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Report

In presenting to the members their Report for the year, which this day brings to an end, the Council have, once more, the pleasing task of congratulating the Society upon the progress and general prospects of the Institute. As far as the accession of members may be assumed to be an index of the general utility and good management of an institution, the past year affords evidence favourable to those of the North of England Institute of Mining Engineers. The number of members who have joined the Institute during the past year is twenty-two; whilst the losses by death or by resignation have been nine; leaving a net balance of thirteen additional members.

To draw attention to the great loss which the Society has sustained, by the demise of their late President, would be merely a superfluous task on the part of the Council. That which all feel and which all lament does not need comment, and does not admit of exaggeration. To repair the loss we have sustained the best way is to follow the example set us by our late President, and never to omit, by the exertion of such energy and talent as are embodied in this Society, to aid its progress and to increase its usefulness as an Institution.

On looking through the Transactions of the year just ended, we shall find the Society indebted to the meeting held at Manchester, and to the gentlemen of that locality for a series of very valuable papers, relative, in part, to the geology of the district, but also embracing various practical subjects. Amongst these the merits of various pumping engines have been treated of and discussed in a way calculated to interest and instruct the mechanical as well as the mining engineer. In addition to these the Council may also draw attention to some able papers, as well as discussions connected with the transit of coals underground; a matter of growing importance, as the working of coal becomes more and more extended, and the area to be passed over of greater dimensions.

Turning their attention to subjects of more general interest, the Council cannot refrain from congratulating the Society upon the appointment of a Commission to enquire into the supplies of coal still remaining to this country. And they may further be permitted to express their satisfaction to find an able, experienced, and practical man—as is the President of this Institute—selected, together with Messrs. Woodhouse and Elliot, to take part in an enquiry at once so important and so interesting. That an estimate, substantially correct, of the supply of coal still to be raised from the coal-fields of Great Britain, may be constructed by the enquirers the Council are inclined to admit, and without much hesitation. They cannot, however, recognise any impropriety on their part if they venture to advert to an opinion, very commonly entertained, that an enquiry if limited to the known coal-fields does not embrace more than half the question.

Those who are acquainted with the Transactions of this Institution must be aware that strong reasons have been adduced by members, perfectly competent to deal with such questions, for the supposition that, in many parts of the United Kingdom, seams of coal exist, as yet untouched and, of course, unexplored. Gentlemen, whose opinion on such a subject are entitled to all respect, have expressed in this room a belief that the Durham coal-field is, in fact, conformable to that of Yorkshire in the Barnsley district; and that, at some future day, these continuous seams will be discovered, thrown down at a great depth probably, as they approach the Tees, within a short distance of which
the Durham seams crop out towards the surface in the south-west and disappear.

The probability that the coal measures will ultimately be found to underlie the new Red Sandstone formation of Cumberland, and the south-west of Scotland, has been also strongly advocated in papers which form part of the Transactions of this Society. Nor are there wanting competent judges of questions of geology, who assert the probable existence, at different depths, of a continuous coal formation, beginning on the east coast of Northumberland and extending directly southwards through the midland counties, where it again appears, as far, at least, as Gloucestershire, where it is also visible. That it would, in a national point of view, be well to submit these conclusions to the test of actual experiment is an opinion beginning to be very generally held. Should the Legislature give the subject their consideration, any expression of opinion by members of this Institute would have its due weight. That it is a matter of the first importance is undeniable, and

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without giving any opinion of their own, as a body, the Council deem it not unadvisable to elicit those of any members of this Society who may see fit to express them.

The advantages to be derived from a coal-cutting machine have frequently been the subject of consideration here and elsewhere. If machinery can be devised which shall, efficiently and cheaply, lighten the labour of working coal, the desirableness of such a machine is admitted both by the collier and his employer. In pursuance of this object a Special Committee of thirteen members of this body, living in various districts, was nominated in October last, of whom three were to constitute a quorum; and who were asked to view and report upon the performance of any coal-cutting machine which might be on trial in any of their immediate vicinities. Thus far, however, the Council have not been favoured with any communication from any of the coal districts.

In conclusion, the Council needs only to draw the attention of the meeting to the Report of the Treasurer and the Finance Committee, which needs no comment from them.

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ADVERTISEMENT.

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

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Finance Report

Your Committee have pleasure in reporting the continued satisfactory state of the Finances of the Institute during the past year. There is an increase of eighteen members and four graduates.

The Receipts and Disbursements are nearly the same as those of the previous year, with the addition of the amount expended on a Portrait of the late lamented President.
The excess of Income over Expenditure is about £200. The Balance in the hands of the Treasurer is now above £900, and it is for your consideration whether a portion of this should not be permanently invested. There still remains about £18 due from the Liquidators of the District Bank.

The entire expenses connected with the very successful meeting, held at Manchester, amounted to under £24. This compares favourably with the previous meeting, held at Birmingham, in 1863, the expenses of which amounted to £175.

The value of the Stock, now amounting to £994, has increased £60 during the past year.

Your Committee regret again to have to call attention to the delay in preparing the Annual Accounts, which causes much unnecessary trouble both to your Treasurer and Committee.

JOHN DAGLISH.

G. B. FORSTER.

LINDSAY WOOD.

[Financial tables]

General statement, July 1866

[Table]

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


Lionel Brough, Esq., Inspector of Mines, Clifton, Bristol, Somersetshire.


Matthias Dunn, Esq., Ex-Inspector of Mines.

Thomas Evans, Esq., Inspector of Mines, Field Head House, Belper.

John Hedley, Esq., Inspector of Mines, Derby.

Peter Higson, Esq., Inspector of Mines, 94, Cross Street, Manchester.

Charles Morton, Esq., Inspector of Mines, Wakefield, Yorkshire.


Goldsworthy Gurney, Esq., Bude Castle, Cornwall.


Dr. H. Von Dechen, Berghauptmann, Ritter, etc., Bonn on the Rhine, Prussia.

Herr R. Von Carnall, Berghauptmann, Ritter, etc., Breslau, Silesia, Prussia.


M. Gonot, Mining Engineer, Mons, Belgium.

Life Member


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OFFICERS, 1866-7.

President

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

Vice Presidents

John Taylor, Earsdon, Newcastle-upon-Tyne.

William Armstrong, Wingate Grange, Ferry Hill.

George Elliot, Betley Hall, Crewe.
Edward Potter, Cramlington, Newcastle-upon-Tyne.

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


Council

Lindsay Wood, Hetton Hall, Fence Houses.

T. Douglas, Peases' West Collieries, Darlington.

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

C. Berkley, Marley Hill Collieries, Gateshead.

J. Daglish, Belmont Hall, Durham.

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

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

J. T. Ramsay, Walbottle Colliery.

Wm. Cochrane, Seghill House, near Cramlington.

J. F. Spencer, Consulting Engineer, 3, St. Nicholas' Buildings, Newcastle-upon-Tyne.

Capt. A. Noble, Jesmond, Newcastle-upon-Tyne.

Dr. Richardson, Framlington Place, Newcastle-upon-Tyne.


R. S. Newall, Ferne Dene, Gateshead.

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

John Marley, Mining Offices, Darlington.

G. W. Southern, Hallgarth House, Durham.

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

Hugh Taylor, Earsdon, Newcastle-upon-Tyne

J. T. Woodhouse, Midland Road, Derby ) ex-officio.

Treasurer

Edward F. Boyd, Moor House, Durham.

Secretary
List of Members

AUGUST, 1866.

1 Adams, W., Severn House, Roath Road, Cardiff, Glamorganshire.
2 Aitken, Henry, Falkirk, North Britain.
3 Anderson, C. W., St. Hilda's Colliery, South Shields.
4 Anderson, Joseph, Solicitor, Neville Hall, Newcastle.
5 Anderson, William, Rainton Colliery, Fence Houses.
7 Armstrong, W., Wingate Grange, Ferry Hill, County of Durham.
9 Ashwell, Hatfield, Anchor Colliery, Longton, North Staffordshire.
10 Attwood, Charles, Holywood House, Wolsingham, Darlington.
11 Aytoun, Robert, 3, Fettes Row, Edinburgh.
12 Bagnall, jun., Thomas, Whitby, Yorkshire.
13 Bailes, jun., Thos., 3, Queen's Terrace, Gateshead.
14 Bailey, W. W., Kilburn, near Derby.
16 Barkus, jun., Wm., Hollymount, Bedlington.
17 Bartholomew, C., Doncaster, Yorkshire.
19 Beacher, E. Thorncliffe and Chapeltown Collieries, Sheffield.
21 Bell, John, Normanby Mines, Middlesbro'-on-Tees.
22 Bell, I. L., Washington, County of Durham.
23 Bell, T., South Moor Colliery, Chester-le-Street, Durham.
24 Benson, T. W., Cowpen Colliery, Blyth.
25 Berkley, C., Marley Hill Colliery, Gateshead, County of Durham.
26 Bewick, Thomas J., Allenheads, Haydon Bridge, Northumberland.
27 Bigland, J., Bedford Lodge, Bishop Auckland, County of Durham.
28 Binns, C., Claycross, Derbyshire.
29 Biram, Benjamin, Peasely Cross Collieries, St. Helen's, Lancashire.
30 Blackwell, J. Howard.

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31 Bolckow, H. W. F., Middlesbro'-on-Tees, Yorkshire.
32 Bourne, P., Whitehaven, Cumberland.
33 Bourne, S., West Cumberland Hematite Iron Works, Workington.
34 Bourne, Thos. R., Care of Ashton Williams, Esq., Black Rock Grange, Newton-in-Cartmel.
35 Bowie, Alexander, Canonbie Colliery, Canonbie, Carlisle.
36 Boyd, Edward F., Moor House, Durham.
37 Boyd, M.E., Nelson, Belfast Foundry, Donegal Street, Belfast.
38 Braithwaite, Thomas, Eglinton Iron Works, Killwinning, Ayrshire.
39 Breckon, J. R., Darlington.
40 Brogden, James, Tondu Iron and Coal Works, Bridgend, Glamorganshire.
41 Brown, J., Harbro' House, Barnsley, Yorkshire.
42 Brown, John N., 56, Union Passage, New Street, Birmingham.
43 Brown, Thos. Forster, Gaveller's Office, Coleford, Gloucestershire.
44 Brown, Ralph, Ryhope Colliery, Sunderland.
45 Bryham, William, Rose Bridge, &c, Collieries, Wigan, Lancashire.
46 Bryham, jun., Wm., Ince Hall, Wigan.
48 Burn, James, Rainton Colliery, Fence Houses.
49 Burns, Edward, 14, Pimblett Street, Cheetham, Manchester.
50 Buxton, William, Snibstone Collieries, near Leicester.
51 Cadwaladr, R., Broughton Colliery, Wrexham, Denbighshire.
52 Campbell, James, Staveley Works, Chesterfield.
53 Carr, Charles, Cramlington, Newcastle-upon-Tyne.
54 Carr, William Cochrane, Blaydon, Newcastle-upon-Tyne.
55 Carrington, jun., Thomas, Holywell House, Chesterfield.
56 Chadborn, Beckit T., Pinxton Collieries, Alfreton, Derbyshire.
57 Childe, Rowland, Wakefield, Yorkshire.
58 Clark, William, Shotton and Haswell Collieries, Fence Houses.
59 Clark, Christopher Fisher, Garswood, Newton-le-Willows.
60 Clarke, Edmund, Colliery Guardian Office, Wigan.
61 Cochrane, W., Seghill House, near Cramlington.
62 Cochrane, C., The Ellowes, near Dudley.
64 Coke, Richard George, Tapton Grove, Chesterfield, Derbyshire.
65 Cole, W. R., Bebside Colliery, Morpeth.
66 Collis, William Blow, Amblecote, Stourbridge, Worcestershire.

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67 Cook, Richard, East Holywell Colliery, Earsdon, Newcastle-upon-Tyne.
68 Cooke, John, 4, Mulberry Street, Darlington.
69 Cookson, Norman, Newcastle-upon-Tyne.
70 Cooksey, Joseph, West Bromwich, Staffordshire.
71 Cooksey, J. H., West Bromwich, Staffordshire.
72 Cooper, Philip, Rotherham Colliery, Rotherham, Yorkshire.
73 Cooper, Thomas, Park Gate Colliery, Rotherham, Yorkshire.
74 Cope, J., Pensnett, Dudley, Worcester.
75 Cossham, H., Hill House, Bristol, Somersetshire.
76 Coulson, W., Crossgate Foundry, Durham.
77 Cowen, jun., Joseph, Blaydon Burn, Newcastle-upon-Tyne.
78 Coxon, S. B., Usworth Colliery, Washington Station, Durham.
79 Crawford, T., Little Town Colliery, Durham.
81 Croften, J. G., Bowdon Close Colliery, Crook, Darlington.
82 Crone, S. C., Killingworth Colliery, Newcastle-upon-Tyne.
83 Curry, James, Turston, Pontefract.
84 Daglish, F.G.S., J., Belmont Hall, Durham.
85 Dakers, jun., Thomas, Willington Colliery, Durham.
86 Dakers, W., Seaham Collieries, Sunderland.
87 Darlington, James, Springfield House, near Chorley, Lancashire.
88 Darlington, John, Moorgate Street Chambers, London, E.C.
89 Davison, A., Hastings Cottage, Seaton Delaval, Newcastle-upon-Tyne.
90 Davidson, James, Newbattle Colliery, Dalkeith.
91 Dees, J., Whitehaven, Cumberland.
92 Dennis, Henry, Brynyr Owen, Ruabon, Denbighshire.
93 Dickinson, W. R., South Derwent Colliery, Annfield Plain, Gateshead.
94 Dixon, George, Lowther Street, Whitehaven, Cumberland.
95 Dobson, S., Halswell Cottage, Cardiff, Glamorganshire.
96  Dorning, Elias, 41, John Dalton Street, Manchester.
97  Douglas, T., Peases' West Collieries, Darlington.
98  Dunn, T., Richmond Hill, Sheffield, Yorkshire.
99  Dunn, C.E., Thomas, Windsor Bridge Iron Works, Manchester.
100 Dyson, George, Tudhoe Iron Works, Ferry Hill.
101  Easton, J., Nest House, Gateshead.
102  Elliot, G., Betley Hall, Crewe.

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103  Elliot, W., Weardale Iron Works, Towlaw, Darlington.
105  Evans, William, Ruabon Iron Works, Ruabon.
106  Feare, G., Camerton Coal Works, Bath.
107  Fenwick, Barnabas, Broomhill Colliery, Acklington.
108  Fletcher, C.E., Jos., 69, Lowther Street, Whitehaven.
109  Fletcher, John, Clifton Colliery, Manchester.
110  Fletcher, Isaac, Clifton Colliery, Workington.
111  Fletcher, Herbert, Clifton Colliery, Manchester.
112  Foord, J. B., General Mining Association Secretary, 52, Broad Street, London.
113  Forster, J. H., Old Elvet, Durham.
114  Forster, A.M., G. B., Backworth, Newcastle-upon-Tyne.
115  Forster, Thomas E., 7, Ellison Place, Newcastle-upon-Tyne.
116  Fothergill, Joseph, Cowpen and North Seaton Office, Quayside, Newcastle-upon-Tyne.
117  Fowler, Geo., Donisthorpe, Ashby-de-la-Zouch, Leicestershire.
118  Firth, William, Birley Wood, Leeds.
119  Firth, S., 5, Port Street, Manchester.
120 Fryar, Mark, Team Colliery, Gateshead.

121 Gainsford, William Dunn, Darnall Hall, Sheffield.
122 Gainsford, Thos. R., 18, York Place, Leeds.
123 Gardner, M. B., Tondu Iron and Coal Works, Bridgend, Glamorganshire.
125 Gillett, F. C., 5, Wardwick, Derby.
126 Gilroy, G., Ince Hall Colliery, Wigan, Lancashire.
127 Glover, B. B., Mining Engineer, Newton-le-Willows, Lancashire.
128 Goddard, C.E., William, Golden Hill Colliery, Longton, North Staffordshire.
129 Gooch, G. H., Lintz Colliery, Gateshead.
130 Gott, Wm. L., Willington Colliery, Durham.
131 Greeves, J. O., Roundwood Colliery, Horbury, Wakefield, Yorkshire.
132 Green, jun., Wm., 6, St. Mary's Terrace, Newcastle-upon-Tyne.
133 Greener, Thos., Etherley Colliery, Darlington.
134 Greenwell, F.G.S., G. C., Poynton and Worth Collieries, Stockport, Cheshire.
135 Greig, D., Leeds.

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136 Haggie, P., Gateshead.
137 Hales, Onas, Oakpits Colliery, Mold, Flintshire.
138 Hall, T. Y., 11, Eldon Square, Newcastle-upon-Tyne.
139 Hall, William F., Brotton Mines, Saltburn-by-the-Sea.
140 Hall, Henry, Haswell Colliery, Fence Houses.
141 Harden, J. W., Folshill Colliery, Coventry, Warwickshire.
142 Harper, Matthew, Whitehaven, Cumberland.
143 Harrison, C.E., T. E., Central Station, Newcastle-upon-Tyne.
144 Harrison, Robert, Eastwood Collieries, Nottingham.
145 Hawthorn, C.E., R., Engineer, Newcastle-upon-Tyne.
146 Hawthorn, C.E., W., Engineer, Newcastle-upon-Tyne.
147 Herdman, John, Park Crescent, Bridgend, Glamorganshire.
148 Heath, Robert, Biddulph Valley Coal and Iron Works, Stoke-upon-Trent.
149 Heckels, R., Pensher House, Fence Houses.
150 Hedley, Edward, Osmaston Street, Derby.
151 Hedley, W. H., Consett Collieries, Medomsley, by Gateshead.
152 Heppell, Thomas, Little Town Colliery, Durham.
153 Heslop, James, Peases’ West Collieries, Darlington.
154 Hetherington, David, Netherton, Morpeth.
155 Hewlett, Alfred, Haigh Colliery, Wigan, Lancashire.
156 Hindhaugh, Thos. S., Moreton Hall Colliery, near Chirk, Denbighshire.
157 Higson, Jacob, 94, Cross Street, Manchester.
158 Higson, P., jun., Brookland, Swinton, Manchester.
159 Hill, Arthur.
161 Hodgson, R., Engineer, Whitburn, Sunderland.
162 Homer, Charles S., Chatterley Hall, Tunstall.
164 Hopper, John, Britannia Iron Works, Houghton-le-Spring.
165 Horsley, W., Whitehill Point, Percy Main.
166 Horsfall, J. J., Fanbottom Colliery, Ashton-under-Lyne.
168 Howard, Wm. Frederick, Kiveton Park Colliery, near Worksop.
169 Hudson, James, Albion Mines, Pictou, Nova Scotia.
170 Humble, jun., Joseph, Garesfield, Blaydon-on-Tyne.
171 Hunt, J. P., Corngreaves, Birmingham.
172 Hunt, A. H., Pelaw Main Office, Quayside, Newcastle-upon-Tyne.

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173 Hunter, Wm., Moor Lodge, Newcastle-upon-Tyne.
174 Hunter, William, Morriston, Swansea, Glamorganshire.
175 Hurst, T. G., Backworth Colliery, Newcastle-upon-Tyne.

176 Jackson, Henry, Astley and Tyldesley Collieries, Tyldesley, Manchester.
177 Jackson, John, Clay Cross, Chesterfield.
178 Jeffcock, P., Midland Road, Derby.
179 Jenkins, M.E., William, 3, Brighton Terrace, Roath, Cardiff.
180 Jobling, T. W., Point Pleasant, Wallsend, Newcastle-upon-Tyne.
181 Johnson, John, Chilton Hall, Ferry Hill.
182 Johnson, R. S., Haswell, Fence Houses.
183 Joicey, John, Urpeth Hall, Fence Houses.
184 Jones, E., Granville Lodge, Wellington, Salop.

185 Kenrick, Wm. Wynn, Wynn Hall, near Ruabon, Denbighshire.
186 Kerr, John, Auchinheath, Lesmahagow, Lanarkshire, N.B.
187 Kimpster, W., Quay, Newcastle-upon-Tyne.
188 Knowles, A., High Bank, Pendlebury, Manchester.
189 Knowles, John, Pendlebury Colliery, Manchester.
190 Knowles, Thomas, Ince Hall, Wigan.
192 Knowles, Kaye, Little Lever Colliery, near Bolton.
193 Knowles, R. M., Eagley Bank, Bolton.
194 Lamb, Robert, Cleator Moor Colliery, near Whitehaven.
195 Lamb, R. O., Axwell Park.
196 Lancaster, John, Ashfield, Wigan.
197 Lancaster, jun., John, Hunwick and Newfield Collieries, Ferry Hill.
198 Lancaster, Joshua, Coal and Iron Works, near Wigan.
199 Lancaster, Samuel, Kirkless Hall Colliery, Wigan.
200 Landale, Andrew, Lochgelly Iron Works, Fifeshire, North Britain.
201 Laverick, George Wm., Zion House, Chesterton, near Newcastle-under-Lyne.
202 Laws, J., Blyth, Northumberland.
203 Lees, Samuel, Barrowshaw Colliery, Greenacres Moor, near Oldham.
204 Lever, Ellis, West Gorton Works, Manchester.
205 Levick, jun., F., Cwm Celyn and Blaina Iron Works, Newport, Monmouthshire.

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206 Lewis, Henry, Swannington Colliery, near Ashby-de-la-Zouch, Leicestershire.
207 Lewis, T. Wm., Mardy, Aberdare, Glamorganshire.
208 Lewis, G., Coleorton Colliery, Ashby-de-la-Zouch.
209 Lewis, Wm. Thos., Mardy, Aberdare, Wales.
210 Liddell, J. R., Netherton Colliery, Morpeth.
211 Liddell, M., Tynemouth.
212 Lindop, James, Bloxwich, Walsall, Staffordshire.
213 Lishman, Wm., Etherley Colliery, Darlington.
214 Lishman, Wm., Bunker Hill, Fence Houses.
215 Lishman, John, Ridsdale Iron Works, Bellingham.
216 Livesey, Thomas, Chamber Hall, Hollinwood, Manchester.
217 Livesey, Clegg, Bradford Colliery, Manchester.
218 Llewelin, David, Glanwern Offices, Pontypool, Monmouthshire.
219 Longridge, J., 11, Abingdon Street, Westminster, London, S.W.
220 Love, Joseph, Brancepeth Colliery, Durham.
221 Low, Wm., Vron Colliery, Wrexham, Denbighshire.
222 Low, Wm., jun., Wrexham, Denbighshire.
224 Maddison, J., Alexander Street, Newcastle-upon-Tyne.
225 Maddison, W., Coxlodge Colliery, Newcastle-upon-Tyne.
227 Mammatt, C.E., John E., Barnsley, Yorkshire.
228 Marley, John, Mining Offices, Darlington.
229 Marshall, Robert, 10, Three Indian Kings Court, Quayside, Newcastle-upon-Tyne.
231 Marshall, F. C., Jarrow, South Shields.
232 Matthews, Richd. F., South Hetton Colliery, Fence Houses.
233 May, George, North Hetton Colliery, Fence Houses.
234 Maynard, Charles, Cardiff and Newport Collieries, Machen, Newport, Monmouthshire.
236 McDonald, Hugh, Standish and Shevington Cannel Works, Wigan.
237 McGhie, Thos., Cannock Chase Colliery, Walsall, Staffordshire.
238 McGill, Robert, St. Helen's Colliery, St. Helen's, Lancashire.
239 McMurtrie, J., Radstock Colliery, Bath.

