diameter ordinary wrought-iron boiler; the working pressure being about forty pounds; the consumption of coal was less for the production of the same amount of steam in twelve hours; for the egg-ended boilers as then fired consumed 1•45 tons of coals in twelve hours, the cast-iron boiler only 1•25 tons. The Harrison boiler, though stated to be smoke-consuming in its arrangement, was very far from it, and this was very objectionable in its steam-producing power in consequence of priming; it would almost appear on examination of the passages between the spheres that their small sectional areas are peculiarly favourable to this evil, and constitute a difficulty to overcome. To the same cause as that of the priming, namely, the small horizontal areas of water surface, may also, I think, be attributed the violent fluctuations of the water-gauge, which took place. A very long gauge was used, and it was connected as shown at G. The level oscillated when the engine was at work as far as six inches, and very rapidly, from which fact may be probably deduced the cause of the next serious defect which was experienced, and which led to the rejection of the boilers, namely, the splitting of the spheres. When the before-mentioned paper was read at Birmingham, it was stated that "no instance of a fracture has occurred in the cast-iron boilers with the present setting (the writer refers to a previous system of setting having brought an injurious strain on the joints), and all the boilers of this kind yet erected are quite free from leaks at the joints." This writer's experience extends over "several years in America, and for upwards of two years in London and Manchester."

When Messrs. Hetherington were consulted for the Elswick plant, this statement no longer held true; for split spheres had occurred in some of the boilers at work in England. It is quite conceivable that by some wiredrawn action through the narrow passages, the sudden with-

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drawal of steam may exhaust one slab more largely than another, and thus lift the water entirely away from spheres at a level below the line T, thus exposing a sphere deprived of water to the fire. Messrs. Hetherington considered the split globes they had seen were the result of overheating ; the same remark does not apply to the cases which will be referred to directly, although in breaking the spheres some front ones on which the fire impinged were found burnt, and among the pieces on the table will be found such a section. At their suggestion, therefore, as each pair of slabs had only one steam connection, as seen on the drawing, three-and-one-eighth inches diameter, the upper caps of aline of spheres at P were replaced by caps with joints for one-and-a-half inch wrought-iron pipe, and a connection made across the steam space of the six slabs, with the object of equalising the pressure and supply of steam in each slab.

On the 25th September, 1865, there was a split globe on the third row above the bridge and fronting the fire; it occurred at 12:40 p.m., while the engine was running; the fire was put out by the large body of water discharged; the fireman only heard a slight crack when it happened. The boiler had to be stripped of its brickwork, the slab disconnected and lifted out, and a new casting of two globes (which was the one broken) put in. No leakage took place at the new joints nor at any of the old ones.

On the 17th November, 1865, another globe split in the second row above the fire, and similar work as in the first instance was necessary. On the 1st February, 1866, a joint leaked, and was readily tightened up by the screw bolts. On the 8th and 9th February, 1866, there were split globes in each boiler, and both were laid off. During this time there had often been occasion to screw up some particular line of bolts, to take off leaking joints, and in one case a bolt so tightened broke; but practically this was not a very serious objection, the boiler being laid off every night gave facility for this work.

In the first case, on examination of the globe, the internal surface was found coated with an incrustation about one-sixteenth of an inch thick. This should not have been; for the patentee claims, as one of the advantages of his system that, if the boiler be blown out at the end of each week the scales of incrustation become detached in the process of cooling, and are discharged with the water. Though the instructions for sludging and blowing out were strictly attended to, the desired result was not obtained, as can be perceived by examination of the spheres in the room, of which No. 1 was in the row similarly marked in the drawing

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(Plate VII.), that is, three of its globes were in the steam space, and the fourth one in the water space. [No. 1 is a four-ball casting, having a uniformly thick and hard deposit over all the interior surface of about one-sixteenth of an inch, and shows no signs of the action of splitting it off; the water sphere has a thicker deposit than the three steam spaces.]

No. 2, also situated as shown in the drawing, was fully exposed to the fire, and in the locality where the split globes occurred. [No. 2 is a two-ball, having on the side exposed to the fire a deposit filling up half the cubical contents of the sphere, which appears to have been formed by the breaking off of pieces of incrustation from other spheres, which have settled here and become solidified. The remainder of the interior surface has a deposit of about one-eighth of an inch thick.]

No. 3 situated below the bridge. [No. 3, is a two-ball, and the particular casting which connects a pair of slabs for the water-feed, having a deposit on the interior surface of one-sixteenth of an inch thick, and in the front part of the globe which first receives the water a very abundant though soft deposit nearly half filling the sphere; the deposit in the other sphere is very hard and of the average thickness, and shows no signs of any removing action.

All have been in use from May, 1865, to February, 1866.

These globes are fair average samples of the condition of the boiler, as a careful examination was made when the boiler was taken to pieces. An incrustation, therefore, over all the interior, even in the steam space spheres, of about one-eighth of an inch, can be fairly stated as an average, while in the globes, immediately above the bridge, it is as far as three inches thick, in some cases filling almost half the space of the sphere, and offering, therefore, sufficient explanation of the splitting of such globes as well as of the loss of power in the boiler.

Many spheres have been broken after taking the boiler to pieces in order to examine the condition of the metal, which is of a clear grey colour throughout, and shows no signs of burning, except in two cases; those burnt were in the front row immediately exposed to the fire, and have already been referred to. The upper sphere of all, marked S, was found to contain a soft light brown deposit of uniform thickness of three sixteenths of an inch, evidently carried there by the priming of the water.

The water used yields with the ordinary wrought-iron boiler a similar scale of about one-thirty-second of an inch in thickness in a month, which is removed on each occasion of cleaning. There is also exhibited a split sphere, No. 4. The examination of the first split sphere showed no signs of deterioration in the metal, either by corrosion or burning; the average incrustation of one-eighth is seen in this case also, and does not appear sufficient to account for the globe splitting.

The expense in labour alone of replacing a split sphere in such a part of the boiler is very great (and each one occurred just above the bridge in the set fronting the fire), without saying anything of the serious inconvenience of having a boiler suddenly laid off. It was felt to be so serious that it was deemed advisable not to continue the experiment, but to substitute the ordinary wrought-iron boilers, worked with Juckes' firebars, which was done. Other reasons weighed, namely, the quantity of steam raised had at this time considerably diminished, and the consumption of coals increased. This was, I think, subsequently fully accounted for, if not already explained by the incrustation; as on removing the masonry all the open spaces, 0, between the spheres were found to retain a large deposit of soot and dust, which increased as the spaces receded from the fire, and behind the bridge, where there was a kind of baffler plate to keep the current of flame in the middle of the boiler, the spheres were quite buried in dust. Some of these spaces about the line of the T-casting were completely filled, and a semi-fusion of the accumulated mass had taken place. Large accumulations had been often removed from the main back flues, but it would not be easy to remove the deposits above-mentioned, and no doubt they would interfere greatly with the regularity of heating and with the economy of fuel.

The trial of the system was thorough, for its advantages if realized are very great, and it is to be hoped that some modification will be adopted to secure them; but I think it cannot be disputed that, as at present constructed, it does not yield the results promised by the inventor, and it is open to very serious objections.

This is not the only case in this country where the system has been proved unsatisfactory, but it is only fair to add the testimony of Mr. Hetherington, who writing on the 22nd of August, 1866, says, that he has just returned from the United States where he had seen a number of these boilers working with considerable success.

The inventor has, however, discontinued the manufacture in this country, and asks £25 per ton for the boiler castings, exclusive of fittings, supplied from America, a price which, under the circumstances, offers certainly no inducement to make further experiments with them.

In Plate VII. the outline of a slab of spheres is shown, and only sufficient of the sphere castings as to explain the mode of building up the slab.

NORTH OF ENGLAND INSTITUTE

OF

MINING ENGINEERS.

GENERAL MEETING, THURSDAY, DECEMBER 6, 1866, IN THE ROOMS

OP THE INSTITUTE, NEVILLE HALL, WESTGATE STREET,
NEWCASTLE-UPON-TYNE.

ISAAC LOWTHIAN BELL, Esq., Vice-President of the Institute,
in the Chair.

The minutes of the Council having been read, it was resolved that Mr. T. E. Forster, Mr. Potter, Mr. Marley, Mr. Boyd, and Mr. Cochrane represent the Mining Institute, at the general meetings of the Societies, to consider the question of building a Hall, etc., for the general purposes of all the Societies.

On the motion of Mr. Cochrane, seconded by Mr. G. B. Forster, it was resolved that instruments proper for making experiments with tail-ropes be obtained at the charge of the Institute, and not of the special fund granted for experiments.

The following new members were elected, viz. : — Mr. T. Spencer, Ryton; Mr. A. Barclay, engineer, Kilmarnock; Mr. William Walker, Tonbridge Villas, Leeds; Mr. B. Cochrane, Alden Grange, Durham; Mr. Alfred Coxon, Bedlington Colliery; Mr. Charles Hunting, Fence Houses; Mr. Joshua T. Naylor, West Clayton Street, Newcastle-upon-Tyne; Mr. T. Hawthorn, Gateshead; Mr. George Cockburn, Summerhill Grove, Newcastle-upon-Tyne; and Mr. J. Reskern. Mr. J. Simpson, Blaydon, was elected a graduate.

Mr. W. Lishman's paper "On a System of Working Coal on the Long-wall Plan," was then read, Mr. Kirkby. attending on his behalf.

Mr. W. Green inquired what was the height of the seam and the nature of the strata immediately above and below it?

Mr. Kirkby — Four feet six inches. There is a very strong metal about four feet above the seam.

Mr. Crone — What is the nature of the covering or roof overlying the coal-seam?

Mr. Kirkby — Strong metal and post.

Mr. Crone — Four feet six inches of metal, and what thickness of post?

Mr. Kirkby — I cannot tell exactly how much post, but more than twenty feet.

Mr. Crone — Does it fall equally immediately the chocks are removed?

Mr. Kirkby — Yes, equally, and in a large frame.

Mr. W. Green — Do the frames break short and squarely off?

Mr. Kirkby — Yes, generally; and accordingly we do not lose one set of chocks in the fall.

Mr. Steavenson — Does the back wall prevent your getting a good fall?

Mr. Kirkby — No, the falls break sharp off.

Mr. Steavenson — The wall will be a hindrance to the succeeding fall. It will prevent your getting a free fall next time.

Mr. Kirkby — No, there is a space between of four feet.

Mr. Steavenson — You do not say that the back wall is ever taken out. It will be in the way of the succeeding fall, and throw the weight on the coal.

Mr. Boyd — Do you use candles or lamps?

Mr. Kirkby — We use candles throughout. We have no gas.

M. GUIBAL'S FAN VENTILATOR.

On the motion of Mr. Cochrane, it was resolved that the discussion on Mr. Steavenson's paper "On Certain Experiments with M. Guibal's Ventilator," be postponed.

Mr. Daglish not being present, the discussion on "Broadbent's Safety Cage" was postponed.

The Chairman remarked that it was very desirable when a paper was announced for discussion, that the discussion of it should be pro-

ceeded with. Many gentlemen have doubtlessly come here to-day expecting to hear it and only find that nothing can be done. He also remarked that it was necessary in order to secure an early issue of the Parts of the Transactions, that gentlemen who have proofs sent for correction should return them to the Secretary with as little delay as possible.

HARRISON'S CAST-IRON BOILERS.

Mr. Cochrane said, he had only to add to his paper that his conclusions had been confirmed by a gentleman in Staffordshire who adopted the boiler, and who wrote to him a fortnight ago stating that he had been compelled for the same reason to do away with it entirely. He had broken it up.

Mr. Willis said, he had promised to bring some experiments on cast-iron boilers to the discussion; but, on looking at them he found that they would assume a different shape from what appeared in Mr. Cochrane's paper, which seemed more a description of the boiler. These were experiments as to the raising of steam and the coal consumed. If he did anything with them it would assume the shape of another paper.

The Chairman — Is it in favour of cast-iron boilers?

Mr. Willis — I would not say that; but I could not introduce them in a discussion on this paper.

The meeting then broke up.

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[Plate IX]

ON A SYSTEM OF WORKING COAL BY THE LONG-WALL PLAN.

By WILLIAM LISHMAN.

Feeling it incumbent on me as a member of this Institute to contribute to its Transactions in proportion to my humble capabilities, I beg to offer the following remarks on what I consider to be an improved method of working coal. There may not perhaps be anything extraordinary in these remarks, but the facts will be stated so as to open a discussion on the question as to whether we cannot improve on the bord-and-pillar mode of working coal, which is now almost the only method used in the counties of Durham and Northumberland.

Mr. H. Vivian, M.P., in the concluding paragraph of his motion for the appointment of a government commission of inquiry on the probable duration of Coal in Great Britain, alludes to this subject by enquiring "whether there is reason to believe that coal is lost either by bad working or by carelessness or neglect." Many letters have also been written and published on this subject.

I, therefore, lay before you a short description of a modified plan of working long-wall, as introduced into the working of the Brockwell Seam, at Newton Cap Colliery, near Bishop Auckland.

The annexed plan marked No. 1 (Plate IX.), shows eight acres of coal won out for future working by modified long-wall. Three headways are driven out from the main rolley-way for a distance of 300 yards. At A and B two pairs of narrow bords are driven to the boundary or fault, and headways are driven out of the narrow bord marked B. Headways are also driven across to the air-way or boundary bords driven for ventilation, twenty-five yards apart.

There are three headway courses in working, with one bay or working place going in each headway.

The portion marked goaf has been worked off, and shows a pack-wall standing thus >>>>> which is eight feet wide and capable of resisting the pressure from the goaf, and which thus leaves an open space between the pack-wall and the coal.

The bays are driven about fifteen yards in width, and from three to four rows of chocks are kept between the goaf and the face where the men are working. A pillar or pack-wall is built with stone taken from the goaf, eight feet wide, and filled in the middle with rubbish. This wall is built about four feet from the coal, leaving sufficient open space for a tramway. It is built up at night and the back-chocks are drawn out at the same time.

Three men work in each bay, and as there are two shifts of men, eighteen are employed in getting coals. The dead-work is done at night by shifters who are employed for that purpose.

The pack-wall answers for two purposes:— 1st. For keeping a safe way from the face for the workmen and for the conveyance of the coals out. 2nd. When the bay is finished it still remains standing, and thus keeps an open space of nearly four feet between the pack-wall and the future bay, thereby saving the risk of losing any coal.

Upon due consideration I have arrived at the conclusion that of the two systems the long-wall is incomparably the better. It possesses many advantages, some of which I will enumerate.

1st. The whole of the mine may be obtained.

2nd. The coals are produced much larger.

3rd. Less small coal is made in "kirving" and cutting-up the side.

4th. Less pit timber is required.

5th. Less shift or dead work.

6th. The creep or thrust cannot take place.

7th. Less strait work.

Perhaps it is only fair to state that there are disadvantages as well.

1st. Less out-put until the exploring- places are driven out to the boundary.

2nd. Additional cost of materials during the first working.

3rd. The strait work having to be driven out at once, will entail a much greater cost for working the first few years.

It will be seen that the method I have adopted is a combination of the pillar-and-stall system and the long-wall so far as driving to the

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[Plate X: plan of working by modified long-wall at Clifton Hall Colliery.]

extremity of the boundary or to the fault is concerned, and then bringing back the coal by long-wall or semi-long-wall.

In working coal we frequently hear of 10 per cent, of the whole produce being lost. Mr. Spencer states that 7 per cent, is lost at Woodifield (Transactions of Mining Institute, Vol. VIII., 1859, p. 89).

In 1861 Mr. A. Basset read a paper before the members of the South Wales Institution of Engineers "On the large Proportion of Coal lost in Working," and there stated as the result of several investigations that the loss of coals in working had in three instances exceeded 30 per cent. of the actual contents of the mine, and that even a larger per centage was lost in some of the mines.

In 1864 the late Mr. Joseph Goodwin read a paper entitled "Long-Wall versus Pillar-and-Stall System of getting Coals." To show the change that has come over the Lancashire coalowners, I will quote a paragraph from the above paper, with an extract from the discussion thereon:— "That the long-wall possesses advantages over the pillar-and-stall system under some circumstances is indisputably true, while, on the other hand, it is simply impossible to work some mines to advantage upon the long-wall plan, however skilfully the workings may be directed. Perhaps the most important advantage in the long-wall system is that all the coal may be worked out without the slightest waste; this cannot be said of any other system."

Mr. Binney remarked "I think we are much obliged to Mr. Goodwin for bringing a novelty before us, for evidently the long-wall working seems to be a novelty in Lancashire."

Last year, an invitation having been given to the members of this society to hold a special meeting in Manchester, which having been accepted, arrangements were made for several excursions. One of these I attended, in company with a large party, and, by the kind permission of Messrs. A. Knowles and Sons, was allowed to examine the workings of the five-quarter seam at Clifton Hall Colliery, where what is called a modified system of long-wall is now being tried. On that plan the loss or waste was under 5 per cent., and there was a fair per centage of large coal.

The plan marked No. 2 (Plate X.), shows the mode of working as pursued at Clifton Hall Colliery, where the inclination of the seam is about 1 in 6. It will be seen from this plan that three places are driven out from the down-cast pit for a distance of 800 yards to the old workings, and then a pair of bords are driven up the full rise to a large dip

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fault about 150 yards from the mainway and headways, which are driven 25 yards apart as shown in the plan.

The plan No. 3 (Plate XI.) shows, perhaps, the best mode of working the broken on the bord-and-pillar mode. The stripes coloured black in the portions of the pillars worked off indicate the proportion of the mine usually lost. This proportion ranges, I believe, from 7 to 10 per cent.

EXPLANATION OF PLATES.

Plate IX. represents eight acres of coal won out for working by modified long-wall system.

Plate X. shows the plan of working by modified long-wall at Clifton Hall Colliery.

Plate XI. shows the mode of working the "broken" on the bord-and-pillar mode.

[Plate XI: Method of Working the Broken on the Bord and Pillar System No.3]

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NORTH OF ENGLAND INSTITUTE

OF

MINING ENGINEERS.

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

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

Mr. Doubleday having read the minutes of Council, the following new members were elected, viz.:— Mr. J. Roscamp, Acomb Colliery; Mr. Asquith, Harton, South Shields; Mr. George Crow, Messrs. R. Stephenson and Co.'s Engine Works; Mr. Joseph Thompson, Seaham Colliery; Mr. William Boyd, Spring Garden Iron Works; Mr. J. H. Moore, Smeaton Park; Mr. William Thomas, Tow Law Iron Works; and Mr. John P. Harper, Derby.

CONVEYANCE OF COAL UNDERGROUND.

Mr. Daglish read a paper on the Conveyance of Coal Underground.

Mr. Berkley said, in the experiments made by Mr. Greenwell and himself, Mr. Greenwell specially wished to have no particulars taken of the actual pressure on the pistons of the engine, but merely to give the practical results of the working. No doubt there was less power exerted than the steam indicated near the engine; but they thought it was better to leave that out of the experiment, so that it might be easier tested by other people.

Mr. Daglish said, he had been led to write this paper from what had been advanced in the paper previously before them. The experiments

which he had made tended to show that the friction of the tail-rope was double that given hy the information before them. And now, when underground operations had extended to such great distances, it was important to know which was really correct. They would very soon get to the end of their power when such an enormous force was required to move the ropes alone. The Committee were now making experiments in Lancashire, which would no doubt throw light on the subject.

The President — These experiments will test the merit of the endless-chain.

Mr. Daglish said, he believed Mr. Greenwell would be here himself next month at the discussion on the paper.

The President said, if the Government should bring a Bill before Parliament to make them sink more pits, which was not at all unlikely, the engine planes would not be required quite so long.

FAN VENTILATION.

Mr. Cochrane read a paper entitled "A Comparison of the Guibal and Lemielle Systems of Mechanical Ventilation;" in connection with which Mr. Steavenson's translation of a statement of experiments with M. Guibal's Ventilating Fan, was open for discussion.

Mr. Cochrane said, he was sorry that the paper was not complete. This arose from the severe illness of M. Guibal, who had supplied him with the information. In fact he (Mr. Cochrane) merely conveyed M. Guibal's arguments, though he endorsed what he said. M. Guibal was really the gentleman to whom the paper was due. The portion read to-day thoroughly discusses the merits of M. Lemielle's pamphlet, copies of which M. Lemielle had been requested to forward to the Institute. The paper gave important information, and refuted many great errors which had been put forward in respect to mechanical ventilation generally, and this mode of ventilation in particular.

Mr. Steavenson said, they must give M. Lemielle fair play. Though Mr. Cochrane had gone fully into the theory of mechanical ventilation, still, he had not given the Institute any data as to the actual work utilised by each machine. A mining gentleman in France was speaking to him lately, in reference to Lemielle's machine, and he stated that a better machine he had not met with. The pupils in the College of Mines there study for so many months and then travel. One of them, writing to him, said— "I must congratulate you on the choice of M. Lemielle's achine. It seems to me the best machine I have seen, both in Belgium and France, and it obtains the preference above all others. He did not say it was perfect; but it gave good results in mines with long air-ways. The expense at first was more than M. Guibal's." It required great expense in the construction, but it was important to adopt that which was the best. He hoped, if Mr. Cochrane found himself in error, he would come forward and admit it, as he had done on a former occasion. For his part, in examining M. Guibal's fan — and he had the pleasure of spending a day in experimenting with it — he did not reach the results stated in M. Guibal's paper. He did not reach fifty per cent. of power utilised, and they applied the speed as far as they dared to go. Mr. Cochrane had instanced an occasion in which M. Lemielle's fan broke down. He believed it was a fact that, in the experiments made with M. Guibal's machine, there was an eccentric broken. He did not say that this showed any defect of principle. It might be a defect simply in the fitting up. Therefore, he thought they should not judge of M. Lemielle's fan simply because it had broken down during an experiment, which might be owing to negligence in adjusting it or oiling it. Neither M. Lemielle, nor any of his agents, were here, and he hoped they would wait to hear what he had to say; and, above all, that they would wait until the machine was put up at Page Bank, when there would be an opportunity given of judging from facts.

Mr. Daglish remarked, that without in any way wishing to detract from the merits of mechanical ventilation, he would only just state that at the Seaham Colliery, which is ventilated by furnace power, last week 320,000 cubic feet per minute were measured in the upcast shaft.

Mr. Cochrane said, Mr. Steavenson had read a letter recommending Lemielle's system. He (Mr. C.) could have read a dozen in favour of the Guibal; but the Council ruled that they should not be introduced into this discussion. He wished to know in what respect he had acknowledged any error?

Mr. Steavenson said, he referred to the cast-iron boilers.

Mr. Cochrane said, he had not heard the word "boilers." He did not, at present, see any probability of his being forced to the abandonment of the Guibal ventilator, as he had been in the case of cast-iron boilers, but he would not hesitate to give up any apparatus which should be proved less efficient, all circumstances considered, than another. Mr. Steavenson was incorrect in giving the impression that any part of the Guibal ventilator broke. The Government Inspector (Mr. Atkinson), who is present, would confirm him in stating that the eccentric rod that was broken had nothing to do with the ventilator. It was the

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eccentric rod of the engine, and that was owing to the negligence of the person in charge who had not eased the bolts of the eccentric strap. In the case of the breakages of the Lemielle ventilators it is the ventilator itself which fails.

The discussion was then adjourned till the next meeting.

ON CONVEYANCE OF COAL UNDERGROUND.

By JOHN DAGLISH, F.G.S.

The subject of the Conveyance of Coal Underground, by ropes worked by engine power, has, on several occasions, been treated of in papers presented to the Institute, by the late President, Mr. Nicholas Wood, and by other members; in all these papers, however, the work actually done has been treated as a matter of calculation rather than as the result of direct experiments, and in many of the cases given as illustrations, the ultimate power of the engines has borne little or no proportion to the work actually performed.

It occurred to the writer that a carefully arrang-ed series of experiments, made on engine planes where the maximum effect was being obtained from the engines, tabulated so as to allow comparison one with the other, and accompanied by indicator diagrams showing the actual power given out at each of the points, when the gradients of the engine plane (and, consequently, also the power given out by the engines) varied, would be of service, not only to the younger members of the profession, but also as a reference to those who are entrusted with the management of collieries, and to whom it might be of value to know readily the amount of work capable of being performed by any given engine over a line of road of a known length and gradients.

To illustrate the necessity of actual experiments to determine the work done by the engines, the writer wishes to refer to some points in a paper recently read on this subject to the Institute, by Messrs. Greenwell and Berkley.

At page 86, Vol. XV., of the Transactions, the writers say —
"During this experiment the pressure of steam, as indicated at the" "engine, was twenty-nine lbs. per square inch, the diameter of the" "piston twenty inches, and the space travelled by each 210 feet per" "minute. We have, therefore, the power represented by 3,826,408 lbs."

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"moved one foot in one minute." This is equal to 116 horse-power actual, and this power the writers estimate to be exerted continually throughout the entire route.

Again, Messrs. Greenwell and Berkley calculate the resistance due to the haulage of the rope itself from friction of rollers, etc., to be 1143•73 lbs., at the rate of 630 feet per minute, or 720,562 lbs. moved one foot in one minute, or equivalent to 21•8 horse-power actual. This is little more than one-sixth of the calculated power given out by the engines.

The writer does not mean to assert that the engine in question is not capable of giving the 116 horse-power actual; on the contrary, there can be no doubt but that with a greater pressure per square inch, or a greater velocity, it is quite capable of being worked up to higher power; but he believes that, under the given circumstances, if an indicator had been applied, it would have exhibited the actual pressure on the piston not to have reached twenty-nine lbs. per square inch as the maximum, and that even this would vary g'reatly according to the load and gradient over which it had to be carried. Practically the engineman is continually varying the pressure in the cylinder, by means of the throttle-valve at various portions of the route, and it is comparatively seldom that the full pressure of steam is applied. In addition, an allowance must be made for back-pressure, etc., which would certainly amount to several pounds loss.

The accompanying section (Plate XII.) represents the North Way Engine Plane in the East Minor Pit at Hetton Colliery:—

	Ft.	in.
The engine is a double horizontal high-pressure engine—		
Diameter of cylinders	0	12
Length of stroke	2	0
Diameter of spur-wheels	5	0
Diameter of pinion	2	6
Two boilers, plain cylindrical, diameter	5	4
„ length	24	0

Area of fire-grate ... 5 ft. X 5 ft. 4 in. = 26•66 sq. ft.

Circumference of ropes ... ... 2 1/4 in.

Length of plane ... ... 1900 yds.

Above the line of section are placed the diagrams, as given by an indicator, of the actual pressure on the piston at various points on the route, where the gradient varies, whilst the empty tubs are drawn inbye, and below the line of section are diagrams showing the amount of power

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[page with plate XII]

expended at the various points in drawing the full tubs outbye. At different points on the line, which traverses all round the section, and indicates the direction in which the wagons are travelling, are placed figures, denoting the time (in minutes) occupied in passing over various portions of the route.

The greatest power exerted by this engine is in drawing thirty full tubs, or 20•08 tons up an incline of 1 in 166, the power exerted here by the engine is 52•2 horse-power actual, the indicated pressure being 28 lbs. per square inch (with a pressure in the receiver of 36 lbs. per square inch), the number of revolutions being- sixty-eight per minute.

With the same pressure of steam in the boilers, the actual horsepower indicated by the engine, when running empty at the rate of seventy-two revolutions per minute, was five horse-power; and the power expended by dragging the rope along, at the rate of sixty revolutions per minute, as shown by the indicator, was 25•5 horse-power (and this reduced to the common term of sixty-eight revolutions gives 26•7 horsepower, or fully one-half of the power expended in drawing the load for friction of ropes and engine).

The result of the experiments with this engine may be tabulated thus:—

The maximum power to drag the load ... ... 52•2 H.P.

The average ditto ... ... 40 „

The constant power to drag the ropes along was 25•5 „

The friction of engine alone ... ... 5 „

The length of rope moving being ... ... 3800 yards.

The average rise inclination ... ... 1 in 174.

Load being ... ... 30 tubs of 8 cwts.

This plane is 2500 yards long, with an average dip of 1 in 50, the rope paid out being 5000 yards.

On Plate XIII. are given the results of experiments recently made with the engine plane at Seaham No. 1 Pit, being indicator diagrams of the pressure in the cylinder of the underground hauling engine.

Fig. 1 is a diagram, taken when the full tubs are being drawn up the heaviest part of the plane (1 in 38•7). The horse-power exerted amounts to 94 H.P. actual.

Fig. 3 is a diagram, taken when the ends of the ropes are coupled together and the engines running without any tubs attached to them, showing the friction of the ropes and engine alone. The power exerted in dragging the ropes being 43 H.P. actual.

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Fig. 2 is the diagram of the indicated pressure, when the engine is running alone with the drums out of gear, showing the absorption of power by friction on the engine alone, which amounts to 11 H.P. actual. The result may be tabulated thus:—

Power required to drag the load ... ... 94 H.P.

Power required to drag the ropes and engine ... ... 43 „

Power required to overcome the friction of engine only 11 „

Length of plane ... ... 2500 yards.

Length of rope moving ... ... 5000 yards.

Average dip inclination ... ... 1 in 50.

Load being ... ... 60 tubs of 8 cwts.

Circumference of main rope .. .. 2 3/4 in.

„ „ tail tope.. ... ... 2 1/2 in.

Diagram Fig. 4 was taken when the engine ran the empty tubs in-bye down a gradient of 1 in 38•7, and the Fig. 5 when the engine ran with the ropes alone, the ends being coupled together, down the same gradient. The power exerted in dragging the ropes alone is actually larger than the power expended in taking the tubs inbye. This is often the case on inclinations where the engineman actually has to put the brake on in order to prevent the tail rope from getting slack by the tub over-running; the gradient being heavier than required to overcome the friction of the ropes.

Now, comparing this with the Marley Hill engine plane, which is 3OOO yards, and a heavier rope (circumference of rope, 2 7/8 in.), the horsepower required to drag the ropes alone along should be much than 21 H.P., as given by Messrs. Greenwell and Berkley, as previously mentioned.

It was originally the intention of the writer to have given a series of results of experiments on various planes similar to that now given; but a Committee of the Institute having recently been appointed specially to consider and report on the subject of underground haulage by ropes and chains, he feels that the subject will now be better left in their hands.

Plate XII. represents a section of the North Way Engine Plane in the East Minor Pit, Hetton Colliery.

Plate XIII. Diagrams showing the results of experiments made on the Engine Plane at Seaham No. 1 Pit.

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A COMPARISON OF THE GUIBAL AND LEMIELLE SYSTEMS OF MECHANICAL VENTILATORS.

Communicated by Wm. COCHRANE.

In the notice which I present to you I shall adhere as closely as possible to the line of argument adopted by M. Guibal, who, residing in the immediate district where mechanical ventilators have been more fully tested than in any other locality, has the facility of ascertaining' facts and of forming a judgment upon the merits of each system which it is difficult otherwise to obtain. M. Guibal directs his attention chiefly to the comparison of his own ventilator (of which a description is already in your Transactions, with the record of experiments upon it), and that of M. Lemielle, which represent two systems quite distinct in theory and practice. The latter has recently been brought prominently before this Institute, though not for the first time, as will be seen by a reference to Vol. VI., p. 130 of the Transactions. It is stated to be the most perfect system of ventilation for mines, and it is this claim which, I think, M. Guibal satisfactorily refutes, at the same time affording valuable information on the subject of mechanical ventilation.

In order to attain the object in view, true scientific theories and actual facts will be brought in opposition to the false ideas and incorrect assertions which have been recently advanced in a pamphlet to which I shall make frequent reference.* The questions at issue shall be thoroughly examined, and I trust you will give careful attention to them, for they are of public interest. I need not, I am sure, instance

* Notice on the Ventilation of Mines by means of Lemielle's Ventilator.

the recent appalling colliery accidents in England as an incentive to the deeper study of the ventilation of mines in order to protect lives and property from such terrible catastrophes. To this end it is important that the laws of ventilation be more generally known than they are, and erroneous ideas among miners dispelled. Of these errors so many occur in the pamphlet upon Lemielle's ventilator, to which I refer, that it becomes a duty to combat them, for when once exposed, the propagation of them, with its attendant danger, will be hindered.

In the first part of this discussion I shall follow successively the arguments of the pamphlet above-mentioned, which I understand contains the grounds of the recommendation of the Lemielle system; and thus easy reference for comparison can be made.

In the second part I will discuss the general theories of the Guibal and of the Lemielle ventilators, or rather of the two types to which these two ventilators are referable, and I shall show by a full comparison, the superiority of the former to the latter.

In conclusion, to make this discussion of the general interest and good which are my main object in undertaking it, I will point out the means by which, with really efficient mechanical ventilators, accidents arising from the explosive mixtures found in coal-mines may be rendered less frequent and less serious.

PARAGRAPH I.— PRESENT CONDITION OF THE VENTILATION OF MINES.

It is here asserted that the immense development given in our days to coal-mining has made all former methods of ventilation insufficient, and the abandonment is predicted of these methods, and the replacing of all by the Lemielle apparatus. No person, I think, will contradict the first statement, for it is this consideration which has directed the attention of mining-engineers to design a ventilator equal to the new requirements. As to the abandonment of all methods known hitherto, it can only mean, that the dimensions which mechanical ventilators have attained being proved insufficient, or their arrangement defective, they will no longer be persevered in, for the principles on which they have been constructed are the only ones on which a ventilating apparatus can be based, and therefore cannot be abandoned; and M. Lemielle, though his words give a contrary impression, is evidently of this opinion, for he simply enlarges the proportions of his old ventilator to bring it out as new. The point on which we differ is the true merit of the principle of his system. He thinks the principle involved in his ventilator is the best, and that he has practically carried it out in the most effective manner. I think that it is a principle the least adapted to an apparatus intended to produce large volumes of air and to overcome great resistances, and of all applications of the principle that could have been devised, that of M. Lemielle is the least calculated to bear the increased proportions to which it is to be carried.

There are only two fundamental principles, first, that of the action of a pump, or as it is generally styled the principle of "varying capacities;" second, that of "impulsion." The little importance I attach to the first, for reasons hereafter to be explained, led to the adoption of the second, and the difficulty presented itself to remove from its practice certain defects which for a long time were considered inherent to it. That this difficulty has been overcome, and that the Guibal ventilator is equal to the requirements of the most extensive mines, of which M. Lemielle seems not to be aware, I can refer to the ventilators working in England and Wales, which produce 110,000 cubic feet per minute, with a water-gauge of three inches, as at Staveley, Pelton, and Middle Duffryn, and others of various power. In Belgium the ventilator is worked to produce a water-gauge as high as eight-and-a-half inches, as at the mines of Monceau Fontaine.

RESULTS OF STAVELEY VENTILATOR.

Diameter of ventilator ... ... 30 feet.

Width ... ... 10 "

Diameter of cylinder ... ... 25 inches.

Stroke ... ... 25 "

Two horizontal engines are arranged opposite each other, so that either can be applied to the same crank.

This ventilator is the best arranged of any which have hitherto been erected in England.

[table]

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PARAGRAPH II.- COMPARISON OF THE VARIOUS MECHANICAL VENTILATOES.

[table]

This table is extracted from M. Ponson's work, upon which M. Lemielle bases the relative values of ventilators most generally in use; condemning all previous systems, excepting his own, which does not figure in this list, although it ought to have appeared in it, seeing that the date of its invention is 1852. This table gives in one column the maximum volumes and corresponding depressions, in another the maximum depressions and the corresponding volumes from experiments which were made twenty or twenty-five years since on ventilating apparatus then in use in Belgium. Without reference to the progress made since that date, the insufficiency of these tabulated results is brought into glaring contrast with the modern requirements of mines, and especial stress is laid on the fact that all these ancient systems yielded volumes of air proportionately less as the depression under which the air was extracted was greater; hence the deduction that such ventilators cannot answer the desired conditions. Persuaded that a new system is, therefore, necessary, he finds that his own is the only solution of the problem, because it is free from this serious defect which attaches to other systems. Nothing is easier than to show the error of M. Lemielle in this conclusion, but to do this, the true interpretation of the tabulated results must be given, and I invite your attention to theory and actual facts to establish this point.

Theoretically, a mine, considered for the purpose of ventilation, is a passage consisting of a succession of shafts and galleries, in which air

[61]

circulates in greater or less quantity, as the force which produces its motion preponderates over the resistances it encounters, therefore the results obtained depend on the intensity of this force, and not on the nature of the means of producing it. For instance, it could not happen that a depression of 4" produced by the Lemielle ventilator should have more power than the same depression produced by a ventilator with flat vanes, or by the pneumatic wheel system of Fabry.

Therefore, in such passage the general laws of air in motion must apply, among which, under similar conditions in other respects, the volumes passing are in the proportion of the square roots of the forces applied to produce the motion; that is, if v and h express the volume and depression in one case, and v' and h' in another, for the same mine and in the same condition,

[formula]

Or [formula]

That is, for the same mine, the relation of the square of volume of air to the depression producing the volume remains constant, no matter what variation in intensity of current there may be; and experiment confirms this law. Hence, if in two successive experiments the same mine furnishes not the constant, but

[formula]

it is evident that the conditions of the mine have varied for the two experiments.

Now the value of k depends on the leng-th of run of the air, the areas of the sections of drifts, and the perimeter of these sections, and any modification of these varies the value of k.

The conclusions drawn by M. Lemielle differ widely from the laws thus enunciated. For instance, a ventilator produces in a mine a current of 10m3, with a depression of 50m/m; and, in a subsequent experiment, 5m8; with a depression of 100m/m. He does not suspect that in the conditions of the mine itself an explanation of this irregularity is to be found, but he at once blames the ventilator, without perceiving that he must attribute to the arrangement or to the principle of the apparatus the singular property of producing at one time a small depression which is very effective, and at another a large depression, which is not effective at all.

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The values of k and of k', resulting from the table above mentioned, are as follow :—

[table]

To produce such great differences in the values of k and k', the condition of the mine must have been greatly altered from one experiment to the other. In fact, this did take place, not by chance but purposely, and by closing the mouth of the shafts. The proofs of this are recorded in M. Ponson's work, in the second volume, page 155, from which the experiments on "flat wings" in the above table are taken, but with this difference in recording, viz.: they are distinguished in M. Ponson's work under two classes of experiments. M. Lemielle gives them as if under the same conditions. In fact, the first experiments, as M. Ponson remarks, were not only upon the open mine, but at a time when the arrangement of the workings was exercising an advantageous influence on the ventilation, to such an extent that the ventilator, making the same number of revolutions per minute and with the same depression, yielded l•83m3 more air than the ordinary quantity of 5•092m3, whilst he points out that the second experiment was conducted to ascertain the useful effect under the influence of a high depression, obtained by almost completely closing the orifice of the intake shaft.

Similar explanations are found in M. Ponson's work on the "screw" of Motte, at page 175; and on the Fabry "wheels," at page 197. For

[63]

the Combes' Ventilator, the original notice of M. Glepin must be consulted, in Vol. III. of the "Bulletin du Musee de l'Industrie Belge," p. 298, where it is mentioned that the distribution of air in the mine was changed when the larger volume with smaller depression was obtained.

Thus, the indications of theory are confirmed in respect of all the apparatus in the very results upon which they are condemned by M. Lemielle; and it cannot be doubted that he is wrong in attributing to these apparatus, as a defect, the property of displacing a volume of air smaller in proportion as depression produced becomes greater. I doubt if any engineer would advance such an opinion; but the argument against it is incontestible. Notwithstanding, it will, perhaps, be urged by the supporters of the Lemielle system, that there is no obstruction of the air-current which can diminish the volume of air drawn into his ventilator as the depression produced increases. To anticipate this false argument, I shall refer to experiments made by M. Jochams, in 1855, on a Lemielle ventilator, established at the mine of Bayemont, the details of which are recorded in Vol. XV., p. 25, of the " Annales des Travaux Publics de Belgique," and from which it appears that this apparatus, which yielded 6•989m3 of air per second, under a depression of 50m/m, when the mine was quite open, only yielded 6•409m3 when the opening of the shaft was almost closed, although the depression had increased to 75 m/m, and in this instance, the values of k and k' did not remain the same, they are respectively •977 and •548, so that it is clearly seen from these experiments, that the Lemielle is no more exempt than the other ventilators from a decrease of volume under an increase of depression; and no wonder, for is it not self-evident that whatever apparatus is employed to ventilate a mine, it can only discharge the air which enters it?

Finally, the table in which M. Lemielle thinks he finds so powerful an argument in favour of his apparatus, means absolutely nothing, if not this, and common sense would indicate it to everybody — viz., that when the opening of a shaft is contracted, the air no longer enters the mine with the same facility. It is a subject of regret that the above-mentioned table was not completed by the experiments of M. Jochams, at the mine of Bayemont, for it would then have been evident that if the conclusions drawn therefrom are true for other apparatus, they are also true for the Lemielle, and thus this error would have been avoided. However, it is a happy circumstance that such a principle is not true,

(lm3 per second is about 2120 cubic feet per minute. I retain the French measures throughout, as offering great advantages for calculation.)

otherwise mining industry must have despaired of ever satisfying the growing wants of ventilation.

PARAGRAPH III.— VENTILATION WITH PNEUMATIC WINGS ON LEMIELLE'S SYSTEM.

The Lemielle system is stated to have been employed for a long time in Belgium and France at many mines, and an example is instanced by M. Lemielle as showing the power of his first ventilator; it is that of Creuzot, where one of his apparatus produced a depression of 300 m/m (11•81 inches). The impression is also given that the new ventilator is different from the first one, of which a description is found in the Transactions of the Institute (Vol. VI.). A careful comparison, however, with the ventilator at Douchy, which was erected in 1803, shows that the system is the same, the dimensions only being varied, and a few unimportant details of construction attended to.

The first Lemielle apparatus has certainly enjoyed but little favour among mining engineers in France and Belgium, as can be learnt by reference to the mines where it has been in use. It remains to be seen how much better success will attend the so-called second; but really the first revived.

At the end of M. Laurent's paper (Vol. VI.), a list of mines is given where the first ventilator was in use. Among these forty-five cases, there are several small machines used for blowing forge-fires, for instance, those used by the Anzin Company, who, however, had two, not three as stated. I also remark that four apparatus are stated to be at work with the "Societe des Produits;" these, I know, never existed. Again, the "Societe de Braquegnies" never had more than one, instead of two, as figuring in the list; so that little reliance can be placed on this list, which takes credit for ventilators which have not been established. I believe there is not one-fourth of these ventilators enumerated at work now; they have been done away with and replaced by the Fabry and by the Guibal. I instance, among the latter, the ventilators of the mines of "Bonne Esperance," "Fosse du Verger d'Anzin," of "Strepy Braquegnies," and of "Ronchamp."