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240 Middleton, J., Davison's Hartley Office, Quay, Newcastle-on-Tyne.
241 Miller, Robt., Outwood, Wakefield, Yorkshire.
242 Mitchinson, jun., Robt., Kibblesworth Colliery, Gateshead.
243 Monkhouse, Joseph, Gilcrux Colliery, Cockermouth.
244 Morison, David P., Pelton Colliery, Chester-le-Street.
245 Morris, William, Waldridge Colliery, Chester-le-Street.
246 Morton, H., Lambton, Fence Houses.
247 Morton, H. T., Lambton, Fence Houses.
248 Muckle, John, Manston Collieries, near Leeds.
249 Mulcaster, H., Colliery Office, Whitehaven.
250 Mulcaster, Joshua, Crosby Colliery, Maryport.
251 Morrison, James, Gresham Place, Newcastle-on-Tyne.
252 Morrison, H. M., Rainton Colliery, Durham.
253 Murray, B.
254 Mulvany, Wm. Thos., 1335, Carls Thor, Dusseldorf on the Rhine, Prussia.
255 Murray, T. H., Chester-le-Street, Fence Houses.
257 Newall, Robert Stirling, Fern Dene, Gateshead.
260 Noble, Captain, Jesmond, Newcastle-on-Tyne.
261 North, Frederick, Tipton, Staffordshire.
262 Oliver, Wm., Stanhope Barn Offices, Stanhope, Darlington.
263 Oliver, John, Victoria Colliery, Coventry.
264 Oliver, Geo., Peases' West Collieries, Darlington.
265 Palmer, C. M., Quay, Newcastle-upon-Tyne.
266 Palmer, A. S., Port Mulgrave, Redcar, Yorkshire.
267 Peace, Maskell Wm., Solicitor, Wigan, Lancashire.
268 Pearce, F. H., Bowling Iron Works, Bradford, Yorkshire.
269 Pease, J. W., Woodlands, Darlington.
270 Peel, John, Springwell Colliery, Gateshead.
271 Perrott, Sam. W., Hibernia and Shamrock Collieries, Gelsenkirchen, Dusseldorf.
272 Piggford, Jonathan, Haswell Colliery, Fence Houses.
273 Pilkington, jun., Wm., St. Helen's, Lancashire.
274 Potter, E., Cramlington, Newcastle-upon-Tyne.
275 Potter, W. A., Monk Bretton, Barnsley, Yorkshire.
276 Powell, T., Coldea, Newport, Monmouthshire.
277 Ramsay, J. T., Walbottle Colliery, Newcastle-upon-Tyne.
278 Reed, Robert, Felling Colliery, Gateshead.
279 Rees, Daniel, Lletty Shenkin Colliery, Aberdare, Glamorganshire.
280 Richardson, Dr., Neville Hall, Newcastle-upon-Tyne.
281 Richardson, Henry, Backworth Colliery, Newcastle.
282 Robson, J. S., Butterknowle Colliery, Staindrop, Darlington.
283 Robson, Neil, 127, St. Vincent Street, Glasgow.
284 Robson, Thomas, Lumley Colliery, Fence Houses.
286 Ronaldson, James, Clough Hall Coal and Iron Works, Stoke-upon-Trent.
287 Rose, Thomas, Millfield Iron Works, Bilston, Wolverhampton, Staffordshire.
288 Ross, A., Shipcote Colliery, Gateshead.
289 Rosser, Wm., Mineral Surveyor, Llanelly, Carmarthenshire.
290 Routledge, William (J. B. Foord), 52, Old Broad Street, London, E.G.
291 Russell, Robert, Gosforth Colliery, Newcastle-upon-Tyne.
293  Sanderson, R. B., West Jesmond, Newcastle-upon-Tyne.
294  Sanderson, Thomas, Seaton Delaval, Newcastle-upon-Tyne.
295  Seddon, Wm., Lower Moor Collieries, Oldham, Lancashire.
296  Shield, Hugh, Woodfield and Whitelee Collieries, Crook, Darlington.
297  Shortreed, Thos., Park House, Winstanley, Wigan.
298  Simpson, L., South America, per E. Simpson, Dipton, Gateshead.
299  Simpson, R., Townley Office, 4, Queen Street, Quay, Newcastle-upon-Tyne.
300  Simpson, John Bell, Hedgefield House, Blaydon.
301  Smith, F., Bridgewater Offices, Manchester.
302  Smith, jun., J., Mining Engineer, Thornley Colliery, Sunderland.
303  Smith, Edmund J., 14, Whitehall Place, Westminster, London, S.W.
304  Smith, Thomas Taylor, Oxhill, Chester-le-Street.
305  Sopwith, F.G.S., etc., T., 43, Cleveland Square, London, W.
306  Southern, G. W., Hallgarth House, Durham.
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307  Southern, Robert, Cassop Colliery, Ferryhill.
308  Spark, H. K., Darlington, County of Durham.
309  Spencer, J. F., 3, St. Nicholas Buildings, Newcastle-upon-Tyne.
310  Spencer, W., West Staveley Colliery, Chesterfield.
312  Steel, Charles R., Ellenborough Colliery, Maryport, Cumberland.
313  Stenson, W. T., Whitwick Colliery, Coalville, near Leicester.
314  Stephenson, George R., 24, Great George Street, Westminster, London, S.W.
315  Stobart, H. S., Witton-le-Wear, Darlington.
316  Stott, James, Basford Hall, Stoke-on-Trent.
317  Sutcliffe, John C, North Gawber Colliery, Barnsley.
318  Swallow, R. T., Pontop Colliery, Gateshead.
319  Swallow, John, Harton Colliery, South Shields.

320  Taylor, H., Earsdon, Newcastle-upon-Tyne.
321  Taylor, H., Tynemouth.
322  Taylor, J., Earsdon, Newcastle-upon-Tyne.
323  Telford, W., Cramlington, Newcastle-upon-Tyne.
324  Thompson, John, Marley Hill Colliery, Gateshead.
325  Thompson, John, Field House, Hoole, Chester.
326  Thompson, T. C, Milton Hall, Carlisle, Cumberland.
327  Thompson, Astley, Truro, near Cardiff.
328  Thompson, James, Bishop Auckland.
329  Thorman, John, Ripley, Derbyshire.
330  Tone, C.E., John F., Westgate Street, Newcastle-upon-Tyne.
331  Trotter, J., Newnham, Gloucestershire.
332  Truran, Matthew, Dowlais Iron Works, Merthyr Tydvil, Glamorganshire.

333  Vaughan, John, Middlesbro'-on-Tees.
334  Vaughan, Thomas, Middlesbro'-on-Tees.
335  Varley, James, Waterloo Foundry, St. Helen's, Lancashire.
336  Verner, Albert, 31, Old Elvet, Durham.

337  Wales, T. E., Brunswick Place, Swansea, Wales.
339  Wardell, Frank N., Plashetts Colliery, Newcastle-upon-Tyne.
340  Warrington, John, Kippax, near Leeds.

341  Watkin, Wm. J. L., Pemberton Colliery, Wigan.
342 Watson, W., High Bridge, Newcastle-upon-Tyne.
343 Webster, R. C, Ruabon Collieries, Ruabon, Denbighshire.
344 Weeks, John G., Phos Llantivit Colliery, Caerphilly, Glamorganshire.
346 Whalley, Thomas, Orrell Mount, Wigan.
348 Williams, E. (Bolckow, Vaughan, and Co., Middlesbro’).
349 Willis, James, Washington Colliery, Washington Station, County of Durham.
351 Wilson, J. B, Haydock, near St. Helen’s, Lancashire.
352 Wilson, R., Flimby Colliery, Maryport, Cumberland.
353 Wilson, J. Straker, Ruardean Villa, near Newnham, Gloucestershire.
354 Wood, C. L., Black Boy Colliery, Bishop Auckland.
355 Wood, Lindsay, Hetton Colliery, Fence Houses.
356 Wood, W. H., West Hetton, Ferry Hill.
357 Wood, John, Flockton Collieries, Wakefield, Yorkshire.
358 Wood, William O., Brancepeth Colliery, Durham.
359 Woodhouse, J. T., Midland Road, Derby.

Graduates
361 Armstrong, L., Cowpen Colliery, Blyth, Northumberland.
362 Bainbridge, Emerson, Londonderry Collieries, Durham.
363 Booth, R. L., Rainton Gate, Fence Houses.
364 Coates, C. N., Skelton Mines, Guisbro’.
365 Crawford, Thos., West Rainton, Fence Houses.
366 Dodd, Benj., Seaton Delaval Colliery, Newcastle.
368 Gilchrist, Thos., Newbottle Colliery, Fence Houses.
369 Harrison, John G., Chilton Offices, Ferry Hill.
370 Maughan, James A., Benwell Colliery, Newcastle.
371 Parrington, Matthew, Normanby Mines, Middlesbrough.
372 Peile, William, Corkickle Forge, Whitehaven, Cumberland.
373 Ramsay, Thomas Dunlop, Trimdon Colliery, Ferry Hill.
374 Ridley, George, Cowpen Colliery, Blyth, Northumberland.
375 Sopwith, Arthur, 103, Victoria Street, Westminster, London, S.W.
376 Taylor, W. N., Ryhope Colliery, Sunderland.
377 Wardell, Stuart C, Townley Colliery, Blaydon, Newcastle.
378 Wright, George H., Rainton Colliery, Fence Houses.

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.
" Poynton and Worth Collieries, Stockport, Cheshire.
" 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.
" Seghill Colliery, Seghill, near Newcastle.
" East Holywell Colliery, North Shields.
Rules

I.—The objects of the North of England Institute of Mining Engineers are to enable its members to meet together at fixed periods, and to discuss the means for the Ventilation of Coal and other Mines, the Winning and Working of Collieries and Mines, the Prevention of Accidents, and the Advancement of the Science of Mining generally.

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

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

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

5.—Honorary Members shall be persons who have distinguished themselves by their literary or scientific attainments, or who have made important communications to the Society.

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

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

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

9.—Each Subscriber of £2 2s. annually (not being a member) shall be entitled to a ticket to admit one person to the rooms, library, meetings, lectures, and public proceedings of the Society; and for every additional £2 2s. subscribed annually, another person shall be admissible up to the number of five persons; and each such Subscriber shall also be entitled for each £2 2s. subscription to have a copy of the proceedings of the Institute sent him.

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

11.—That the Officers of the Institute shall consist of a President, six Vice-Presidents (four of whom, only to be mining engineers), and eighteen Councillors (twelve of whom, only to be mining engineers), who, with the Treasurer and Secretaries (if Members of the Institute), shall constitute a Council for the direction and management of the affairs of the Institute; all of which Officers shall be elected at the Annual Meeting, and shall be eligible for reelection, with the exception of the three Councillors whose attendance have been fewest, and such Vice-Presidents as have held office for three consecutive years; but such Members are eligible for reelection after being one year out of office. All Officers, with the exception of the paid Officers (who need not necessarily be Members of the Institute), to be nominated at the General Meeting next before the Annual Meeting; a list of whom, with voting papers, shall be posted to every Member at least fourteen days previous to the Annual Meeting. All nomination and voting papers must be in writing, and signed by the respective Members, and delivered personally or forwarded under cover, and in the latter case signed, sealed, and addressed to the Secretary, so as to be in his hands before the hour fixed for the nomination or election of Officers. The Chairman shall, in all cases of voting, appoint scrutineers of the lists, and the scrutiny shall commence on the conclusion of the other business of the meeting. At meetings of the Council, five shall be a quorum, and the Minutes of the Council's proceedings shall be at all times open to the inspection of the Members of the Institute.

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

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

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

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

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

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

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

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

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

20. — All proofs of discussion forwarded to Members for correction

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must be returned to the Secretary not later than three days from the date of their receipt.

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

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

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

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

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

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

ERRATA.

Page 181, line 11. for line read hire.
Page 265, line 5. *For Washington Colliery, etc.*, read, *Washington Colliery*, were convicted but not punished, owing to the arrangement of the solicitors.

Page 266, Appendix A, line 5. *Dele* from the Bishoprick Halmot Court Book, and *read* from the Enrolled Decrees of the Court of Chancery of Durham.

[1]

NORTH OF ENGLAND INSTITUTE OF MINING ENGINEERS.

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

E. POTTER, Esq., Vice-President, in the Chair.

The minutes of the Council having been read, the following new members were elected:—Mr. John Hopper, Britannia Works, Houghton-le-Spring; Mr. James Morrison, Gresham Place, Newcastle; Mr. Edward Williams, Middlesborough-on-Tees; Mr. William Anderson, Rainton Colliery, Fence Houses; Mr. John Thompson, Field House, Hoole, near Chester; Mr. Robert Lamb, Cleator Moor Colliery, near Whitehaven; Mr. Embleton (a graduate), Seaham Colliery.

Mr. Boyd read a paper, contributed by Mr. T. Y. Hall, on the "Progress of Coal-Mining Industry in China."

Mr. Howse said, that carboniferous fossils had been brought from China, and Devonian also.

Mr. Boyd said, if a single specimen of a fossil from the carboniferous series had been brought home, it would have been very interesting.

The Chairman said, he had seen coal from the Island of Formosa, and it was pretty good in quality.

Mr. Boyd said, that looking at its undeveloped coal-fields, the history of China may be only beginning.

Thanks were then voted to Mr. Hall for his able and interesting paper, after which the meeting separated.

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NORTH OF ENGLAND INSTITUTE OF MINING ENGINEERS.

GENERAL MEETING, THURSDAY, OCTOBER 5, 1865, IN THE ROOMS OF THE INSTITUTE, WESTGATE STREET, NEWCASTLE-UPON-TYNE.
HUGH TAYLOR, Esq., Vice-President, in the Chair.

The Secretary read the minutes of the Council,

After which the question of amending Rule 11 was discussed, and an amendment carried.

Mr. Wm. Seddon, Lower Moor Colliery, Oldham, Lancashire, was elected a member.

Mr. Doubleday read his paper on "The Causes of certain Boiler Explosions," which was ordered to be printed.

GENERAL MEETINGS, NOVEMBER 4, AND DECEMBER 7, 1865.

In consequence of the absence of Dr. Richardson, Mr. John Taylor, and many others whose presence was deemed desirable, the business of these meetings was adjourned till February next.

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ON THE CAUSES OF CERTAIN STEAM-BOILER EXPLOSIONS.

By THOMAS DOUBLEDAY.

The following observations are submitted, by their author, as embodying a mere theory. He has never attempted to verify his conclusions experimentally; and, with the exception of one experiment, detailed by Professor Tyndall in his Treatise on "Heat," he has not seen any account of any experiments that may seem to confirm the theory he has framed.

It is generally admitted, I believe, by those who have attended to, and are conversant with, the accounts of explosions of steam boilers, that, in the circumstances of many of them, and especially of those of a violent nature, there remains something to be explained. We have many instances of boilers exploding with terrific violence, under circumstances that give no clue to any probable or assignable cause for the phenomena. It may be, and probably is, true, that if—through some almost inconceivable carelessness—the water of a boiler is suffered to exhaust itself until the iron becomes red-hot, a supply of water, suddenly let in, may produce an explosion of great violence. So may a neglected safety-valve. And it may be, also, easily conceived that, owing to a sedimentary deposit at the bottom from impure water, the iron may become overheated and its quality deteriorated. This, however, can hardly be deemed a cause of those terrible explosions which occur so frequently, although it may account for a plate giving way; with more or less of risk to those who happen to be near.

These admissions may be safely made; but there are records of catastrophes caused by boilers bursting, with extraordinary violence and vast damage, which are quite inexplicable under the evidence adduced. In many of these cases it has been distinctly shown that there was no want of water; that the water did not deposit a sedimentary crust, and that the safety-valve, or valves, were not in bad condition, nor over-loaded.
Of these important negatives there has been undeniable proof. Yet, notwithstanding all these
admitted negations, the boiler has exploded with vast force, and vast damage to all in its vicinity.

If these assertions be admitted as true,—as, I think, they will be by most persons who have attended
to the subject,—we must look for some other mode of explaining phenomena at present
inexplicable. In one very striking and suggestive fact, as it appears to me, a clue to this explanation
may possibly be found.

It has been observed and commented upon by those who have narrated the circumstances of some
of these explosions, that many of the most destructive have occurred after the boiler has been, for
some time, at rest — that is to say, just after the breakfast or dinner-hour. In this fact may, I believe,
be found a clue to the explanation of the other facts. In order to begin at the beginning, and to
conduct the reader, regularly, to the conclusions to which it is my aim to lead him, I must first advert
to some general facts connected with water. It is admitted that, in ordinary cases, all water, and
especially all running water, contains, interspersed throughout its bulk, a considerable portion of
atmospheric air, with a little free oxygen over and above. This is a truth sufficiently notorious. It is by
separating this air from the water that the gills of fish enable them to breathe; and its presence is
necessary to their existence. I take it for granted, then, that all water, in ordinary use, contains a
considerable quantity of air; and that it is the presence of this interspersed air that, for the most
part, causes the ordinary phenomena of ebullition. The most accurate experiments that have been
tried, in order to ascertain the relative conducting powers of water and of atmospheric air, prove
that water is a somewhat slow and feeble conductor of heat, and that atmospheric air,—especially
when under more than ordinary pressure,—is, though not absolutely a non-conductor, even a
slower conductor than is water. I say that it is slower when under pressure than it is when that
pressure is diminished; this being evidenced by the fact, that when water is exposed to the action of
fire at high elevations, ebullition takes place much sooner than when it is boiled under ordinary
circumstances. In ordinary cases water only boils when heated up to 212° Fahrenheit. But at an
elevation, above the sea, of 10,000 or 12,000 feet, it boils at a much lower temperature: and
Humboldt, I think, states that, upon the ridge of the Cordillera of the Andes, it was almost impossible
to cook an egg by boiling—the water never retaining sufficient heat to coagulate the egg.

This seems to show that, when the air was less condensed, owing to

the effect of the diminution of the weight of the column of the atmosphere, it conveyed the heat
more rapidly to the watery particles amongst which it was interspersed. Hence, those particles
sooner became steam, and found their way to the surface; which is the cause of that motion of
heated water which we term "boiling." I conclude, therefore, that air under pressure is a very slow
conductor of heat; and that as the pressure is augmented the time of boiling is delayed; and that if
air were not present, the water could not exhibit the phenomena which we style "boiling."

I now come to a second portion of the theory which I am endeavouring to establish—

I understand that it is known and admitted, and has been amply proved, that water may, by being
subject to long heating or boiling, be deprived of its air. And I presume it will be further admitted, as
a consequence of this, that the particles of water thus deprived of the air usually interspersed, must necessarily cohere more strongly together, as being homogeneous.

If these conclusions be admitted, I assume it, first, as a possibility, and next, as a probability, that in a boiler of the water of which a portion may continue long unchanged—the fresh supplies being always introduced when the water is at a certain level—there may be contained portions of water that have been deprived of their air. And if this be admitted, it seems necessarily to follow that these airless portions, being of a greater density than the rest of the water which contains air—must have a tendency towards the bottom of the boiler, unless kept from it by some extraneous action.

Now then, if this be admitted to be not only possible, but to some extent probable, let us proceed to ascertain what would be likely to happen under two given sets of circumstances.

If first, we suppose the mass of water in a steam-boiler to contain here and there smaller bodies of water deprived of air, and the whole subjected to the action of the furnace, what, under these circumstances will follow? Heat will be transmitted through the iron bottom to the entire mass, but will find different portions of that mass very differently circumstanced. The entire mass consists for the most part of water interspersed with air. To the particles of water thus mixed with air, that air conveys the heat, and these particles as they absorb it, one after another become steam, and ebullition begins as the steam rises, to the surface and escapes. But upon the small bodies of water deprived of air the heat cannot so act. They are homogeneous and only to be heated slowly, and if heated throughout up to 212° Fahrenheit, will not become steam (as has been frequently proved) even at that temperature. But above that temperature they cannot, under these circumstances, be raised, any extra heat will be carried off by the surrounding air-interspersed water turning into steam. Hence, these small portions of airless water will merely be tossed to and fro by the action of ebullition agitating the whole mass, without becoming steam at all; and this seems to me to be the process that must go on whilst the boiler is in strong action.

Let us now take an opposite set of circumstances, and ask ourselves, as before, what kind of results are likely to follow?

Let us now suppose a boiler, which has been in constant use for some time, gradually brought to the state which I have described,—that is to say, let us suppose the water it contains to be, generally, water mixed with air, but to have here and there interspersed small portions of airless water, made so by frequent boiling. These portions of airless water, being denser than water that contains air, must be of slightly greater specific gravity. This seems undeniable. But as long as the entire mass is kept rapidly boiling, these portions must be tossed up and down by the ebullition, and prevented from settling down towards the bottom, which their somewhat greater density must tend to cause them to do. Let us, however, reverse the circumstances, and then inquire of what nature the probable results are expected to be?

If, then, we suppose the action of the furnace to be now discontinued, the fire slackened or drawn, and the water left to tranquillise itself; this consequence seems naturally to follow: that the air-deprived portions must slowly and gradually, owing to their somewhat greater specific gravity, find their way to the bottom, and there form a sort of substratum of airless water; all above being
composed of water containing the usual mixture of air. Thus, then, in this supposed case, the bottom of a large boiler may come to be covered, up to a certain depth, with a layer of water almost or entirely free of air, quite homogeneous, and with all its particles in close and intimate coherence. This lower substratum of air-deprived water may be of such magnitude that, if heated to the steam-producing point (whatever that may be in such a case), it would produce a prodigious volume of steam. This is not difficult to be conceived. Let us enquire, then,—for that is the important point,—what would be the probable consequences of again setting the furnace in action, the water within being in the state which I have just described? It appears to me, that in the case I am supposing, the consequences would be these:—As the fire gave out heat, this layer of homogeneous, air-deprived water would gradually absorb it throughout its entire mass. This heating would be quite regular, and though gradual, it would be more rapid than the heating of the air-containing water above it. This is sufficiently obvious; because, water being a better conductor than air, the air-less would receive and absorb it, as it came from the furnace, faster than the air-containing mass above it would receive and absorb it. Thus it seems to follow, as a necessary result, that the air-deprived, homogeneous substratum must be brought to the steam-producing point sooner than any portion of the water above it. It appears further to follow, that the entire layer, being homogeneous, would reach this point at one moment of time; and thus, in the single fraction of a second, a vast number of cubic feet of steam might leap into existence, and explode the strongest boiler like a bomb-shell.

In this way I explain these hitherto inexplicable cases of violent boiler explosions, which are noticed to have occurred soon after the boiler has been at rest and the fire re-kindled. The immense violence of many of these recorded explosions of steam-boilers, appears to me to be fully accounted for, when the following facts are taken into view.

In the first place it has been proved by Professor Tyndall and others, that water when completely free of air becomes much more dense. "Water (says he in his Treatise on 'Heat' pp. 110 and 112) becomes vastly more cohesive, and in a glass tube when moved, sounds like a solid body." This is when it is completely deprived of its air, which may be effected by the following ingenious method. I extract it from page 113 of Tyndall's Treatise.

"Water, in freezing, completely excludes air from its crystalline architecture. Supposing then, we melt a piece of pure ice under conditions where air cannot approach it, we have water in its most highly cohesive state; and such water when heated, ought to exhibit the effects to which I have referred. That it does so has been shown by Mr. Faraday. He melted pure ice under spirits of turpentine, and found that the liquid thus formed, could be heated far beyond the boiling point, and that the rupture of the liquid by the act of ebullition took place with almost explosive violence."

This statement unquestionably goes to bear out, to a certain extent, the conclusions as to the causes of certain violent boiler explosions, at which I have arrived. More especially will this be allowed when it is considered that, in all human probability, this experiment was made by heating the air-less water in an open vessel. At page 112 of his Treatise on "Heat," Professor Tyndall, however, makes use of still stronger expressions as to the result of this particular experiment.
Talking of the augmentation of the cohesion of the particles of water when it is completely free of air, he proceeds thus:—"So much for this augmentation of cohesion, but this very cohesion enables the liquid to resist ebullition. Water thus freed of its air, can be raised to a temperature of 100° and more above its ordinary boiling point (212°) without ebullition. But mark what takes place when the liquid does boil. It has an enormous mass of heat stored up. The locked-up atoms finally part company. But they do so with the violence of a spring which suddenly breaks under strong tension, and the ebullition is converted into explosion. This was proved first by M. Donny, of Ghent."

Here we see Professor Tyndall asserting without hesitation, that water deprived of its air exhibits a greater cohesion of the watery particles—in short becomes more dense; and in a glass tube, sounds as if it were actually a solid. We see him further to assert that this air-less water will resist ebullition until its temperature be raised more than 100° above the boiling point—that is to say to more than 312° Fahrenheit, and that when the locked-up atoms, at length "part company," they do so suddenly and with violence, so that "ebullition is converted into explosion."

It appears to me to be only fair to assume that these experiments, whether made by Mr. Faraday, Professor Tyndall, or M. Donny, of Ghent, have been all made in open vessels. Had any of them used a close vessel, and any fracture occurred, as is most likely, the fact would have been noted. If we suppose this sudden conversion of air-less water into a volume of steam to take place in an ordinary close boiler, there cannot be any difficulty in predicting the result.

Before concluding, it seems to me to be proper to hazard one or two further observations as to one important part of the question. I have assumed the possibility of the ordinary water of a boiler having small, interspersed portions deprived of their air. Now, it may be asked, through what imaginable process would this result occur? The question can only be replied to hypothetically; but it seems to me capable of being so answered.

It must occasionally happen, especially when the boiler is large, that the heat of the furnace may reach the water to be heated irregularly and partially, and that this irregular and partial action of the fire may continue for a considerable time before the whole mass is heated up to 212°. Now, in this case, it is not difficult to conceive that in portions of the water where the fire is hottest, the commingled air may be expanded and driven out. This expanded air would ascend, leaving this portion of the water of a greater density and a firmer coherence, and incapable of forming steam, until heated to a point far above 212°. Whilst the boiler was in action, these portions would be driven, by the motion of the mass of water, hither and thither. When the fire was damped, and the mass tranquil, such portions would sink to the bottom, from their somewhat greater specific gravity, form a layer and explode, when, by a renewal of the furnace heat, they were raised to some point above the ordinary boiling point of 212°.