And now I propose to examine the Creuzot ventilator, to which M. Lemielle calls especial attention as a model of his system.

Let me remark, first, that not the ventilation of a large mine, but of some particular portion of workings, is the instance he gives; for he mentions the air-current as passing along a passage of 104 square inches section (•0076m2) and 318 yards long (286m), therefore, the volume

[65]

of air circulating could not be large, notwithstanding the evidence of M. Schneider, the mine owner, that the workings were sufficiently ventilated.

The exact information of the extent of these workings is as follows:—

The air descended by a shaft 3•70m diameter, 315m deep, and along a gallery 272m2 area x 270m long, then along a gallery of 360m2 x 150m long. The current then returned, along a gallery of 1•60m2 area x 130m long, and a bricked archway of •26m2 area x 270m long to the bottom of the shaft, where a sheet-iron tube, of the dimensions named by M. Lemielle, conveyed it up the shaft to the inlet of the ventilator.

The extent of workings being sufficient to employ twelve or fifteen men, an opinion may be formed of the importance of the Creuzot ventilation.

To have a fair appreciation of the wrork done, the volume and the d imensions of the ventilator, as well as its speed, should have been stated, but this information is withheld. I am, therefore, induced to make a calculation from such data as are communicated, to ascertain these details.

CALCULATIONS UPON THE CREUZOT VENTILATOR.

Depression 11•81" = 300m/m of water.

Theoretical velocity of air v = [formula]

And, supposing one-third the velocity lost by contraction of the passage and the resistances, the actual velocity would be about 40m per second. The section of the passage is 104"= •0676m2. Volume extracted, 40 x •0676 = 2704m3 per second.

Now, the Bayemont ventilator proves a reentry of air of 2•744m3

under 50m/m depression, therefore, under 300m/m, the reentry of air will

be [formula]

The yield of air will be, therefore, [formula] and the

engine having a coefficient of •65, the total useful effect will be •29 + •65 = •19.

The volume, per revolution, of the Bayemont ventilator, is 36•500m3,

the total volume generated being 6•585 + 2•704 = 9•289m3; hence,

the apparatus would be working at [formula] = •25 revolutions per second,

or •25 x 60 = 15 revolutions per minute.

The depression being 300m/m, the theoretical velocity of the air is

67•40m per second. The contraction at the entrance of the passage,

and the resistances along it, lead to the opinion that the real velocity

could not exceed 40m; and in such case the volume of air in one

second would not exceed 2•7m3. The apparatus is probably similar to

the Lemielles which were made at that time; for instance, that of

Bayemont referred to. The experiments by M. Jochams, on this apparatus,

afford the means of ascertaining the volume that the Lemielle

ventilator must have generated, to create the above-mentioned current

in the passage. This volume, so calculated, is 9•289m3, corresponding to fifteen revolutions of the apparatus per minute. Therefore, to draw 2•7m3 of air, a volume of 9•289m3 has been generated in the ventilator, representing a useful effect, in air extracted, of only 29 %. If we admit that the engine which drives the ventilator transmits to the axis •65 of the steam power applied to the piston (which is a fair result from experiments to be given hereafter), the useful effect of the Creuzot ventilator is reduced to 19 %. And this is, in practice, the cost at which the large depressions, so much insisted upon under the Lemielle system, are attained.

PARAGRAPH IV.— INFERIORITY (AS ALLEGED BY LEMIELLE) OF VENTILATORS WITH FLAT WINGS MORE OR LESS IMPROVED.

M. Lemielle again appeals to his imaginary objections against all ventilators except his own, and states that, with his ventilator, which acts like a pump, the depressions, however great, have only a very slight influence on the volume of air displaced. As he adds no proof of this assertion, I presume that he relies on appearances, as he did in the case of the decrease of the volume of air corresponding, as he stated, with an increase of depression in all ventilators except his own. True, that in all the experiments reported as made at Aniche, and at Nord du Bois de Boussu, the volume of air extracted from the mine at each revolution of the apparatus remains nearly constant, notwithstanding considerable difference in the depressions produced; therefore, there is clearly foundation for the statement; and, indeed, how can it be otherwise, since theory indicates that, under the circumstances of a mine offering the same conditions of resistance, which is the case in point, such result must follow. But, I must add that this is equally true for ventilating apparatus of any kind, and that M. Lemielle errs in attempting to attribute it to his only. Another error is also apparent, and springs from the same source as the first, for I shall show that, if the volume

[67]

extracted by each revolution of his apparatus remains constant, it is not because it acts like a pump, but simply because the shafts where the experiments were conducted remained fully open during the experiment. And I will further show that, if the shafts had been more or less closed, as was the case with the other ventilators previously mentioned, the volume extracted would have decreased in the same manner.

The Lemielle ventilator acts by forming a succession of increasing and decreasing capacities, which alternately draw air in and force it out, like the pnuematic wheels of Fabry, piston machines, bell plungers, and all the apparatus on the pump principle, which, from this action, are called machines of "varying capacities." These capacities being known, and the number of times they are filled and emptied in a unit of time, the volume generated by the apparatus is at once calculable.

The volume of air extracted from the mine would be equal to the volume generated, if passages of varying number and dimensions did not allow the air exterior to the apparatus to enter it, and only in the event of preventing such reentry could it be said that the volume displaced is independent of the depression produced. But if there are sources of leakage in the apparatus, the volume of exterior air which is thus let in will increase as the depression increases, and therefore the air drawn from the mine will proportionately diminish.

This simple enunciation of what takes place in all ventilators of "varying capacities," but especially in Lemielle's, will form a basis for the following demonstration :—

Let it be assumed that

V_u be the volume per second of air-current produced by a Lemielle ventilator; in other words, its "useful or effective volume,"

V_r the volume per second which reenters the apparatus through the open spaces, or the "ineffective volume,"

V_e the volume per second generated (engendre), or the "theoretical volume."

For every ventilator in action upon a mine, V_u is known by means of measurements, and V_e by the actual dimensions of the apparatus. V_r is found, therefore, from V_u and V_e, for the theoretical volume is equal to the sum of the useful volume and the reentering volume :

$$V_e = V_u + V_r$$

Now, let the number of revolutions in a second be observed and represented by n (ordinarily this number is taken per minute, and then [formula] the useful volume corresponding to each revolution, and which we will represent by Q, will be equal to [formula].

Now, the volume of air Q, extracted from a mine by one revolution of the apparatus under a depression h, is the same as the volume Q' under another depression h' obtained by an increase or decrease of speed of the apparatus, so long- as the mine remains free—that is, if no change has been made in the length of the air-course, or in the area of shaft or galleries, or in their perimeter. The values of Q and Q' being respectively [formula] and [formula] it remains to be proved that, at whatever depression they are observed (the mine remaining under the same conditions), these values are equal, i.e., that [formula]

Now, any cause by which the depression produced by an air-current in a mine varies from h to h', varies also the volume Vu in such a manner, that

[formula]

Every modification in the depression influences in a like manner the volume which flows through existing orifices, such as the joints of the apparatus, hence, for the volume re-entering in the second case,

[formula]

The volumes generated being proportional to the number of revolutions of the apparatus

[formulas]

so that the volume displaced by each revolution of the apparatus remains constant, whatever be the depression produced; and this is true, for every ventilating apparatus so long as the conditions of the mine

[69]

remain unchanged. And it is important to observe that this is true, independent of the greater or less volume of reentering air. The Lemielle ventilator is subject to this universal principle, but it is an erroneous conclusion to draw therefrom that no reentries of air arise in the Lemielle.

The above demonstration exposes very clearly the unsound reasonings upon the Lemielle system, which may advantageously be further elucidated by a comparison.

Suppose water is being drawn from a well by two vessels alternately, each capable of containing one hundred pints, andnt is found that the one only contains eighty pints when brought to the surface, the time occupied in transit being one minute, and the other which has been raised in half a minute, also contains eighty pints, can it be inferred that the two vessels having brought the same volume of water at each ascent, have neither of them lost any in their course ? On the contrary, it must be at once admitted that each vessel has lost twenty pints, and that the second vessel presents sources of leakage of double the extent of the first, since it has lost an equal volume in half the time.

The same conclusions are drawn from the experiments made on all entilators of "varying capacities." They present sources of leakage—for the useful volume is never equal to that which they generate, and, inasmuch as they yield an equal useful volume per revolution at various speeds on the same mine, the only conclusion is, that more air enters these apparatus when they work quickly than when they work slowly, otherwise their effect ought to increase with their speed.

The error in this case arises from neglecting the consideration of the increase of the reentering volume proportionate, as is well known, to the higher depressions due to the increased speed, and it is forgotten that the increase of the reentering volume is concealed by the increased "useful volume" which follows the same law in the case of a free mine, and that it is necessary, in order to make evident the reentries of air, to experiment on different mines, or on the same mine, under various conditions of resistance, such as will yield depressions independent of the speed of the ventilator.

The following demonstration will make this clear; for, what is the useful volume corresponding to a revolution of the apparatus in the case of the speed of the apparatus remaining constant ? It is found that a variation in the depression arises on opening or shutting the orifice of the shaft, in other words, in varying the conditions of resistance of the current.

Adopting the same notations as in the first demonstration, we shall have the value for the useful volume per revolution,

[formulas]

V'e = Ve since velocity is the same in the two cases,

[formulas]

and diminishing as h' becomes greater than h. The useful volume, corresponding to each revolution, is, therefore, no longer constant under these new circumstances.

The experiments of M. Jochams, at the Colliery of Bayemont, already quoted, will serve me to prove that theory is here again in conformity with practice.

In the first experiment on the free mine he found, at sixteen revolutions of the apparatus, 6•989m3 (Vu) under a depression of 50™/m (h),

[formula]

In the second experiment on the mine partly closed, he found a volume of 6•409m3 under a depression of 75m/m (h'),

[formula]

M. Jochams having calculated the volume generated per revolution of this apparatus, found it to he 36•500m3. Therefore, when it made sixteen revolutions per minute, the volume generated in a second, or V„

[formulas]

In the first experiment the useful effect in air was [formula]
and in the second, with the mine partly closed, [formula].

Now, as the formula in this case agrees so nearly with the experimental results, it will be readily admitted that in any other cases the deductions drawn from it will represent very accurately the actual facts, so that we may deduce from this same formula what would have been the result at Bayemont if the shaft had been more nearly closed, so as to increase the depression to 300m/m (which M. Lemielle states was obtained at Creuzot) the speed of the ventilator remaining the same. Under these circumstances the value of Q is [formula]
the useful volume per revolution; and as the apparatus generated 36•50m3 the useful effect in air would be [formula].

Can it be said, in the face of such results, that the depression produced has only a very slight influence on the volume of air extracted by the Lemielle ventilator?

The volume reentering per second would be in this case
[formula]

And as the volume generated per second, at sixteen revolutions per minute, is 9•733m3, it follows that the useful effect in air will only be [formula], which gives the same result as above,
[formula]

It is easy to see, as the useful effect decreases from •71 to •33, when the depression increases from 50m/m to 300m/m, that there will be a depression at which there will be no air drawn from the mine. Such will be the case when the volume re-entering is 9•733m3, that is when

[formulas]

if at sixteen revolutions per minute the depression were 629m/m, the

ventilator would not discharge any air. Indeed, if this value of h' be substituted in the formula for Q', the result is zero,

[formula]

The conclusion, therefore, cannot be disputed that the Lemielle ventilator does not possess the peculiar properties which are claimed for it alone, nor are the other ventilators open to the objections which are made to them. Should any doubts still remain on the points discussed, nothing but a practical test can set them at rest. This, however, cannot be other than confirmatory of true theory.

PARAGRAPH V.— FIRST IMPROVED LEMIELLE VENTILATOR, ERECTED AT THE MINE DOUGHY, AT ANICHE.

M. Lemielle gives an account of his first improved ventilator, erected in 1863, at a mine of the Aniche Company, to extract twenty cubic yards of air per second, "under any amount of depression whatsoever;" and he gives a table of experiments, conducted on this apparatus, showing that the promised results were exceeded. Such excess was in the proportion of [formula] ; not a very important excess, and by no means indicating that the ventilator is good; for if a machine capable of producing 100 horse-power be applied to produce twenty horse-power, it is not astonishing that a result of twenty-one horsepower should be attained. Still, M. Lemielle must congratulate himself on the result, having undertaken the extraction of twenty cubic yards of air, "under any depression whatsoever;" for it might have happened that the conditions were not possible of fulfilment, owing to the resistances of the mine over which M. Lemielle had no control; and if these had been such as to require a depression of eight or ten inches of water to admit of twenty cubic yards of air circulating in the workings, it is quite probable that the ventilator would have failed to do the work. The consideration of the motive power required, which M. Lemielle seems entirely to negiect, is a point which must not escape notice, for it is absurd to expect the fulfilment of impossible conditions.

The guarantee that M. Lemielle offers is, in fact, such a case, when he undertakes in any particular mine to furnish a given volume of air at a depression which is not fixed. M. Lemielle leads some who do not carefully study the question to believe that his ventilator in one revolution must displace a volume of air equal to its capacity; and he argues, "how can the depression to be produced interfere with this result?

[73]

The motive force must be greater as the depression increases, but do I not apply a force in excess of all possible requirements? — and it is simply a question of power applied."

But this question of power applied is a serious one. First, inasmuch as it is important not to apply engines of greater power than required, and second, it is necessary to know that the power applied is sufficient for all requirements, which, according to M. Lemielle, there are no means of fixing; and then it is quite a mistake to take for granted that his ventilator extracts a volume of air from the mine equal to its capacity at each revolution. So contrary is this to the actual result, that it will be shortly proved that this volume varies for each different mine, or for the same mine if the current is more or less obstructed. And though an engine a hundred times above the power required were used, on the supposition that the volume of air displaced is equal to the capacity of the ventilator, or even a certain fraction of its capacity, it will only be by chance that the results guaranteed will be obtained.

Enough has now been said upon the question of unreasonable guarantees. As to the merit which M. Lemielle attributes to himself of leading the way in mechanical ventilation, I can point to the establishment of the Guibal ventilator since 1860, and the production by it of large volumes and depressions; and therefore, in deciding to increase the dimensions of his ventilator in 1863, he was only following the steps of others, with the object of removing the discredit into which his ventilator had fallen.

PARAGRAPH VI— VENTILATOR ERECTED AT THE MINE OF THE NORD

M. Lemielle records the fact of the ventilation of the Alliance Pit being insufficient, and the Public Administration of Mines requiring a quantity of forty cubic yards per secondunder a depression of 3•142", the engineer of the mine did not know how to attain such a result, as no apparatus of such power was in use. He applied to M. Gonot, the head engineer of the Public Administration, to indicate the system which should be adopted, and this gentleman, after minute enquiry and experiments on the ventilators in use, came to the conclusion that the Lemielle was the only one which could fulfil the desired conditions, and he advised its adoption.

This may be in the main correct, and no doubt M. Gonot may have decided to give the preference to Lemielle''s ventilator for the ventilation of the Alliance Pit, but it is not true that such preference was given

after minute enquiry and experiments on all the apparatus in use. Indeed, had he taken the trouble to make enquiry and experiments, he would easily have learnt that several Guihal ventilators were in use which exceeded the power required for the Alliance Pit. For instance, at the mines of Crachet and Picquery in the same district as the Nord du Bois de Boussu, and placed under the direction of the same financial company, where a current of 83m3 per second had been obtained by using the full power of the ventilator; and again at the mine of Monceau Fontaine, where a working depression of 215 m/m had been regularly maintained.

M. Gonot was led to the recommendation of the Lemielle ventilator by the preconceived idea that ventilators, acting on the centrifugal force principle, were incapable of producing large depressions, an opinion held at that time by many engineers, who drew their conclusions from the unimportant results of ancient apparatus of this kind, and from a misconception of the mechanical principles involved in this system of action. Having recorded these facts, M. Lemielle gives two series of experiments upon the Alliance Pit ventilator, indicating only the depressions and volume of air obtained at different speeds.

An omission occurs here again, which, from its repetition, seems intentional. No details are given from which the useful mechanical effect can be estimated• in other words, the relation of power applied and economised is not mentioned. But if it was an unimportant matter to utilise only 20 or 25 per cent, of the motive power when the ventilation of mines only required a few horse-power, it is no longer so now, when machinery of more than 100 horse-power is required.

Fortunately, the Commission, whose report on this Lemielle ventilator is quoted by M. Lemielle, mentions its dimensions, and as another Commission, experimenting on the same apparatus, has measured the motive power applied, the calculations of its useful effect can be made, and the discussion of the merits of this ventilator can be conducted on precise facts.

The first step is to find the capacity of the Alliance ventilator, and from it the volume generated per revolution. The chamber of this apparatus is 7•10m diameter by 5m high. Its interior 2•50m broad. The centre of this drum is •835m distant from the centre of the chamber.

The accompanying sketch (Plate XVI.), to 1/20th scale, shows by a dark shade the space in which the air from the mine is confined between two vanes, and is conveyed to the exterior; also, by a light shade the space

[75]

which is filled with air from the exterior and re-enters the mine behind each vane. To ascertain the volume of air in these spaces, the cubical contents might be mathematically calculated, but it would be a complicated process. A simpler mode is to use a good "planimetre," which I have done.

This instrument gives, for the dark surface 35050m/m2, and for the light surface 8014m/m2. As the sketch is to 1/20th scale, these surfaces must be multiplied by 202 = 400, yielding 14•0200m2 and 3•2056m2 respectively. Each of these surfaces being the base of a solid 5m high, it follows that the capacities are 70•100m3 and 16•028m3 respectively. Now, as the apparatus makes one revolution, these capacities are reproduced three times, .*. the volume of air discharged = 210•300m3, and the volume of air re-entering = 48•084m3, and .*. the volume actually displaced or the theoretical volume = 162•216m3.

This result will enable me to complete the table furnished by M. Lemielle, by contrasting with each result the volume generated by the apparatus.

In the first experiment the apparatus made five revolutions per minute. The volume generated per second, or Ve of the formula, was [formula]. The actual volume tested by gauges was 11•466m3, hence a re-entry into the apparatus of 13•528 — 11•460 = 2•062m8 per second. The ventilator operates .*. in this experiment on 13•528 to yield only 11•466, and a yield of air is obtained of [formula]. Similar calculations for the other experiments give the following results :—

[table]

The yield of air varies, therefore, from 83 % to 93 % in these experiments, whereas theory indicates that it should be constant for the same apparatus on the same mine. This requires explanation, and it is thus. The measurement of the air-current at the Alliance Pit was

[76]

conducted in a passage 6m x 8m section, which connects the pit and the ventilator; that is, in a position where the current is suddenly bent at a right angle, and is, therefore, subject to very varying velocities at various points. Now the Commission referred to mentions that they only placed the anemometer at three points of this passage, and in the last experiment at only two. Under such conditions accuracy is impossible, especially with high velocities.

Another Commission conducted experiments much more complete and accurate on this same ventilator, especially as regards the measurement of the air-current, for the anemometer was placed by them at ten different points, and several observations taken at each.

The results obtained on the 10th June, 1866, were:—

Ventilator at 10•125 revolutions per minute;

Volume of air, 20•640m3;

Average depression, 40•75m/m.

Therefore, the volume generated in a second was [formula]

=27•597m3, and the air-current produced only 20•646m3.

The volume re-entering is thus 6•951m3 and the yield of air is [formula]

=75%

This result must be more accurate than the preceding one, for it was found that at the lower part of the passage there were layers of air not only stagnant but at some points having an inward velocity, a circumstance which could not be noted by the first commission because they only operated at three points of the gallery. And the proof that the first experiments were not carefully conducted is found in the different values of [formula] which ought to be the same. The following table shows these values :—

At 5 revolutions [formula] =13•14

10 „ [formula] =12•70

14•5 „ [formula] =11•15

18 „ [formula] =11•87.

According to the report of the second Commission, this value was [formula] = 10•46.

[77]

The results of the second Commission are clearly much more reliable than those of the first, especially as the second Commission took diagrams to test the power applied in the steam cylinder. I shall, therefore, adopt their figures, the more so, as M. Lemielle was present on the occasion of the second experiments.

The before-mentioned yield of air enables the calculation of the useful effect of the apparatus; for to obtain in kilogrammetres the work represented by a volume of air at a given depression, this volume, expressed in cubic metres, is multiplied by the height of the column of water in millimetres, measuring the depression; and as the depression is the same, the relation between the actual air-current and the volume of air generated expresses the result.