I now conclude, and I do so by saying that if this theory be assented to as probably founded in fact, those who do so will easily devise means for obviating the danger arising from this source. To prove the truth of the theory laid down by means of further experiments will be a less easy matter. The important point will be to prove, experimentally, that frequent boiling does actually deprive small portions of the water of a boiler of their ordinary mixture of air. If this could be accomplished, the
remaining conclusions might, perhaps, be admitted without much hesitation; or, at all events, might be experimentally tested without much difficulty.

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ON SOME OF THE LEADING FEATURES OF THE
LANCASHIRE COAL-FIELD.

By JOSEPH DICKINSON, F.G.S.

Read at the Manchester Meeting, July 11th, 1865.

In a paper which I read before the Manchester Geological Society on the 31st of March, 1863, "On the Coal Strata of Lancashire," * I gave a general description of the coal-field, together with detailed sections of the strata at several of the principal places where the coal is being worked; and as that paper and the sections have been printed for the society, and may be bought by the public, it would be undesirable to repeat the same matter here. Having, however, been requested by the South Lancashire and Cheshire Coal Association to give a paper upon that subject, on the occasion of the visit of the North of England Institute of Mining Engineers to Manchester, I have much pleasure in offering a few brief observations, without trenching upon my previous paper.

The most remarkable points in the Lancashire Coal-field are,—

1st, —The great thickness of the strata, which constitute it one of the thickest coal-fields in the kingdom. North Staffordshire and Somersetshire being two others which are also of great thickness.

2nd, —The great number of workable coal seams which it contains, which afford every variety of coal, except lignite, that is required for use.

3rd, — The magnitude of the faults by which the coal-field is dislocated; the vertical displacement of the strata reaching to as much as 1,000 yards.

Owing to the large number of the seams of coal, and the similarity in the thickness and quality of some of them, together with the magni-


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The table shows that there are in the Lancashire Coal-field about 2,150 yards of strata, which actually contain seams of coal; and it is possible that some higher beds may yet be discovered under
the Trias and Permian; but most likely the top, or very nearly the top, of the coal-field has been already discovered.

In addition, however, to this 2,150 yards, there are the Millstone-grit, shales, etc., which are here of great thickness, and the Mountain-limestone below, all of which lie conformably to the Coal-measures. The thickness of the Millstone-grit and the shales may be judged of at several places; but one of the best natural sections is near Burnley, between the north of Padiham, through Sabden, to near Chatburn. The strata there dip at a steep angle, and the thickness of the whole is apparently about 2,000 yards. Towards the lower portion, which is chiefly dark shale, the strata become impregnated with Limestone, and nearer the bottom thin bands of impure Limestone intervene, until the main upper bed of Limestone is reached.

The limestone strata are apparently of a medium thickness compared with what they are further south and north, the thickness here being probably about 700 yards.

We have, therefore, altogether, —

<table>
<thead>
<tr>
<th>Strata</th>
<th>Yards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proved coal-bearing strata</td>
<td>2,150</td>
</tr>
<tr>
<td>Millstone-grit, shales, etc.</td>
<td>2,000</td>
</tr>
<tr>
<td>Mountain-limestone</td>
<td>700</td>
</tr>
<tr>
<td>Carboniferous formation</td>
<td>4,850</td>
</tr>
</tbody>
</table>

Viewing the formation here with regard to the position it assumes further south and north, remarkable transitions are to be observed. In the south and west of England, and under the principal part of the South Wales Coal-field, the Old-red-sandstone is of great thickness underneath the Mountain-limestone; whilst, in Lancashire, the Old-red-sandstone is almost wanting, and the Mountain-limestone rests unconformably upon or against the metamorphic rocks. And as the Old-red-sandstone is thus disappearing from below the Limestone, the Millstone-grit and the Shales above the Limestone are simultaneously becoming greatly increased in thickness. The Limestone itself, also, which in the south is bedded in almost one dense mass, with only scale partings,

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Table of Superposition and Connection of the Principal Coal Seams of the Lancashire Coal Measures. Referred to in Mr. Dickinson’s paper, July, 1865.

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begins, in Lancashire, to be divided by other strata; and at Ardwick, near Manchester (where, apparently, the thickest part of the Lancashire Coal-field has been proved), some beds of Limestone, called Carboniferous limestone, but possessing the property belonging to the Lias-limestone of setting in water, are found capping the coal-field. Whilst further north, on reaching Cumberland and Northumberland, the change is still continuing; and workable coal-seams are found amongst the upper beds of the lower portion of the Limestone until, on reaching Scotland, the Limestone has almost disappeared from below, and is associated with the principal coal-measure strata, and at
some places the principal coal-seams may be seen bassetting or resting unconformably against the metamorphic rocks, and the transition is completed.

DISCUSSION ON MR. JOSEPH DICKINSON’S PAPER ON SOME OF THE LEADING FEATURES OF THE LANCASTRIAN COAL-FIELD.

J. T. WOODHOUSE, Esq., Vice-President, in the Chair.

The Chairman said, Mr. Dickinson appended a table of superposition in connection with the principal coal-seams which Mr. Cochrane had passed over. No doubt if, in the middle of a paper, a mass of details were entered into, it tended to confuse the mind, and the listener lost the thread of the general bearing of the paper; but he would undertake himself to give the thickness and relative position of some of the mines, if it were their pleasure that he should do so. It was not desirable that they should work their volunteer Secretary too hard, and as he (the Chairman) had devoted none of his time to their business before, he thought it was only proper and right that he should take all the work upon himself he could to make amends. The Chairman then said, this was a very complete table indeed, and showed clearly to the mind even of a non-geologist, who had got the least idea in the world of what stratification meant, the relative position of the different series of the coal-fields in this county, and their respective thickness. He would take, for instance, Wigan. The description was this:—The upper series to the Worsley four-feet coal, as proved at Patricroft, was about 390 yards in thickness, while the upper strata at Clayton, Manchester, showed the full thickness to be about 550 yards. He was not now speaking to residents in Lancashire, but to those who might not know its exact geographical position. There was a very excellent map which could be seen, showing the relative position of these beds; but when Mr. Dickinson spoke of Patricroft, he (the Chairman) saw some gentlemen present who might not be aware of the collieries around it. Years since it was a well known name in this county, and there, it appeared, the upper seam was about 390 yards in depth.

Mr. J. Dickinson—The upper seam is at a greater depth, but there are some of the Permian strata, at the top, which are not classed as coal-measures.

The Chairman—The Coal-measures you take at 390 yards, and the Permian at 50 more. I will make one remark upon Wigan. It is described as being thin.

Mr. J. Dickinson—At Wigan the measures above the Worsley-four-feet are not in the ground, and consequently not included in the table.

The Chairman, after making several extracts from the table, said that an inspection of it would show a clear and concise comparison of the various series—the upper, middle, and lower—and give a full explanation of many points of interest. He then said it had been suggested that as they had so much to do, they had better postpone the discussion on the papers until a future day. If, however, it would be more agreeable to the meeting for the discussion to proceed, he was entirely in their hands.
Mr. Boyd—I was going to ask Mr. Dickinson to give us the appearance of the Magnesian-limestone. Does it appear at all? In our county it underlies the New-red-sandstone.

Mr. J. Dickinson—I think there is no trace whatever of the Magnesian-limestone. If it be, it is so thin as to be scarcely worth noticing. Mr. Binney, of Manchester, who has devoted a great deal of attention to the Permian strata, thinks he can trace a little of it, about a foot in thickness. He has shown it to me; but generally you may say that the Magnesian-limestone does not appear here.

A Member said, he had been told that there was some to be seen at a place called Skinner Clough, and he went with a friend there to look for it; but the brook was so swollen by heavy rains that they did not succeed in finding it.

Mr. J. Dickinson—Some of the rocks which are here classed as Permian, are, by some of our local geologists, supposed to be some of the Red-stone of the Coal-measures, pushed up by faults. The Trias or Upper New-red-sandstone is well developed, and the marls underneath it, and also in Lower New-red-sandstone. The last is particularly known as being well suited for foundry purposes—good moulding sand.

The Chairman—How do the geologists of this district classify the New-red-sandstone? They take the Trias as the upper portion; then

immediately below that the Permian. But have you any of the great conglomerate?

Mr. J. Dickinson—The thin bed, about one foot thick, that I have spoken of, called Magnesian-limestone, appears to me to be a sort of conglomerate; but I do not put myself forward as an authority on this matter. For anything we know yet, the coal-field is extending under this New-red-sandstone.

The Chairman—I understand that New-red-sandstone dips generally towards Wigan.

Mr. J. Dickinson—No, not towards Wigan. It overlies the coalfield as it dips southwards, and also in tongues or thin wedge-shaped pieces at the deep side of some faults.

Mr. Lancaster—The popular idea, I think, amongst the mining engineers, up to a very recent period, was that the thin seams of Limestone found at Ardwick occupied the position of the Magnesian-limestone of the Northern and Eastern counties.

Mr. J. Dickinson—Mr. Lancaster is right, and when he began to sink his pit at Patricroft he was very much ridiculed; and I know Sir Henry de la Beche expressed himself that he was "knocked off his stool" by Messrs. Lancaster's discovery of coal there. But this idea was the popular idea twenty or thirty years ago. I think it is not so now. The popular idea is right, so far as regards the western portion of the Patricroft and the Bedford-limestone. They do not lie conformably to the Coal-measures, and are allied to some of the upper strata. But the Limestones at Ardwick do lie conformably to the Coal-measures, and are supposed by geologists not to be the same Limestone as Bedford and Patricroft.
The Chairman—I beg to move that the paper be printed and placed amongst the archives of the Institute; and also to propose that the thanks of this meeting be presented to Mr. Dickinson for the very clear and able explanation of the coal in this part of Lancashire.

The resolution was carried by acclamation.

Vol. XV Plate I.

Cleggswood Pumping Engine.

Vol. XV Plate II.

Cleggswood Pumping Engine.

Vol. XV Plate III.

Clifton Hall Winding Engine.

Vol. XV Plate IV.

Clifton Hall Winding Engine.

Vol. XV Plate V.

Plan of Arrangement of Pump Rods.

Vol. XV Plate VI.

Plan of Water Cistern for the winding at Clifton Hall.

Vol. XV Plate VII.

Plan of Cages for Clifton Hall.
ON DIRECT-ACTING PUMPING ENGINES AND DIRECT-ACTING WINDING ENGINES.

By JOHN KNOWLES.

Head at the Manchester Meeting, July 11th, 1865.

Having been informed that a paper on the above subjects, in connection with those in use in Lancashire, would be interesting, I have thought it desirable to combine both in one, as they are very much connected with each other in colliery operations, and an opportunity is given by which a comparison of their respective merits may be made, where they are employed to do the same kind of work, namely, raising water. As the pumping engine has had greater and earlier attention paid to it in consequence of the enormous expense that some collieries have been subjected to on account of the large quantities of water raised, it is, perhaps, desirable to state the improvements that have been made with respect to it; and, in doing so, I have taken the engine at Cleggswood Colliery, near Littleborough, as a sample of this kind of engine.

The engine is a direct-acting engine, with a cylinder fifty-one inches diameter and a ten-feet stroke. It is placed over the pit, and was used to pump the water during the sinking of the shaft. The steam is used on the underside of the piston, at a pressure of 40 lbs. per square inch, and is cut off at a part of the stroke; and when the up-stroke is completed, the steam is allowed to go through a regulating valve to the top side and make the down-stroke, then it is ready for condensing for the next up-stroke. Since the erection of this engine, a plan is adopted of having a beam, with a balance at the back end, equal to half the weight of the rods in the pit, and by using the steam on both sides of the piston, there is an opportunity of gaining two vacuums of 10 lbs. each, instead of one, and thereby saving fuel. The Cleggswood engine has a beam, with a small balance to it, to counteract the weight of the draw-lift rods. The top set of pumps are eighty yards long, with a ram twenty inches in diameter; and the rods, in this case, are so arranged that the weight of them will force up the water to the top of the pit. The lower set of pumps has a bucket-lift of eighteen inches diameter, and forty-six yards long, and these rods are balanced by the weights on the engine beam.

In sinking the pit a very large quantity of water was met with, and a draw-lift of eighteen inches diameter was placed in the front of the engine, and connected with the top rods of the pumping engines by two fiddles (see plate).

This plan will answer during sinking, but it would be better changed to direct-acting as soon as practicable. A ram-pump is much better than a draw-lift for the top-lift, where a direct-acting engine is used, unless it is some distance down the pit to the place where the water is delivered from the pumps, and thereby have a long length of rods out of the pump-trees.

If it is only a short distance from the engine to the top of the draw-lift, there is a difficulty in getting the rods in and out of the "trees;" and as this has often to be done where buckets are used, it is much better to have a ram-pump, provided there is very little risk of the pumps being drowned out.

When the pit was sunk eighty yards, the twenty-inch ram-pump was then put in, and connected directly with the top rod, and the lower draw-lift was put to it in the usual manner.
During the sinking of the pit, which was an oval one, there was a feeder of 600 gallons of water per minute to contend with; and when the engine stopped, it rose up the pit one foot per minute; and when the clacks required changing, the change had to be accomplished in fifteen minutes. A difficulty arose in sinking the pit on account of the long-stroke of the engine causing the use of a short slide, instead of a long one, which would allow a nine-feet tree to be put in during a change, and therefore the changes had to be made oftener.

When the bucket was drawing with the long stroke, it would get too high for the proper action of the draw-lift when sinking, and as a large quantity of air gets in, the lift is liable to lose its water if the lower part is too long.

There is connected with this engine an arrangement by which the handles opening the valves can be so arranged that they will open at any speed, and cause the engine either to work fast or slow, at the up-stroke or the down-stroke, or, if requisite, remain stationary a short time. There is also a registering indicator, so arranged that every stroke, or part of a stroke, is counted, which has been at work since the engine started, and it is possible to ascertain the number of strokes it has made since it was erected.

The first of these indicators was used in 1851, at the Belfield pumping-engine, and as it then was found so useful, they were adopted at all the pumping-engines owned by Messrs. Knowles.

One of the great advantages of this kind of engine is, that there is very little friction between the power which is exerted upon the piston, and the work of raising the rods and water; and, of necessity, it must use less fuel. Another advantage is, that it obviates the risk and chance of such an accident as that which occurred at Hartley Colliery, in Northumberland, as the beam which is used as a balance is kept in such a position that it is almost impossible for it to fall down the shaft.

In comparison with the old kind of beam engines, with cog wheels, slide rods, and L legs, there is a very great saving, and we cannot wonder at this when the power has to be transmitted round eleven corners, each adding to the friction and work.

The Table on the next page, compiled from the actual work of seventeen engines, will show the wonderful difference in their respective values; and although they are not yet up to the proper theoretical working of engines, they show the true principle which ought to be adopted; and as the experiments were made in their ordinary working condition, it may be presumed they are a fair sample of those generally adopted.

The first direct-acting pumping-engine, erected by the late Mr. Andrew Knowles, of Eagley, was at the Eccleston Colliery, near St. Helens, in 1829, and at the time there were many difficulties to contend with, not only on account of the engine, but, also, as this was the first place where the ram-pump was tried, it was with difficulty the two could be made to work well. Since then there have been a great number erected, and no doubt the idea of the steam-hammer and the steam pile-driving-machines was taken from these.
In comparing the work of the engines, the ordinary slack of the colliery was used, and as it takes six tons of slack to five tons of coal, the economic result would be much better if the experiment had been made with coal. In balancing these engines, it is of the greatest importance that it should be done very accurately; and if the engine has to work

[22] Table of Results of Engines Raising Water from Collieries

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slow, then it requires very little extra weight of rods, over and above the weight of the column of water, to work well.

But if the engine has to work a great number of strokes per minute, then it requires the weight of the rods to predominate much more, to get it to work at the required speed.

The Cleggswood engine now works only three strokes per minute, because the feeder is now much less; but when sinking, it varied from six to eight strokes per minute.

In arranging the dimensions of the rods, and weight for the ram-pump, it is desirable that they should be a little heavier than the column of water, so that the engine will not have to press down upon them, and cause them to bind, and rub against the bearers, but should really be made to hang in such a way that there will only be the friction of the glands. At a small pumping-engine at Lever Colliery a wire rope was used, and the weight of the ram itself was sufficient to force the water to the top of the "trees."

The wire rope is about to be replaced with some strong old round iron conducting-rods, because it was liable to breakage.

On examining the Table, the best engine is the one at Cleggswood; and this may be accounted for by the fact that it has been well balanced for the work, and is a large lift for a short depth, with very little friction of the rods against the bearers, and also less friction of the water in the pump-trees.

The little Hey pit engine works exceedingly well, considering it has down brow-pumps attached to it, and it is singular that this engine, or, I may say, the parts not renewed, was the engine first erected, in 1829, at Eccleston Colliery. The Outwood engine is also connected with down brow-pumps, which no doubt adds much to the friction in working. With respect to the Hagside engine, it is possible that the great length; of the lifts in this case will materially affect the power, by causing greater friction in the pump-trees. The Allen's Green engine does not work so satisfactorily as could be wished, and no doubt it is caused by the balancing being imperfect. With regard to the other kind of engines using wheels and L legs, those to take as a fair sample of work are the Agecroft, Clifton Moss, and Ben's Pit, Outwood; and as these give a result of forty per cent, of the value of the direct-acting, considering that the direct-acting engine will, at the least average, pump 120,000 gallons of water 100 yards high, by the consumption of a ton of slack; and, in the other case, there will only be, at the best average, 48,000 gallons pumped 100 yards high, also with a ton of slack.

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There cannot be any doubt as to their relative merits, and the first cost in the erection is also in favour of the direct-acting engine.
The engine at the Clifton Hall Colliery has been taken as a sample of the direct-acting winding-engine in Lancashire; and this has been chosen on account of its being the largest erected by Messrs. Knowles, and has a compensating drum.

It is also used for winding water, by which an opportunity is given to test its economical value in comparison with pumping-engines of various kinds. The cylinder is forty-two inches diameter, and has a six-feet stroke; pressure of steam 45 lbs. per inch. The connecting rod is eighteen feet long, and the shaft is fourteen inches square, and of wrought iron. The compensating drum commences at fifteen feet diameter and ends at twenty-five feet diameter.

The ropes lap on the drum from each outside, and a line drawn from the pulleys at right angles with the main shaft of the drum, will come on to the drum at the point where the rope begins to lap on the flat part (see plate). Therefore, the tendency of the rope, on ascending, is to lie against the side of the drum, and avoid slipping off. The outside of the drum is made of English oak, and the grooves are cut into it, and on some parts of the scroll there are iron-plate guards. A steam break is used at this engine, and is under the command of the engineer, who can throw on the steam at any moment; and it is so powerful that it will stop the main engine in less than two strokes, if it is going at full speed, with all steam on; but if the steam is off, it will stop it instantly. The engineer uses the break in his ordinary work, so that it has always to be kept in order, and, therefore, ready for any emergency. Round iron wire-ropes, four inches circumference, 7 lbs. per yard, were used at the first; but now there is a steel wire-robe on the one side of the drum, and an iron one on the other side. It is intended to use steel wire-ropes on both sides, if they are found to answer satisfactorily. The pulleys over the pit are three feet six inches from each other, and are fifteen feet diameter, with wrought-iron arms, and the outside rim is arranged to be filled up with timber, so that the rope will not be so much injured as it would be by running upon the iron surface. Teak wood was first used, and lasted eighteen months; then English oak, which lasted four months; and now lignum-vitae is found to be the most suitable, having been used for thirty-six months.

It is found that the wire-ropes are much worn with running upon iron; and, consequently, every care should be taken to avoid this.

At the present time the engine has not full work for its power during the day; but it was erected in anticipation of an increased quantity, which is now being prepared. The average amount of coal raised is 280 tons per day from one pit, which is 430 yards deep.

The pit is nine feet diameter for 220 yards, and ten feet diameter for the remaining depth, and has two ropes in it.

The cages have two decks, with two wagons of coal, containing 7 cwts. each on both decks, making 28 cwts. of coal raised at one lift; and it is raised up in forty-five seconds, or at the rate of nearly twenty miles per hour. The greatest speed of the cage, when in the middle of the pit, is twenty-five miles per hour.

When the full tubs are placed in the lower deck, at the bottom of the pit, the cage is lowered by the aid of a lowering platform, so that the top deck comes to the level of the plates; and when the tubs

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are taken off at the top, the engine raises each deck to the level of the pit-brow when required. There is a great advantage in using the lowering platform, when the engine begins to raise the load from the bottom of the pit, because the weights of the lowering platform assist the engine with the start. The cages are 25 cwts. in weight, and are fitted up with safety catches, which have often been successfully used, and have, at various times, saved a large amount of property from destruction. The water-cisterns weigh 20 cwts., and contain 530 gallons of water, and are used at the end of every week or fortnight, according to the quantity of water made in the mines. The cisterns are so arranged, that when they come to the top they empty themselves by means of a lever and a moveable weight. By this means of winding water, thirty-three cisterns have been raised per hour, making 290 gallons per minute; and this has been done for ten to twenty hours together.

During this time it has occupied two men to fire up at the boilers, and notice is taken how many cisterns are raised, and the length of time in doing it.

The average quantity of water made in the mine is now fifteen gallons per minute, but it has been up to twenty-six gallons per minute.

By this method of raising water from the depth of 430 yards, the experiments show that 106,975 gallons can be raised 100 yards by the consumption of one ton of slack, and thereby showing that this system is much better than using beam-engines, wheels, and L legs but not so economical as the direct-acting pumping-engine.

In deciding upon so important a subject, many considerations must be thought of; and although this result is considered satisfactory, it would not be so at the shorter depths, as exemplified by the Farnworth Bridge winding-engine, which only raises 55,000 gallons of water 100 yards high, by the consumption of one ton of slack.

If the quantity of water to be raised is but small, and at a great depth, with sufficient lodge-room for a week, then this plan will, perhaps, be the best; one of the considerations being the great expense of erecting a pumping-engine for a small quantity, when the winding-engine could easily do the work. If the quantity of water is large, even at any depth, the direct-acting pumping-engine will be found to be the most economical in the end, and it is quite certain to be so with a moderate depth.

There is a great objection to winding water in a pit used for raising coal, as it is sure at times to inconvenience the regular work.

There is also the necessity of having a number of men to put on and take off the cisterns at the commencement and ending of the winding; and as these men cannot be usefully employed in the meantime, a loss must, of course, arise in their having to come to the colliery for that special purpose.

DISCUSSION ON MR. JOHN KNOWLES'S PAPER ON DIRECT-ACTING PUMPING ENGINES AND DIRECT-ACTING WINDING ENGINES.

J. T. Woodhouse, Esq., Vice-President, in the Chair.
This is a very interesting and valuable communication indeed. This paper, in fact, contains the substance matter of two papers—one upon pumping engines, the other upon winding engines and the comparative merit of drawing water by beams, or wire ropes. I am happy to see several gentlemen in this room who have had great practice in pumping and drawing water; and I am sure the meeting will be most happy to hear their opinion on the subject. I cannot do better than turn, first, to my friend, Mr. Lancaster; and I do so because I believe Mr. Lancaster, in his practice, has constructed the largest plunge direct pumping engine that was ever built, and if he will favour us with his experience in that matter, we shall be delighted to hear him. There is a valuable table put in with this paper, containing much useful statistical information.

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A Member—It would be valuable to add the number and size of the boilers used. [It was intimated that this addition should be made.]*

The Chairman—Well, now, gentlemen, it is my duty to inform you that we are going this afternoon to see, I believe, these very engines.

Mr. Knowles—We are going to see the winding engines.

The Chairman—Therefore, we shall have an opportunity of completely investigating their merits. Of course, we can go into the discussion here, and then into further discussion after we have inspected the engines.

Mr. Lancaster said, he was not able to go into all the details; but so far as he had been able to make experiments, he could quite confirm what Mr. Knowles had said. Some gentlemen would, perhaps, give an account of the Cornish engine, as a contrast with this. There appeared to be, in this case, a total absence of the duty performed by the Cornish engine. There were several of the latter in the county, and it would be well if they could be compared with the direct-action engines. He believed it would be found that there was a saving of from twenty to twenty-five per cent, in friction. The value of these engines consisted in the saving of first cost, and in the saving of that friction. As to the bell cranks and T bobs, there could be no doubt that there was a saving of fifty per cent, upon these. It would be useful now to small colliery owners to know that pumping by that plan cost fifty per cent, more than with direct-acting engines. He believed Mr. Knowles had adopted the double-flue boilers, which were fired internally. They (Mr. Lancaster’s firm) had not adopted them, but had the externally-fired boilers. The engine the President alluded to was a large one—100 inches diameter, working pumps twenty-four inches diameter to a depth of 250 yards. It had been worked satisfactorily for the last few years. He was sorry he had not the experiments by him as to the consumption of coal by that engine; but he had no doubt it would compare favourably with those which had been mentioned by Mr. Knowles.

The Chairman thought Mr. Maddison might be able to add some information on this subject.

*Note.—In reply to the inquiry respecting the boilers used. There are more boilers at the collieries where the experiments were made than is absolutely requisite for pumping the water; and as it would not give any useful information to name them here, it is perhaps better to state the kinds of boiler used, viz.:— Two flued boilers, 26 feet long, 7 feet diameter, with two flues through, 2 feet 10 inches diameter; and one flue boiler, 26 feet long, 6 feet diameter, with one flue 3 feet diameter.
The ends of the boilers are flat, and the fireplace is in the flues. During the experiments, only the requisite amount of boiler power was used for the purpose; and as it was not noted at the time, cannot now be given.—J. K.

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Mr. Maddison could not say that he was at all prepared to state, at this meeting, his experience of the matter, as he had not expected to be called upon to do so. He had had considerable experience in pumping with both sorts of engines. One, at the new colliery at Thornhill, with a thirty-eight inch cylinder, was working two sets of pumps, driven by a pressure of forty-five pounds. The sets of pumps were each eighty-seven yards lift, and eighteen inches diameter. He believed he might say they got a very large per centage of power from that engine, and that the weight of water lifted would be very little less than the power exerted upon it. The engine itself had been viewed by numbers of experienced men, and had been thought by them to be, at least they had so expressed themselves, one of the best they had ever seen.

The Chairman—Will you give us the depth of the pit?

Mr. Maddison—The length of the sets is eighty-seven yards, the depth of the pit 120. The engine itself is so void of friction, or nearly so, that with a fly-wheel of twenty-two feet diameter it has been known to run at the rate of one stroke in three minutes five seconds, and the motion never ceased. Had I been aware, I would have brought further particulars with me; but at present I do not know that I am prepared to say more.

The Chairman—At any rate, gentlemen, we have an instance here of very economical working of wheels, cranks, and pumps. Mr. Maddison, did I understand that these are plunge pumps?

Mr. Maddison—No; these are lifting pumps, of eighty-seven yards in length.

The Chairman—Do you recollect the velocity—either the number of feet per minute, or the number of strokes? You gave one instance of an engine taking three minutes and a fraction to complete a stroke; but what is the maximum velocity?

Mr. Maddison—Six strokes a minute we have had with that engine. I dare not say what would be the maximum if we placed the whole of the steam against the engine; I believe we should break something or other. The length of stroke was four feet six inches in each set.

The Chairman asked whether Mr. Lancaster could tell them any more?

Mr. Lancaster—It would have been well if Mr. Maddison could have furnished us with the consumption of fuel, or some other guide of that sort. We have got at present information of an excellent working engine, without any data. No doubt, it is possible to construct a very

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good machine, worked through by indirect motion; but I think before we compare the two, we ought to have data. Perhaps, if Mr. Maddison could furnish that, there would be a very good contrast.
A Gentleman suggested that perhaps it would be well to adjourn the discussion for this purpose.

Mr. Maddison said, he would have pleasure in furnishing the particulars at some future day.

Mr. Lancaster—This may be a very arbitrary rule which has been chosen by Mr. Knowles, but at all events it is a very simple one, viz., that the duty is measured by the actual amount of coal consumed. The old Cornish plan may be more scientific, but this plan is a good one. The test is the number of tons of coal required to raise a certain number of gallons of water 100 yards high.

The Chairman said, the absence of notice on the paper, when a paper was to be read, was found to be very inconvenient. It would be well if notice could be given of all papers intended to be read, in order that engineers might be fully prepared for the discussion. It had been proposed that, if it were agreeable to the meeting, the discussion should be adjourned until Thursday, in order that their friend might have an opportunity of preparing a few statistics; and also to afford Mr. Knowles an opportunity of completing his paper, by filling in the number of boilers, and a few other tabulated results connected with the subject. That being so, unless there was any objection, they would adjourn the discussion of that paper until Thursday, when there will be time to take it.

Mr. Marley thought that at this point it was well to call attention to the rule of the Institution of Engineers with regard to the process these papers would have to undergo after this meeting. It was well that the members present, and especially the strangers, should know that before the papers were published in the volume of the proceedings, an opportunity would be given for the embodiment of any further remarks; and the actual discussion would be held in Newcastle. The Newcastle discussion was usually pro forma; but persons were enabled to bring in anything which might have been previously omitted. In all these cases they would have an opportunity—in addition to Thursday's discussion—after having seen the paper in print (which enabled them to understand it better than the simple hearing) of adding to it what might be thought important, or making any observations they pleased upon it.

The Chairman was obliged to Mr. Marley. The gentlemen who read papers at these meetings would all agree with him that that was a

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very wise and useful regulation of the Institution; because it enabled a man to have what they called fair play. He not only had his paper reported and printed, but it ultimately came before the world in the shape in which he intended to present it. They might not, however, for some time to come be assembled so numerously as at present; and, to afford an opportunity of getting these particulars, the discussion would be continued on Thursday; and after that the useful rule which had been described by Mr. Marley would come into operation. They had, perhaps, better now proceed to the consideration of the third paper.

Mr. Spencer—I should like to ask Mr. Knowles a question. You mentioned that a safety apparatus was applied to the cages. Whose is it?

Mr. Knowles—It is Owen's.

The Chairman—Can it be inspected to-day?
Mr. Knowles—Yes; and there is a sketch of it on the wall of this room.

Mr. Dickinson—Owen’s is the safety apparatus generally adopted in this county. There is, I should think, a much larger number of Owen’s in this county than in all the other mining districts, except Scotland, put together. They are working successfully. You will have an opportunity of seeing some of them.

Mr. G. C. Greenwell—I think you said the engine could be stopped by the brake after it had made two strokes, and I understood that was with the steam on. If I understood Mr. Knowles aright, two strokes of the engine must be made before it could be brought to a stand; and as the extreme diameter is twenty-four feet, that is something like twenty-four fathoms. Am I quite right?

Mr. Knowles—I was only showing the great power of the brake, which could stop the engine, although it was at full speed. But the steam can be taken off and the brake put on, and it can be done instantly—the engine can be stopped in a moment.

Mr. Bigland—What is the size of the screen?

Mr. Knowles—Three-eighths of an inch spaces.

Mr. Spencer asked whether Mr. Knowles, who had mentioned a plunger pump, could give a comparison between it and the piston or tight-bucket pump. In his (Mr. S.’s) experience, the piston-pump, the rod of which worked through the packing, was more economical than the plunger or ram-pump. The packing in the leather case being round the larger diameter of the ram itself.

The Chairman—The ordinary lifting pump?

Mr. Spencer—No, the tight-bucket—the same as the piston.

The Chairman—I understand Mr. Knowles to say he has not tried that experiment.

Mr. Marley said, it occurred to him that, as the discussion was to be adjourned, it might be as well to throw in a comparison with regard to a very important element which came into the question, besides the exact merit of the engines—that was, the amount of capital employed in making the winning in the first instance. The direct-action engine essentially required a separate shaft for the cylinder and plunger. Other shafts were used for both the purposes of drawing coals and pumping water. Many parties might use one engine in preference to another, not because it was essentially a better engine in the abstract, but because of the saving of capital. A remark had been made as to the winding engine requiring a separate shaft and also as to its requiring a larger quantity of coal. He thought the same remark applied to the direct-action engine.

Mr. Lancaster—Perhaps I can correct one or two matters off-hand. First, as to the separate shaft. I have not found that any more room is taken up by the engine, than is necessary for the pumps. In point of fact, the measure or size of the pumps determines the amount of space in the shaft, and the engine never takes up more room than the pumps require.

Mr. Marley—Not for the cylinder?
Mr. Lancaster—The overhanging of the cylinder is never beyond the pumps in the shaft. We invariably use them in winding shafts, as well as for pumping. As to capital, where you have actual employment (for often there is not full employment, and it all depends upon that) for an engine, these are, I believe, cheaper in the first cost than any other modes of pumping.

Mr. Marley—My remark as to capital was made under the impression that, as a rule, you required a separate shaft. Therefore, it does not apply to the original cost of the engine.

The Chairman—I suppose a good deal will depend upon the size of the shaft?

Mr. Marley—Everything.

Mr. Lancaster said, he had had these engines put to shafts of nine feet diameter up to thirteen feet.

Mr. Higson said, that if the engine required a separate shaft it might be set back, and the beam extended over the pit. It seemed to him to be the nicest application of the direct-action engine.

In answer to a question,

Mr. Lancaster said, his firm had one of these engines at work with fifteen-inch pumps—the size of pit was ten feet diameter; and they were drawing coals out of the same shaft.

Mr. Dickinson remarked that, practically, the discussion upon this paper appeared to be going on.

The Chairman said, he listened with great interest to what was being said. He had rather thought his friend on the right (Mr. Knowles) had got himself into an awkward position in dealing with the diameter of the cylinder; because it had a good deal to do—suppose there was no, or very little, off-take. He could suppose that where that was long there was no difficulty, or where a plunger lift was used at the top. But still, it must be that, where they had a cylinder of so large a diameter, it would occupy to a certain extent a large segment of the pit. He had not seen the large engine of which Mr. Lancaster had spoken—the engine of 100 inches diameter and fourteen feet stroke. That must be a very large, powerful machine indeed. But the nature of the ground or the architecture he did not know. He understood that in that engine the spears were directly suspended from the end of the piston-rod.

Mr. Lancaster—Yes.

The Chairman—Then the question arises—how far the outer rim or flange of the cylinder will project beyond the line of the buntings down the shaft?

Mr. Lancaster said, that in the case in question the shaft had never been intended for a winding shaft, although there was room for a pair of cages. It had always been intended to be simply a downcast and pumping shaft, and it had been reserved for that. The pumping rods went as near the side of the shaft as possible—perhaps about six inches; and the cylinder front of the flange went parallel with the horse-trees. The engine was direct-acting. All the engines he alluded to were direct, and were coupled parallel with the piston-rod. He had no instance of the top-lift being anything but
a plunge lift. With that engine, there were three plungers—one under the other, and the lower lifts, eighteen inches diameter, lifting to supply a twenty-four inch plunger.

Mr. C. Berkley asked whether they had applied double-acting rams to force the water to the surface?

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Mr. Lancaster replied, that he had tried one twenty years ago, in the Patricroft shaft. They had put an engine in the bottom to draw the coals up an incline. They found that the friction was excessive. He had no statistics of the experiments before him at present; but the friction at that depth was very considerable. That had succeeded; but he could scarcely recommend it for the same depth—440 yards at one lift. They had one working successfully now at 160 yards, with a small pair of engines; but on too small a scale for sufficient data. They were only six inches diameter—the pair working at right angles. They were very successful and gave very little trouble.

Mr. Berkley—What is the greatest depth for plungers?

Mr. Lancaster said, on a large scale 200 yards in one column.

Mr. G. C. Greenwell said, there was an engine at the Bradbury Colliery, which he should be glad to have described. Unfortunately, Mr. Livesey, was not in the room, or he would have referred to him, because Mr. Livesey would be able to give particulars if he were present.

Mr. Clegg Livesey said, there was a ten-feet stroke cylinder, eighteen-inches in diameter, with six-inch ram and eight-inch pipes. The depth of the pit was 200 yards. The boiler pressure about thirty-five pounds. They were working with a smaller one at another colliery, where the pressure was forty pounds. But he could not say what was the quantity of water sent up.

Mr. J. Dickinson—I think it is very important that as many of these practical questions should be suggested as possible, before this discussion be adjourned; for if there be one thing more than another, in which you may expect to find excellence in this district, it will be the machinery. It bears comparison with any I have seen, in this country or out of it. Mr. John Knowles, being connected with a firm which has so many collieries at work in this district, has had so many opportunities of comparison, that I think this paper of itself, will establish the superiority of the direct-acting, over the indirect-acting, engines. But although that is the experience he has arrived at, there are parts of Lancashire where that practice is not adopted. For instance, in the Burnley coal-field the view prevails that the intervention of wheels, so as to make a difference between the velocity of the pump-rods in the pit, and the velocity of the piston in the cylinder, is advantageous, and gives facilities in changing the pump-rods which more than counterbalances the friction which is inherent in the indirect-acting engines, the rate at which the piston travels being rather more than twice that of the pump-rods. In Cornwall, also, where, perhaps, we take our best pumping engines

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from, at all events the Cornish principle, the old view was, that the stroke of the pump-rods should not be the same as the stroke in the cylinder; and for years and years, I believe, all the Cornish engines were made with a difference of about one foot between the stroke in the cylinder and the stroke in the shaft. But latterly, in Cornwall, I have found that new engines were being put up with
the stroke the same in the shaft as in the cylinder. I think this paper of Mr. Knowles's will establish the superiority of the direct-action engines in regard to the quantity of fuel used.

Mr. Lishman asked what was the number of strokes per minute, and the quantity of water raised by these engines?

Mr. Lancaster had scarcely come prepared with figures; but he thought the quantity of water was 280 gallons per stroke, and the maximum speed was eight strokes per minute. They could work it as slow as half-a-stroke per minute; though he did not know whether there was any advantage in that. He believed it was the rule with most Cornish pumpers not to run the pumps more than 120 to 140 feet per minute; and, as they were all aware, Watt’s rule for the piston was 240 feet per minute. Now they were going at the rate of 300 to 340 feet per minute. But by having the steam cylinders jacketed and working at this slow speed, making up for want of power and loss of speed of the larger cylinder, he thought they got pretty nearly as economical results out of an equal amount of steam duty.

Mr. Lishman said, that within the last three or four months his firm had raised about 2,000 gallons a minute, and they were raising it about fifty-five fathoms. He had been up in London some time ago, and heard of a patent, which was in operation in some works there. He went to examine it and found it a most economical mode, and he was thinking of introducing it into his own works. There was a wrought iron tube with glass enamel inside and outside. The depth was 178 feet. It worked with a chain, in the old chain-pump fashion, and a wheel, one metre, or three feet three inches in diameter. There was a continuous flow of water out of a 4½-inch pipe. Of this mode of pumping M. Bastier, was the patentee; and he had given a license to a person in Scotland, and his (Mr. Lishman's) firm was in treaty with him for a license to attempt to raise water fifty fathoms. The endless chain went down the pit, and up the tube over a pulley at the top of the engine. The discs being only three feet three inches apart, there was a flow, of water continuously. They were pumping about one hundred and twenty gallons a minute.

The Chairman—What is the power?

Mr. Lishman—A twenty-five-horse power engine. The pump is driven by a belt, and other machinery is connected with it as well.

Mr. W. Cochrane—Do you think the system of valves would do for a larger size?

Mr. Lishman—He has granted a license for a cylinder of fifteen-inches diameter, for sixty feet. He will guarantee to fit ours with an eight-inch one.

Mr. J. Dickinson—asked whether there was any difference between this and the other chain pump of which they had read in the old mining books?

Mr. Lancaster said, in this case there was a wheel at the top of the pit, three feet three inches. It was pretty nearly the same mode as the original pump. It brought the water up a pipe, and at each diameter of the wheel at the top the buckets fitted in.
The Chairman thought there must be some similarity between this pump and the ordinary chain pump which had been so much used.

Mr. Lancaster said, they were very similar.

The Chairman said, it was common to use the old chain pump for ordinary purposes, such as draining railway cuttings, but he was not personally informed as to the height at which they had been used in this country, nor did he recollect the velocity at which they worked. Did Mr. Lishman know what was the velocity of this pump?

Mr. Lishman had known it, but it was not in his mind at present. It was not a great velocity. I think about 180 feet per minute. The pump had been in operation twelve months, and had not cost the firm a shilling.

Mr. Marley thought he could state what was the principal difference between the pumps. The ordinary pumps were worked with buckets, a very few feet apart. This pump had the chain constantly ascending, and there was a tube contracted for a few feet. He had examined it at the exhibition of 1862. There was a flat bucket, so they might almost call it, which fitted certain parts very tightly, and there was the ordinary momentum; and they got the water in a continuous stream, not like the ordinary chain pump.

The Chairman explained that he was not speaking of the old chain which was rigged like a dredging machine. He meant the chain pump with flat discs, driven at a certain velocity. It was rather as to quantity that he wished to ask the particular application of this pump.

A Member suggested that Mr. Lancaster should be asked to give, at the future discussion, some further information, as he was sure that gentleman, from his large experience, would be able to do so.

The Chairman—I am sure I concur most fully in the suggestion. Mr. Lancaster—One proviso I must make—that you will allow time sufficient.

Mr. Homer said, he had a large pump on the old principle, but he was abandoning those pumps and adopting the system of winding water. It would be well to compare the cost of winding with the cost of pumping in the various modes. He had got sixteen-inch and thirteen-inch dip at some of the pits, and very dirty water; and where it was so dirty he found it cut up the buckets and wore the plungers very much indeed. Where they were working a sixteen-inch ram he need not stop pumping. In another place they were only opening out. It was his intention to drive out lodgments of sufficient size to draw the water. The only cost was the wear. They were drawing 100,000 gallons a day.

Something had been said in this discussion about taking up room in the shafts; but that could be obviated by putting the engine further back. As to the direct-acting engine—the first erected in Staffordshire had been erected by Mr. Lancaster, at Redhills Colliery. That engine was driven from twenty to twenty-three strokes per minute in a sinking shaft. Perhaps Mr. Lancaster would be able to get for them the figures connected with that engine. That engine was a wonder. With respect to the whole question, if his (Mr. Homer's) firm put down engines at all, he should put down direct-
acting engines. But he thought expense would be saved by winding the water. If he could have been present on Thursday, he would have brought statistics of the cost of pumping in comparison with this system; but he could not be present on that day.

The Chairman remarked that the meeting would be glad if Mr. Homer would furnish these particulars by Thursday. They should have proper attention.

Mr. Homer was sorry that he should be obliged to attend quarter-day at Birmingham, on Thursday.

The Chairman said, this was another melancholy instance of science having to give way to more necessary concerns. The plan of winding, with a compound cage, he had no doubt was effectual. He understood the cage was fitted with a tub underneath, and filled itself with water while the man below was landing. They had, he thought, in this discussion, lost sight of a very old friend. They had been talking very fully of direct-acting pumping engines, and of winding water by ropes;

but they had lost sight in a great measure of the old beam engine. Mr. Lancaster was the only member who had referred to it. He would be glad to hear if any one in the room was prepared to give them the results of experience as to pumping on the old beam plan. From the information they got from Cornwall, it appeared that with the old beam a more economical result had been arrived at than with any other method; but whether the same degree of economy would be attained by the direct-acting engine he had yet to learn. Were these engines condensing?

Mr. Lancaster said, they had both types. For smaller engines, he preferred the non-condensing type, on account of the economy of first cost; and they had generally a high pressure of steam for the first-class, and therefore they worked from the same boiler. If they had well-jacketed cylinders there was not much difference between them, when they had 45 or 50 lbs. pressure, if they expanded the steam properly. By the condensing plan they brought the cooling process into the cylinder, and in a slow working engine that told against economy. With a non-condensing engine they never reduced below 200 degrees. With regard to winding water instead of pumping, he thought, for very deep shafts, with a small quantity of water, there was, perhaps, more economy in winding; but where they got a large quantity of water, they could lift more in a given time by pumping than by winding, that is, where pit room was valuable.

The Chairman was sorry to find that his attention had been so taken up by this discussion that he had quite forgotten that he was looking at a diagram of a condensing engine on the wall near him, in fact, a beam engine. There was no reason why the condensing process should not be effected as cheaply by this as by the beam engine.

Mr. Langdale asked what was the difference between the whole moving weight of the pump-rods, and the weight of the column of water raised? What was the preponderance? He believed there was some. If the difference was small, the engine must go slowly. The work of the engine was to lift the rods. That would bring out again what was the best speed at which to work it. If it was best slow, there was no necessity for anything but a small difference in the preponderance of the rods. If there was a great difference, the engine had better go quickly. Mr. Lancaster observed that they would easily see that that must be determined by the velocity. The proper velocity was, he believed, about
150 feet a minute. Beyond that, the increase of wear and tear became excessive. A very small
difference in the weight, he could not

give it now, but he should think something like two or three per cent, of the gross load was
sufficient. Two or three per cent. extra of the weight of the rod was sufficient to drive an engine at
six or eight strokes a minute. Having all parts equally balanced that was quite sufficient to give the
velocity.

Mr. Marley said, that if Mr. Homer’s statistics were not ready by Thursday they would be happy to
receive them at Newcastle.

The Chairman moved that the thanks of the meeting be given to their friend Mr. Knowles for his very
interesting and excellent paper.

The motion was carried by acclamation.

Communication from Mr. Charles J. Homer, relative to the Pumping Apparatus at the Chatterly and
Weston Coyney Collieries.

I have much pleasure in complying with your wish, of forwarding to you particulars of the pumping
at the Chatterly and Weston Coyney Collieries, with which I am connected.

Chatterly No. 1. pit, is 200 yards deep, has three lifts of pumps, four feet stroke, the top one eighty
yards sixteen-and-a-quarter inches plunger; second, seventy yards sixteen inches; bucket and
bottom fifty yards; also sixteen inches bucket, worked by a horizontal engine; cylinder twenty-six-
and-a-quarter inches diameter, which is quite equal to its work. But, owing to the greater portion of
the water, coming in one of the lower seams, the bottom of which is a soft alum shale, eighteen feet
thick, which renders it almost impossible to keep a water-course by the side of the level, and causes
the water to be very dirty, and consequently wears the buckets very much. We have also to cleanse
out the bottom lodgment every fortnight, which is an additional expense, in this particular case, and
which ought not to be considered in calculating the comparative cost of raising water.

No. 2. plant. Up to last June, the water at these pits, was raised from the depth of 125 yards, with
two plunger pumps, each thirteen-and-a-half inches, and five feet stroke, by a pair of horizontal
engines, with twenty-two inch cylinders.

One eight-and-a-half inch bucket-lift, four feet stroke, forty-two yards below surface, worked by a
fourteen-inch cylinder horizontal engine,

(and which is still at work) each engine delivering the water to the surface. The water to the bottom
of the pit, a depth of 220 yards, was drawn by means of a ringe, and not less than 40,000 gallons per
day, which with the quantity 115,000 gallons, lifted by the large pumps, is now raised by a steel
water-chest, 4 ft. 6 in. x 3 ft. 4 in. x 3 ft. 2 in. deep, attached to the bottom of each cage, also made
of steel, self-acting, the water emptying itself during the time the load of stone is being removed from the top compartment of the cage, the only cost being the additional wear on the ropes, whereas for No. 1 pit, we cannot put down the cost at less than £500 per annum.

During the time the water was pumped at the No. 2 pit, it was found very difficult to keep the clack in order, the leather being often times cut through in a few days, the cast iron plates on top side of lid 1¼ inches thick, and the bottom plate of lid 9/16 of an inch, wrought iron, broke several times, the joints breaking and the packing round the plungers continually giving way, which caused very great trouble, owing to so great an amount of pressure, when it was determined to erect a direct-acting pumping-engine of sufficient power to pump the whole of the water from both pits, but as the pumping pit requires to be sunk down 120 yards lower, I resolved to test the cost of winding the water, as compared with the pumping at No. 1 pit, where the water is not nearly so much.

At the Weston Coyney Colliery we pump the water from the depth of eighty-two yards, and below that to a depth of 275 yards, we draw the whole by an iron chest, for the purpose, in one pit, and draw coals from another; the cost being trifling, as compared with pumping.

I would always recommend keeping the top water back by tubbing in deep pits; otherwise, I would put down a direct-acting engine, to pump the said surface water, but where it would involve a heavy outlay, (which is the chief consideration in opening a colliery) to pump several hundred yards, with the continual expense of packing plungers, changing buckets, examination of rods, &c, &c, which is absolutely necessary, together with the interest of capital at first employed, I am firmly of opinion, that water can be as cheaply raised, without first cost of pumping machinery, by winding as pumping.

In all pumps more than seventy yards long, I would put in a second clack, which will be found beneficial.

I beg you will excuse the brief manner, in which I have presented this, having been very much engaged all day. Any further particulars I shall be glad to give.

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ADJOINED DISCUSSION ON MR. JOHN KNOWLES'S PAPER ON DIRECT-ACTING PUMPING ENGINES AND DIRECT-ACTING WINDING ENGINES—JULY 13th, 1865.

J. T. WOODHOUSE, Esq., Vice-President, in the Chair.

The Chairman, referring to the paper read by Mr. John Knowles, on "Direct-Acting Pumping Engines and Direct-Acting Winding Engines," and to the subsequent discussion, which was adjourned, said that Mr. W. P. Maddison was kind enough to say that he would prepare some statistics in reference to one of the pumping engines at present in use at the Thornhill Collieries.