At five revolutions, for instance,the useful effect would be [formula] = 84•8 % that is if the ventilator had 100 horse-power applied to it, only 84•8 are utilized. But the force produced in the cylinder is not entirely transmitted to the ventilator, a portion is absorbed. If the power transmitted to the ventilator be known, as we know what per centage of it the ventilator utilizes, the product of these two quantities would show the power utilized, or as it is called the coefficient of useful effect of the steam introduced into the cylinder. The second Commission proved this to be 48•3 %, when the yield of air-current was, as above shown, 75 %. Therefore, if x represents the fraction of the power of the engine transmitted to the ventilator •75 x x = •483 [formula]= •65, so that in this experiment out of 100 horsepower of steam applied in the cylinder, only 65 were transmitted to the ventilator; and this loss of 35 % is not the result of the imperfection of the steam engine, but of the construction of the ventilator, which is very complicated, and entails a serious absorption of power even when the oiling of the bearings is attended to most carefully, the neglect of which is still more serious. The Alliance ventilator .'. has 65 % of the power applied to it to utilize, and as it only utilizes 75 %, its useful effect is reduced to 48•3 %, as before stated. This useful effect remains constant at all velocities of the apparatus; for, the yield of air, as has been seen, remains the same, and the coefficient of the engine may be considered as invariable. But if the yield of air were varied, and instead of being 75 % it was only 50 %, the useful effect would fall from 48•3 % to •75 X •50 = 37• %. Now, in order to diminish the yield of air it is only necessary to increase the resistances of the current as was done

in the case of the Bayemont ventilator, and if Messrs. Plumat and Canelle had tested the current when, at seventeen revolutions per minute, they obtained 220 m/m depression, their experiment would have confirmed this statement. But no experiments are required to corroborate such simple matters. Suppose a Lemielle ventilator acting' upon a closed mine, it is clear that it can extract no air from it — still, a certain speed can be given to the ventilator which will absorb a large amount of power ; it is evident, under such circumstances, that the yield of air will be nil, and that the product of this result zero, with the coefficient of the engine, which is always •65, will be also nil, so that much power might be required to drive the apparatus and no useful effect be produced by it; the conclusion from which is that the Lemielle apparatus will work less advantageously on a mine as the depression increases, for I have shown that the yield of air decreases as the depression increases — the contrary is affirmed by M. Lemielle. One more remark of M. Lemielle's requires attention, viz., his protest against experiments on ventilators in which air has been taken at the surface instead of being drawn through the mine. The experiments to which he alludes are those of two engineers, MM. Gille and Franeau (which are recorded in the Transactions of this Institute*), on the Guibal ventilator at Crachet and Picquery, and which were published with the object of explaining the system of the Guibal ventilator, and of proving its efficiency in each detail of its arrangement, also to show its points of difference from previous ventilators which were more or less analagous.

The mine of Picquery being very unfavourably circumstanced in the matter of ventilation, only yielding 23•751m3 per second under 85m/m depression, it was necessary, in order to act upon large volumes without increasing the depression, to facilitate the access of air by opening more direct communications to the mine, and this was done at the surface; but these communications by no means destroyed the depression, as M. Lemielle states, for when the volume reached 82•900m3, the depression in the chamber through which the air passed into the apparatus was still 51m/m, which is duly recorded with the volume in the original notice of these experiments.

It is to be regretted that M. Lemielle should observe with so much prejudice, for, as in the same page of M. Ponson's work from which he quotes, he does not notice that the orifices of the pits have been contracted in the cases where the reduction of the volumes of air seems to him

* Vol. XVI.

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so startling, so in the same phrase of this pamphlet, he does not see the depression under which the large volume of 88m3 was obtained. Whatever may be the object in refusing to see facts as they are, it will be prudent not to conduct a similar experiment on the ventilator of the Nord du Bois de Boussu as this on the Guibal ventilator at Picquery, which is criticised so strongly, for the result will be that under the depression of 51m/m, the volume re-entering the apparatus per second will be

[formula] = 7•788m3

Therefore, to extract 83m3, 83m3 + 7•788 = 90•788m3 per second must be generated, and as the capacity of the ventilator of the Alliance Pit is l62•336m3 per revolution, it would have to make [formula] = •56 revolutions per second, or •56 x 60 = 33•6 revolutions per minute; and, as will be seen hereafter, there is every reason for believing that, at such a speed, the apparatus would not work an hour without breaking itself to pieces.

PARAGRAPH VII.—VENTILATOR OF THE PIT TURENNE AT DENAIN, COMPANY OP THE ANZIN MINES.

This ventilator supplied to the Anzin Company is expected to produce at twenty revolutions per minute a current of sixty cubic yards per second, whatever may be the depression. This peculiarity of guaranteeing a given volume of air, independently of the depression, is again conspicuous. M. Lemielle knows, nevertheless, that the force required to produce a current varies with the depression under which this current is produced, for in the preceding paragraph, he shows that 53•32 cubic yards at a depression •039" only require two-thirds of a horse-power, whilst 53•32 at a depression 5•90" require eighty horse-power. To be logical, therefore, if an apparatus is wanted equal to the extraction of 53•32 cubic yards at a depression of 0•39", he should supply an engine of eighty horse-power, since the depression being unlimited, it may be quite necessary to have 5•90", and thus this force would be required. Indeed, there is no reason for stopping at 5•90", and at eighty horse-power, but any greater power might be demanded.

The neglect of the consideration of the force required to drive the ventilator leads M. Lemielle into great errors; so, for this Turenne Ventilator, he says he will extract even 93•32m3 by a little increase of the speed.

This little increase must certainly be one-half more, for clearly it

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must be at least proportional to the volume extracted; and not looking at the additional power required, he speaks as of a small item of the increase from sixty cubic yards to ninety-three. To produce a small increase of a ventilating current, however, as is well known, involves a considerable additional power. And this increase from sixty to ninety-three cubic yards, will require a power applied of 3•724 times the power expended to produce sixty, viz., [formula].

And if the expectations of M. Lemielle in this respect are not realised, no doubt some fault in construction will be blamed for the non-performance of work, which it was impossible to realise. I regret to have to call attention so often to similar false ideas, but as they constantly recur, and may mislead others, they must be exposed.

M. Lemielle, in one of his deductions, remarks, that because the Anzin Company have already three Guibal ventilators, and have adopted a Lemielle for the Turenne Pit, instead of putting up a fourth

Guibal, the Company have no great confidence in the Guibal system. In this case, the Guibal ventilator was offered to the Anzin Company to be fixed alongside of the Lemielle, at the Turenne Pit; and it was proposed that the one which should be declared inferior, should be at the disposal of the Anzin Company gratis. I regret that private details compel me to be silent on the reasons why this company had recourse to Lemielle's apparatus for the Turenne Pit, after having replaced most successfully the only Lemielle they had, by a Guibal, at the Verger Pit. But I may remark that it is one thing to give a preference to one of two apparatus in competition, and it is another to do away with a ventilator in operation, especially when the wisdom of the substitution has been confirmed by several years of regular and satisfactory working; whilst the preference, of which M. Lemielle boasts, has still to earn its justification. It is certainly not a step towards this justification that a serious breakage should occur about two months ago, which has entailed a stoppage of this ventilator for about six weeks; but this is one of the many confirmations of the liability to derangement which has already been commented upon.

PARAGRAPH VIII.—ADVANTAGES OBTAINED FROM A MECHANICAL POINT OF VIEW.

I have had occasion already to state that the new ventilator of M. Lemielle is only the original one established upon a larger scale, and if I have not hitherto called attention to the important bearings of this increased size of the apparatus, it is because I contemplated the discussion of this paragraph. The following is an extract:— "It might be apprehended that my ventilator, when constructed of large dimensions, is less strong than formerly, but it is precisely the contrary that takes place; a fact easily perceptible, because its parts working more slowly, offer the best requirements for duration."

M. Lemielle foresees the objection which common sense must make to the increased dimensions of his ventilator, and he is right in doing so, for the original apparatus possessed so little strength of structure, or safety in working, that whoever has seen it at work could not but anticipate an increased number of accidents from the same system on a larger scale. This natural fear had to be dissipated, and the only argument advanced by M. Lemielle in favour of the strength of his larger apparatus is the slower speed of working. Not only is there no value in this argument, but in stipulating a less speed for the longer duration of his ventilator, M. Lemielle virtually admits the inference, that the greater the speed of the ventilator, the more liability to breakage, which is, indeed, the case; but it would scarcely have been admitted if the exigency of his position had not disclosed it.

It is useless for M. Lemielle to try to urge that, the vanes of his apparatus having their surface doubled, and being subject to double the force, the pressure of air remaining constant, the force will not remain double when the speed of the apparatus is only one-half as great. To raise a weight of 200 kilos., at a speed of lm per second, involves no more work than to raise 100 kilos, at a speed of 2m per second. Does the conclusion, however, hold, that the cord which carries the first weight has no more load upon it than that which carries the second? It is so palpable an error, that it needs no further comment, and the objection which it is attempted to meet remains in all its force.

As to the example of the Alliance ventilator, quoted as not needing any repairs since the 10th June, 1865, I refer to the report of the Director of this mine, M. Plumat, for the true facts.

This apparatus broke down the 6th May, 1866, during an experiment conducted by the second Commission, to which I have already referred. And I think I can explain, from the circumstances of the case, the reason of the accident which M. Plumat says he cannot understand, but the repetition of which he must consider as not unlikely, having made provision of the working parts in reserve which were in this instance damaged. The Alliance ventilator was supplied to extract 30m3 of air per second, at a depression of 80m/m, with a speed of fifteen revolutions per minute. The trial, therefore, had to take place at this

speed. But at 14•5 revolutions the depression was 86m/m, and at 15•5 revolutions it was 100m/m; the ventilator was worked at a speed between these two limits, as the precise fifteen revolutions could not be maintained. The testing operations requiring special arrangements, and at various points of the ventilator, occupied four or five hours, when suddenly a crack was heard, and the apparatus came to a standstill; it was broken. Several rods, connecting the vanes to the central shaft, were bent or broken, and one of the vanes was shattered. As this apparatus had made seventeen revolutions, under a depression of 220m/m, in previous experiments, it is evident that its working parts should not have yielded at a speed and depression so much less, except some unusual circumstance had occurred This circumstance was no other than the continuous working on the day of the accident. The apparatus having worked four or five hours, and being subjected to a thorough trial, the collars round the cranked shaft became heated, and by their resistance to the motion gave rise to the bending of the rods which guide the vanes, and one of them so bent struck the side of the chamber and broke. Whether this be the precise explanation or not, it is clear that the apparatus is liable to breakage, even when it is working at a lower speed and producing a less depression than it had attained before, which proves that the breakage does not depend simply on the excessive work put upon it, but denotes a total absence of safety. I may cite in addition to the accident at the Nord de Bois de Boussu, that at the Turenne Pit of Anzin, the circumstances of which are well known in Belgium, and which have hitherto prevented the regular working of this ventilator upon the mine.

If my information is correct, a third Lemielle, recently erected at the Mine des Produits, has met the same fate. Facts, therefore, combine to show, that this system of ventilation loses stability of structure in proportion as its dimensions are increased; and a study of its mechanical details cannot lead to any other expectation.

Among the mechanical advantages of the system, M. Lemielle instances the use of expansion of the steam, facilitated by the slow speed at which the ventilator works. The result of using expansion in an engine is to make the work variable. Now to meet a uniform resistance, like that arising from a ventilating current, it is indispensable to make the machinery self-regulating; and, as the action of regulating masses varies as the square of their velocity, I do not see how the Lemielle ventilators, the different parts of which are intended to regulate the power of the engine, should be more fitted to the use of expansion of

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the steam at a slow than at a high speed. It is, however, another peculiar Lemielle theory, to which I merely draw attention.

Finally, the last, but not the least, mechanical advantage attributed to the ventilator, is that: "As the useful effect of the old apparatus was proved to be 80 % to 90 %, it is yet superior in the apparatus of large dimensions." I need not recall the facts and calculations which I have brought forward to show the radical exaggeration of this statement, while the assumption that a machine which yields 90 % of useful effect can be improved is rather too far ahead of even modern progress, and would require mechanical science in a state of nearly absolute perfection.

The useful effect of 80 to 90 %, of which M. Lemielle speaks, and which I have called the "yield of air," may actually reach this value in special cases; but it is very inferior to it when the depression increases—contrary to the theory of M. Lemielle. If, therefore, the new apparatus are intended for great depressions, they will not furnish a larger but a smaller yield of air. Indeed, instead of their large dimensions tending to increase the yield of air they only tend to decrease it, for it is dependent on the sources of leakage, and these increase proportionally to the square of the diameter of the ventilator. Further, the useful effect of a machine is not a matter of assertion but of proof, either by demonstration upon mechanical principles or by actual experiments. Only in this way can the value of M. Lemielle's statements be appreciated.

PARAGRAPH IX. — RESULTS.

Like much of the matter already discussed, there is in the recapitulation of the merits of the Lemielle system, assertion only, not proof. But the assertions are slightly modified, for instance, though it is asserted, that this ventilator answers all the requirements of modern ventilation, it is no longer to the exclusion of every other system. It is further stated that apparatus can be supplied capable of extracting from forty to one hundred and thirty-three cubic yards of air per second, under the depression requisite for such ventilation. This is at last a reasonable proposal, and only requires the adoption of suitable proportions in a machine to carry out; but it is not sufficient simply for a thing to be possible, it must for practical working be advantageous;

and so M. Lemielle concludes his pamphlet by offering the owners of

mines a guarantee double of that which has ever been offered before,

both as to quantity of air and duration of the ventilator. Upon the

facts which are submitted to you, the value of such guarantee can be

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judged. But for a full estimate of the merits of the ventilator, the only satisfactory appeal is to actual results, tested hy experiments. There are some "improved Lemielle ventilators" in Belgium of large size. How is it that no complete experiments on any of these have been conducted by M. Lemielle himself, or by others, the recording of which, were they satisfactory, would convince those who doubt ? The natural inference is that it does not possess all the advantages claimed for it, and the only complete experiment which has been made (that of the Nord du Bois de Boussu, already referred to,) prove it to be unsatisfactory in yield of air and in stability of structure.

The Guibal ventilator has been subjected to a very different-test, and practical results had confirmed the indications of theory as to the absolute superiority of ventilators acting by centrifugal force, if suitably modified, before this system was brought prominently into notice. Its success over ten years has been uninterrupted, and though its principle of action has been, even by eminent engineers, misconceived, I hope to lay it before you in such a manner as will convince you that the theory which formed the basis of the machine, and the practical manner in which it was carried out, form the elements of success in this system. A mass of evidence, in my possession, could be produced from engineers in England and on the Continent bearing witness to the entire satisfaction afforded by the G-uibal ventilator, and of its superiority wherever it has replaced a Lemielle.

I am obliged to refer to one letter as it is the only evidence that can be brought forward to correct an erroneous impression which might otherwise arise respecting a ventilator at the Thiers Pit, the performance of which is stated in the pamphlet not to have been what was expected. This letter is from the Anzin Colliery Company, certifying that this ventilator is only partially on the Guibal system, the complete arrangement not having been carried out. The other certificates and opinions of engineers I would have gladly communicated, but your Council has ruled that they shall not be submitted to you in this discussion as being foreign to the objects of the Institute.

To conclude, therefore, the discussion of the merits of the Lemielle ventilator, as set forth in this pamphlet, it is, I think, satisfactorily proved that advantages are attributed to it, and defects to other systems, which do not exist; that the theories advanced in reference to mechanical ventilators, the Lemielle included, are incorrect; and that many assertions which it contains cannot be supported. If the experience on the Continent fails to satisfy English engineers, and a practical test of this

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ventilator be made in England (which, for the interests of the true science of ventilation, is much to be desired), it will certainly be proved to possess the disadvantages which have been enumerated, instead of the advantages claimed for it.

The necessity of limiting this discussion, as first intimated, to the contents of the pamphlet on the Lemielle ventilator, in order to remove the erroneous impression it conveys, made it impossible to draw a systematic comparison between the Guibal and Lemielle, which I propose in a following part to do.

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NORTH OF ENGLAND INSTITUTE

OF

MINING ENGINEERS.

GENERAL MEETING, THURSDAY, MARCH 7, 1867, IN THE ROOMS OF THE INSTITUTE, NEVILLE HALL, WESTGATE STREET, NEWCASTLE-UPON-TYNE.

EDW. POTTER, Esq., Vice-President of the Institute, in the Chair.

After the reading of the minutes of the Council the following new members were elected, viz.:— Mr. Joshua Cowlishaw, 74, Osmaston Street, Derby; Mr. Arthur Beanlands, Durham University; Mr. H. Nelson Smith, Manchester; Mr. J. C. Broadbent, Rochdale; M. Jules Henau, Valenciennes; Mr. E. L. Waddington, Burnley; Mr. Thomas Ackroyd, Birkinshaw, near Leeds; Mr. W. H. Stephenson, Summerhill Grove, Newcastle; Mr. S. D. Croudace, Willington, Durham; and Mr. Thos. Bell, jun., Usworth Hall. Mr. Fred. Verner, Cowpen Colliery, Blyth; Mr. Henry White, Harton Colliery; and Mr. Wm. Aubery, jun., were elected graduates.

BROADBENT'S PATENT SAFETY-CAGE.

Mr. Daglish said, when he read his paper on Broadbent's safety-cage it was simply with the view of bringing the matter before the Institute. The patentee was now himself a member, and being present, he could make any remarks he thought necessary.

Mr. Broadbent said, he came there to listen to any statements that might be made by gentlemen to whom his apparatus had been supplied. They might speak either in testimony of its value or the contrary. He was prepared to answer any questions. He had submitted a model, and his agent was here and would be glad to submit it to them again.

Mr. Daglish said, there were several gentlemen who were making arrangements to apply the apparatus, and they would he able to say more about it when they had fitted it up. He did not know of any pit in the neighbourhood that had got it in operation yet.

The discussion, at the suggestion of Mr. Broadbent, was accordingly postponed.

ON THE CONVEYANCE OF COAL UNDERGROUND.

Mr. Daglish's paper on this subject next came on for discussion.

Mr. Berkley said, he wished to make some remarks in reference to what Mr. Daglish had said, in alluding to the paper written by Mr. Greenwell and himself. Mr. Daglish said, that at page 86, Vol. XV. of the Transactions, the writers had shown a pressure of steam "equal to 116 horse-power." He thought that Mr. Daglish was wrong. It was unfair to read part of a paper without reading the context. If he might go on to read the next paragraph, after the writers account for forty per cent, of the power, they say, no deduction being made for the friction of the engine and resistance of the atmosphere; if, however, they make the usual deduction of one-third from the estimated power, they reduce it from 3,826,468 lbs. to 2,550,979 lbs., moved one foot per minute, or from 116 horse-power to 77 horse-power effective. He took it that the meaning of that deduction, on account of friction, included the friction of the steam passing into the cylinder. Then, Mr. Daglish said, the power was exerted throughout the whole route. He (Mr. B.) could not find anything in the paper that warranted such an assertion. The experiment on which the amount of resistance was calculated was over a run of 420 yards. In one part of the route the brake had to be applied to prevent the tubs over-running the hauling rope. The object of the writers, in giving the statement in the manner they had done, was to enable any person to try a similar experiment on any engine plane without going to extra cost for indicating instruments, or spending any length of time in making it. The best reason the writers could give for going into the subject in this practical way would be by Mr. Daglish describing the instruments he used, and the modus operandi in taking the pressure on the pistons of the engine. Of course, they were required, in calculating the power of an engine for a plane of this kind, to take the heaviest gradient it was expected to have to overcome. Then, Mr. Daglish noticed the power required to drag the ropes. He made it out to be twenty-four or twenty-five horse-power. A very great deal of that power was due to the brake, put on the tail-drum, to prevent any over-running of the rope. That power, applied to the tail-rope drum, might be considered a constant power. It was very seldom they required more; and the greater the distance, the less resistance was required to keep the tail steady. The power required to turn the ropes and drums could only be ascertained by putting both drums into gear. He would like to have tried this experiment himself, but he had not had time. That would give more accurately, he thought, the power the engine had to exert in turning the drums and the rope. The simple idea of Mr. Greenwell and himself, in making these experiments, was that any person might try the same on any other engine, and ascertain how they agreed with theirs, without going to any extra expense to test the accuracy of pressure on the pistons, as Mr. Daglish had given it.

Mr. Daglish said, as Mr. Berkley's observations would probably be printed, he would wait till the adjourned discussion before he replied; but he could not say he agreed with these observations.

Mr. Steavenson said, if Mr. Daglish would take into consideration the late Mr. Wood's experiments, given in Vol. III. of the Transactions, a t page 286, he would find that Mr. Wood arrived at the conclusion that a moving power of 1/28 was sufficient to draw the rope. He says, "taking the aggregate result of these experiments, we find the total moving power of the four experiments to be 1376 lbs., the total weight of the rope 18,806 lbs., making the moving power equal to 1/13•6 part of the weight of the rope; and the weight of the sheaves being 19,911 lbs., the moving power is equal to the 1/14•4 part of their weight; and the weight of the rope and sheaves together being 38,707 lbs., and the moving power 1376 lbs., equal 1/28. It appears, therefore, that when the moving power is equal to 1/28 part of the weight, it will drag the rope over sheaves and rollers, similar to those used in the experiments, at an average speed of about five miles an hour." These were experiments which happen to have been conducted very carefully, and he did not see any reason why they should not be correct.

Mr. Daglish said, Mr. Steavenson referred to that very valuable paper which was read by their late President, Mr. Wood, which embodied almost all they knew on the subject. His were simply continuations of these experiments, applying the indicator as a special arrangement. Suppose an engine plane 500 yards long; the same inclination would not take a rope out if you extended it to 2000 yards. What was true of 500 yards would not be true for 2000.

Mr. Steavenson-—Suppose the inclination is one in twenty-eight,

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with thirty-five tubs a plane may be worked nearly 2000 yards in length.

Mr. Daglish, he must refer Mr. Steavenson to the work he had quoted from, and he would rather Mr. Steavenson would illustrate his views by some experiments of his own.

Mr. Berkley said, the deductions given by Mr. Greenwell and himself in their experiments were taken from Mr. Wood's paper.