Mr. W. P. Maddison then read the following:—In compliance with the wish of the President, I have now the pleasure to give particulars of one of the pumping engines at present in use at the Thornhill Collieries. The engine, built by Messrs. Thomas Murray and Co., of Chester-le-Street, from instructions given by the writer, is horizontal, and working at high pressure, with a cylinder thirty-eight inches diameter and five feet stroke, and having a fly-wheel attached, twenty-two feet
Two legs connect the engine with two sets of pumps, the stroke in which is four feet six inches (which can be varied six inches, either more or less), with working barrels eighteen inches diameter, the total length of each set being 261 feet, and each lifting and delivering independently of the other. The maximum speed yet worked has been eight strokes, but ten, or even twelve strokes, may be considered a fair estimate of a safe maximum. At the increased speed of eight strokes, it has been found that the engine accomplished its work comparatively with much less steam, and that in proportion to the velocity of the fly-wheel.

At eight strokes per minute, of four feet six inches in the pumps, we have 864 gallons per minute raised 261 feet, being equivalent to 225,504 gallons raised one foot high per minute.

The two sets in the pit are uniform, having the same sized spears, etc., attached, and, consequently, an exact counterpoise is obtained; and in order to ascertain what is the precise amount of friction, an experiment has been made for the purposes of these remarks, which will, I hope, elucidate the matter in a very clear and satisfactory manner. The engine, being at work, was stopped, and a steam-gauge and indicator, previously tested and found correct, were attached to the cylinder. The column in both sets was then allowed to run off by the easing of the clack and bucket doors, and until the buckets worked freely in air. The engine was then again started, and run at a speed of eight strokes per minute, working all the machinery, but lifting no water, the steam gauges indicating, momentarily, when the steam was admitted through the valve, seven pounds, instantly dropping to two and three-quarter pounds, and decreasing, to the end of the stroke, to a pressure of two pounds on the square inch. This, consequently, is the exact amount of steam at thirty-five pounds in the boilers (the then pressure) required to overcome the friction of such an engine, or rather better than seven per cent. The weight of a column of water in an eighteen-inch set, 261 feet long, will be 31,320 lbs.; to overcome which we have 1,134 inches area of cylinder x 32½ lbs., the remaining available pressure, or 36,855 + 1-10th for difference of stroke in pumps and cylinder, or 40,540 lbs.

Unfortunately, I am not able to state, upon so short a notice, what weight of coal is required to do this work, in consequence of the steam being taken, conjointly with other engines, from six boilers, six feet diameter and thirty-six feet long, all working at one uniform pressure of thirty-five pounds; but I may state they are all fired with slack or "duff," as known in the North of England.

I must explain an apparent discrepancy in these figures and my remarks on Tuesday last, when I stated the working pressure at forty-five pounds. Until a few weeks ago such was the pressure on the boilers, but having since made an alteration to one of the other engines attached to the same boilers, the pressure has been reduced to thirty-five pounds, and it is at this reduced rate that these data have been obtained.
It will be understood that these remarks are not in any way made as in disparagement of the principle of direct-action, as set forth in Mr. Knowles's paper, but as simply showing that efficient pumping arrangements may be arrived at by other than direct action.

The Chairman remarked that those who heard the previous discussion would probably be desirous of asking Mr. Maddison some questions in further elucidation of the subject. If not, he should simply propose a vote of thanks to Mr. Maddison for his paper, which would be placed in the archives of the Institute.

Mr. J. Knowles said, with respect to the boilers they had in use, connected with the engines to which he referred in his paper, he had not

been able to get their exact size and number. But he might say that the average size would be twenty-six feet long, seven feet diameter, and two flues of three feet diameter. That was the general size of the boilers they used. In connection with the Cleggswood pump, the boiler there was only six feet diameter, with one flue through.

The motion proposed by the Chairman was then carried by acclamation.

NORTH OF ENGLAND INSTITUTE OF MINING ENGINEERS.

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

EDWARD POTTER, Esq., Vice-President, in the Chair.

The following gentlemen were elected members of the Institute, viz.:-Capt. Noble, of Elswick Works; and Mr. H. M. Morrison, of Rainton Colliery.

A letter was read from Mr. Lindsay Wood, thanking the members of the Institute for their expression of condolence on the decease of his father, the late President of the Institute.

Mr. Doubleday read a Memoir of the late President, Mr. Wood. On the motion of the Chairman, seconded by Mr. Hunt, it was resolved that the same should be inserted in the proceedings of the Institute.

A letter was read from Mr. W. Green, Jun., stating his inability to be present. The reading of his paper entitled "The Chronicle and Record of the Northern Coal Trade in the Counties of Durham and Northumberland," was postponed to the next meeting.

The discussion on Messrs. Richardson and Bunning's "Reports on the Experiments at Keyham," was postponed, sine die, neither of these gentlemen being present.

Mr. Doubleday then read the following remarks supplementary to his paper "On the Causes of Certain Steam Boiler Explosions:"—
FURTHER CONSIDERATIONS ON BOILER EXPLOSIONS.

It has been remarked, if we assume that certain portions of water at the bottom of a boiler may be deprived of more of the interspersed air than other portions, owing to the inequalities of the heat applied, that this is a mere assumption as yet unproved by any fact. This, however, is perhaps hastily said. It must be remembered, that to assume the

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antagonistic proposition, and to assert that in all cases the heat of the furnace is applied quite equally to the bottom of the boiler, is a more improbable assumption than the other. The plates of which the bottom is composed are not precisely equal, and a furnace generally burns more rapidly in one place than in another. It seems to follow, therefore, that we must admit some inequality in the heat applied; and, if this be admitted, let us ask ourselves to what this admission leads?

It is an ascertained truth, that beginning at 32° Fahrenheit, every additional degree of heat applied to air, expands its volume to the extent of one 480th of its bulk.

If, then, we suppose, as I think we may fairly do, that some portions of the water of a boiler may, owing to the inequality of heating, receive five, ten, fifteen, or twenty degrees of heat more than the surrounding portions receive, the air contained in those portions must be expanded to the extent of expansion which is given to air by each degree of additional heat that it receives. Now, as it is ascertained, that commencing at 32° Fahrenheit, each additional degree of heat which it receives expands air one 480th of its bulk, it follows that twenty degrees of heat, added to a portion of air, would expand the volume of that air one-twenty-fourth of its bulk. If, then, we may be allowed to assume that a portion of air at the bottom of a boiler may receive twenty degrees of heat more than the rest (and twenty degrees is only the difference between a cool spring and hot summer's-day), it seems to follow that the chances of part of that air leaving the water, and escaping must be in the ratio of the expansion. It further seems to follow that, after such escape, the cohesion and mean density of the particles of the water must also be increased in the ratio of the quantity of air which it has lost; and it further follows that the difficulty of turning that water into steam must increase in the same ratio.

These considerations, when taken together, appear to the writer to render it probable that the theory by which he has tried to account for those violent boiler-explosions, which occur after the boiler has been at rest, may be founded in truth, and capable of being proved to be so by the test of careful experiment.

Mr. Bell said, in the first place, he must express their gratitude to their friend the Secretary, for having taken up so important a question as the explosion of boilers. But, in congratulating him and themselves on the resulting paper, he (Mr. Bell) could not say that he agreed either

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with all the arguments, or admit all Mr. Doubleday's facts. Mr. Doubleday tells us, "the most accurate experiments that have been tried, in order to ascertain the relative conducting powers of water and of atmospheric air, prove that water is a somewhat slow and feeble conductor of heat, and that atmospheric air, especially when under more than ordinary pressure, is, though not
absolutely a nonconductor, even a slower conductor than water. I say that it is slower when under pressure than when that pressure is diminished; this being evidenced by the fact, that when water is exposed to the action of fire, at high elevations, ebullition takes place much sooner than when it is boiled under ordinary circumstances." Mr. Doubleday then refers to Humboldt's well known experiments on the Cordilleras. He (Mr. Bell) had not been able to lay his hands on any experiments undertaken for the express purpose to ascertain whether water was a better or worse conductor under pressure; and therefore he was not in a position to answer the theory which Mr. Doubleday there lays down; but he would suggest that the result to which Mr. Doubleday alluded would probably not be found due to any alteration in the conducting power of water, but simply owing to the fact that atmospheric pressure is lower on the top of the Andes than at the base of the mountains. Ebullition depends on the liberation of vapour from water, and takes place more freely when the pressure on the surface of the water is diminished. This has little or nothing to do with its conducting power, but is simply owing to the difference of pressure. Following Mr. Doubleday's reasoning, it appeared from circumstances which had been observed, and about which there could be no doubt, that water deprived of its air by boiling, or in any other way, might be heated, without ebullition taking place, to a temperature beyond that of boiling water. He (Mr. Bell) had not been able to find any account of the difference of specific gravity of water so deprived of its air, and water not deprived of its air. But he was strongly inclined to the belief that the difference of specific gravity between airless water, and water charged with air, as in its natural condition, was so small that the assumption of one taking up in the boiler an inferior position to the other, he apprehended could not be substantiated by actual experiment. But supposing such to be the case, and that we have two portions of water, one of which has been deprived of the air which it is capable of absorbing, so that its specific gravity is raised, as Mr. Doubleday supposes; and suppose both in the same vessel, separated by an imaginary line of demarcation, he felt

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satisfied that the heavier portion, as Mr. Doubleday assumed it to be, namely, the airless portion, being; at the bottom of the boiler, would, by its expansion, have its specific gravity reduced below that of the air-impregnated water. In point of fact, the airless water, by that expansion, would rise almost immediately to the top of the boiler. Notwithstanding all this, he was not inclined to dispute the conclusion to which Mr. Doubleday arrived, that boilers might, from having within them water, previously deprived of air, be liable to explosion; because there was no doubt, he believed, of this fact, that where to water so circumstanced you add a small quantity of water in its normal condition, those curious results to which Mr. Doubleday had alluded did take place. This water, impregnated, it might be, by an infinitesimal amount of air, loses the power which it had before of being raised to a high temperature, without being converted into steam; and we might well conceive a boiler filled with airless water entirely, having, in starting the engine, injected into it a quantity of air-impregnated water; and then the super-heated water becoming mixed with air-impregnated water, would no doubt produce a quantity of vapour, which the steam pipes or safety-valves might be incapable of carrying off. While he considered it quite possible that airless water might frequently cause explosions in boilers, he was also very strongly of opinion that boilers frequently do explode by sheer overpressure. He believed, in the case of exploded boilers, that they who directed the investigation frequently shifted the responsibility off their own shoulders on to the shoulders of others; and that the first explanation they rushed to was, to find that the unfortunate engineer or fireman were to blame by permitting the boiler to become deficient in water. He believed it would
be found, if these cases were properly examined in that critical way which the requirements of science demanded, that very frequently the boilers exploded by one portion giving way. Conceive a portion of a boiler built with its plates lengthways, in the direction of the circumference of the boiler. Suppose such a portion of plate two feet wide in a boiler six feet in diameter, it would require very little calculation to show that the pressure over such a section, at thirty lbs. to the square inch, amounts to a very considerable strain. The shape of the boiler itself at this particular part was preserved by the circumstance of the pressure, as it were, being in a state of equilibrium on every portion. They knew that if that boiler was square, instead of round, a very speedy deviation from its original construction would be the result. If you imagine a line across the portion of the boiler where the fire is, corroded till not more than one-eighth of an inch thickness of iron is left to resist the pressure to which it is exposed—a crack takes place in that length, and instantly, excepting so far as that portion of the boiler is restrained by its being in connection with the adjoining plates, the tendency of that row of plates, to which he had been referring, was immediately to flatten out. Well, this instantaneously gives exit to an enormous volume of steam; and, acting on the opposite end, throws the boiler out of place. His impression was that very many of the explosions were due, not to any particular condition of the water in the boiler, but simply to a want of care on the part of those to whom the boilers belonged, in not examining into their condition more carefully and systematically than he believed in many cases was done.

The Chairman said, they were glad to receive all the explanation that could be given of a very difficult subject. He had no doubt that the society in Manchester, which was extending itself materially, would have a good effect.

Mr. Bell gave notice of the following motion:—"That a committee of three be appointed to assist the President in revising the Reports of the Transactions previously to their being printed."

The meeting then separated.

MEMOIR of THE LATE NICHOLAS WOOD, ESQ.

B THOMAS DOUBLEDAY.

Mr. Nicholas Wood, the late President of this Institute,—an office to which he was annually elected from its commencement,—was born April 24, in the year 1795. His birth-place was Sourmires, in the parish of Ryton, situated on the south side of the river Tyne. In early life his constitution appears to have been delicate; so much so, that its superintendence seems to have been undertaken by an uncle, Mr. Greener, of Hallgarth, near Winlaton, under whose care he was placed. His first school was the village-school of Crawcrook—a hamlet on the south bank of the Tyne. His schoolmaster was Mr. Craigie, a man said to have been of some ability as a teacher; an assertion which the future career of his pupil, young Wood, does not certainly tend to disprove. At Crawcrook the youth seems
to have shown considerable readiness, as well as application; and his progress in the ordinary branches of education was so great as to attract the notice of Sir Thomas Liddell, of Ravensworth, who appears to have taken an early interest in his future welfare. Through the influence of Sir Thomas, the young man was sent to Killingworth Colliery—in which Sir Thomas was a principal partner—to learn the duties of a viewer—a profession which he not only helped to adorn, but materially to advance.

At Killingworth Colliery the young man was thrown into the society of one who exercised a considerable influence over his future life; and whose own arduous and successful career his young companion unquestionably assisted to bring to a fortunate issue. This was George Stephenson—then, himself, a young man—whose persevering ingenuity had already begun to attract attention, and who, about this time, was made directing engineer of Killingworth High Pit. In young Nicholas Wood, Stephenson found exactly the coadjutor he wanted. He found

his young companion endowed with imperturbable good temper, a docile disposition, great power of application, and perseverance under difficulties hardly inferior to his own. Young Wood became accordingly the confidant of Stephenson; the depositary of his plans and schemes, of whatever description; and his assistant in that series of persevering experiments which at last resulted in the modern locomotive, which, but for the early and irrepressible energy of Stephenson and his young companion, might yet, possibly have remained a desideratum.

It must not be supposed, however, that Stephenson’s speculations were confined to the invention and construction of the iron horse. He was at this period engaged in the construction of a safety-lamp. His experience in coal mining soon taught him the necessity that existed for some invention which should shield the miner from the tremendous risk to which, in deep and fiery collieries, he is constantly exposed, from sudden and unforeseeable irruptions of the masses of carburetted hydrogen gas, pent up in these perilous seams. The result of Stephenson’s attempts was the first "safety-lamp"—long since superseded by those of Clanny and Davy—of which young Wood, who was already a very fair draughtsman, made a drawing from which, under its inventor’s instructions and supervision, the lamp was constructed.

The metallic part was put together by Mr. Hogg, then an eminent tin-worker in the Side, Newcastle. The glass portion was made at the Northumberland Glass House, in the Close, by the foreman of the works. The lamp, though in many requisites, imperfect, was found to be efficient for its main purpose. It could be burned, with comparative safety, in an explosive atmosphere; and young Wood, it is stated, was one of those who had courage to attend his friend, and witness the testing of the lamp at a "blower" in Killingworth Colliery—a perilous experiment, but one readily fronted by men really enthusiastic in pursuing scientific improvements and inventions of whatsoever nature; as witness the "Montgolfier Balloon," the precursor of the present balloon, which, many years before that period, had brought Pilatre de Rozier and his companion to an untimely end. In 1815 the lamp was exhibited, before a numerous gathering of persons interested in the invention, at the rooms of the Newcastle Literary and Philosophical Society, which at that time were in the Bigg Market. At this scene the writer of this memoir was present, and well recollects the mixed ingenuity and simplicity of the inventor, who was greatly indebted to his young coadjutor for such proofs and explanations as were given of the merits and details of the invention.
That Stephenson's lamp was generally superseded by that of Sir Humphrey Davy experience has demonstrated; but this proves nothing beyond the fact, that the original inventor rarely brings his own idea to entire perfection. The Marquis of Worcester, Savory, and Newcomen, had the notion of the steam engine before Watt developed it. Neither was the multitubular boiler of the locomotive the device of Stephenson, though but for him the rest might never have existed; and, in point of fact, the George Stephenson lamp, a little modified, is still in use at Killingworth, under the suggestive title of the "Geordy-lamp." The consequence of this not uncommon occurrence was, that after the Davy-lamp had appeared, a controversy arose, in which, as usual, each party looked at his own side of the shield, and denied any merit on that of his opponent. The truth, in fact, lay between them, and was thus verified by both, and is now recognised by less zealous partizans. In this controversy Mr. Wood is stated to have taken some part, as was sure to be the case. In fact, in the accomplishment of clear delivery, and in the art of expressing his thoughts clearly in writing, George Stephenson, like some other eminent men, was very deficient. In this point his young friend had somewhat the advantage of him; and, no doubt, he was glad to avail himself of the aid he needed. It is needless to say that this connection soon ripened into a friendship between Stephenson and his companion, which, with little interruption, lasted whilst they lived. Of Stephenson's appreciation of the acquirements and ability of Mr. Wood we cannot have a better proof than the fact, that he obtained for his son Robert—afterwards the eminent engineer—the advantage of Mr. Wood's experience as a colliery viewer and mining engineer, whilst he held that position at Killingworth Colliery. That Robert Stephenson was a pupil of Mr. Wood is a fact honourable to both; nor was the former ever slow to acknowledge his obligation to his early instructor.

About this time, one of the earliest developments of the railway system occurred in the guise of a scheme for a railroad between Stockton and Darlington. The railway system was then in its infancy, and Mr Stephenson was accordingly sent for and consulted by the promoters of the enterprise. On this occasion it appeared that Mr. Wood accompanied his friend Stephenson to Darlington; and the result was, ultimately, the employment, by Mr. Pease and the other promoters of the line, of George Stephenson as engineering manager of the work. The line did not present any difficulty that would give trouble to the engineers of the present day; but railway engineering as a science was, at that period, an uncultivated field, and its greater results, as yet, not only unpredicted, but, probably, unforeseen. Such knowledge as existed was, no doubt, familiar both to Stephenson and Wood, and about this time the latter gave the world an opportunity of being partaker in that knowledge by the publication of his "Treatise on Railroads"—a treatise which embodies what was then known of the subject, and is to this day a standard work. This book was written in the year 1825. It unquestionably helped to impress upon the public mind the possible facilities to be derived from a system of railway communication, and was one of the precursors of the once celebrated enterprise of opening a railway communication between Liverpool and Manchester. Mr. Wood, in 1827, gave evidence as to the practicability and desirability of this undertaking before the committee appointed to investigate and report upon it. By this committee Mr. Stephenson was subjected to a searching examination as to the practicability and possible advantages of a scheme which, to the minds of many, at that period, seemed so questionable. Mr. Stephenson's evidence was confirmed, in its material points, by
that of Mr. Wood. The result it is unnecessary to state. After this date railway communication became that which it is the fashion to designate "a great fact." The system went on developing itself at a still accelerating pace, though few minds, indeed, could foresee and embrace the multiform results and consequences which must necessarily spring from a change at once so great and so complete.

Mr. Wood's authority as a mining engineer and as a geologist, as far as the North of England and its coal-field were concerned, had now become very considerable. His knowledge and experience caused his assistance to be sought by those engaged in mining speculations. Engagements so extensive could not but produce their appropriate fruit; and Mr. Wood, in due time, became the owner as well as viewer of collieries, and gradually acquired an influence in the trade, possessed by few individuals, which continued undiminished up to the day of his death.

The year 1838 afforded him an opportunity of displaying his geological knowledge of the strata of the county of Northumberland. During the autumn of that year the British Association for the Diffusion of Useful Knowledge held a session in Newcastle. Before the geological section of the association Mr. Wood was induced to read an elaborate essay on the geology of the county of Northumberland. A summary of the contents of this valuable paper makes portion of the seventh volume of the Transactions of the British Association. It embodies the most accurate account that had, up to that time, been given of the geology of the county; nor will the geologists of the present day find much reason to modify any of its more important statements. Its details are, however, confined to the geology of Northumberland; nor does it attempt to connect the Northumbrian geological formations with those of any of the neighbouring counties.

Up to the year 1844, Mr. Wood had continued to reside at Killingworth, in the vicinity of the colliery where he originally became versed in the duties of a viewer, and where all his early experience—whether as to coal-mining, or the construction of railroads and of locomotive engines—was acquired and matured. He now, however, removed to Hetton Hall, in the county of Durham—a residence which his extended connections as a coal-owner rendered more convenient, and where he passed the remainder of his arduous and useful life.

About this time began to be felt that steady extension of the demand for coal, commencing with the growing use of coal-gas, or carburetted hydrogen, for lighting, which gave a stimulus to coal-mining to which succeeding events largely added. The consequence was, not only an increase of work in the existing mines, but the opening out of other royalties, hitherto untouched. The certain effects of this over-competition were attempted to be met by increased quantity; and out of these combined circumstances arose, naturally, a greater frequency of accidents.

In the year 1839 this was manifested in the occurrence at St. Hilda's Colliery, South Shields, of one of those terrible explosions which involve a serious destruction of life. About fifty persons, in all, were destroyed by this sad casualty, and public attention was strongly drawn to the necessity and desirableness of some system of inspection, by which the working of coal mines might be regulated, and rendered less perilous to those engaged in it. In accordance with this feeling, a committee of gentlemen were appointed by a public meeting of the inhabitants of South Shields and its vicinity, to
investigate the circumstances attending these casualties, and to report upon them. One of the most active members of this committee was Mr. James Mather, a man of some talent and considerable energy and perseverance. After lengthened investigations, occupying upwards of two years, the committee published their report. It was able and plain-spoken, and accordingly obtained much and deserved attention. Public opinion on this occasion

prevailed; and properly prevailed. The Government of that period saw the necessity of taking some step in accordance with the prevalent feeling; and, ultimately, two commissioners—Sir Henry de la Beche and Dr. Playfair—were sent down to inquire, authoritatively, into the general management of the collieries of the North of England, and into the causes of the loss of life to an extent so serious. These gentlemen's report was published, at last, in 1847; and, as might easily have been anticipated, amongst other recommendations, it advocated the proposal, by Government, of some system of "inspection," to be sanctioned by Parliament. This suggestion was acted upon by those then in power. Parliament were readily induced to take the matter up; committees were appointed, and evidence taken. A second commission, consisting of Professor Phillips and Mr. Kenyon Blackwell, was sent down to examine all the circumstances still more narrowly—an investigation in which the leading coal-owners, including Mr. Wood, took an active and important part. It was, of course, felt on all sides that the subject was, of necessity, beset with difficulties, and must be handled in a manner proportionately delicate and cautious. In the general principle of an inspection the trade, however, unanimously acquiesced; and the result was the enactment of the first Inspection Act, Victoria anno xviii. and xix., cap. 108.

One of the earliest consequences of this combined action, on the part of the public and of the Government, was to convince the leading members of the Coal Trade of the Counties of Northumberland, and Durham that some further effort, on their part, to improve both the theoretical and practical departments of mining science was, if not imperative, at all events highly advisable and desirable. On the 3rd of July, 1852, accordingly, a meeting of owners and viewers of collieries was held at Newcastle, the late Mr. William Anderson occupying the chair. This meeting resulted in the formation of a society, which was proposed to be entitled "The North of England Society for the Prevention of Accidents, and for other purposes connected with Mining." At a second meeting, however, both the plan and title of the proposed society were altered, and the title of "The North of England Institute of Mining Engineers" substituted for the other. The Institution was formally commenced in August, 1852, when Mr. Wood was elected its first President; the four Vice-Presidents being Messrs. T. J. Taylor, Forster, Anderson, and Potter; Mr. Boyd, Treasurer; and Mr. Edward Sinclair its first Secretary. The President's inaugural address was delivered on the 3rd of the following September. The number of members enrolled during the first year seems to have been about one hundred. The Institution has gone on steadily increasing in numbers and utility up to the present time; and, although the officers were annually elected, so highly were Mr. Wood's services as President estimated by the body over which he so long presided, that he was annually chosen President by a great majority of votes, and held the office up to the day of his lamented death. The Transactions of the Society have, since its commencement, been published in monthly parts, and collected into an annual volume, of which fourteen are complete. To
this valuable collection of essays, on almost every subject connected with mining for coal, Mr. Wood's contributions are numerous, varied, and important, being replete with practical knowledge. They may be enumerated as follows:—

Vol. I.—Inaugural Address to the Members.

Experiments on the Relative Value of the Furnace and the Steam Jet in the Ventilation of Coal Mines, with eleven diagrams. [This is a most elaborate paper in defence of furnace ventilation. It extends over 101 pages.]

On Safety-lamps for Lighting Coal Mines.

Vol. III.—On the Conveyance of Coals Underground in Coal Mines, with ten plans. [Another voluminous paper, comprising experiments on the friction of underground tubs at several collieries, and a most comprehensive account of the various modes of underground locomotion and their relative values.]

Vol. V.—On the Conveyance of Coals underground in Pits. [A continuation of the experiments given in the previous paper on the same subject,]

On Sinking through the Magnesian Limestone at the Seaham and Seaton Winning, near Seaham, with four coloured plates.

An Account of the Explosion of Fire-damp at the Lundhill Colliery, with two coloured plans.

Vol. VII.—On the Deposit of Magnetic Ironstone in Rosedale, with six coloured plans.

A Summary of the various conclusions which appear to result from the several papers and discussions brought before the Institute on the subject of Ventilation.

Vol. VIII.—Biography of the two late eminent Engineers, George and Robert Stephenson.

Vol. IX.—Sketch of the Life and Career of Joseph Locke, Esq., M.P., one of the Vice-Presidents of the Institute.

On the Explosion in the Boiler Flues of one of the Engines at Hetton Colliery, on December 20, 1860, with three coloured plates.

Vol. X.—Inaugural Address delivered at the Central Meeting of the Institute at Birmingham, on July 16, 1861.

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Vol. XI—On the Upper and Lower Beds of Coal in the Counties of Northumberland and Durham, with nine coloured plates and several wood-cuts. [The object of this paper is to establish the connection of the Northumberland and Durham coal-basin with the smaller coal-fields of Berwick and Plashetts, and more particularly with the coal-basin of Canonbie, on the borders of Scotland, and with the coal-fields of Scotland generally.]

Observations on the Mineral Section of the International Exhibition of 1862.
Vol. XII—On Safety-lamps.

As these and all other papers read to the Society, were discussed at the next or some succeeding meeting, and these conversations are recorded with tolerable accuracy; they form an interesting portion of the Transactions. In these discussions the President, when present, rarely omitted to take a leading part. His observations and criticisms are characteristic. They exhibit abundant practical knowledge, a ready reference to facts, recorded during a life-long experience in coal-mining in all its branches, and a knowledge of the geology of the district, perhaps only to be obtained through an experience like that of the late President.

It is unnecessary to remind those to whom these reminiscences are addressed, that since the enactment of the first Mines' Inspection Act, in 1851, there has been a continuous agitation on the subject of the inspection of coal-mines, and on various other subjects more or less connected with coal-mining—an agitation both within and without the walls of parliament; and most perseveringly carried on whenever a renewal of a Mines' Inspection Act became a matter of debate. On these occasions Mr. Wood, amongst other leading engineers and coal-owners, was always appealed to as a high authority on every subject connected with management and working of collieries. He was invariably called upon to give evidence before committees of one or other of the Houses of Parliament, whenever coal-mines and their management formed the subject to be enquired into. The evidence there given is on record; and it is worthy of note that the views of the late President of the Institute, and those of the other leading engineers and coal-owners of this district, have been most frequently adopted by, and recommended in the reports of, these committees, and finally embodied in such enactments, relative to coalmines, as have become law for a time.

After the establishment of the North of England Institute of Mining Engineers, Mr. Wood's efforts, as a writer, were nearly confined to the production of the papers which he contributed to, and which are printed

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in their Transactions. One exception seems to have occurred, in the shape of an essay "On the Improvements in the Working of Coal-mines," during the last half-century, read at a meeting of the Society of Mechanical Engineers, in Newcastle, 1858, and published by them in their Proceedings.

Mr. Wood's attention was now, however, actively engaged by other projects for the improvement of mining science, towards which he had already so largely contributed. Sometime during the year 1855, the circumstances of that period seem to have impressed upon the minds of some of the leading mining engineers of the North of England, as well as of some of the principal coal-owners of this district, a conviction that the time had arrived when an effort ought to be made, whether with or without the aid of government, to establish some collegiate institution for the cultivation, improvement, and teaching of mining science, especially as applicable to coal-mines. This impression soon led to active measures. The subject was brought, by those most strongly interested in the success of the enterprise, before the council of the North of England Institute, and was by them brought under the notice of the society at one of their general monthly meetings. The result was the immediate appointment by the body of a special committee, whose instruction it was to take the entire subject into consideration, and to report to the society thereon; appending to that report, if deemed advisable, the prospectus and plan of such a college, embodying all the requisite details.
Nor was any time lost in carrying these instructions into effect. The prospectus of a mining college was matured and finally drawn up, for the most part under the able auspices of the President, and of the late Mr. Thomas John Taylor, then one of the Vice-presidents of this Institution; and on the first of November, 1855, this report and prospectus, with the ground plan and elevation of a suitable building, supplied by Mr. Archibald Dunn, were presented to the council by Mr. Thomas John Taylor, on behalf of the committee. By the council the documents were laid before a general meeting of the society, with a recommendation that the meeting should adopt, print, and distribute them wherever such distribution might promise to be of service. This recommendation was at once acted upon by those present. The prospectus and plans were printed without loss of time, together with a circular appended, calling upon the patrons of the Institute, the leading coal-owners, and various other influential persons connected with mining generally, and coal-mining especially, to aid the undertaking. The document was extensively distributed, and no effort spared to impress upon the public mind, and particularly in the North of England, the importance of such an institution to a country whose mines exceed those of any other country in the world in extent and value. Under the same auspices an attempt was also made to impress upon government, the national importance of such an establishment as that proposed.

The time, however, was not ripe for the success of an undertaking so weighty. Notwithstanding the liberal offers of aid, tendered from some few quarters, and most especially by that munificent patron of everything that promised to be useful to his fellow-men, the late Algernon, Duke of Northumberland, the project was doomed to fail. For this disappointment, some causes not without weight, may be adduced. The coal-trade was not then in a state to induce those, whether immediately or mediately connected with it, to expend capital upon an establishment only remotely bearing upon their interests. Much difference of opinion also existed as to the locality most proper for such an establishment. By many, Newcastle was held not to be sufficiently central. It was also feared that, unless the endowment should much exceed anything that could be reasonably expected, the receipts would fail to meet the demands of an institution where not only mining science was to be taught, but other branches of knowledge collaterally connected with it. Be the causes of failure, however, what they might, the project proved abortive. Nor was the attempt more successful which was made under the same auspices, to induce the heads of the University of Durham to add mining science to the curriculum of the studies there promoted, the funds at their disposal been deemed insufficient for the purpose.

During the closing years of Mr. Wood’s life his attention was principally occupied with the management of his own extensive coal-mining concerns—quite enough for most minds, however well balanced and inured to the active business of life. He attended the meetings of the Institute, and, to the last, took part in such discussions as occurred, but ceased to employ his pen in its service. He also attended, up to a late period, the meetings in London of the General Mining Association, of which he was chairman.

During the second session, however, in the town of Newcastle, of the British Association for the Advancement of Knowledge, Mr. Wood read a very able paper, composed by himself, in conjunction with Mr. John Taylor, Mr. Isaac Lowthian Bell, and Dr. Richardson, on the various industrial pursuits
of the northern counties, including, of course, as the most prominent, the coal and iron trades in all their branches. This
elaborate and interesting tract has been published as a separate volume, of which two large editions have been sold.

The last time of his taking the chair, as President of this Institute, was on the occasion of a paper "On the Hydraulic Coal-Cutting Machine," which created great interest, being read by Mr. T. W. Embleton, of Methley, near Leeds. After this time Mr. Wood's state of health became too precarious to admit of his attending the monthly general meetings of the Institute. His illness gradually assumed a more serious form; and, after a protracted struggle, he expired in London—whither he had gone for medical advice—on Tuesday, the 19th of December, 1865. Mr. Wood was for some years a widower, having survived his wife, Miss Lindsay, of Alnwick, for some years. He leaves four sons and three daughters—two of whom are married—to inherit his ample fortunes.

The prominent characteristics of Mr. Wood's mind were plain, practical good sense; steady perseverance in his pursuits; the faculty of calmly contemplating and patiently investigating the subjects to which he applied himself; and an equanimity of temper, hardly, if ever, exceeded, for which he was very remarkable. As a public speaker he was deficient, seizing the appropriate expression with apparent difficulty and hesitation. This want of fluency sometimes caused him to repeat the last words of a sentence as if they were meant to serve as a sort of index to the next—a habit which occasionally impeded the clear expression of his views, however accurate, of the questions to which he applied himself. To praise some men, even after death, is difficult. To praise others is an easy task; whilst, in the case of some few, praise is all but superfluous. Under the last of these divisions the writer may, without exaggeration, place the late President of this Institute; for whether he be viewed as an employer of labour, as a successful man of business, as a promoter of knowledge, as a friend to education amongst all classes, as a neighbour, a parent, or a friend, we may safely say that his place in society will not be easily filled.
This apparatus has been in operation for fourteen months. It consists of a line of spouts attached at one end to the slack or duff-hopper of the nut-screening apparatus, and is continued to each row of coke ovens, or, if necessary, to each oven.

By means of valves worked by the attendant, who is stationed near the coke ovens, water and slack are admitted together, or separately, as required, into the spouts at the end attached to the nut screen. The slack is conveyed to the coke ovens by water, any pyrites, earthy matter, or other impurities, being deposited at the bottom of the spout whilst in transit. For particulars as to construction, see plate. The distance from the screens to the ovens is about 600 feet. The spouts are arranged as follows:—From the screen to a point, 275 feet, the spout is ten inches x ten inches inside, with a fall towards the ovens of one in eighteen; then, forty feet, ten inches x ten inches inside, falling one in twenty-four; then, seventy feet, twenty-three inches broad and ten inches high, falling one in twenty-four.

The spouts are supported by single upright poles, about sixty feet apart, the centre of each being held up to the level line by wire-rope suspenders or guys, reaching from pole to pole. At the point 326 feet from the slack screen there is a valve A (plate IX.), which, when opened, the slack being previously shut off at the screen, allows all the dirt and refuse, that may be deposited in the spout down to this point, to pass into the dirt wagon beneath.

Fifteen feet further there is a dam B (plate IX.), consisting of a piece of wood, three inches deep, which arrests the progress of any of the lighter particles of dirt which do not settle higher up the spout. When the first portion of the dam of three inches high is filled with dirt, another piece of wood of the same thickness is added, and so soon as the refuse accumulates behind it to the level of the top, a valve is opened, and the dirt falls into the dirt wagon, after which one of the pieces of wood before-mentioned is again inserted.

Again, at a point twenty-four feet lower down, a dam C (plate IX.) is formed by another loose piece of wood, which secures any stray pieces of dirt that may have escaped the obstructions higher up; and thirty-one feet nearer the ovens another loose dam D (plate IX.), two-and-a-half inches high, is placed, where there is a valve to let out the dirt from both.

The quantity of Arley Mine slack washed daily is 120 tons, yielding about six per cent, of refuse. The water required is about eighty to ninety gallons per minute. The attendance to the washing department costs three shillings per day, or three-tenths of a penny per ton on the slack.

The advantages of this mode of washing small coal are these:—

1st, Simplicity of arrangement.

2nd, Economy in first outlay, and in cost of working and upholding.

3rd, Efficiency.

First, then, as to its Simplicity. It will be seen that the first requisite is a copious supply of water; the spouts, dams, and valves are simple in design, and not difficult to keep in order. I may here be allowed to say, that if the distance the slack is now floated could be doubled, it would, in my
opinion, be an advantage, seeing that the separation of the heavier and soluble parts of the earthy matter from the coal would be more complete, even with fewer dams than I employ in this case.

Secondly, its Economy. By reference to the model, it will be observed that the repairs of the spouts, valves, and dams, must be very small indeed. There is also a considerable saving in the carriage of the slack by water, as compared with the ordinary modes of transit. In this case the difference in favour of water is great.

As to its efficiency. I can only say that the cleansing of the coal is complete, without the least possible loss of coal amongst the refuse, and the quality of the coke is greatly improved.

DISCUSSION ON MR. G. GILROY'S PAPER ON A COAL WASHING MACHINE.

J. T. Woodhouse, Esq., Vice-President, in the Chair.

The Chairman—Most of us who visited the works yesterday had an opportunity of inspecting the model and seeing it in action, and, therefore, perhaps that may, in addition to the drawing which is on the paper behind me, be of considerable assistance in enabling you to arrive at a conclusion, or in promoting discussion on the merits of this machine. There were two large washing machines in the immediate vicinity in use by the Kirkless Hall Company. These gave us an excellent opportunity of comparing the merits of washing by continual agitation, and by merely running the slack down a long spout. The machine is so simple and appears to be so effectual that we imagine that it does all that can be required. At the same time there may be subject for discussion.

Mr. Lancaster—I can testify to the quality of the coke manufactured from it, and the result is very near, if not quite, equal to the machines you saw at our works.

The Chairman—to the coke washed by the agitation principle?

Mr. Lancaster—Yes.

The Chairman (addressing Mr. Gilroy) said, in your paper you say "at the point, 326 feet from the slack screen, there is a valve," etc. Had you any particular reason for fixing that distance? That appears to be the first weir upon the machine, and that is where the first accumulation of dirt takes place.

Mr. G. Gilroy—The object of having that valve there is simply, that it is very nearly upon the termination of the spout. You would observe that we have two different inclinations. First, one in eighteen for the length of 275 feet. That was found out entirely by experiment. We did not work upon any rule, but had to watch the action of the water and do the best we could, and we found it required a fall of one in eighteen for that distance. Further on we make the inclination a little less, one in twenty-four, and that caused the deposit of the heavier matter in the spout from that point. The greater portion of the whole deposit is made between these two points. We observed, also, that the nearer level you can keep the spouts, supposing there
to be plenty of water, so much easier does the deposit go on. That must be obvious so long as you can get through the quantity and float the slack. I have mentioned that there might be an improvement by lengthening the spouts. I do not say the machine is anything approaching perfection; but the further you can convey the spouts, up to 400 to 500 yards, the more perfect would be the cleansing, and the deposit would, no doubt, go on more satisfactorily.

Mr. G. C. Greenwell—As to the present state of its perfection, I can only testify to this, that, having an object in view, I went to see Mr. Gilroy's machine, and I carefully examined both the refuse that was taken out and the coal that was left; and I could not find any coal amongst the refuse, or any refuse amongst the coal. Another point was the light colour of the water when it was taken away with the dirt. The water was more like milk than anything else.

Mr. Marley—I wish to ask Mr. Lancaster, as to his washing machine, if he can answer, off-hand, what the relative cost is? Mr. Gilroy estimates his at three-tenths of a penny per ton. I missed the opportunity of going to see the washing itself; but I saw the model and was very much pleased with it. And I have to ask Mr. Gilroy where he gets the large quantity of water, whether he has it to lift or has it ready at hand?

Mr. Gilroy—In this statement of cost, it is the real cost and not an estimate. I think I said it was for the attendance to the washing. That does not include the cost of lifting the water which, I suppose, was thrown up about seventy feet by a donkey engine.

Mr. Lancaster—I have no hesitation in saying that our cost is very much larger, and that the original cost of the erection of machinery is also much more expensive. I feel certain it is more than double.

Mr. Lowe inquired the per centage of dirt in the slack?

Mr. Gilroy replied, six per cent.

Mr. Lancaster said, the loss of theirs consumed over half a year was about twelve per cent.

Mr. Lowe said, they found in their district that the cost was thirty per cent.

Mr. Lancaster said, that would depend upon the quality of the slack.

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In reply to a question from Mr. Spencer,

Mr. Lancaster said, he was hardly prepared to say off-hand, what amount of ashes was produced by coke from washed as compared with unwashed coal. Taking theirs as a type, the ash was very much reduced by the process of washing. Theirs was just the same seam as Mr. Gilroy's.

Mr. G. Gilroy—The coke in both Mr. Lancaster's case and mine is very much improved. Before we commenced to wash, the vertical fractures in the coke were very frequent indeed, coming out in thin, shivey pieces. It is now very much larger, something like, on the average, three or four inches square. I should be very glad if any gentleman can explain the cause of this. Whether it is on account of the large amount of sulphur being in the unwashed slack, or whether it is that the slack is put in in an unwashed state, I cannot say.
The Chairman—Do you think the construction of the oven has anything to do with it?

Mr. G. Gilroy—The construction of the oven is exactly the same.

Mr. Southern—It is not always the case that the coke from washed coal is larger than from coal unwashed. It being so in Mr. Gilroy’s case, does certainly differ from some that I have seen.

Mr. Lancaster—I believe, in this particular case, the moisture has a great deal to do in assisting the melting of the bituminous parts.

Mr. W. Cochrane—If the mechanical intermingling of the shale and coal does not explain that, I do not know how it can be accounted for. If you have a fine coal with a quantity of foreign matter, you will find that the coking process is stopped, and the coke will be broken across in small fragments wherever shale intervenes. If you get rid of the shale you do not find this. By passing the small coal over a wire gauze, and not washing, the shale is sufficiently removed to yield a perfect coke.

Mr. Marley—I agree with Mr. Cochrane, that it is the mechanical operation, the large particles of dirt, that makes the difference in the size of your coke, more than the chemical process.

Mr. Spencer remarked, that the coke was not so large after being washed; it drew smaller.

Mr. Douglas said, his experience taught him always to expect that the more foreign matter there was mixed with the coal, the more was the coke broken up, and in a way that did not appear when the same coal was found free from foreign matter.

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No further observations being offered,

The Chairman moved the usual vote of thanks to the author for his paper, which was directed to be placed in the archives of the Institute.

Mr. G. Gilroy, in acknowledgment, said, I beg to thank you for the manner in which my paper has been received. We shall be glad, if any member wishes to see the machine, to show it at any time.

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Map of China showing the Coal Districts.

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ON THE PROGRESS OF COAL MINING INDUSTRY IN CHINA.

By THOMAS YOUNG HALL.

Read at Newcastle, September 2nd, 1865.

There exists abundant evidence in the written annals of China,* to prove that coal was used by the Chinese as an article of fuel many centuries before its properties were known in Europe.
In the history of the Han dynasty, which was preeminent for its men of learning and genius, commencing the year 202 B.C., and ending Anno Domini 25, mention is made among the remarkable events of that period, that in the province of Kiang-see, there were black stones found which the inhabitants used as a fuel for cooking. In the seventh century of the Christian era, a writer on the products of China mentions coal as an article of commerce; and a poet in the tenth century at Pekin, passes a high eulogium on its value in the manufacture of iron implements of agriculture.

Then we find the famous traveller, Marco Polo, who visited China in the 13th century, stating that there are a kind of black stones cut from the mountains in veins, which burn like logs.

* [For this account of Coal and Coal-Mines in China, I am indebted to Samuel Mossman, Esq., who accompanied me on a mining expedition through Austria, Styria, France, Prussia, &c, and has since spent some years in Australia and China. On Mr. Mossman leaving for China, I requested him to examine the coal mines of that country, and to communicate his observations to me for the information of the members of the Northern Institute of Mining Engineers. Mr. Mossman was resident in China for a considerable period, and travelled through the chief provinces of that empire, so that much of what is here stated came under his own experience, and he can vouch for the general accuracy of the whole; although the calculations of extent and produce must be taken as only approximate.—T. Y. H.]

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Although the first to discover the combustible utility of coal, yet the Chinese have been very slow in adopting it as a substitute for wood and charcoal in manufactures and for culinary purposes. Several causes have been assigned for this neglect of a product which may be said to have raised the material prosperity of Great Britain to its present unexampled height. Some travellers of eminence consider that it has been the policy of the Chinese Government from time immemorial to encourage the labours of the field in preference to those of the mine from political views; in order that public tranquillity should not be disturbed by the owners of mines becoming too rich and haughty, and cause the people to neglect agriculture, the first and highest occupation inculcated by the state under the immediate patronage of the Emperor. Perhaps this discouragement of mining occupations by the state did exist in early times, especially when famine forced the people to use all their time and means for the growth of food; but I did not find anywhere a direct prohibition to work coal mines, whatever may exist concerning the precious metals. On the contrary, wherever coal has been found, the inhabitants of the vicinity have used it as fuel when it was to be purchased at less cost than wood or charcoal; and if the Government never assisted in working the mines, they have not in any instance, that I am aware of, prevented the mining and sale of coal. I attribute its limited use, chiefly to the high cost of production, and the inferior quality of the coal obtained from the surface workings; while the miners have been deterred from deep sinking from fire-damp, choke-damp, and flooding, which they cannot overcome by their rude appliances and want of scientific knowledge. In general, the seams have been worked where they happened to crop out of the hill sides, and the borings made with a pickaxe just sufficient to allow the miner to creep into. Through time, the pits have been carried a long distance into the mountains, so that the labour in bringing the produce to the surface is very great and costly, and, consequently, coal is dear in China. Some idea of this may be gathered from, the fact, that at the "pit's-mouth" of the coal mines in the province of Che-kiang, the cost is equal to £1 5s. 8d. per ton. Notwithstanding this high price the miners are extremely
poor, and they find it more convenient and cheaper to burn the shrubs and grass of the sterile
mountains for their own use, than the coals they dig from their mines.

In its pristine state, there is abundant evidence to show that not only the plains and the valleys of
the "Great Flowery Land" (as the Chinese term their mother country) were densely covered with
trees, but the

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mountain ranges likewise, and that for ages the fuel of the inhabitants was confined almost
exclusively to wood. In the course of time the primeval forests disappeared as the plains and valleys,
and even the mountain sides, were cultivated to produce vegetation for the food of man, that for
culinary purposes being of secondary consideration, and for mere bodily warmth ignored altogether.
Hence the whole extent of this vast empire with its dependencies, greater than Europe, is destitute
of forest land or trees three feet in diameter; and hence, also, the people who live in the cold
provinces in the north, where the thermometer falls below zero of Fahrenheit, maintain animal heat
in the rigorous season by clothing padded with cotton, or lined with furs. In all the multitude of
habitations for a population of 416 millions, from the prince to the peasant, there is not a stove or
fireplace for warming the person, while those for cooking are of the most economical construction
for the consumption of wood or charcoal. To the practical Chinese mind, it seems a waste of money
to spend it for such a purpose, when sufficient warmth can be obtained by means that are not so
evanescent or costly. Yet they highly appreciate the "barbarian coal fire." As I have witnessed in
Shanghai, when a wealthy Chinese merchant would sit before the Englishman's fireside with out-
stretched palms and glowing face, enjoying the cheerful heat with infinite gusto, remarking that we
foreigners had something good which they had not in China.

There is no coal found near Shanghai or in the province to which it belongs, as the country is an
extensive alluvial plain, but in the adjacent provinces of the Che-Kiang and Kiang-see, it is found
plentifully in the mountain ranges leading into the green tea districts. These deposits are of
considerable extent, and the qualities of the coal are various, from slaty, cannel, and bituminous
kinds to anthracite. The last-named quality is most in demand at Shanghai, where it costs about 50s.
per ton, and is almost entirely used by the manufacturers of brass and nickled tobacco pipes. It is
very compact, occasionally iridescent, specific gravity 1.34, and burns intensely with a small blue
flame, its ashy residuum being of a reddish colour. The proximity of the coal measures in these
provinces to ferruginous ore and lime, facilitates the manufacture of iron. Some of the mountains,
which contain carboniferous strata, furnish the disintegrated granite of which the celebrated
porcelain is fabricated. The furnaces at the great factories at Kingteh-chin, the chief seat of this
branch of industry, are heated by coal procured from adjacent mines. These form quite an extensive
coal-field

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on the eastern slopes of the Wookwye mountains, in the district of Kew-chow, about 130 miles S.W.
of Ningpo. There are several varieties of the mineral here, the one most valued being termed "wood
coa" from its fibrous appearance, yet it has a bright conchoidal cleavage, cakes while burning,
emitting hydrogen gas, and leaving light-coloured ashes. Its specific gravity is 1.29. It possesses a
much larger proportion of carbon than ordinary bituminous coal, and compares favourably with
English coal for the use of the navy in the East; yet as a rule, Chinese coal is not suitable for steam engines. This "wood-coal," when employed for culinary purposes, is reduced into a powder, then mixed with mud, and formed into bricks, something similar to patent fuel. In this shape it is sometimes used by blacksmiths, but more frequently in the tea shops, for keeping water constantly boiling, and in making the "Samshoo," or vice whisky, hot, by means of a rude brick furnace, with a mud orifice, over which the vessel containing the liquor is placed, keeping it hot all day, without further care, at a cost of about 2d. The annual produce of coal from the mines in these provinces is about 80,000 tons for Cho-kiang, and 190,000 for Kiang-see. At the pit it costs on an average 25s. 8d. per ton, the baskets in which it is packed cost about 3s. 6d., and its carriage to Shanghai 5s. to 6s. Of course, that great emporium of commerce and steamers obtains its supplies by the sea-board from every part of the world. What is here stated relates only to the native coal mines.

The province of Che-kiang being situated on the eastern sea-board, and Kiang-see on the inland frontier, shows that the coal-measures trend from thence towards the interior, becoming richer in that direction.