Mr. Morrison wished to ask Mr. Daglish, in reference to the power of the engine applied to the indicator, whether it was by levers or pulleys ?

Mr. Daglish said, it was taken by levers. It was not by pulleys; he had not used pulleys in these experiments.

Mr. Berkley said, he had asked Mr. Dagiish the description oi instruments he used.

Mr. Daglish said, he used three indicators — Richards', McNaugt's, and Hopkinson's.

Mr. Berkley — State how you applied them — with two or three engines — whether on the cylinder itself or on the pipe adjoining the cylinder, and with a throttle valve ?

Mr. Daglish — Fixed on pipes connected with the top and bottom of the cylinder.

Mr. Berkley — You did not take the amount of the back pressure ?

Mr. Daglish — Yes, of course, the diagrams show this.

Mr. Steavenson said, if these diagrams were the exact size it would be well to state the scale.

Mr. Daglish — That was perhaps an omission. It was advisable to give the scale; but having the figures they could always deduce their own scale. His object was to make the large diagram as simple as possible.

Mr. James Nelson said, he had frequently obtained as much as ten pounds variation of pressure to the square inch.

Mr. Daglish said, he never saw it so much, but, no doubt, if they ran the engine hard enough they might have that amount. He used a short pipe. In the various experiments made with the indicator he did not find much difference.

Mr. Nelson said, he once tried two indicators, one on the cylinder cover and the other on the pipe. Both were Richards' indicators. It was a three-eighth inch pipe, not a long one.

Mr. Lindsay Wood — At what distance was the indicator from the cylinder ?

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Mr. Nelson — Direct on the cylinder end; in one instance on the centre of the cylinder cover, and in the other on the pipe coming out of the steam passage close to the cylinders, about six inches long.

Mr. Daglish — It was on the opposite side of the ports ?

Mr. Nelson said, yes, on the same side; one was placed in the passage.

Mr. Daglish — Still the connection was on the opposite side of the ports and subject to the friction of the passage of the steam through them before it got into the cylinder. In the instances given in this paper, if a pipe is employed, it is fastened on the cylinder top itself; the only difference is that on the cylinder cover there is a small piece of pipe intervening. He had never found it more than a pound or a pound and a half variation between the diagram given by an indicator so placed, and one placed direct on the cylinder cover.

Mr. G. B. Forster said, the first report of the Tail-rope Committee was expected to be ready next month, and the discussion of both subjects might go on simultaneously. This discussion was, therefore, postponed.

MECHANICAL VENTILATION.

Owing to the absence of Mr. Cochrane, the discussion upon his paper, being "A Comparison of the Guibal and Lemielle Systems of Mechanical Ventilation," was also postponed.

SAFETY-LAMP COMMITTEE'S REPORT.

Mr. Daglish said, as a portion of this report was read at the Manchester meeting, he need not, therefore, read that part of it. It referred to the supposed action of the oil in the gauze of a safety-lamp, which became volatilized when heated to a high temperature. The Committee were convinced that no accident could arise from that cause. They then proceeded to test the safety-lamps in a box made for the purpose, which was represented in a diagram at the farther end of the room. He would read the text of these experiments without reading the table of experiments. Mr. Dagiish produced a safety-lamp which he said had stood the test and would not pass the flame, but whether it afforded light sufficient for working by was another question.

The report was then read.

After some conversation on the subject, an invitation was given to the members by Mr. Lindsay Wood, to witness the experiments which w ere being made at Eppleton Pit, which invitation was cordially accepted.

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UNDERGROUND CONVEYANCE IN THE CLEVELAND DISTRICT.

Mr. Cockburn read a paper on "Underground Conveyance in the Cleveland District," with especial reference to the use of Fowler's Portable-Engine and Clip-Pulley.

Mr. G. B. Forster said, he had one of these clip-pulleys, but it had been only a short time in operation. It was used for a drop-staple, of thirty fathoms, sending down one tub containing nine cwts. of coals; the weight of tub six cwts. It could stop the tub at any position in the staple.

Mr. Steavenson said, he had had one of these sheaves pumping at Page-Bank Colliery for the last two or three years. The pumps are 1000 yards from the engine, and the lift is 40 feet. During the period named it had worked satisfactorily. The rope was put in in September, 1865, and it was only taken off in January or February of this year. It had been going night and day, so that the wear and tear was not very great.

Mr. Boyd asked Mr. Cockburn what was the largest diameter of pulley he used?

Mr. Cockburn — Eight feet. He had two of eight feet; one was working regularly, the other was not under way yet.

Mr. T. Douglas inquired what was the expense of these large-sized pulleys? He had used a pair of clip-pulleys about fifty-two inches in diameter, and believed they cost about £40 each.

Mr. Cockburn said, he believed each pulley cost £90.

Mr. G. B. Forster — The cost of the eight feet one is £85, and the four feet £35.

Mr. Steavenson suggested that the small wheel, as shown in one of the diagrams, was not desirable, as it gave a double bend to the rope.

Mr. Cockburn said, he thought the same thing, and he had worked the pump a certain time without it. He found the rope was working satisfactorily; but he had not worked it a sufficient length of time to decide whether it was better with or without the small wheels.

Mr. G. B. Forster said, the object of the double bend was to keep the rope in more clips at one time.

Mr. T. Douglas said, he had been much surprised to find so little wear and tear in ropes. In his case a pair of five-inch pumps, placed 00 yards inbye from the engine, forced water a height of about forty feet. The rope was an old rope to begin with, and lasted a year and a

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half, pumping night and day during that time, and had been taken off simply because the pumping was laid off. The engine had other work to do, but the rope was kept continually attached, there being no necessity for putting the clip in or out of gear, as would have been the case had drums for pumping been attached instead.

Mr. Cockburn said, he found the portable pumps were a very great advantage. He could stop at four o'clock in the afternoon, and run them down at the face, and then put them on again within eight hours. He had done so frequently.

In reply to a question as to the expense of working,

Mr. Cockburn said, that previous to the introduction of the clip-pulleys he did not keep an account of the actual cost of the ropes. It varied from •38 to •52. He now found it was from •22 up to •38. This was the highest he ever found.

The Chairman — That is in pence per ton?

Mr. Lindsay Wood — Did that cost include firing the boilers ?

Mr. Cockburn — Everything.

Mr. Berkley — Did not you say so much per ton on the distance ?

Mr. Cockburn — On the distance travelled.

Mr. Marley— The first experiment you gave was without the clip-pulley.

Mr. Cockburn — I find the coals used by our stationary engine to be three tons per day, at 5s. per ton; tallow, oil, and hemp, 8d.; engine-plane-man, 6s. 1od.; enginemen and fireman, 6s. 8d.; wire-ropes and repairs, 7s. 10d. On the portable engine the coke used was five and a half cwts. per day; wire rope, 5s. 8d.; engineman, etc., 4s.; wear and tear of sheaves, and men attending the plane, 8s. 7d. or •38. When in full operation, equal to •22 on the cost.

Mr. G. B. Forster - I suppose it is quite a different boiler ?

Mr. Cockburn —- The portable engine is similar to the one I have shown. It is fourteen horse-power, and on the same principle.

Mr. Steavenson said, he had one employed in raising the stone from the shaft. The lift was eighteen fathoms. It was very easily packed up, and taken away the same day. It gave off what was equal to forty horse-power, the weight sixty cwts., cage included. The hind wheels were made into drums.

Mr. G. B. Forster — With respect to the wear and tear of the ropes, it is to be observed on an ordinary drum, in working with a tail-rope, it is wound tight on to the drum, and it remains so till it is unwound

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again ; but with the clip-pulley, as soon as the rope reaches the pulley, all the strain is taken off it, except what is due to its own weight.

Mr. L. Wood said, it was liable to some objection. If you shut the clips too close you jam your rope, and if not sufficiently close the rope is apt to slide. It was worse to have the rope sliding on a clip-pulley than on the ordinary sheave.

The Chairman — You can adjust your machinery to avoid that.

Mr. Cockburn said, he had never known it to happen.

Mr. L. Wood said, he had one working a pump with a lift of thirty fathoms with 1600 yards of delivery pipes. One rope worked well, but he could not get any other to do so, and he had to do away with it. It was a heavy lift, and had to run at great speed.

In reply to a question, Mr. Wood said he was sure the heavy clip was lying at the bottom, and it was horizontal.

Mr. Morrison — At a high speed it does not clip.

Mr. G. B. Forster — Our tubs go down nearly at the rate of a falling body. With great speed at thirty fathoms it does not fail.

Mr. Marley suggested that it would be very useful if Mr. Wood would give his observations as to the employment of clip-pulleys for pumping at a great depth. He might state that in one of the clip-pulleys which he first adopted, he had the same difficulty as Mr. Wood had experienced; and he was advised by all the agents to take it out. of an hour adjusted it, and it had never needed adjusting since. It was still answering beautifully on a self-acting inclined plane. He accounted for the difficulty from the fact that the machinery was new to the men, and they had never had the adjusting screws explained to them.

Mr. Lindsay Wood said, they had two pulleys; and when he found the clips breaking he sent to Mr. Fowler, who sent another wheel to try, but with that they could not get the ropes to last.

Mr. Marley said, his was an ordinary sheave. It had been working nearly twelve months, and the adjusting screws had never been realtered.

The Chairman said, they were all much indebted to Mr. Cockburn for his paper.

The meeting then broke up

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ON

UNDERGROUND CONVEYANCE

in the

CLEVELAND DISTRICT,

WITH REMARKS ON THE ACTION OF THE CLIP-PULLEY, ETC.

By WILLIAM COCKBURN.

The subject of the present paper is one of great importance in connection with the mining operations carried on in this country. It is at all times essentially necessary that the underground conveyance should be as economically conducted as the scientific principles can be arrived at which are called into requisition in general mining operations. In no case are those principles of cheap conveyance more needed than in the conveyance of ironstone in the Cleveland district.

I intend to lay before you a few facts and estimates in connection with the underground conveyance of the minerals in the district of Cleveland, and also the adaptation of a patent clip-pulley and portable-engine, as applied both to haulage and pumping operations now in use at the mines of Messrs. J. and J. W. Pease at Upleatham and Lofthouse. I also give plans and section of clip-pulley, portable-engine, portable-pump, self-acting inclines, engine-planes, and stationary-engine used for pumping.

The performances of horses underground have been so ably treated upon by the late Nicholas Wood, Esq., that it is unnecessary for me to make any remarks thereon. I will, therefore, at once proceed to show the cost of stationary-engines now working at Upleatham mines, after which I will also show the cost of hauling stone by Fowler's portable-engine, with patent clip-pulley attached, and, lastly, point out the advantages of the clip-pulley for pumping operations, self-acting inclines, and hauling underground; and also the conveyance of power to underground workings.

The main winning at the Upleatham Mines is worked by a stationary-engine, with two cylinders placed horizontally, twenty inches diameter and three feet stroke, with two drums six feet diameter, both drums being fixed to the shaft, and driven by a spur-wheel. The drums are put in and out of gear alternately. This engine is only working with one drum at present, the length of the engine-plane being nearly 700 yards, with a gradient upon the average of 1 in 14•3. The engine is placed upon the surface. There are three boilers five feet diameter, thirty-five feet long, two of which are used at present; the pressure is 351bs. per square inch upon the boiler. The distance from the boiler to the cylinder is about sixteen feet. The exhaust steam is emitted by a pipe direct out of the house-top; the length of the exhaust-pipe is about eighteen feet. This engine hauls a train of thirteen tubs, each containing thirty-two cwts. of ironstone, besides the weight of the tub, which is nine cwts. The average speed of the tubs travelling on the engine-plane is about seven-and-a-half miles per hour.

The quantity of work performed between November 4th, 1865, and July 12th, 1866, was 183,983 tons 4 cwts. on an average of 860 tons per day when at work, the cost of which, per ton, was •38d., including wire-ropes, coal, engine- and fire-man's wages, repairs and men attending engine-plane.

Plate XV. shows the engine-plane. This engine is employed hauling the ironstone up the incline.

The east-end of the Upleatham Mines is worked by a stationary-engine, with two sixteen-inch cylinders, three-feet stroke, with two loose drums, each seven feet diameter; one only working at the present time. There are three boilers connected with this engine, two of which only are worked at one time. This engine, like the other, is placed upon the surface, and is hauling ironstone up an engine-plane, having an average distance of 1,100 yards, on a gradient of one in sixteen. The load is thirteen tubs, each containing thirty-two cwts. of ironstone, and travelling at the rate of seven-and-a-half miles per hour. The quantity worked between March 28th, 1865, and January, 1866, was 279,349 tons eight cwts., on an average of 1,170 tons per day, when at work. The cost of which per ton, was •37d., including wire-ropes, coals, engine- and fire-man's wages, repairs, stores, and engine-plane men's wages, etc., etc.

The western portion of the Upleatham Mines was worked by a Fowler's portable double-cylinder engine, with patent clip-pulley attached, as shown on Plate XIX., from June 9th, 1863, up to the year 1866;

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the engine has since been employed pumping water. The distance this engine worked was 1,550 yards. The average quantity of ironstone hauled per-day, as specified, was 750 tons, in small wagons, thirteen to the train, carrying nearly thirty-two cwts. each, and travelling at the rate of six miles an hour, at a cost of •38d. per ton. This could have been reduced to •22d. per ton, had another train of wagons being attached to the engine, which would not have incurred any extra cost, and would have increased the quantity to 1,300 tons per-day, after allowing for incidental stoppages.

In proof of this, a Fowler's portable-engine, with clip-pulley attached, as before mentioned, is now at work at Lofthouse Mines. The actual cost of working per-ton of twenty cwts, is •2d., including all expenses in connection with it.

With these statements respecting the portable-engine, I come next to the patent clip-pulley, the description of which, given before the Institute of Mechanical Engineers, at Birmingham, on the 4th of May, 1865, I cannot improve upon.

"The clip-pulley consists of a series of pairs of jaws or clips, A and B as shown on Plate XVII., hinged round the circumference of the pulley, close together in a continuous line, forming a complete groove, in which the rope C works. Each pair of clips in succession, as it passes round to the point where the pressure of the rope upon the pulley commences, seizes hold of the rope as shown on Plate XVII., and continues to grip the rope throughout the half revolution, until reaching the point where the rope begins to leave the pulley, the clips fall open, being relieved from the pressure of the rope. The amount of grip is in all cases proportionate to the pull upon the rope, so as effectually to prevent any slipping. The only provision requisite to suit the clip-pulley for working with any size of rope, is to adjust the width of opening of the clips to the particular diameter of the rope to be driven, by widening or contracting the distance between the centres of motion of each row of clips. This adjustment is effected in a very simple and complete manner, by having the lower row of clips B centred upon a ring D which forms the circumference of one-half the depth of the pulley, and this ring is screwed upon the body of the pulley by a thread chased round its entire circumference, so that by turning the ring round in either direction the distance between the centres of the upper and lower clips is simultaneously increased or diminished in every pair to exactly the same extent; all of them being kept in perfect parallel positions. The ring D is held in the desired position by the bolt E which prevents it from turning."

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"The lower clip B of each pair having a heavy overhanging lip F on the outside, is enabled to lift the upper clip A by means of a small finger G projecting from its inner end, and pressing upon the tail of the upper clip so that the clips always remain open, until receiving the pressure of the rope, and they fall open again and release the rope the moment the pressure is withdrawn. The stop H on the upper clip coming in contact with the body of the pulley prevents the clips from falling open too far. The action of the clip is thus just similar to the closing of a hand upon a rope, laying hold at once so firmly that the rope cannot slip, and retaining this hold uniformly until the rope is released altogether by the opening of the clips, so that all friction or surging from an imperfect hold is avoided, as well as any shifting of the rope at the beginning and end of its contact with the pulley, such as is inevitably the case in round or angular grooves."

"At the same time, by means of the ring D on which the lower row of clips are centred, the hold upon the rope can be adjusted to any desired amount, according to the power required to be transmitted, and it can be absolutely depended upon, when once adjusted, to continue working uniformly with the same amount of hold."

An important practical advantage found to result from the working of this clip-pulley, is that the rope is subjected to a continual pressure upon its sides whilst passing round the driving pulley, thus avoiding all tendency to the rope being flattened by the pull, as in an ordinary round bottomed groove, where the pressure of the rope is upon the bottom of the groove only. Also the groove in the clips being so curved as to fit the rope closely round a considerable portion of its circumference, the pressure preserves the form of the rope, and serves to consolidate it, by continually closing down all protruding wires, and preventing the deterioration of the rope by such parts passing the subsequent guiding-pulley. It may be remarked here, that these advantages of the clip-pulley, render it especially adapted for use in other positions where the rope is the medium of conveying power. It is believed that the action of the clip-pulley is mechanically correct, and that it will be found highly advantageous in transmitting power by means of ropes.

The clip-pulleys are working at various places in England, Scotland, a nd Wales. I will confine myself to those which are working immediately under my own inspection at Upleatham Mines. As before stated in the description of the portable-engine, a clip-pulley has been used satisfactorily in every point, in hauling ironstone on the level with a tail-rope part of the way, and up a gradient of one in twelve on to an incline-head, after

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which it was, and is used for pumping water a distance of 363 yards, by a double portable five-inch pump with a clip-pulley attached vertically, the pump-rods being connected by cranks direct from the axle of the pulley. The distance between the clip-pulley on the engine which is placed horizontally, and the clip-pulley on the pumps which is placed vertically is 363 yards. The gradient being 1 in 15•66, and the engine standing seventy feet above the level of the suction-pipe; and the perpendicular height between the suction-pipe, and delivery-pipe being seventeen-and-a-half feet according to Plate XVIII.

Plate XV. shows a section of the engine-plane at the main winning, also ropes working from a clip-pulley attached to a stationary engine. (Plate XVI.) — The engine is a common high-pressure with a twelve-inch cylinder, a small pinion-wheel is attached to the fly-wheel shaft, which is connected with a large wheel attached to the shaft of a five-feet clip-pulley, placed vertically, from which the rope is taken nearly 700 yards to a portable nine-inch pump, to which is attached a five-feet pulley. The pump-rods are connected to the shaft by means of cranks direct from the axle of the pulley; the distance between the two clip-pulleys is nearly 700 yards, and the perpendicular height between the engine and the pump is 125 feet. The gradient is 1 in 14•3, the delivery-pipe is nearly 400 yards above the pump, and the perpendicular height the water is raised eighty-three feet. Only one of the nine-inch pumps is working at present. The cost per day and night for labour consists of the wages of two enginemen and two men attending to the rope, sheaves, and pump. The quantity of stone laid dry by this engine is equal to 1,200 tons per day, which makes the cost •25d. per ton for all expenses connected with engine, pump, labour, and ropes.

Plate XX. is the plan and elevation of a portable double force-pump driven by clip-pulley in the main winning.

A clip-pulley, six-feet diameter, working inside Upleatham mines, down an incline with a gradient of 1 in 12, lowers down with ease and safety thirteen tubs at one time, each containing above thirty-two cwts. of ironstone, independent of the weight of the tubs (weighing about nine cwts. each). This clip-pulley is managed by a boy fourteen years of age, who has perfect control over the load, and can stop it in any part of the incline desired without in the least injuring the rope, he having frequently lowered the loaded set of thirteen tubs to the bottom of the incline without the compensating balance of the empty set, which proves the assertion formerly stated that it can be absolutely depended upon when once adjusted.

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A clip-pulley eight feet diameter is also used at these mines in lowering trucks down an incline of 1 in 11; the weight of each truck is on an average when loaded fifteen tons. Three of these trucks compose the quantity lowered down at one time. This clip-pulley has been recently placed to supersede a pair of twelve-feet drums, which have been used at these mines nearly nine years. The advantage to he derived from this is, that only one rope is required instead of two, thereby diminishing the original cost of ropes, and securing a greater uniformity in the wearing of the ropes, also a greater security in case of a break of the rope, the clips holding uniformly which is not so on a roll or drum.

From my experience in the working of clip-pulleys, I think that they are considerably more economical than the ordinary method of drums, and are capable of being applied to any place where a drum is or has to work. Also for pumping purposes, where the pumps have to be carried forward as the places progress, they cannot be superseded. The despatch with which the portable-pump, with the clip-pulley attached, can be removed is to be highly commended for mining operations.

Plate XXI. is a plan and elevation of a clip-pulley, applicable for conveying power to underground workings from engines placed upon the surface, the application of which the writer has not seen in operation, but from the experience already acquired he is perfectly satisfied that it is suitable for the purpose, and he intends putting it into operation the first opportunity that presents itself.

Plate XXII. is a drawing of a thirty-horse portable-engine with clip-drum attached vertically.

Plate XXIII. is a drawing of a five-inch double-acting pump, driven by the portable-engine Plate XIX. at the inclination shown on Plate XVIII.

Messrs. Bell Brothers have several of these pulleys pumping, etc., etc., also Messrs. Bolckow and Vaughan.

A clip-pulley four feet diameter has recently been erected, and is now working with perfect success at Cowpen Colliery, under G. B. Forster, Esq.

Plates XV. to XXIII. illustrate Mr. Cockburn's paper on Underground Conveyance in the Cleveland District, and on the Clip-pulley.

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NORTH OF ENGLAND INSTITUTE OF MINING ENGINEERS.

GENERAL MEETING, SATURDAY, APRIL 6, 1867, IN THE ROOMS OP THE INSTITUTE, NEVILLE HALL, WESTGATE STREET, NEWCASTLE-UPON-TYNE.

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

The minutes of the Council were read, and a second sum of £50 was, on the recommendation of the Council, voted for the use of the Tail-rope Special Committee, to enable them to prosecute their investigation and experiments further.

A report was also read by the Special Committee, appointed November 3rd, 1866, to revise the duties of Secretary. The report was adopted by the general meeting; and the sum of £25 per-annum was voted unanimously to Mr. Doubleday on his resignment of the duties of Secretary.

The following new members were elected:— Mr. John Thompson, Norley Colliery; Mr. D. G. Dunn, Greenfield Colliery, Hamilton, N.B.; Mr. W. France, Upleatham; Mr. Wm. B. Harrison, Norton Hall, Cannoch, Staffordshire; Mr. Thos. Dawson, Garmondsway Moor, near Ferryhill. Mr. Wm. Armstrong, jun., Londonderry Collieries, Seaham Harbour, was elected a graduate.

Mr. D. P. Morison read a paper on Underground Conveyance at Pelton Colliery.

Mr. Daglish said, this paper seemed to corroborate his own.

Mr. Morison said, one thing ought to be borne in mind. The engine had been reduced to a common velocity; but to arrive accurately at results in horse-power, the diameter of the coils on the drums ought to be taken into consideration.

Mr. Daglish said, he did not think the horse-power was the measure of resistance so much as the diagram. Horse-power was to a great extent boiler-power.

Mr. Morison said, the size of the diagram was increased in proportion to the speed at which the engine was working. Consequently, you have an increase of the diagrams, and, on account of the speed, in case the engine has more work to do, more steam would have to be introduced. In both cases the diagrams are increased.

Mr. Daglish — By letting the steam in faster, you would have much the same diagram, but an increased number of strokes.

Mr. Morison — The reason you have a higher power is that the diameter of your drum is increased so much; and with this additional power, instead of seventy-six horse-power absorbed by the ropes, it only comes to something like forty-eight.

Mr. Daglish said, this was even higher than he made it out to be in the special instance he had given in his paper. He thought it something under fifty per-cent. He made forty-three horse-power out of ninety-four.

Mr. Morison — What is the leng-th of your rope ?

Mr. Daglish — 2500 yards.

Mr. Morison said, as he had mentioned in his paper, no doubt the increased friction at the curves did make a difference. On a straight line a man with a winch at 5 to 1 could move the rope along, the power must be lost at these curves.

Mr. Daglish said, a member, who, he hoped, would have been here, was possessed of a good deal of valuable information on the subject. He had had occasion to go into experiments, not in the same form, but bearing upon it — the friction of belts for turning machinery. He believed Mr. Ramsbottom had made extensive experiments, and found that in belts for travelling cranes seventy-five per cent, of the power was absorbed.

Mr. G. B. Forster said, that was rather a different question. It showed the great loss caused by using belts.

Mr. Daglish said, he believed that curves caused a great loss of power with tail-ropes.

Mr. Morison said, it was on this account that in the west way, which was 600 yards shorter, the power required to move the ropes was almost the same.

Mr. Steavenson stated, in confirmation of the results obtained by Mr. Daglish, as to the large per-centage of power absorbed by the machinery and ropes when hauling tubs upon engine-planes, that he had made experiments upon an engine with two cylinders of twenty-inches diameter and three-feet stroke, the plane being 1,700 yards long, with two curves in it, the one three chains and the other four chains radius.

The diagrams were taken at a speed of forty-six revolutions per minute; their scale being 1/24.

No. I., Plate XXIV.— The ends of the main- and tail-ropes were coupled together without any tubs attached. It shows that forty-two H.P. was required, simply to move the engine and ropes.

No. II., Plate XXIV.— This diagram was taken when hauling forty-five tubs up a gradient of one in thirty-one, and gives the gross force applied, namely, ninety-one H.P.

These experiments, therefore, afford as a result 53•85 per-cent. of the power applied as effective, and 46•15 lost in friction, etc.

This agrees very closely with the figures of Mr. Dagiish (see p. 56, Vol. XVI.); the difference in amount utilised being •5 per cent.

BY MR. DAGLISH. BY MR. A. L. STEAVENSON.

To drag load	94 H.P.	... ...	91 H.P.
Ditto ropes and engine ...	43 H.P.	... ...	42 H.P.
Per-centage of force effective	54•26	... ...	53•85

Practically these results may be considered as proving the accuracy of each other, but they are not strictly correct as to the power utilised, because the friction of machinery running without its load is very different when the machine has its load on, and the results are, therefore, better than they should be, and I hope to be able, at an early date, to show what the work done in hauling the tubs really is, taking into account their weight, ascertained friction, and the height and speed; also, by application of a dynamometer, to find the force passing through the rope, the remainder being the loss in the engine.

It is also necessary to reconcile these results with the extensive experiments conducted by the late Mr. Nicholas Wood (and referred to by me at our last meeting, see p. 286, Vol. III.), upon the moving power required to drag out the rope on a plane where the inclination is sufficient to avoid the necessity for applying a tail-rope, and by which it is proved that a power equal to one-twenty-eighth of the weight is sufficient to drag the rope, over sheaves and rollers, nearly 2,000 yards. There can

be no doubt as to the accuracy of these figures; and I believe the great loss of power will be found in properties of the tail-rope, peculiar to itself, and in curves. Then, if we look further on in the same paper, at page 294, we find the average performance of the Springwell engine to be 53•4 per-cent. of the pressure upon the piston; and in Mr. Nicholas Wood's general results, page 313, he gives the efficient performance of engines on an average, with tail-rope, 40 per-cent., and without, 50 per-cent. The conclusion to be arrived at from all these experiments and results is that there is great room for improvement, but whether by endless-chain, the atmospheric railway, locomotive, or some principle yet to be evolved, I do not at the present time wish to enter upon.

Mr. Greig said, he would give some information on the haulage of ropes in steam ploughing at a future day. He had not got his experiments completed yet.

Mr. G. B. Forster inquired if there was any increase of friction allowed for when they put the load on to the engine.

Mr. Daglish said, Mr. Morison suggested five per-cent. That was not much. There was a greater strain on the drum when it was loaded; but the rope itself formed the great portion of the load.

The President said, they were very much indebted to Mr. Morison for his paper. He would now call on the Tail-rope Committee to read their report.

Mr. Cochrane, as secretary of the Committee, read the following report:—

TO THE NORTH OF ENGLAND INSTITUTE OF MINING ENGINEERS.

Gentlemen,— The Committee appointed on the 14th July, 1865, to report upon the various systems of the underground haulage of coals have now the pleasure of presenting their first Eeport.

The grant of £50, which was made to them in September, 1866, and the purchase, by your Council, of instruments required for the investigation, have enabled them to carry on the experiments necessary for attaining the objects which the Institute had in view when appointing this Committee.

Of the five systems which the Committee have to report upon, they have examined the endless-chain, and they are now engaged with the tail-rope. They think it advisable to present their report on the endless-chain at once, as the results are very interesting. They also present a report on one mode of using the endless-rope.

The endless-chain system has been tested at Burnley, in Lancashire, principally at the collieries under the direction of Mr. Waddington, where it is carried out more largely and more perfectly than at any other collieries ; and the Committee consider that they have among these reports the most effective work of which this

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system is capable. It is highly satisfactory, and to many members of the Institute will be surprising. It is a system which, in the opinion of the Committee, answers remarkably well in conditions similar to those which prevail in the Burnley district, and it can and no doubt will be largely used in other coal-fields, when its merits are known.

The following appear to be some of the chief advantages of this system. The first construction is very simple and cheap. The way need not be levelled ; faults may be surmounted at almost any gradient. The direction can be varied as required by the angle of the mitred or other gearing at any station. The rails need not be so good, or so expensively laid as for high speeds. There are no sheaves to support the chain ; hence a great saving in wear and tear. The length of chains is only twice the length of road instead of three times, as required for tail-ropes. The chains last twelve years, and then work lighter "ginneys." The working of the ginneys is very simple ; there is no waiting for sets on the main or branch roads ; tubs may be run on or off the main line without stopping, and with no sidings. There is no waste of power by drum-brakes, and the tubs descending help those ascending. No idleness is possible when the ginney is going.

The line of rails and chain is so easily and quickly extended in any direction, that putting distances are very short; in the Burnley district, about thirty yards on an average.

The Fowler's Clip-pulley has been tested at Shireoaks: it is at present of limited use, and at this colliery is not extensively applied. A trial on a larger scale and of different arrangement, in the North of England, is being made, and the Committee purpose to make further experiments. The difficulty of adaptation to branches and curves, also to varying gradients, is an objection to this system.

A clip-pulley for endless-chains may prove to be a desirable arrangement, reducing friction and preventing much of the noise which occurs at each "ginney." It has received the attention of the inventor of the clip-pulley, and the Committee hope to give a description of it in a later report.

Your Committee regret that hitherto they have been unable to obtain permission to test the endless-rope, as employed at Cinderhill, where a slow speed and a double line of way are adopted, and several sets are running simultaneously on the full and empty sides. It seems desirable that the slow and regular delivery should be adopted in this system in preference to that used at Shireoaks; there is much, however, to be done to accommodate this system to an extensive underground plane, and probably it will be found that gearing similar to that of the endless-chain, as already described, will be required at branches to make it practically useful.

The Committee have expended up to the present time the sum of £38 9s., leaving a balance in hand of £11 11s. They consider that the information which is being obtained will satisfy you as to the expediency of making a further grant which will be necessary in order to complete the experiments.

The Committee beg to remind you that it is in consequence of the gratuitous services of the engineer, and the facilities afforded to them at the various collieries, that the expense falls so lightly on the Institute, and they take the earliest opportunity of thanking Mr. G. H. Wright, who acted in that capacity for the first two months, and Mr. E. Bainbridge who succeeded him, and is still working for them. These gentlemen volunteered to carry out the experiments wherever the Committee wished, and the Committee have only borne the actual expenses. The attention and skill which have been devoted to the work are sufficiently evidenced by the results which the Committee now lay before you. The Committee also beg to record their thanks to the owners and managers of the collieries where they have been allowed to conduct experiments. Expense and inconvenience have no doubt been incurred by them, but every facility has been gladly afforded, and information given in such detail as deserves the warmest thanks of the Institute.

(Signed) WM. COCHRANE, Hon. Sec.

Mr. G. B. Forster, assisted by Mr. E. Bainbridge, gave a detailed account of the experiments, which were illustrated by diagrams. After a brief conversation on the subject, the President called on Mr. J. P. Harper to read a paper "On Harper's Improved Safety-cage Apparatus."

After reading the paper, Mr. Harper said the invention was in course of being patented. It was designed for ordinary iron-wire conductors, and the principle was that of compression. It pressed not only the side, but the whole circumference of the conductor. The effect of this was that the conductors were preserved uninjured.

Mr. Nelson Smith produced his model of Broadbent's Patent Safety-cage, and again pointed out the merits of that invention. Wherever it was used the ropes had been found uninjured.

The President said, they were indebted to Mr. Harper, who was a member of the Institute, for his paper. He believed that he (the President) was one of the first that tried Fourdrinier's Safety-cage. Previous to that time it had been the custom to examine the ropes, and now it became necessary to watch the safety-cage. For his part he preferred looking after the ropes. These cages might be better than Fourdrinier's. He saw some safety-cages working at Lord Fitzwilliam's collieries last week. They were said to answer very well; but they never had been called into use, and, therefore, one could not say whether they would hold or not.

Mr. Smith said, at Titus Salts' both ropes broke, and the cage fell full twelve inches. It was the means of saving the lives of the men in the cage.

The meeting then broke up.

Plate XXIV. —Diagrams to illustrate Mr. Steavenson's experiments and remarks, p. 103.

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NORTH OF ENGLAND INSTITUTE

OF

MINING ENGINEERS.

GENERAL MEETING, THURSDAY, MAY 2, 1867, IN THE ROOMS OF THE INSTITUTE, NEVILLE HALL, WESTGATE STREET, NEWCASTLE-UPON-TYNE.

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

A letter was read from Mr. Ansell, requesting that copies of his paper should be furnished to him, which was agreed to.

Mr. Doubleday read the Report of the Committee appointed to select a site, etc., for the proposed Memorial Hall.

After some discussion Mr. Marley proposed that the Committee be empowered to open a negotiation for the purchase of a suitable site, subject to confirmation by a general meeting of members.

Mr. Lishman seconded the resolution, which was carried unanimously.

The following1 new members were elected :— Mr. John Straker, West House, Tynemouth; Mr. James Burrows, Douglas Bank, Wigan, Lancashire; Mr. B. P. Bidder, Powell, Duffryn Collieries, Aberdare; Mr. W. S. Cope, mining engineer, North Staffordshire.

THE LONG-WALL SYSTEM.

A discussion then took place on Mr. Lishman's paper "On the Long-Wall System."

The President asked Mr. Lishman if he had tried the system in workings having both bad and good roofs ?

Mr. Lishman said, he had only tried it in this particular locality. It had been tried in Lancashire in very bad roofs, and it had been found to answer.

The President said, in his opinion they could work far more effectually by long-wall, under a bad roof, than with a good one, because the bad roof would fall so freely behind.

Mr. W. 0. Wood said, that in case of a bad roof, they were just as liable to be obliged to leave small pieces of coal between the packed wall and the coal left for the next working, as they were in ordinary pillar working.

Mr. Lishman said, yes, in rotten roofs; but, in this case, it was blue metal, six feet thick, with overlying sandstone strata, which kept it quite free and open. Since this paper was read he had had the per-centage taken of four days' work of 2580 tons, which produced 900 tons of best merchantable coal, equal to thirty-four-and-a-half per-cent. of best. He had the long-wall system tried four nights, out of which he got a few scores. During the four nights there were 470 tons, which produced 190 tons of best merchantable coal, or equal to 40•4 per-cent. of best to 5•9 per-cent.

Mr. Marley inquired if there was any distance between the two places where it was tried, and any difference between the strength of the coal ?

Mr. Lishman said, the four days' work was from the ordinary working, and in the long-wall district it was pretty uniform.

The President inquired what was the length of the wall face ?

Mr. Lishman said, it was fifteen yards in width, and twenty-five yards in length.

The President said, this was only partial long-wall. It was in a measure the Yorkshire plan, and it was identical with the system which he had seen pursued in Lancashire last year.

Mr. Lishman said, the cost of this plan of working came to about one-fifth more per ton. He tried the expense of working out a pillar of coal nineteen yards in width by thirty-three in length, to try the comparative expenditure, and he found that the cost was one-fifth more per ton by long-wall working than by ordinary working under the old system. To make up for this, however, they got 420 tons more of merchantable coal out of an acre; and, in addition to this, they would lose, on the other plan, something like four or five per-cent. in the pillar, or 220 tons to the acre. By the modified plan of long-wall they got it very nearly all off. On the gross area the loss was rather more than three per-cent. on the ordinary working. There was comparatively no loss on the long-wall system.

The President said, he was afraid Mr. Lishman would have a loss.

Mr. Morison inquired how far the work of deputies was affected by the system ?

Mr. Lishman said, there was the ordinary deputy work. Two men managed to keep fourteen men in the broken.

Mr. J. Bigland said, he thought that Mr. Lishman had hardly given them all the information he might have given. First, as to the distance from the goaf to the coal in the " bay." Next, how often he changed the chocks, and how long the chocks stood ? Standing one day they did not get much weight; but when they stood four or five days they got a crush. Then as to the produce, he said the whole of the mine might be obtained, but he would like him to say how much was obtained? In his list of advantages he said — "less shift or dead work." He (Mr. B.) could not agree with that, and thought that when the area of the goaf became enlarged, the labour would be increased. Mr. Lishman should have given them some figures, to show how his results were arrived at.

The President said, as the coals were taken away the chocks must be moved.

Mr. Lishman said, they were moved nightly. In long-wall the money had to be laid out earlier than under the other system for narrow work. You might have a larger quantity, but it cost more for dead work. They heard of creeps coming on; he did not know how Mr. Bigland found it.

Mr. Bigland — We have none.

The President — How did you take out the pillar ?

Mr. Lishman — By driving a jenkin up the side. The pillar was thirty-three yards in length, and nineteen in width.

Mr. Cockburn inquired if Mr. Lishman's plan had been sufficiently tried ? He thought that was the drift of Mr. Bigland's remarks.

Mr. Bigland said, the long-wall system had been tried long enough in other collieries ; but at Newton Cap they had hardly had time to get a crush.

The President said, he thought the trial had been too short.

Mr. Bigland said, on such an important subject they wanted a little more information.

The President said, he had visited a colliery about twelve months ago in the neighbourhood of Sheffield. The Barnsley bed was only four feet eight inches in thickness. They had gateways at every eighty or one hundred yards. They took down in these gateways six feet of stone

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and packed it on each side, and they never had any shift-work afterwards, and they got the coals out well. Taking- the stone down cost twelve shillings per yard at first, but not another penny after that.

Mr. Bigland said, that at Adelaide Colliery, where they worked a large quantity of broken, they removed the whole of the pillar at once by means of chocks. The labour of changing the chocks was considerably more than under the ordinary system, and they lost a quantity of them. There was not only the loss but they were destroyed in the mine. At first they thought they got all the coal, like Mr. Lishman, but they now found they were not getting it all. They got wide boards every twenty-two yards in the first working.

Mr. Lishman said, they had already got a surface fall, but it was not perceptible. The farther portion (shown on the diagram) was all worked off. They were busy with the other between the first and second boards. This was at a depth of fifty-five fathoms, and the seam was four feet eight inches thick. He was laying out more pit room on the same principle.

The President said, it was a subject which required great consideration, and it was most important to the district at large. If they could get four or five per-cent. more merchantable coal than by the old system it was a very important thing. If they could save two hundred tons to the acre it was a very important thing to the country.

Mr. Cockburn said, if it could be done at the same expense it was very important.

Mr. Lishman said, he asked Mr. Dickinson last year, at Manchester, which system was, in his opinion, the best. He replied, "If you go and see this particular place (Clifton Hall), you will say it is the best system in the kingdom."

The President said, Mr. Dickinson drives exploring drifts to the far side of the royalty. At Seaton Delaval they had two miles to go, and it would not suit to drive two miles before working coal.

Mr. Lishman said, you might lay out a district within that district.

The President remarked that three or four months hence perhaps Mr. Lishman would enlighten them a little more on the subject, and that he would then tell them what quantity of coals per acre and square yard he had got.

Mr. Marley said, great credit was due to Mr. Lishman for giving them his paper even in its present unfinished state. He hoped Mr. Bigland would follow it up and give them the results as to his twenty-two yards pillars. If he would go and see Mr. Lishman at the workings

and talk with him there, as well as in the railway carriage, it might help them to arrive at sound conclusions.

Mr. Bigland — I shall be glad to go.

Mr. Marley continued — Perhaps the crush was partly attributable to these boards which he had got at every twenty-two yards. In answer to Mr. W. 0. Wood's remark that there was no distinction between them and the ordinary pillar workings, to some extent he was under a mistake. In long-wall, if they did get it carried out, they got relieved of the pressure behind the chocks; therefore, they did not get that pressure on the coal which they had in the broken or pillar workings. In South Staffordshire, in 1849, he remembered seeing the worst roof he ever saw worked in long-wall. They used a portion of their broken timber for putting in between the chocks, so as to keep up the same and save any portion of coal being left, as was done in the board-and-pillar system in the jenking, so that that loss of coal was not necessary.

Mr. Lishman said, relative to the crush, Mr. Bigland would find that the last pack-wall had a tendency to keep the crush off the chocks. The roof settled down upon it, and there was nothing like the crush that they expected, because the two packed-walls operated as pillars and kept the crush off.

Mr. Bigland said, he was not speaking without experience. He found that with the pack-walls the chocks were crushed to some extent. He had tried them three yards thick in a wide board.

The President said, he had seen coal worked in the ordinary way at Brancepeth, where they did not lose more than five per-cent. Mr. Wood would bear him out in that statement.

Mr. W. 0. Wood said, when the roof was anything like good, a very small per-centage was lost. There might be a little "stook" left at the end of the pillar. He observed in the plan here, that a good deal was supposed to be lost at the end of the pillar, and also between the lifts. There was none of that loss at Brancepeth.

Mr. Cockburn inquired if they were working in Brancepeth on the old regular system ?

Mr. W. 0. W^ood said, yes, but it had been varied a great deal. In fourteen- or fifteen-yard pillars they put a jenkin in the middle.

The President — That does very well where it does not matter whether the coals are round or small.

Mr. Lishman said, he had a little experience in that district. It was a strong post roof.

Mr. W. 0. Wood said, there was a good deal of blue metal. He had

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had pillars forty yards square, and removed them on a similar principle to that advocated by Mr. Lishman. When they had pit room to spare that they could work on this plan, instead of the ordinary pillars, they did so. It was a great saving of timber.

The President inquired if the hewers got less or more?

Mr. Lishman said, the score prices were the same in long-wall as in pillar working; but the men make considerably more wages. The broken was sixpence less than the whole.

The discussion was then adjourned.

The discussion on Mr. Cockburn's paper, "On Underground Conveyance and the Clip-pulley," was postponed, some delay having occurred in printing the paper. It was observed that Mr. Spencer had given notice of a motion that papers should be printed before being read.

Mr. Marley said, as this would put more responsibility on the Council, and involved to some extent a departure from the rule, the proposal had better be made at the June meeting, and discussed at the annual meeting.