Consequently, in the central province of Hoonan, coal mines of the greatest extent and best quality have been found. Of the produce, that called "Kwang" coal is most in demand, being the best anthracite, nearly as good as American. This is carried by junks down the tributaries of the Toong-ting lake, which is 300 miles in circumference, and from thence down the Yang-tsze river to the cities on its banks. At Hankow, the farthest inland river port open to foreign trade, where the writer has seen it in blocks of one hundred-weight and more, showing that the working of these mines is on a larger scale than in the maritime provinces. It is used almost entirely for smelting iron, and in the manufacture of iron and brass wares of all kinds. Among the former is a cast-iron boiler for cooking, made of such fine and thin material, that our Birmingham manufacturers have failed in producing an equally light and durable article. This is attributed to the high carbonaceous properties of the coal used in smelting, which imparts a texture approaching to steel, and finer than the best puddled iron by Bessemer's process. The yield of the coal-mines in Hoonan is not less than 260,000 tons per annum.

Above Hankow, on the lands of the Great River Yang-tsze, which is 3000 miles long, coal-mines are worked on the hill side, where the formation, for more than a hundred miles, presents the same features as those of the coal measures in England. The workings are nearly all horizontal, with a dip to the North-East, and the character of the coal is more or less bituminous and slatey. Most of it is got out in small pieces, which are pounded up, mixed with water and loam, and then made into the shape of bricks, which are dried in the sun and exported in junks.

Near Canton there are coal-mines in the hills of Fa-yune, from whence the manufacturing town of Fat-shan is supplied with the mineral. Along this range of hills excavations are seen over a distance of four miles, but nearly the whole of them are abandoned.

Apparently the miners dig as far as they can profitably work, and if any obstacle comes in the way, such as flooding, choke-damp, or firedamp, or the seam dips too perpendicularly, they leave the pit to commence afresh from some other spot on the surface. Still many of these pits show the
rudiments of mining machinery, where the perpendicular seams are worked by men in galleries at different depths, and where the water accumulates at the bottom it is raised from one gallery to another by bamboo pumps; a most laborious and apparently unsatisfactory process. The descent into some of these mines is by a rude wooden staircase at an angle of 70 degrees, others are by horizontal shafts, while the best coal is found at the greatest depth. At one of these pits in full working order, recently visited, large piles of coal were seen at the mouth, with numerous people at work, exhibiting symptoms of activity and animation. The managers stated that with sixty men working below they could turn out 500 peeculs a day, or about 30 tons. The coal was of inferior quality, in small pieces, the largest about 4 lbs. weight, and mixed with a large proportion of shale. When these lumps were struck with the hammer, they proved very friable, but adhered together upon being submitted to the action of heat, and emitted fumes of sulphur. The value of the coal at the pit’s mouth was about £1 4s. 4d., and its carriage to Canton 4s. 10d. These mines are worked by a wealthy Chinaman, belonging to Fat-shan (the Birmingham

of China), who has leased them from the Government for a period of ten years, by paying a premium of 2000 tael, or £666, and a royalty of 2 tael, or 13s. 4d. on every 100 peeculs or 6 tons. After several years mining, he found that he was working at a loss, with the tedious inefficient hand-labour at his command, and wished to give up the lease, but the government officials would not allow it. If he had the means and appliances of English coal-mining, he would soon make a fortune. The annual yield of the Quand-tung mines is about 130,000 tons.

The western provinces of Yen-nan, Sze-choven, and Kwy-chow have the carboniferous system superimposed upon a granitic base throughout a great part of their extent, in numerous sections of which the coal-measures exist generally interstratified with beds of slatey clay and limestone. Very little is known, however, of the extent to which these have been worked. Of the coal-fields in the northern provinces of Shan-see, Pe-che-lee, and Shing-king more is known. Touching certain mines in the last-named province, Chinese cosmogonists, drawing on mythology, gravely state, that in one of them the furnace still exists in which Nioo-kwâ fused stones, for repairing holes in the heavens, and that it is the original of all furnaces now in use. This probably shows, that at one period, some of these mines have caught fire and burned so intensely that they could not be extinguished.

Of these northern coal-mines, the oldest still at work are those that supply the Chinese capital, Peking, with this kind of fuel. They commence at about twenty miles from the city, in the western mountains, and extend for a great distance north and south. The coal is brought to the city in panniers on the backs of ponies, mules, and camels. The long strings of tawny, funereal-paced camels, begrimed with the carbonaceous loads they bear with such melancholy fortitude, conducted by their sooty Tartar drivers, through the wide dusty streets of Peking, the sonorous tinkling of the heavy brass-bells suspended to the lower part of their necks, and the frequent shrill, discordant scream of anger or fatigue emitted by these slow, but patient creatures, tells the traveller of the neighbourhood of coal. It is a good day’s journey, however, for him to reach the nearest of these mines on horseback. As he begins to ascend the low rounded hills which contain the coal, their structure appears to the eye essentially slatey, but the strata are upheaved and riven where the seams are laid bare and crop out on the surface. A narrow gorge leads from the road in a tortuous
manner up the sides of the hills, and where it presents difficulties in the way of ascent, steps of mica-

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slate or gneiss are made to facilitate the transport of baskets of coal from above by men and boys. At the pit's mouth is a coal yard, where small heaps are collected and streaked or dribbled over with whitewash to mark whether any one takes a portion away, as practised in this country on heaps of bricks. In like manner, at the entrance to the pit, a large coal fire is kept burning in order to ventilate the mine, like the up-cast shafts here. And so, also, the miners furnish the visitor with an old Chinese skull-cap and suit of coaly clothes to descend into the mine, while they slip the string of a lamp over his head, and when ready to go below he looks the exact picture of a Lancashire or Newcastle miner. Then he follows his guide, descending backwards, down the shaft, cut through a thick stratum of rock at an angle of 45 degrees, the top and sides loose and soft, requiring to be propped up with timbers. At every fifteen feet or so, the shaft twists in a spiral direction through the rock, and terminates at about 120 long strides, where the strata is a kind of blue compact limestone. There is a gallery, narrow and wet, running along the surface of the coal, which in this seam is considered inferior to the lower one. A trap-door opens into another passage, which the guide states is to divert the current of air from one gallery to another. Down this the visitor descends some thirty strides, where a series of adit levels branch right and left into the seam, where the miners are at work, with small pickaxes, lying on their sides. Without much care in picking out the shale, a long basket on wooden skids, containing about 251bs. weight, is filled and dragged away by a boy with a rope-band passed over the shoulder and allowed to play between his legs, while he hauls it up the spiral shaft painfully and laboriously.

The character of this coal approaches that of ordinary household coal, more than any other found in China. It is used in all the houses of the towns and villages close to the mines, but at a few miles distant the inhabitants prefer burning wood or charcoal. Coal is, however, commonly used in the kitchens of the tea-houses, and the wealthy mandarins of Peking; while the Tartar population of that city have less antipathy to its use for culinary purposes than the pure Chinese. At an approximate calculation the annual produce of the coal-mines in the northern provinces is 340,000 tons. This, added to the other estimates, makes about 1,000,000 tons as the production annually of coal in China, valued in round numbers at £1,200,000 sterling, at the pit's mouth. Compared with the population, the consumption is only 1 ton to 406 people.

Besides these coal-measures on the mainland of China, there are

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deposits in the Island of Formosa, and in the Japanese Isles, which are of superior quality, and more accessible to shipping. However, sufficient data is here given to show that the coal measures of the "Far East" are as yet undeveloped. A new field is open there to the enterprising "men of the West," not only to show what they can do in developing the coalmines of China for their own profit, but how they may enrich the Imperial Chinese Treasury. If it be the case, as abundantly shown in the foregoing memoranda, that it is the cost of the article which prevents its consumption by the people, from the slow, rude process of mining, there is no doubt that, provided with the steam-engine and the safety-lamp, the Chinese miner could produce inexhaustible supplies of coal at a cheap rate.
Now is the time for English capitalists, and engineers skilled in coal-mining, to obtain concessions from the Chinese Government, with whom we are on the most friendly footing, since the ratification of the "Treaty of Tientsin." Under that "treaty" Englishmen may traverse the length and breadth of the land without molestation, and the Government would gladly grant concessions to responsible individuals for a royalty, to fill their impoverished exchequer. Of course, those who might obtain such concessions would be bound to send out skilled "viewers" and "miners," with the most approved appliances of machinery to raise the coal, and carry it by tramways to markets and ports of shipment. In doing so, they would show the slow Chinese mind how superior is the civilisation of the West to that of the East, especially in the arts and sciences bearing upon works of utility and profit. By such means, if coal became cheap and abundant in China, it would not only make the fortunes of its promoters, but it would be a lasting benefit to the shipping and commercial interests of this country by increasing our trade with that vast empire.

[On the Map attached to this paper (plate XIV.) the localities where coal has been obtained in China are shewn in red.]

NORTH OF ENGLAND INSTITUTE OF MINING ENGINEERS.

GENERAL MEETING, THURSDAY, MARCH 1, 1866, IN THE ROOMS OF THE INSTITUTE, WESTGATE STREET, NEWCASTLE-UPON-TYNE.

EDWARD POTTER, Esq., Vice-President, in the Chair.

The minutes of the Council meeting having been read,

The Chairman said, the business of the day would be commenced by the election of a President, and fortunately there were a great many gentlemen who were capable of filling that office. There was a proposal that the term of office should be limited, but a difference of opinion existed as to whether it should be for one, two, or three years.

Mr. Isaac Lowthian Bell said, that question would be brought to an issue by his bringing before the meeting the notice which stood on the paper in his name—viz., that the mode of electing the President be altered from the practice hitherto pursued. A variety of circumstances, to which he need not allude at any length, had caused the election to fall on their late lamented President, Mr. Nicholas Wood, who held the office from the first establishment of the Institute to his death. The fitness of Mr. Wood for this office, and the fear that the choice of the Institute might fall on any other, whose avocations might interfere with the discharge of the duties, operated, no doubt, against any gentleman becoming a candidate for the office for the last dozen years. The time had arrived when they were led to inquire whether the plan hitherto pursued was, on the whole, most conducive to the present interests of the Institute, and a strong opinion was held that a limit ought to be placed on the number of years any gentleman ought to serve. The office of President, he hoped, was,
and ever would be, an object of honourable ambition on the part of their members, and it was desirable that the selection should have as large a scope as possible. He thought, again, it was not desirable, perhaps, looking at the duties of the office, to look to any one gentleman for their discharge for so long a period as Mr. Wood had held them. He had come to the conclusion that a limited time would best meet the requirements of the case, and best serve the interests of the Institute. Whether that time should be one year, two, or three was a question they would now be called on to discuss. The words of the motion placed on the paper left it to his option to move it for any of these periods, and it was equally at the option of the meeting to take which was most likely to be acceptable. The reason why one year was preferable to any other term would be, that the office itself would be brought within a reasonable prospect of being filled by a greater number of their own body. On the other hand, no doubt, the longer the period, the greater the distinction. But while thus gaining on the one hand, they would lose it on the other by circumscribing the number of gentlemen who would be called on to discharge its functions. Having consulted, as far as circumstances permitted, with other gentlemen, he had come to the conclusion that a middle course was the best fitted to meet our requirements. Therefore, if they saw no objection, he would submit for the consideration of the members that two years should be the limit. He, therefore, begged leave to move that the President shall not be eligible for more than two years in succession; and that the retiring President shall be ex-officio a Vice-President for one year.

Mr. Southern seconded the motion.

Mr. Armstrong suggested that the retiring President should become ex-officio a member of the Council.

Mr. Bell consented to that alteration. The motion was then amended as follows and carried unanimously:—"That rule No. 11 shall be altered so far as regards the election of President, who shall hold office for two years, and shall, on retiring, become ex-officio a member of the Council. Any President shall be re-eligible after being one year out of office."

Scrutineers were then appointed, and the votes taken. There was an absolute majority in favour of Mr. Thomas E. Forster, who was consequently elected. The voting was as follows:—Mr. Forster, thirty-one votes; Mr. Potter, nine; Mr. Armstrong, three; and Mr. J. T. Woodhouse, two.

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The President, in taking the chair, thanked the members of the Institute for the honour they had conferred upon him. He dare not promise to devote as much time to the duties of the office as their late President, but he would do as much as he could, relying on their assistance.

The following new members were elected, viz.:—Mr. Joseph Tolson White, Wakefield; Mr. Thomas Dunlop Ramsay, Trimdon Colliery, Ferry Hill, was elected a graduate.

Mr. Cochrane called attention to a recommendation which had been made some time ago for preparing a list of books to be obtained for their library, and to the generally neglected state of the Recommendation Book.

Mr. Green said, the library ought to be made as complete as possible, as their funds were in a good state. There were some valuable books connected with the coal-trade in the possession of the
Society of Antiquaries. That society made no objection to anyone inspecting their books, but they could not be removed. These books contained reports upon, and plans of, the working of collieries a hundred years back.

On the motion of Mr. Berkley, seconded by Mr. Armstrong, Mr. Green's paper, entitled "The Chronicle and Record of the Northern Coal-Trade in the Counties of Durham and Northumberland," was considered as read, and it was ordered that it be printed.

Mr. Bell said, that availing themselves of the fact that they had a numerous meeting, he begged leave to submit whether they might not, by enlarging the sphere of operations of the North of England Mining Institute, render it a more important body, not only to the coal-miners themselves, but to the district generally. The question had been considered in the Council, whether they might not so far enlarge it as to take into their society mechanical engineering, and, probably, other branches of manufacture connected with the district. There were objections urged by some, and one was, that they might so far obscure the objects they had in view as entirely to alter the complexion of the Institute—that instead of being one of entirely a practical character, they might get into the discussion of pure theoretical science. There was not much danger of that, because all the papers, before they were read, must be submitted to the Council itself; and that body ought to take care that such questions were excluded from consideration. There would be no more danger of having their time taken up with such questions as he had mentioned, than there was at present. He could not say that he himself had sufficiently considered the question to recommend that the Mining Institute should so far depart from its original objects; but he knew that this question had occupied the attention of gentlemen who took no part in their discussions; who, though members, never attended its meetings, and never gave information, or took any other part, except to subscribe to our funds. He thought that an alteration of their constitution might be attended with beneficial results. It was a reflection on the North of England that they had no institution that took special cognizance of scientific subjects, excepting those of Natural History and Medicine. Recently they had a Literary and Philosophical Society. The late Robert Stephenson, by a very munificent offer on his part, effected a change in the constitution of that body. One of the results was, that that which was, to a great extent, a philosophical institution, had become almost exclusively one of a literary character. He apprehended, though he did not say it in condemnatory terms, that every year would see a nearer approximation to its becoming an exclusively literary institution. Whether or not this Institute, by joining to itself gentlemen of scientific and manufacturing skill, might possibly supplement that which he thought they were seeing about to depart from them, he could not tell. If they had any establishment recognising the objects of manufacturing science, and uniting with it a museum of products and models, they would possess a collection having great interest, not only to themselves, but to the community generally. In Newcastle such a collection was totally wanting.

The President said, that from the little that was said at the meeting of the Council, they seemed all agreed that it would be a great benefit to the Institute if mechanical engineers could be united with them.
Mr. Marley said, that in looking at the rules, he found that the first rule related to the objects for which this Institute was originally founded. These were connected with the ventilation of mines, the winning of collieries, the prevention of accidents, and the promotion of mining science generally. In the last clause they might introduce a great many of the subjects referred to by Mr. Bell. Then, with regard to the qualification of members, the rule said, "Other persons connected with or interested in mining;" so that without any alteration in the rules they might meet Mr. Bell's wish. He would suggest that this matter should go to the Council for their consideration. It was a matter of very great importance, and before they altered or interfered with the title of their society, the subject should be well discussed. They should not be in a hurry to make any radical change till the annual meeting. With the principle in the remarks of Mr. Bell he cordially agreed. With regard to the title of the Institute, it might be a question whether, instead of saying "Mining Engineers," it would not be better to say simply "Engineers," or "Mining, Civil, and Mechanical Engineers."

Mr. Boyd said, he happened to have a pamphlet in his possession, written by Mr. Thomas, applicable to this subject. It was a proposal that a society be formed for lodging plans of mines that might be discontinued, and to prevent accidents from new workings approaching such mines. Some information might be gleaned out of this pamphlet assisting the object which Mr. Bell had in view.

Mr. Southern said, it would be well if the recommendation of the Council on this matter were in the hands of members as early as possible, that they might have time to consider it before voting upon it.

Mr. Atkinson said, he did not quite agree with Mr. Marley in the propriety of putting it off till August. If the thing was good, why put it off?

Mr. Marley said, that it would require till then to make such a fundamental change.

Mr. Cochrane said, no papers on mechanical subjects would be refused; he did not see what further inducement the Society could offer to members to bring these subjects before the meeting.

The President—Probably these mechanical engineers were not aware of it.

Mr. Atkinson—They are, I understand, ready to join us, but they want to be acknowledged.

Mr. Marley said, one of the founders and framers of the rules of this Institute, the late Mr. Thomas John Taylor, said his object was to make the rules so expansive and liberal as to bring almost everything reasonable within them.

Mr. Atkinson said, that from conversations he had had out of the meetings of the Society, he had reason to believe that several able gentlemen, connected with mechanical engineering and chemical science, would join the Institute if they had a distinct recognition. They would wish to have a share in the management as well as contribute papers. Unless something was done in this way he thought they would stand aloof. It would be an infusion of new blood, and make the society more lively and more useful.
Mr. Bell said, they could not but notice the extreme languor [sic] of their discussions. A paper was read by Mr. Doubleday the other day on the explosion of steam boilers, and scarcely a single gentleman took part in the discussion upon it.

The meeting then broke up.

ON TAIL ROPES.

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

Read at the Manchester Meeting, July 13th, 1865.

A very usual mode of conveying coal tubs, either underground or at the surface, in the Lancashire and Cheshire collieries, is by the use of endless chains.

Where the inclination is sufficiently steep and the load descending, the full tubs bring up the empty ones; when the load is brought from a lower to a higher level, or along a flat plane, the wheel round which the chain passes is turned by machinery.

It is not necessary for us to describe the process in each of the above cases, and we will, therefore, confine ourselves to that in which the load is descending.

There is placed at a few yards from the top of the plane a horizontal wheel about five feet in diameter, and another wheel is placed, also horizontally, at a like distance beyond the bottom of the plane. These wheels are of peculiar construction. At intervals of six or eight inches in the groove of the wheels are small webs, in each of which there is a nick or indentation into which any link of the chain will slip edgeways, but which when the wheel is stopped by the brake, immediately holds the chain, the broadway of the next link being stopped by the web.

The sheave, both at the top and bottom of the plane, is fitted with a brake, so that either when there is a deficiency in the supply of full tubs at the top or of empty ones at the bottom, the attendant may stop the working of the bank. The tubs are attached to the chain by the edgeway of the link of the chain falling into a similar nick to that

described above, in a moveable piece of iron which is easily slipped on to or off the edge of each tub; by this contrivance and by having the sheaves rather elevated above the top of the tub the chain detaches itself from each tub at the end of its journey.

At the top and bottom of the bank for every tub that is detached from the chain, another is attached by the attendant. Any number of tubs may be running at a time, and as the deliveries are regular a very large amount of work may be done, although the speed of the chain may be very low.

However simple and efficient the above process may be, there are many circumstances under which it is inapplicable. The friction and weight of the chains, for instance, would be found to be productive
of an immense waste of power in long planes, and there is a disadvantage which must not be overlooked, viz., that it involves the necessity of double way throughout, and, consequently, a large increase in the cost of road making. We conceive that the application of this mode of conveyance along long flat planes underground would be so disadvantageous as to be almost, if not entirely, impracticable whether viewed commercially or mechanically.

The object of this paper is to describe the tail-rope principle by which large quantities of coal may be conveyed, by engine power, very long distances underground along level or undulating planes. As illustrative of the system, we shall describe it as practised in the Marley Hill Colliery, county of Durham. The engine which there is placed in a chamber under the waggonway and near to the shaft, as will be seen on reference to Plate XI fig. 1, has two horizontal cylinders, twenty inches in diameter each, with three and a-half feet stroke. There is upon the main shaft a fly-wheel, weighing five tons, and a spur-wheel, six feet in diameter, into which, on opposite sides, two other spur-wheels, also six feet in diameter, work by means of sliding gear, so that either of them may be attached to or detached from the engine as required. On each of the shafts of the last-mentioned spur-wheels is fixed a drum, of the diameter of six feet, and three feet wide. The engine is supplied with steam by two boilers, forty feet long and five and a-half feet in diameter, with egg ends and wheel flues, which are placed at the surface, the length of steam pipe, from the boilers to the engine, being five hundred and eighty-two feet, and its internal diameter seven inches. The steam pipes are covered with dry hair-felt, closely lapped with tarred small line, and the whole coated with boiled tar and sand.

Vol. XV. Plate X.

Plans and Sections of Underground Engine Roads at Marley Hill Colliery Durham.

There is a receiver near the engine, the length of which is ten feet, and diameter three and a-half feet. The ropes used are of iron wire, and are of the weight of seven pounds per fathom, or two and seven-eighths inches in circumference.

It will be seen that the length of rope required to work any plane is, by this system, three times the length of the plane; for supposing the empty train of tubs to be starting from the shaft there is the rope which, fastened to the front of the train, passes to the far end, round a sheave and back to the drum which (now in gear) draws the train to its destination, and the rope which fastened to the back of the train is drawn off the other drum (now out of gear), and which, together with the other rope, when the empty train has arrived at the station is detached from it, and attached to the full train waiting to be drawn out. The drum first-named is then thrown out, and that last-named into gear and the load drawn to the engine. Strictly speaking, either rope is the tail-rope, as it is attached to the tail of the train, but that which is used to bring out the full train is commonly called the main-rope, and the other, which is usually of a lighter description, is called the tail-rope.

The brake is always kept lightly on that drum which is out of gear, so as to prevent its momentum from allowing any slack rope to run off, or any sudden check to the speed of the train, or to prevent the train, where the road may have an inclination, from over-running the rope which is in gear, and
where this inclination is steep it is necessary to apply the brake more strongly. The main-rope is carried in the middle of the railway by cast-iron rollers, eight inches long and four inches in diameter, weighing eighteen and a-quarter pounds each, and the tail-rope, travelling by the side of the way, runs upon sheaves twelve inches in diameter, weighing twenty-eight and a-half pounds each; both rollers and sheaves are put in twelve yards apart. The sheave at the far end, round which the rope passes, is six feet in diameter. It will be seen, on reference to the plan, Plate X., that the machinery in use at Marley Hill Colliery is applied to bring coal from four stations; the distances of which from the engine are shown by the plan; the section shows the various undulations on the planes. When, therefore, it is desired to bring coal from some station, other than that from which it was brought last, the following process is gone through.

We shall suppose that a train of full tubs has been brought from the station No. 3, and that the signal has been given that the next train of

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empties is required to be sent to station No. 1, where a full train is ready to be sent away.

There is lying in the branch, from the point of divergence from the main line to the station No. 1, a rope, which having at the end a few yards of chain with large links, passes over rollers similar to those already described, round a six feet sheave, and back along the side of the way upon sheaves to the same point, and at this end of the rope there is a plain socket.

When the empty train has been drawn to this point it is stopped; the rope fastened to the front is detached, and the branch rope is hung on by means of one of the links referred to, the remaining part of the chain, if any, being put in the first tub.

About the same point that the other end of the branch rope is lying, there is a joint in the tail-rope by means of two sockets which are fastened together by a common shackle and screw-bolt, the bolt having a head like a bed-screw; this joint is now broken, and made between the end of the tail-rope next to the engine and the socket at the other end of the branch-rope. The engine being again put in motion draws the empty set into station No. 1, and this process is repeated whenever any other station is ready to send away coals. When the socket at the end of the branch-rope is not opposite to the socket in the tail-rope, it is sometimes requisite to employ a winch to haul it to this point, and it is therefore necessary to keep a winch for the purpose. Instead of carrying the branch tail-rope round the curve, it has been found more convenient to pass it under the way and to turn it round a six feet sheave by the side of the main line (Plate XI., fig. 2).

The coals are conveyed in tubs (Plate XI., fig. 3), each of which when empty weighs five hundred weight, and when full thirteen and a-half hundred weight. The tubs have flanged wheels, eleven inches in diameter. The number of tubs in each train is seventy, although sometimes if a set is not quite ready at the station, a short, or sixty-tub set is run out. Fig. 3, Plate XI., also shows the self-acting apparatus used for detaching the rope from the end of the train, when drawn up to the shaft. The top part of the gradient A, striking against a piece of wood, lifts the pin B, by which the shackle at the rope, or chain-end, is at once disconnected from the tub.

The following experiments show the time occupied in drawing a train from each of the stations. The train going to Nos. 1 and 3 having to be changed at No. 1 branch end.
No. 1 STATION.—2,156 Yards from Shaft.

No. 2 STATION—1,276 Yards from Shaft.

In both of these cases it will be observed that the full set could not be brought in for a few minutes, the winding engine in each case not having cleared off the previous train.

No. 3 STATION.—2,904 Yards from Shaft.

The following experiment was made in order to arrive at the amount of power of the engine utilized.