The President suggested that it might be well to have all their general meetings on a Saturday, and the suggestion appeared to meet with general approval.

BASTIER'S PATENT.

Mr. Bigland said, that some time ago Mr. Greener read a paper on Bastier's patent chain-pump. At that time there was no pumping apparatus in the district to which he could refer. About a month ago they had commenced one at St. Helen's Auckland. It was raising water forty-five fathoms from the yard-seam, and was working every day, and giving satisfaction. It was a small one, the diameter of the pipes was three-and-a-half inches. The cylinder was nine-inches diameter, with eighteen-inches stroke. They were raising a hundred gallons per minute. Though small it showed the principle. They had no engineman, and no extra fireman. The same staff kept it going.

The President said, he had recently put a new engine at the bottom of the pit at Seaton Delaval, to force the water to the surface, and it was pumping at the rate of six hundred gallons a minute. It was at the depth of 112 fathoms, and they thus avoided the use of spears. The length of stroke was four feet, and it could go forty strokes a minute. There were other engines of the same description in use; Lord Durham had two or three working regularly.

The meeting then broke up.

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ON HARPER'S IMPROVED SAFETY-CAGE APPARATUS FOR THE ORDINARY WIRE-ROPE CONDUCTORS.

By JOHN P. HARPER.

As there have been very recently both papers and discussions on safety-cages before the members of the Institute, I will not encroach on your time in adverting to the different descriptions of apparatus from time to time brought under your notice; the main features of which are well known and understood by all connected with mining operations.

There has been, and is still, great diversity of opinion in this matter, for, while some earnestly advocate the general adoption of safety-cages, others are equally prejudiced against them.

Generally we are all agreed so far, that if the apparatus be not a reliable one, in any way easily deranged, or of complicated mechanical construction, the evil sought to be remedied is increased rather than diminished. My safety-cage differs both in principle and detail from any that have preceded it, and certainly stands alone in this respect, that it is specially designed, constructed, and adapted for the ordinary wire-rope conductors.

Safety-cages have hitherto been brought out more particularly for adaption to the wooden guides, but, as these are fast becoming superseded by the iron-wire ones on account of their durability and cheapness — if safety-cages are to be universally adopted, they must be made applicable to the wire-rope conductors.

I think, indeed, that safety-cages can be used to greater advantage in connection with the iron-wire than with the wooden guides, for, with the wooden ones sharp-pointed or toothed instruments are usually

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brought to clutch or dig into the conductor, and if it so happens that the length of guide rods on which the apparatus is brought to play be rotten, unsound, infirmly fixed, or in any way defective, the safety apparatus is of no avail; indeed sometimes, be the rods ever so sound and in good repair, we hear of accidents occurring, owing to the guide rods being split and ripped down by the apparatus brought to bear on them.

Accidents of this description are less liable to occur with the iron-wire guides. I have latterly devoted a considerable time in experimenting upon them, and have found that it would not do to employ an instrument with a sharp point, a toothed or uneven surface, to bear on the conductors, for, as the circumference of a wire-rope is uneven, they would cut and injure the more prominent parts.

The safety-cage, which I now desire to call your attention to, answers beyond my most sanguine expectations, acting- effectually without damaging or depreciating in the least the wire conductors, of whatever description they may be. The apparatus is extremely simple, substantial, inexpensive in its construction, is not easily deranged, and can be applied to cages and hoists, of whatever description or size, whether conducted at the ends, corners, or sides, and carrying any weight. The principle by which the apparatus, on the severance of the winding-rope from the cage, is brought to bear on the conductors is by compression; and its operation is (of its own accord) to bring the cage to an immediate stand by means of catches or compressors which fasten on, encircle, and compress not only the sides but the whole circumference of the conductor.
When the winding-rope is re-adjusted by the tension of the rope, the compressors spontaneously release their grasp of the conductors, and the whole is again in working order.

The general features of the cage will be readily seen by referring to the working models, which will also admit of being experimented upon (see annexed drawing of model No. 2, Plate XXV.). As the catches, or more properly the compressors, are of very peculiar shape, I have wooden models to show their general construction, [a model was handed round for inspection] and also detailed drawing-s of them (Plates XXVI., XXVII., and XXVIII.), showing their positions when out of play, and held from the guides by the tension of the rope, the position they assume when first brought into play, and the iron wire-guide in extreme compression. This will, of course, vary in proportion to the weight on the cage at the time they are brought into requisition.

Model No. 1, the smaller of the two, is one-fourth the full size of a

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description of cage used at small collieries, ironstone and lead mines, where one wagon at a time only is drawn, and conducted on each side with the ordinary wire-rope guides. No. 2 model, the larger one, is a design one-sixth the full size, for douhle cages in a thirteen-feet shaft, fitted with wire-rope conductors, each cage having two, three, or four guides as may he required, and single or double tiered to carry either two or four wagons. I have chosen these two forms of cages to show that the apparatus can he applied successfully to cages of any description, and carrying any weight.

Both cages, although varying slightly in detail, are precisely similar in principle (for this reason a drawing of No. 2 model, Plate XXV., only is annexed). On the small cage, model No. 1, the apparatus is attached to the sides of the cage, and is brought to bear simultaneously on both conductors.

On the large rectangular cage (model No. 2, see Plate XXV.), though conducted by four guides, the apparatus is brought to bear on two only, that is, across the corners. The compressors, which are made of malleable iron and case-hardened (lettered A on Plate XXVITI.), are of peculiar construction (see detailed drawing, Plate XXVII.), made in plan, in a fork-like shape, and of any proportionate elevational depth. They work on each side of the conductors on axles, B, attached to the cage, and when not in play are held by the tension of the winding-rope at an acute angle; and, when brought into play, as presently explained, slide into each other, and encircle the conductor, assuming a nearly horizontal position, and forming, both in plan and elevation, a circular hole the full depth of the compressors, but less in diameter than the conductor, so that as the angle is made to increase in proportion to the weight on the cage, so will the compression also increase on the conductors.

The compressors A are constructed with lever ends, and when the cage hangs freely on the winding rope they are held away from the conductors by side rods D, attached on each side of the cage, to main vertical and shouldered rods E working through guide boxes F, in which are inserted spiral springs (merely to give impetus to the compressors) bearing on the inside shoulders of the main vertical rods E, which are connected on each side of the cage by a cross bar G, working over the top or cover of the cage H, and attached to the winding rope. To prevent the compressors A wrenching apart, they are connected by a front tie-plate C. K represents ordinary cast-iron guide boxes through which the conductors slide.

By the above description, and with reference to the working models

(see drawing of model No. 2, Plate XXV.), it will be seen that when the cage hangs freely on the rope the shoulders on the main vertical rods E are brought up by means of the cross bar G to the undersides of the grade boxes F, and the compressors, now being held away from the conductors, are allowed to pass freely between the forks of the catches, but immediately on the rope becoming disconnected from the cross bar G the concealed spiral springs, hitherto held in subjection, are released, give impetus to, and assist in bringing the compressors A into instantaneous play, which, then sliding into one another so close round, and compress the conductor into a circular hole, less in diameter than the conductor itself, through which it is impossible for it to pass, so that the cage is brought to an immediate stand.

In the arrangements by which the compressors are connected to the winding rope, it will be perceived that both sets must work simultaneously on the guides, and are such as cannot be easily deranged.

I may add, in conclusion, that the apparatus and arrangements are in course of being patented, provisional protection having been already allowed.

Plates XXV. to XXIX. illustrate Mr. Harper's paper "On Improved Safety-cage Apparatus, etc."

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ON
UNDERGROUND HAULAGE AT PELTON COLLIERY

By D. P. MORISON and JAMES NELSON.

The means of conveying coal underground being of such great importance to the efficient working of collieries, as regards the speed and economy of producing large quantities of coal, and there having already been some papers read on the subject, and published in the Transactions of the North of England Institute of Mining Engineers, it occurred to the writers to lay a summary of the results of some recent experiments, made by them, before the members of the Institute.

These experiments were made, and this paper was compiled, before the writers were aware that the investigations, now being carried on by the recently appointed Tail-rope Committee, would bear upon the subject in a much more detailed and interesting form. It will, however, not be out of place to set before you the following data, as they may be of some use to the Committee in elucidating the same subject, from, perhaps, a different point of view; and, also, as they have a special bearing on the papers read on previous occasions by several members.

The experiments were made at Pelton Colliery, on two of the principal branch-lines in the engine-plane of the Hutton-seam, termed respectively the "South-Side-New-West Way" and the "Far-Off Way," the length of the former being 2354 yards, and of the latter 2995 yards, both measurements being taken from the drums of the engine to the return sheaves.

The way on these two branches is in remarkably good condition, a considerable portion having been lately relaid with heavy-edge rails, chaired and fished at the joints, and carefully cross-levelled and ballasted over the whole length. The weights of these rails, with the numbers and weights of sheaves, rollers, and drums, are given in Appendix No. III.

The engines, of which a plan on a small scale is annexed, Plate XXX., are two horizontal cylinders, twenty-four inches diameter, with three feet stroke, geared two to three into two drums, five feet two inches diameter on barrel. The main-rope is three inches in circumference, and the tail-rope two-and-three-quarters inches, the weight of the Far-Off Way ropes being five tons six cwts. and nine tons two cwts. respectively; and of the New-West Way ropes three tons eighteen cwts., and seven tons two cwts. The sheaves and rollers, for carrying the ropes, are set ten yards apart, of good construction, and may be considered a fair sample of those generally in use in this neighbourhood.

The engines were indicated with two of Richards's indicators, of the best make, and the taps were placed on the ends of the cylinders (without the intervention of any pipes, which are so liable to give erroneous results), diagrams being taken from each end of the cylinder at the same stroke, the revolutions of the engine and the pressure of steam in the receiver being at the same time carefully noted. The motion was transferred to the indicators from the cross-head by iron levers, very accurately adjusted over each cylinder.

The first experiment was made on the engine running empty, and the indicated effective horse-power was 18•362 (as per Appendices Nos. I. and II.). On the ropes coupled in the Far-Off Way the indicated horse-power was 77•742; and on the ropes coupled in the New-West Way 72•99. The Far-Off ropes were then attached to a loaded set of ninety tubs, and in drawing these up an incline of 1 in 74 (at the point marked A on plan and section, Plates XXXI. and XXXII.), the indicated horse-power was 166•535, the diameter, including coils of rope of the main drum, being at that point five-feet-six-and-a-half inches; and the engine, therefore, making one revolution for 11•63 feet travelled by the rope. On the same loaded set, when on the level (at the point marked B on plan and sections), the diameter of the drum being then six feet seven inches, and the feet travelled by the ropes for one revolution being 13•78, the indicated horse-power was 134•982.

On a full set of eighty tubs (coming along the point marked G on plan and section), from the New-West Way, the diameter being then five feet ten inches, and the feet travelled 12•21, the indicated horse-power was 120•556. On the same set, at the point B, the indicated horse-power wras 126•218, the diameter of drum being six feet one-and-a-half inches, and feet travelled 12•82.

For the experiments on the empty sets, as well as the data upon which the calculations are based, the writers would refer you to the

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tabulated statements (Appendices Nos. I. and II.); and in order not to take up time by going into them at present, they will merely lay before you the following general deductions from the results of their experiments, which appear to them to be supported by the data given.

First. — That in the New-West Way the power requisite to move the ropes, at the rate of sixty-eight revolutions, or 883 feet per minute, is fifty-seven per-cent. of the total power indicated on the engines when drawing along the level a full set weighing about fifty-eight tons at the same number of revolutions.

Second. — That in the Far-Off Way the power required to move the ropes, at the above speed, was forty-seven per-cent. of the total power indicated when drawing a set weighing sixty-five tons up a gradient of 1 in 74, and 57•6 per-cent. of that when drawing' the same set along the level, both at the same speed of sixty-eight revolutions.

Third. — Inasmuch as the New-West Way ropes are only 6910 yards, and that the Far-Off Way ropes are 8810 yards long, or, in other words, that one is to the other as 1 is to 1•28; and, as the power requisite to work either is nearly the same, it follows that a large per-centage of the power required to move the shorter rope is absorbed by the greater number of sharp curves in the shorter way, and by being bound round a sheave attached to the pumps; and, hence, the tail-rope system, or the haulage of ropes of any description, may be considered to work at a serious disadvantage, where there are any sharp curves; and it is evident that before any fixed and constant per-centage of power lost by ropes or tail-ropes can be laid down, the friction at the curves must be arrived at.

Fourth. — The apparent anomaly of the great loss of power per-cent. in drawing the ropes is explained by the following facts :—

1.—That the weight of the ropes is actually eighteen per-cent. of the total weight to be moved in the Far-Off Way, and nineteen per-cent. of that in the New-West Way.

2.—That a certain amount of friction must be applied to the tail-drum, to prevent the tail-rope over-running or becoming slack.

3.—That the large amount of friction caused by the rigidity of the rope passing round the return sheave, and over the drums and sheaves at all the curves, must be taken into account.

4.—That in the transmission of the total effective power of the engine through the spur-gearing to the drums, a loss takes place of at least five per-cent., in addition to the power absorbed by the friction of the drums.

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The comparisons of the New-West Way and the Far-Off ropes, when hauling, were taken at the same point B; so that the results are in no degree affected by the difference in the state of way — the rails or the gradients in their respective branches.

It may, in conclusion, be remarked, that the writers have arranged a series of experiments by which they hope to be enabled to lay before the Institute an actual rule and formula for calculating the loss of power occasioned by the passing of a rope in a state of tension over a return sheave, or a drum at a curve of any given angle, there being at present no ascertained rules for arriving at these conclusions, as the formulae of General Morin for the rigidity of ropes cannot well be applied in these instances.

[page with plate XXX]

[page with Appendix No. II : Tabulated Statement of Work Performed by Hauling Engine in New-West Way, Hutton-Seam, Pelton colliery]

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APPENDIX No. III.

DETAILS OP ENGINE, ENGINE - PLANE, Etc.

1.—Engine.

Diameter of cylinder ... ... 24 inches.

Length of stroke.. ... ... 3 feet.

Diameter of piston-rod, fore end ... ... 3 1/4 inches.

Do. Do. back end ... ... 2 3/4 „

Area of steam-ports ... ... 20 „

Do. exhaust-ports... ... ... 35 „

Length of main-pipe ... ... 400 feet.

Do. exhaust-pipe... ... ... 300 „

Diameter of main-pipe... ... ... 8 inches.

Do. exhaust-pipe ... ... 9 „

Do. driving-pinion ... ... 4 feet.

Do. spur-wheel... ... ... 6 „

Do. fly-wheel ... ... 10 „

Weight of fly-wheel ... ... 5 tons.

Diameter of drums ... ... 5 feet 2 inches.

Do. do. including Flanges ... ... 8 feet 2 inches.

Width of Drums between Flanges ... ... 3 feet.

Receiver, length 15 feet by 3 feet 6 inches diameter.

2.—Ropes.

	Yards.	Yards.
	MAIN.	TAIL.
Far Off	2990	5820

New West Way 2200 4710

Circumference ... ... 3 inches... ... ... 2 3/4 inches.

Weights—Far-Off ... 5 tons 6 cwts ... ... 9 tons 2 cwts.

New-West Way 3 tons 18 cwts ... ... 7 tons 2 cwts.

3.—Sheaves, per detailed statement.

Distance apart, 10 yards.

4.—Rails.

28 lbs. per yard and 24 lbs. per yard. Gauge of way, 22 1/2 inches.

5.—Tubs.	Cwts.	Qrs.	Lbs.
Average weight empty...	5	2	14
Coals	9	0	7

DETAILED STATEMENT OF ROLLERS AND SHEAVES, ENGINE-PLANE,

HUTTON-SEAM.

Engine to Far Off Station—

	5 in.	8 in.	14 in.	14 by 10.	2 ft.	4 ft.	6 ft.	7 ft.	Total.
Main-sheaves	264	...	...	26	...	...	...	...	290
Tail do... ...	9	170	110	...	7	2	2	...	300
Total...........	273	170	110	26	7	2	2	...	590

Engine to South Station—

Main-sheaves	207	...	...	32	...	...	...	...	239

Tail do	33	71	112	...	18	2	2	1	239
Total...........	240	71	112	32	18	2	2	1	478

APPENDIX No. IV.

Plates XXXIII. and XXXIV.

RESULTS OF EXPERIMENTS ON COMPARATIVE DIAGRAMS TAKEN FROM INDICATOR ON CYLINDER AND IN PIPES.

As a statement affecting the accuracy of diagrams, when taken off indicators connected with an engine cylinder by means of pipes, was made by one of the writers at the last meeting of the Institute, he thought it might be satisfactory to make direct experiments with the view of laying before the Institute a proof of the great discrepancy which invariably arises from the use of pipes when indicating engines.

The experiments were made on the top side of the cylinder of the engine driving the ventilating fan at Pelton Colliery. This cylinder is 23 5/8 inches diameter, 23 5/8 inches stroke, and works at a speed varying from 56 to 64 strokes per minute. The indications were made at the former speed, at nearly the same stroke, and the results were :—

	Effective Pressure of Steam on Piston.		Back Pressure.		Effective Horse-Power.
Cylinder cover ...	19•886	...	1•995	...	58•24
Pipes	15•570	...	4•73	...	45•6

The pipes were half an inch inside diameter, and the length, from cylinder to indicator, was two feet ten and a-half inches, as shown on sketch annexed.

Plates XXX. to XXXIV. illustrate Messrs. Morison and Nelson's paper on Underground Haulage at Pelton Colliery.

[page with Appendix No. 4 : Comparative Diagrams
Cylinder of Fan Engine, Pelton colliery]

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NORTH OF ENGLAND INSTITUTE

OF

MINING ENGINEERS.

GENERAL MEETING, SATURDAY, JUNE 1, 1867, IN THE ROOMS OF THE INSTITUTE, NEVILLE HALL, NEVILLE STREET, NEWCASTLE-UPON-TYNE.

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

The minutes of the Council were read, after which the following new members were elected:— Mr. Benjamin Huntsman, West Retford Hall, Retford; Mr. Edward Greenway, Brierly Hill; and Mr. Thomas Lloyd, Brierly Hill. Mr. Frederick Siddon, of Wigan, was elected a graduate.

UNDERGROUND CONVEYANCE AND THE CLIP-PULLEY.

Mr. Cockburn said, since reading his paper he had made a few experiments on a double-acting pump. It was a nine-inch pump which he had now working at Upleatham Mines. He found that taking the last nine months' working, it had pumped on an average at the rate of 146 gallons per-minute on single-action, and 293 gallons on double-action. Taking the two pumps together, he found they had pumped 352,200 gallons in twenty hours. It was a two-feet stroke, and it gave twenty strokes per-minute. The distance was 450 yards, and the water was forced up an incline and raised vertically eighty-three feet. He estimated the actual weight of water in eighty-three feet of nine-inch pipe to be 6 tons 8 cwts. 2 qrs. 4 lbs. When he calculated the work of the ropes which had been working for nine months, he found they had travelled during that time 18,200 miles; the cost per-mile on the rope being 1•85d. He meant this calculation to be taken in connection with the pumping of the water. In working out the data he found that the actual cost for every thousand gallons of water on the sixteen-inch stroke was l•19d.; and on the twenty-four-inch stroke the cost per thousand gallons was •79d., or a little over three-farthings for a thousand gallons.

The eight-feet pulley to which he had referred in his paper, he found working from two to three thousand tons per day. The gradient was one in eleven, and the brake held considerably. He also found that the brake had not sufficient power in running from the wheel, as it was technically termed. There was another difficulty; the brakesman sometimes laid his lever too strongly on the wheel, and he once broke the rope. He held one side on the incline, and the other went amain. To obviate this he put two screw brakes on the wheel, so that every time the wheel was running into the brake. He found it working in every respect in as satisfactory a manner as he could wish.

Mr. Boyd called Mr. Cockburn's attention to a remark made by Mr. Lindsay Wood at the last meeting, namely, that he had found the wear and tear of ropes heavier on the clip-pulley than it was on the ordinary system.

Mr. Cockburn said, he could not speak as to a comparison between the plain-pulley and the clip-pulley, as he had not the plain-pulley working at the present time. At the Loftus Mines the cost had been •22d. per-ton for the last four months. It was an inclined-plane of one in fourteen, and it was 360 yards long. This estimate of cost included everything except the capital sunk.

Mr. Boyd — You estimate the entire cost including wear and tear, and still it does not amount to more than that?

Mr. Cockburn said, his experience was that the wear and tear was not so much as that. He had it running round three curves, almost at right angles to each other. He might just state for the information of the meeting, that last Thursday morning on his eight-feet pulley on the incline, the socket caught the point-end and held it there till the rope broke. There were three trucks weighing ten tons each, and they were kept quite still by the man holding the brake.

Mr. Steavenson suggested that there ought to be a standard of comparison for experiments agreed upon. Some of the members who read papers gave the cost per-ton, and others gave the quantity of water raised. Mr. Cockburn, in his paper, gave a certain cost per-ton, but he had not given the cost per-ton per-mile. It would be well to give the cost per-mile also. There was a want of uniformity, and it would be

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well if the Council or the Members generally could agree on some uniform standard.

The President said, the Tail-rope Committee were drawing up their paper so as to show the cost per-ton per-mile.

Mr. Steavenson said, the gradients must also be taken into account.

The President — Certainly.

Mr. Morison said, in connection with his and Mr. Nelson's paper, the cost had been gone roughly into as well as they could, the ropes doing both the pumping and hauling. After allowing for the pumping, they estimated the cost at 1•7d. per-ton per-mile.

The President — That is very moderate. I should think that would be the cheapest. You do not take interest of capital?

Mr. Morison — No.

Mr. Douglas — How do you estimate the wear and tear ?

Mr. Morison — We can only take the number of miles travelled by the rope.

Mr. Southern — Do you take the entire working cost ?

Mr. Morison — Yes; tubs, ropes, upholding of the way, and repairs to engine, rollers, etc.; everything but interest of capital.

UNDERGROUND HAULAGE AT PELTON COLLIERY.

Mr. Morison said, they had been waiting, before making any further experiments, to see the report of the Tail-rope Committee. It might give them some help and save them a great deal of labour.

The President said, the Tail-rope Committee were very much engaged. They were progressing; but he feared their report would not be ready before the annual meeting.

Mr. Daglish said, the more their labours continued the more they saw they had to do.

NOTICE OF MOTION.

Mr. Douglas gave notice of motion for the annual meeting, that in in future the general meetings should be held, not alternately on Thursday and Saturday, but always on a Saturday.

SAFETY-CAGES.

Mr. Harper's paper "On Harper's Improved Safety-Cage Apparatus, for ordinary Wire-Rope Conductors," was set down for discussion. The President read a letter from Mr. Harper apologizing for his absence.

Mr. Southern said, in reference to the accident which had occurred yesterday at Washington, that it would be a useful thing to have a committee on safecy-cages, and have the question thoroughly gone into, with a view to prevent such accidents as far as possible.

The President approved of the suggestion, and the following gentlemen were appointed a committee :— Messrs. E. F. Boyd, C.Berkley, S. Crone, T. Douglas, A. L. Steavenson, J. F. Spencer, and Jas. Nelson.

Mr. Daglish said, Mr. Broadbent's agent was present, but he suggested that the discussion should be taken at the next meeting. A model was on the table, and the apparatus itself was at work in one of the West-Rainton Pits. He would be glad to show it to any gentleman who might visit the Alexandra Pit where it was working.

The President — Do you use round ropes or flat?

Mr. Daglish — We use round ropes.

The discussion was then postponed.

The President announced that Mr. G. B. Forster had presented to the Institute a model, which was then on the table, of a malleable iron-beam, which had been put up at Cambois Colliery.

Mr. S. Crone moved a vote of thanks to Mr. G. B. Forster, and said that it was a good beginning to their collection of models, and he hoped other gentlemen would follow the example.

Mr. Cockburn seconded the motion, which was carried by acclamation.

After some remarks had been made with respect to an intended visit to Ryhope Colliery.

The President submitted a resolution which had been already agreed to by the Coal-Trade, namely, that Mr. T. W. Bunning be appointed Secretary to the two Societies.

The motion was carried unanimously, and the meeting shortly after broke up.

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NORTH OF ENGLAND INSTITUTE
OF
MINING ENGINEERS.

ANNUAL MEETING, THURSDAY, AUGUST 1, 1867, IN THE ROOMS OF THE INSTITUTE, NEVILLE STEEET, NEWCASTLE-UPON-TYNE.

JOHN MARLEY, Esq., in the Chair.

Mr. Bunning, the newly-appointecl Secretary, read the proceedings of the Council, and last general meeting.

The voting papers for the election of the officers for the ensuing year were, by the direction of the Chairman, placed in the hands of the scrutineers, Mr. C. Berkley and Mr. G. B. Forster.

The Chairman said, that some little mistake had arisen relative to the election of President. Most of them were aware, that prior to the election of Mr. T. E. Forster, the rule was altered as to fixing the term of office — that it should be vacated in the same way as that of Vice-president, after a period of so many years. Mr. I. L. Bell, in January, 1866, proposed that the term of office should be for three years. The question was not settled till the month of March, 1866. Some members were for two years and others for three years. About twelve months ago it was discovered that the late Secretary had omitted to make any minute as to what rule was arrived at. Then, in consequence of that discovery being made, he had entered in the book that it was not more than two years. Supposing this entry to have been correct, Mr. T. E. Forster ought to have been starred as ineligible in the voting papers just issued. The Council after weighing the matter over, had come to a resolution this morning, which they submitted to the meeting to get out of this difficulty. To decide that two years was what was agreed

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upon, would be to cancel all the votes which had been given by all the absent members, and to decide that three years was so, would leave the matter in such a way that Mr. T. E. Forster would be eligible. The recommendation of the Council was that three years should be declared to be the term, so as to be consonant with the rule as to Vice-presidents.

The resolution on being submitted was carried unanimously.

A resolution requesting the Building Committee to continue their negotiations was also adopted.

Mr. G. T. Manners, of Birtley Iron Works, was elected a member, and Mr. Griffith, of Cowpen Colliery, Blyth, a graduate.

The Secretary read a recommendation of the Council to the effect that, inasmuch as they had appointed a Safety-cage Committee, it would be advisable that the discussion on Mr. Daglish's paper and Mr. Harper's paper, on the subject of Safety-cages, should be postponed until after the Committee had made their report, which was agreed to.

The next subject was a resolution submitted by the Council, viz.:—
That the next monthly meeting be considered special to consider Rule 5, in order that the words "Mining Inspectors during the term of their office, and "be inserted after the words "Honorary Members shall be."

On the motion of Mr. Cochrane, permission was given to Mr. Greener, to translate his paper on "Bastier's Chain Pump" into French.

Mr. Cochrane having raised a question as to the position of Mr. Howse, it was resolved, on the suggestion of the Chairman, that the subject be left to the Council.

The Secretary then read the Annual Report of the Council.

Mr. L. Wood read the Report of the Finance Committee, and presented the Treasurer's Statement.

The Chairman, in adverting to the Report, said, however highly it spoke of the late Mr. Jeffcock, it was not more than he deserved. As an individual member of the Institute he would add one remark, namely, that the Accidental Insurance Company, in the most unhandsome and unwise manner, had repudiated the payment of the insurance on the life of Mr. Jeffcock. The Council had made no comment upon his, but it had been well discussed in the public prints. He (the Chairman) happened to be the holder of a policy in that Company; when it expired, which it would do in November, he should not renew it, and he had told them the reason why. Not only that, but he should recommend every mining engineer and other gentlemen to do the same, and he should be quite willing at any time to contribute his mite towards compelling the Company to pay, which he believed they could

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be made to do. With regard to the papers read at the meetings, he hoped the young members would not wait till the whole of their experiments were completed before they gave the Institute the benefit of their experience. The Royal Commission had been alluded to. A difference of opinion had been expressed as to the advantage of that Commission. He hoped the result of their inquiries, when it came before the public, would inform them, not only what coal they had left, but also that some ideas would be brought out, and facts brought together, such as would assist the mining engineers of the district to find out whether coal exists where it had not been considered to exist hitherto, otherwise the Commission would fall short of its object. They would all join in the eulogium pronounced on their treasurer, Mr. Boyd; but for his services they would not have been in such a good financial position.

The confirmation of the Reports, etc., was carried by show of hands.

Mr. Waller, in the absence of Mr. J. F. Spencer, moved, — "That all papers proposed to be read at the meetings of the Institute, shall be printed before they are read, and that copies shall be given to the members present at such meeting, absent members being supplied as usual." He (Mr. Waller) thought the members would be better able to follow the paper as read, if they had it before them.

Mr. Newall seconded the motion.

Mr. L. Wood said, if the copies were only given to the members at the meeting very little good would arise, as they would have very little time to read the paper after they came to the meeting. It would be better if the copies were posted to members two or three days before the meeting, that they might have time fully to understand the paper.

Mr. Cochrane said, it would throw the entire responsibility upon the Council to decide on what papers should be printed. He thought it better to read all papers to the general meeting; the Council having as usual approved of them generally, and that the sense of the meeting should be taken as to their worth. He was decidedly of opinion that it would be better to continue as they were. He should vote against the alteration.

The Chairman begged to call attention to Rule 17, which was "That 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."

Mr. Newall said, probably the resolution would be taken with a

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little amendment. The time was too short if merely delivered at the meeting. If it were decided that the papers were to be printed before being read, they had better be sent to the members a few days beforehand, so as to enable them to discuss the subject fully.

Mr. Cochrane said, it was a pity Mr. Spencer was not here himself; he understood that such an amendment was quite contrary to Mr. Spencer's wishes. That gentleman did not wish to send the papers to members beforehand, because then the subject would have lost its novelty, and members would not care to attend the meeting. It was a pity Mr. Spencer was not here to state on what grounds he proposed this motion.

The Chairman said, the Council was expected, according to Rule 17, to have read and considered every paper that came before it before it was read to the meeting. Perhaps it was only proper to confess that the Council had not always done that duty. It had relied on the standing of the writers as showing prima facie that it was a proper paper to be read; and they also had relied, on the other hand, that the paper as actually read would be eliminated and considerably improved before it got into the printer's hands, partly by the remarks at the meeting, and partly by themselves. It was too great a responsibility to place on the Council that they should have to decide whether a paper should be printed or not. There had been instances where a general meeting had given instructions to the Council that a paper had better not be printed. Although the object which Mr. Spencer had in view was good, his own view was that they should hesitate in adopting this motion, and see if the Council could contrive something to meet the difficulty.

Mr. Lishman moved as an amendment that the Rule remain as it is, which being seconded by Mr. Greener, was carried by a large majority.

Mr. Dougias's motion "That Rule 13 be altered, and the General

Meetings be held on the Saturdays instead of as at present," was proposed by Mr. Cochrane, seconded by Mr. W. Lishman, of Bunker Hill, and carried by a large majority.

Mr. A. L. Steavenson's paper "On Experiments with Bastier's Patent Chain-Pump" stood for discussion. That gentleman was not present, but a letter from him was read, in which he suggested that further experiments were desirable.

The Chairman said, that he had suggested to Mr. A. L. Steavenson that, inasmuch as the experiments at St. Helen's Auckland had been

made on a pump driven with a second motion, lifting the water after it had been got to the surface higher so that it might be applied to coke oven purposes, there might be considerable difference if those experiments were made with the same pump and engines with the delivery immediately when it arrived at the surface. He would suggest to Mr. Greener, who represented Bastier's pump in this district, that he should forthwith make a delivery pipe at the surface and provide the necessary means at St. Helen's Auckland for working the pump by direct-action, instead of by a second motion.

Mr. Greener said, that in a month's time they would be in a better position at St. Helen's Auckland pump. They had got some crooked pipes there from the parties that enamelled them.

The Chairman pointed to a model showing the working of the clip-pulley, which had been presented to the Institute by the President.

On the motion of Mr. Willis, seconded by Mr. Bailes, the thanks of the meeting were voted to Mr. T. E. Forster for his present.

Mr. Waller then read a paper on Pumping Water, which was illustrated by diagrams.

Mr. Cochrane inquired whether any of the pumps of which examples had been given, were worked at both ends of the beam ?

Mr. Waller said, in one of the examples, Windsor, there was a balance-beam below the surface, but in no case were they worked at both ends.

Mr. Smith's paper "On Fasteners for Safety-Lamps," was withdrawn; and after a vote of thanks to the Chairman the meeting separated.

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ON PUMPING WATER.

By WILLIAM WALLER.

What should be the cost of raising 1,000 gallons of water 100 feet is a question of vital importance to all parties interested in raising coal. My experience is offered, with the following observations, to supply some answer to this question.

It was stated at the Birmingham Meeting of the British Association that the quantity of water raised over the 125 square miles constituting the South Staffordshire Coal-field, was 50,000,000 gallons per 24 hours (representing ten times the weight of coal raised), at a yearly cost of £125,000, or, deducting five per cent, on the stated capital employed, £500,000, at a cost of £100,000. In endeavouring to ascertain the depth this quantity was lifted, I have been informed that 128 yards or 381 feet may be taken as the average depth of the pits of the whole field. Assuming this depth to be the average of the lifts, and the quantities raised by each to be equal, pumping on the South Staffordshire Coal-field costs •343 pence per 1,000 gallons raised 100 feet, or, in other words, per million foot pounds. In endeavouring to establish a comparison between this and the Northumberland and Durham District, I have not at command the same details to guide me that I have quoted for South Staffordshire, and, therefore, cannot come to any conclusion on the matter, except, that from observation I should think it would not be below the •343 pence per million foot pounds above given. But as it was stated, at the aforesaid Birmingham Meeting, that fifteen times more water was lifted than coal in this district, and as the coal lifted in 1865 was 25,000,000 tons, there are something like 84,000,000,000 gallons to raise, say the same height, viz., 384 feet, which, at the same rate, would cost £459,200. This sufficiently shows the importance of the matter.

I propose to place beside these data the results obtained under my own observation in waterworks for the supply of towns, where generally the

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work is more economically executed. Should any object that these are not parallel cases, I submit that the mining engine, works under more advantageous circumstances, for this reason, that, being necessarily in the first instance sufficient to reduce the water, in keeping it at the reduced level it is working well within its power, and under very economical conditions; whereas, the waterworks engine having to contend with ever varying demands, with extra and intermittent exertion, with increased friction and resistance in restricted pipe area, is under every disadvantage. For the purposes of comparison, however, they may be considered as working under similar circumstances.

The Wolverhampton Waterworks raise water from two wells, and the work done in 1849 was equal to raising 426,000,000 gallons 100 feet high, and the cost (coal 7s. 6d. per ton) £750 per annum, being about •422 pence per million foot pounds.

There are two pumping stations, one at Tettenhall, and one at Goldthorn, the former 140 feet deep, the latter 300 feet deep. The standpipe of the Tettenhall engine is 180 feet high, making a lift of 320 feet. The pumps have plungers 13 inches diameter and 10 feet stroke.

The South Staffordshire Water works, in 1859, raised 1,250,000 gallons 450 feet high, at a cost of •22 pence per million foot pounds.

The East London Waterworks Company, in 1849, with 2121 1/2 tons of coal, at 10s. 6d. per ton, raised 2,889,000,000 gallons 100 feet high ; and Mr. Wickstead states the total cost of lifting a million foot pounds, taken on the average of several years, with the different engines, to be as under:—

Single-acting Engine, Bolton and Watt			... ...	•543 pence.
Two	do.	do.	... ...	•358 „
Two	do.	do.	... ...	•333 „
Single-acting Cornish Engine, Harvey & Co.			... ...	•150 „

We see here, from high authority, what a very important difference there is in the duty of the several engines in the same undertaking.

The Southwark and Vauxhall Company, in 1849, with 2920 tons of coal, at 10s. per ton, raised 4,061,000,000 gallons 100 feet high, or •084 pence for coal for lifting a million foot pounds, making the very liberal addition of five-sevenths for labour, repairs, wear and tear, etc. This gives •144 pence per million foot pounds.

The Grand Junction Company, in 1849, with 3170 tons of coal, at 14s. 6d. per ton, raised 2,810,000,000 gallons 100 feet high, or •192 pence for coal alone, for lifting a million foot pounds; adding labour, etc., as before, this gives •276 pence per million foot pounds.

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The Liverpool Corporation Waterworks present a comparison more nearly approaching the general pumping arrangements of a colliery; engines both of the ordinary crank-engine and Cornish type are used, and the cost of pumping is given with great detail and accuracy.

I now proceed to describe these Engines separately, with such remarks as may appear necessary to explain discrepancies, which might otherwise be taken for errors.

At the Bootle Station there were three engines each with beam and crank, and with a single-acting bucket-pump (see Plate No. XXXV.), and worked direct from the beam of each engine. Only two of these engines were worked together, and they delivered through an air-vessel. In 1849, with 1809 tons of coal, at 7s. 3d. per ton, 329,486,250 gallons were raised 170 feet high, or 561,000,000 gallons 100 feet high, giving •281 pence for coal alone per million foot pounds, or, including all expenses, taken from the actual returns, •619 pence per million foot pounds.

At the Bevington Bush Station there was only one engine working a bucket-lift at the outer end of the beam, the cylinder was thirty-eight inches, with a stroke of five-and-a-half to six-and-a-half feet. During one quarter of this year very little work was done, and the expense thereby very much increased. The engine was altered from a bucket-lift to a plunger (see Plate No. I.), and considerable repairs effected. The depth of the well is 150 feet, the total lift being 228 feet. In 1849, with 575 tons of coal, at 8s. 3d. per ton, 95,433,850 gallons were raised 228 feet high, or 217,000,000 gallons 100 feet high, giving •263 pence for coal alone, per million foot pounds, or, including all expenses taken from the actual returns, •789 pence per million foot pounds. Whilst alluding to this engine, I may add that the saving effected by the alteration was, in after years, found to be •201 pence per million foot pounds.

The Soho Station had one beam and crank engine with two pumps, the main pump being a bucket-lift delivering 19•16 gallons, the outer a plunger throwing 15 gallons per stroke with a lift of 247 feet, the well being 140 feet deep. In 1849, with 983 tons of coal, at 8s. 4d. per ton, 168,812,589 gallons were raised 247 feet high, or 417,000,000 gallons 100 feet high, giving •236 pence for coal alone per million foot pounds, or, including all expenses, taken from the actual returns, •480 pence per million foot pounds.

The Water Street or Park Engine was like that at the Soho Station, but both pumps were bucket-lifts like the main pump, delivering about 19•7 gallons, and the outer 17•37 gallons per stroke. The lift was

257 feet, the well being 157 feet deep. In 1849, with 1225 tons of coal at 8s. 6d. per ton, 150,038,675 gallons were raised 257 feet high, or 385,000,000 gallons 100 feet high, giving •309 pence for coal alone per million foot pounds, or, including all expenses, taken from the actual returns, •544 pence per million foot pounds.

The Hotham Street Station had an old engine of the beam and crank class, with a double-acting piston pump (see Plate No. XXXV.), delivering about 14 1/2 gallons per stroke, under a load of 205 feet, the depth of well being 110 feet. In 1849, with 682 tons of coal, at 8s. 6d. per ton, 80,783,430 gallons were raised 205 feet high, or 106,000,000 gallons 100 feet high, giving •419 pence for coal alone per million foot pounds, or, including all expenses, taken from the actual returns, •874 pence per million foot pounds.

The Windsor Station had one engine with about 50-inch cylinder, on the Cornish principle, making about 8 3/4 feet stroke, and throwing about 77 gallons per stroke 287 feet, the well being 212 feet deep (see Plate No. XXXVI.). In 1849, with 1090 tons of coal, at 7s. 7d. per ton, 252,922,650 gallons were raised 287 feet high, or 726,000,000 gallons 100 feet high, giving •135 pence for coal alone per million foot pounds, or, including all expenses, •341 pence per million foot pounds.

The Green Lane engine is of a similar class to that referred to by Mr. Wickstead, and made by Harvey and Company, being a Cornish engine with 50-inch cylinder and 9 feet stroke (See Plate XXXVI.). There were two plunger lifts of 18-inch diameter, delivering 83•4 gallons per stroke 270 feet high, the well being 196 feet below the engine-house floor. In 1849, with 916 tons of coal, at 6s. lOd. per ton, 367,378,629 gallons were raised 270 feet high, or 992,000,000 gallons 100 feet high, giving •075 pence for coal alone per million foot pounds, or, including all expenses, taken from the actual returns, •222 pence per million foot pounds.

Recapitulating the above results, we get the whole comparative cost at a glance.

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We may fairly conclude that the cost of coal for lifting 1000 gallons 100 feet high, or a million foot pounds, need never exceed one-eighth of a penny where Cornish engines of the best make are employed ; and that the total expense, exclusive of interest of capital, for doing this amount of work, might be within one farthing instead of the halfpenny and three farthings we very often find it.

It will be also seen that the larger the amount of duty performed the less cost there is in doing that duty, which clearly shows that Associations formed for draining large districts should, on this account alone, be able to work more economically than the smaller efforts of each colliery proprietary.

Again, when the Bevington engine was altered from a lift to a plunger-pump (see Plate XXXV.), the cost fell from •789 pence to •588 pence; the difference may be explained by the fact that with the bucket-pump the whole weight of the rods had to be lifted with the water, while after the alteration the water was lifted by the weight of the rods, no steam being used except to lift the rods and the small column of water that was below the clack.

The reduction in cost at some of the stations of the Liverpool Waterworks may be attributed, some to improved machinery, and at others to the increased quantities of water lifted; and I would conclude by

* The Liverpool engines, during 1849, were burning two kinds of coal; the price given is the average price of the mixture.

observing that the best system of raising water seems to be a high-pressure condensing engine of large power, working at variable speeds by cataract or other known appliance, and that as a rule the plunger-pump gives the most certain results.

The writer has to acknowledge the assistance and information given by Thomas Duncan, Esq., C.E., of the Liverpool Corporation Waterworks, and Edward B. Marten, Esq., of the Stourbridge Waterworks, formerly of the South Staffordshire Waterworks.

It is not wished to raise an invidious comparison between different modes of raising water, but to give the practical result of pumping; and the writer would wish to disclaim any opposition to plans that have been previously brought before this Association, and to explain, that with a desire to assist in the economical drainage of the district he has responded to the invitation of some of the members, and given in this paper the result of his own experience, confirmed, as it seems to him to be, by the reports of others engaged in a similar enquiry, and though the dates m ay be different the results seem to bear out the conclusions arrived at.

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NEWCASTLE-UPON-TYNE: A. REID, PRINTING COURT BUILDINGS, AKENSIDE HILL.