The engine drew seventy tubs, chiefly with the load, on a gradient of from 1 in 252 to 1 in 440, or practically level, 420 yards in exactly two minutes; the resistance being as follows:—

The space travelled over was that between the points a and b on the plan and section X., the train having come from station No. 3; consequently there would be 5,863 yards of rope in motion, which, at seven lbs. per fathom, weigh 20,520 lbs.

In this length of rope, there are 240 rollers, which, at eighteen and a-quarter lbs. each, amount to 4,380 lbs.; and 250 sheaves, which at twenty-eight and a-half lbs. each are equal to 7,125 lbs.

| Weight of rope | 20,520 |
| Rollers | 4,380 |
| Sheaves | 7,125 |

And taking the friction at 1/28th (Transactions of North of England Institute, vol. III., p. 286), we have the resistance of the ropes, rollers, and sheaves = 32,025/28 = 1,143.75 lbs. The weight of seventy full tubs at thirteen and a-half cwts. each, is 105,840 lbs., and taking the friction (Transactions, vol. III., p. 258) at 1/82, we have the resistance of the tubs = 105,840/82 = 1,290.73 lbs. The total resistance, therefore (1,143.75 + 1,290.73) = 2,434.48 lbs., and this multiplied by 630 feet, the rate per minute, gives a total resistance in pounds moved one foot per minute, of 1,533,722.4 lbs. During this experiment the pressure of steam, as indicated at the engine, was twenty-nine lbs. per square
inch, the diameter of the pistons twenty inches, and the space travelled by each 210 feet per
minute. We have, therefore, the power represented by 3,826,468 lbs. moved one foot per minute.

The effective performance of the engine is, therefore, forty per cent, of the estimated power (no
deduction, however, being made for the friction of the engine, resistance of the atmosphere, etc.)

If, however, we make the usual deduction of one-third from the estimated power, we reduce it from
3,826,468 lbs. to 2,550,979 lbs. moved one foot per minute, and the effective power is thus 60.1 per
cent. of that of the engine.

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The consumption of coal used in firing the boilers for five days was 25 tons 2 cwts., during which
time the quantity of coal and fireclay drawn along the planes was 2,805 tons, the engine not being
employed more than ten hours in the day, or about 9.7 lbs. per hour per indicated horse-power. A
large quantity of heat is, however, unavoidably wasted during the periods when the engine is not
actually at work, and this deduction is probably of not much value. From the nature of the gradients,
the power required to take in the empty load is equal to that required to bring out the full one. The
number of people employed daily to carry on the work is as follows:—One fireman at the boilers,
one engineman, one man attending drums, one boy getting set ready at shaft, one bank rider, one
assistant ditto, one boy at No. 1 way branch end, one boy at No. 1 station, one boy at No. 2 station,
one boy at No. 3 way branch, one boy at No. 3 station, two men greasing rollers and sheaves, three
waggon-way men. In all ten men and six boys, of whom three men and the six boys would be
required whether machinery was employed or not.

The following shows the actual cost of bringing coals, etc., along these planes for one year:—

[Table]

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The quantity of coal, etc., led during the year was 159,553 tons 13 cwts., or 216,271¼ tons led over
one mile of way. The cost per ton per mile was, therefore,

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour</td>
<td>0.711  pence.</td>
</tr>
<tr>
<td>Materials</td>
<td>0.679  &quot;</td>
</tr>
<tr>
<td>Coals</td>
<td>0.273  &quot;</td>
</tr>
<tr>
<td></td>
<td><strong>1.663</strong>  &quot;</td>
</tr>
</tbody>
</table>

Prior to the application of the engine, the same amount of work required the employment of
twenty-four horses, the maintenance of which, with that of the roads, etc., would not be far short of
£2,500 per annum. The present cost, however, as compared with what it would have been with
horses, is no criterion of the advantages gained by the substitution of machinery. The same
machinery will draw the quantity when the coal has to be brought double the distance, in which case
from forty to fifty horses would be required. The only disadvantage of machinery is, that any
derangement of it involves the entire stoppage of the works until the repair can be effected; but
with everything strong, good, and well appointed, such occasions should be very rare. During the year in question, the pit worked 280 days,—the average daily quantity being 569 tons, all brought to the shaft by the engine.

**DISCUSSION ON MESSRS. G. C. GREENWELL’S AND C. BERKLEY’S PAPER ON TAIL-ROPES.**

J. T. Woodhouse, Esq., in the Chair.

Mr. G. C. Greenwell said, the paper just read was written at the suggestion of certain members of the South Lancashire and Cheshire Coal Association, who thought that as the system had scarcely been introduced in this county, some information upon it would be useful. The paper was the joint production of himself and Mr. C. Berkley, the latter having made the experiments referred to in it.

The Chairman was sure they would agree with him that the paper just read was a most valuable contribution to their proceedings. He thought it ought to lead to extended discussion, particularly on the respective merits of tail-ropes and the endless-chains which were so much used in Lancashire.

Mr. Whaley said, Mr. Greenwell told them the tail-rope plan was not generally adopted in the Lancashire district. He happened to be the manager of the Norley Colliery, and eight years ago he put down a tail-rope exactly on the principle just described. He could speak to its very great efficiency, and he thought it the best mode of bringing coals under such circumstances. Since then they had introduced another tail-rope.

Mr. Gilroy said, as Mr. Greenwell had mentioned the endless-chain mode of drawing coal, and as he had stated the weight of the chain to be an objection for long distances, perhaps he was not aware that wire ropes, very small ones indeed, were used in the neighbourhood of Wigan; some by the Ince Hall Company, and he thought Lord Crawford had got some, as an endless-rope, on the same principle as the chain was used.

Mr. Lancaster—We have several miles of that description at work, but having seen the tail-rope, I certainly prefer it for various reasons, such as the varying inclines. I think the system is invaluable for overcoming those inequalities. There is also this consideration, that with the endless-rope you can only travel about three miles per hour, but on this system you can go ten miles. I am now substituting the tail-rope in the place of the endless wire rope, as described by Mr. Gilroy. I, for one, pressed Mr. Greenwell to bring this paper forward, thinking there was a want of information, especially in our county, upon it. It will be of great service in facilitating their use, which is desirable, especially where the mines are flat.

Mr. Hughes said, they had a great many endless-ropes at Lord Crawford's, but the difficulties were precisely what had been pointed out. It was necessary to have a road with one gradient, or with a very little change in gradient. If there were several changes, the tubs were apt to get off the way; and the road should be as nearly straight as possible. These two circumstances had made him think a good deal of adopting the tail-rope instead of the endless-rope. He did not, however, agree that it
might be driven at the rate of ten miles an hour, as they were apt to get off the way. He had been anxious to hear a paper on the tail-ropes. He knew something about them, but not sufficient to enable him to understand the whole of their merits, and he felt indebted to Mr. Greenwell for bringing the subject forward. He thought the result would be that he should adopt some of the tail-ropes.

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Mr. Forster said, they had at Seaton Delaval a mile and a-half of tail-rope, and they had done 1,200 tons a day without the slightest difficulty, the full load being brought out in eight minutes, and the empty one in seven minutes.

Mr. Lancaster—With the endless-rope you rather want a double way unless you reverse the rope, but with this plan you can do more work with a single road than with a double road under the other way. This is, perhaps, the most prominent feature in its saving.

Mr. Matthews said, they carried out the same principle at several of their pits. At Murton there was one more than two miles, where part of it was level, and part dipping at something like two inches to the yard. They were bringing out 5,000 or 6,000 tons a day without any difficulty whatever, and taking them round turns, and up hill and down hill, with a tail-rope and a single way.

Mr. Wood thought there was a great deal of time lost by stopping the train at the way ends to change the ropes. At one of their pits they were drawing, with a small engine, from seven different stations, about 500 tons a day; and with the gradients—some being about three inches in the yard—they could not bring many coals out at once, not more than eleven tons. The saving of time, therefore, was a great object, and they always changed the ropes for the different ways while the train was at the shaft.

Mr. G. C. Greenwell remarked that the changing did not occupy more than two minutes.

Mr. Berkley inquired of Mr. Wood what amount of double rope they had lying in order to make the change at the shaft.

Mr. Wood replied, that it was double rope all the way. They generally had the loose ends as near together as possible. One small boy could change the ropes without any difficulty.

The Chairman—We seem rather carried away by these tail-ropes. I hope some one will say something about endless-chains. We saw a very ingenious contrivance the other day—I think at the Agecroft Colliery—from the top of the shaft to a railway, on a very simple and inexpensive plan. It is true the train travelled very slow; but taking into consideration that there was a considerable number of tubs attached, somewhere about twenty, I think, and the weight of the chains being carried on the top of the tubs, entirely as a self-acting machine, it appeared to me that by that convenience alone any amount of coal might be conveyed a day, say a thousand tons, and any distance at a trifling expense. In fact, a gentleman who was there told me that in some colliery in Lancashire they were drawing underground, I think, several thousand yards with a machine of that kind.

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Mr. Dorning (the gentleman alluded to) said, the pits he referred to were Mr. Hargreaves', near Newchurch. He believed they had about seven miles of chain in use there. He was working the chain himself for at least half a mile, and the cost on the surface was about 3d. per ton. For working on the surface, he did not think there could be a more inexpensive plan than these endless chains.

The Chairman—Will you permit me to ask you, if it be economical to work it on the surface, why not equally so underground, provided your roads are all of sufficient capacity and your ventilation is perfect?

Mr. Dorning—The reason is really this, that the chain entails a double road, and that is the only reason why I do not adopt them underground. And most of our collieries here have very steep inclinations. I should not apply the chain if the incline was one in three or one in four, but only when not steeper than one in twenty.

The Chairman—To what part of the working would you apply this chain? I do not suppose at the jig and brows, but you would apply it along level lines?

Mr. Dorning—I am not an advocate of the chain down a colliery at all, I should prefer the rope (and especially in our part of Lancashire where you have a gradient steeper than one in ten) for dragging the tubs down a working with an engine.

The Chairman asked what was the relative quantity of coal that could be sent out by a single road with a tail-rope, and a double rope worked with an endless chain or wire?

Mr. Forster said, that at Seaton Delaval they could send out 1,200 tons a day, a mile and a-half, with a single way.

Mr. John Knowles did not feel that he should be an advocate of an endless chain at the bottom of a pit. They had one some years ago, but at the collieries the members saw on Wednesday, they had employed on the surface three endless chains, and they found them useful when they had to take the coals from the pits to where they had to be loaded. He thought, so far as he had seen of the method adopted, that this tail-rope was the most suitable of all.

Mr. Spencer asked what there was to prevent an endless rope going faster?

Mr. Lancaster said, they had had both systems in operation, and he

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had no hesitation in saying that the tail-rope would do more work with a single way than could be done with any double way and an endless chain. As he had stated before, they were pulling up endless ropes and putting tail-ropes down as a substitute for them. First they tried Messrs. Knowles's plan of having tubs attached here and there, but there was great difficulty in the intermediate attachment. Then they followed a plan, long adopted by the chairman, of having a single way with a rope alongside, and having the train of tubs attached by clips to the rope; and they had also adopted the double road plan. If they must have the endless rope and do any work with it, they must have the double way.
Mr. Gilroy said, he was not an advocate for the endless rope, but he should like to see it have fairplay; and more particularly with regard to the mode of attaching tubs at intervals. A very simple plan was introduced by Mr. Hartley at the Ince Hall Colliery some time ago. He must first say that this endless rope business was somewhat in a retail way. It had only sent about 150 tons a day, but it answered exceedingly well. The mode of attaching was this. There was a chain four feet long with a hook at each end; the hook was attached to the coupling-chain by one end, and the attendant just gave it a swing round the rope and the other hook caught it. It went up so, and when it reached the top, the lad there detached the hook and gave it a swing the other way. For this quantity it answered very well, and the changing did not damage the rope.

Mr. Dickinson—I am glad you have endeavoured to draw some attention to the merits of the endless chain. One thing I particularly notice in moving over wide districts of country, and that is, that one particular system seems to pervade a particular neighbourhood. In South Lancashire, I may say that the general system is the system of drawing by ropes, whilst in North Lancashire the general system is exactly the reverse,—it is drawing by endless chains. Mr. Dorning has told you of the colliery in Rossendale, belonging to Mr. Hargreaves, where they have about eight miles of endless chain at work, and which works over gradients of various kinds, steep and level. He has named, also, that of another firm, at Burnley, the executors of the late John Hargreaves, where they have between thirty-five and forty miles of endless chain at work. The Cliviger Colliery also applies it extensively; and, indeed, it is the general system of traction in North Lancashire. They work it over gradients as steep as one in five, without any means of attachment except the fork which is attached to the tub. The chain drops into the fork and requires no other attachment,—drops of itself, and is lifted out by the pulley at the floor end where the tub is delivered. They not only work these endless chains on the surface, but they take the chains down their shafts; they carry them along their level roads, they run them down their brows, and they run them up their brows. The attachments at the different junctions which have been inquired about, are made with the greatest ease. It simply requires a pulley to be placed for the chains to run round. A new chain may be started, or it may be the same chain, but there must be a pulley at each place where the hookings on or takings off have to take place. The roads are also changed from one direction to another in the same way; and the change is not unfrequently made without having a person to attend to it. But it is better to have some one, particularly if it be on the surface and there be snow on the ground, or liability to any interruption. This done, you have an alteration in the direction. The tub is first drawn up to a little elevation, and then by its own gravity it runs down, taking the curve to alter the line of the road. I think if the members of this Institute, who are so strong in their advocacy of these tail-rope, were to pay a visit to those collieries in North Lancashire, where the system is carried out, they would be much more doubtful than they are now of their system of tail-rope. The weight of the chain has been spoken of by Mr. Greenwell as an objection, on account of the increased friction produced. It actually produces no friction except its actual weight. It touches nothing from end to end. It is merely laid on the tubes; it never touches the ground; there is no friction whatever. And the other objection as to having double roads, of course that must go for what it is worth. But the surface tram-roads are laid in such an inexpensive way as to weaken this objection. They lay their sleepers on the bare ground,—on the field as it exists; up hill and down hill, just as the surface undulates. And for this reason, the chain being an endless one, and the weight distributed throughout it, there is a
counterbalancing action going on from one end of the chain to the other. They are often carried through fields where the descent is tolerably steep on one side, and have to go up the other, which, by many people, has been supposed to be impracticable because of the stretching of the chain. This is an objection, because, with hollows, it does occasionally take place that the chain may be lifted; but if the chain is of sufficient weight it is not found insuperable in practice. At the Cliviger Colliery, you may see a very excellent illustration of the kind. I should say for economy, the endless chain will bear comparison with any system of traction. I only wish we had Mr. Waddington, the manager of the Burnley Collieries here to tell us some of its advantages. I am quite satisfied he would have listened in a most sceptical manner to all those arguments which have been brought forward in favour of the tail-rope. In reply to a question, Mr. Dickinson said, they had different lengths of chain in connection with the different collieries in the neighbourhood of Burnley, both above ground and underground. He thought in some instances they carried these chains more than a mile in length underground.

A Member said, he did not understand how they changed the tubs.

Mr. Dickinson—It is rather difficult to explain; but I endeavoured to say that at each alteration in the direction of the road, there must be a pulley for the chain to go round, and the tub must be liberated from one chain to make its curve. It must pass underneath the pulley, and in doing so it has to be taken to a certain elevation so as to give it a descending gradient, to run itself round the curve, on to the next chain. There is, perhaps, as good an illustration of that at the Towneley Colliery, near Burnley, as can be found.

Mr. Forster did not think there was much difficulty in conveying coals on the surface; the intermediate stages constituted the difficulty. At a pit belonging to Lord Durham, they had not a single horse employed. The pit was entirely worked by machinery. He believed he was himself the first to introduce the tail-rope system in his locality, and since then almost every colliery had the machinery applied to level roads.

Mr. Dickinson—The objection that has been stated in regard to having the extra width of the road underground is not altogether an objection. You do not wish in your underground roads to have them so small that the trams interfere with the ventilation. It is always desirable when you can to have the inclined planes sufficiently broad and spacious not to interfere with the currents of air. In reply to another question, Mr. Dickinson said, they had as bad roofs in the neighbourhood of Burnley to contend with as any in his district.

Mr. Southern asked how, in pits like the one at Marley Hill, with four different ways going into one main way, the chain could be adapted for such workings?

Mr. Dickinson did not see that the number of branches had anything to do with the system; it was equally adapted to four as to one. They must have different chains, one for each way.
Mr. Gilroy—I should like to ask Mr. Dickinson whether it is absolutely necessary to have a separate system of pulleys for each different branch, and whether it could not be obviated in this way. Supposing the tubs to be thirty yards apart, and at any place midway between the two pulleys a branch is made for the tubs to be brought and attached there, —whether a slight undulation, just a hollow, opposite that branch end would not enable a man to draw out and push his tub in underneath; and if there was a slight dish at that point, whether the chain would not be sufficiently high for a man to get his tub underneath, and by pushing it up the brow a little get it out of the way?

Mr. Dickinson—That is occasionally done; and where the pulley is resorted to, the mechanical arrangement for freeing the tub from the chain, where the fork is used, is both simple and efficacious.

Mr. Gilroy—We may consider that it is quite possible and feasible to attach the tub anywhere between these pulleys whilst the rope is in motion?

Mr. Dickinson—Where you have to use the fork as a means of attachment for the chain to lie in, it is merely not so easy to get the chain out at that particular place, as where the chain only lies on the tub.

Mr. Gilroy—I think you might do it by having a siding running nearly parallel and joining the main road, where the rope is just of sufficient height to admit the tub.

Mr. Stott called attention to a pit which the members had seen, where, at a depth of 148 yards a very small engine was employed in winding coal at the rate of two boxes a minute, or 220 tons a day, and with certainly not more than a fourteen-inch cylinder. I think no one can put the same power to work, winding with ropes, and get the same results out of it as if he applied the same power to endless chains. The same rule at least ought to apply to the application of endless chains underground as aboveground on almost any incline. I am an advocate of this chain as against any rope whatever, and having a considerable length of chains working, I might have been in possession of a few favourable statistics as to the cost of the working, had I known what would take place at this meeting. As to the difficulty of changing the boxes, I believe there is no difficulty whatever, whether on a horizontal or incline road. The plan I have found best has been to have the chain carried by pulleys, in framework, suspended from the roof, so that the chain shall be clear from the waggons as they pass under these points; or it might be done by depressions in the road. But there is some difficulty about the latter, assuming the distance from waggon to waggon to be thirty yards, on account of the increased depression in the chain. I think whoever in this room went to look at the collieries at Cliviger, Burnley, or Marsden, would be forced to the conclusion that the advantages of chains are very great indeed. You would be told, I believe, that chains have been in work for fifteen years, and that since they were fixed they have never broken, nor have they incurred any cost beyond the interest of the first outlay. I have, in Derbyshire, chains which were only of three-eighths iron to begin with, working an incline of 560 yards long, and the amount of coal got is now 150 tons a-day. I am quite sure that six or eight times that amount could be turned on with this endless chain. I could point to numerous parallel instances, and mention this one simply because the chain was fixed on an
incline of one in five, that it was only three-eighths in thickness, and that it has never cost a shilling in repairs during about eight years' use.

Mr. Forster asked, if the engine first-mentioned was fourteen inches in diameter?

Mr. Stott—The engine is not mine, but I am prepared to say that it is not above fourteen inches in diameter; the depth of the pit is 148 yards, and the quantity of coal raised 220 tons per day.

Mr. Forster—You talk about these chains lasting. That entirely depends upon the quantity of coal raised.

Mr. Stott—My argument is, that if you apply the same power to winding by means of ropes, you will not get the same results.

Mr. Forster said, he had a very powerful engine. It would raise 1,500 tons a-day at 224 yards.

Mr. Stott—I say that if you will apply your powerful engines to the endless chain, you will still get double the quantity.

A Member remarked, that he thought there was a limit to the use of chains.

Mr. Dickinson said—The points upon which Mr. Forster has made the inquiry of Mr. Stott, who has put the advantages of endless chains before you, are very precise. But the question relates more to the system of winding the coal up the pit-shaft by the endless chain. As an observer of what is going on over a wide district, I must say that the experience of endless chains in the shafts appears to be rather against their use. So much so, that the number of pits worked upon that principle is rather on the decrease than on the increase. There are, though, I should say, from half-a-dozen to a dozen still at work in this county. But those that have been worked above 100 yards deep are disappearing. About 100 to 120 yards appears to be about the depth these endless chains can be advantageously worked. For shallow depths they are considered very advantageous, but still there has been a decrease with the winding by endless chains, in shafts, whilst the application of the endless chains, for traction on railways, has been considerably on the increase.

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

Mr. Forster again proposed the appointment of a committee to inquire into the relative merits of endless chains and tail-ropes.*

Mr. Hewlett seconded the motion.

* Further remarks on this subject, and on the appointment of a committee to inquire into the respective merits of tail-ropes and endless-chains, are reported in vol. xiv., p. 113, et seq.
PARTICULARDS OF AN EXPLOSION AND STANDING FIRE AT NEWBOTTLE COLLIERY.

By WILLIAM LISHMAN.

Read at the Manchester Meeting, July 14th, 1865.

Before proceeding to relate the circumstances under which this explosion took place, it may not be uninteresting if a brief account be given of the locality where it occurred. In connection with the Newbottle Colliery there are several old pits, some of which have not been worked for many years. Amongst these is the Jane Pit, in which there was an explosion and standing fire in the year 1799. No lives were lost, with the exception of one man, who was left in the pit, and, as the shaft was filled up and never again reopened, the body of this man has never been recovered.* The tract of workings from this shaft were not very extensive, but some time ago it was determined to hole into them for the purpose of taking away the pillars and barrier round about them. Accordingly a single drift was set away into the barrier, of course preceded by bore-holes never less than twelve yards in advance. All these holes, after being set away, had a cock-pipe inserted and made secure, and tested by a hydraulic apparatus up to 150 lbs. per square inch, and some of them were bored as far as thirty yards. On the 30th November, 1863, one of the bore-holes, nineteen and a-half yards in length, communicated with the old workings, from which water came off with great force. Upon closing the cock and attaching a pressure-gauge to the pipe, the pressure was found to be seventy-one lbs. on the square inch,—the pressure gradually diminished until at thirty-eight lbs. gas commenced to be discharged and continued to come off in immense quantity. When the pressure was reduced to thirty-seven lbs. a second hole was put in, and at length when the pressure was lowered to two lbs., preparations were made to double the drift, and also to lessen the thickness of coal, for the purpose of putting in more holes preparatory to opening the place with the pick.

On the night of the 8th April, there were three hewers working at the points marked A B and C on the plan annexed (Plate XII.). The man who was thinning the coal at the point C, suddenly holed into one of the bore-holes, it having taken a turn from the course in which it was set away. This being a nearer outlet than at the end of the hole, the gas came off with considerable force. This frightened the man, also the other at B, and they both rushed outbye, leaving their lamps; and as they passed the place end A a, where the other man was hewing, they shouted, "Come away; she's holed!" This man took his lamp and followed, but had not proceeded many yards down the drift when an explosion took place. It was very slight, and did not hurt them, but resulted in a standing fire. It is not necessary to state the measures adopted for the extinction of the fire, further than to say that as soon as all air was taken from the place, the gas (which constituted a source of danger whilst battling with the fire) appears to have extinguished the fire very soon, for it had not extended any further after being left. On the plan is shown by blue shading where the coal was burnt, and it will be seen that in the face, there was no cinder-coal whatever, and, indeed, none on the intake side of the drift.

* Since the above was written, the bones of this man have been found, and in a good state of preservation.
until the point where the brattice of brick (shown by the red line on the plan) was broken, so as to take off the air. When the accident took place, a current at the rate of about four feet per second, or 5,000 cubic feet per minute, was passing to the face.

When the place was opened out, the lamps (ordinary Davy's) were found perfectly uninjured. The one in the place B, hanging on a lamp-stand at the point marked (*) on the plan, the one at C on a stand at the point marked (°) on the plan, but the stand in the place C had been knocked over, whether by the man in his flight and hurry to escape, or by the explosion, it is impossible to say. At first it was conjectured that the lamp had been damaged, and thus caused the explosion; but the lamps both being found perfect, it becomes a matter of certainty that the flame had passed the gauze in some way or other.

As it appeared to be a matter of importance to know the exact nature of this gas, and whether it was of a different nature from the ordinary fire-damp met with in coal-mines, an analysis was made by Dr. Richardson, of Newcastle, and his analysis is as follows:—

Laboratory, Neville Hall, Newcastle-on-Tyne,

19th December, 1864.

Sir,—We have examined the bottles of gas sent here by you some time since, and find them to contain a mixture of light carburetted hydrogen with some nitrogen, and a small quantity of oxygen. Olefiant gas, carbonic oxide, and hydrogen were carefully sought for but were not present. Carbonic oxide may have been present in the original mixture, but as each bottle contained some water, which would absorb it if present, no separate determination of it was attempted.

We are, Sir,

Your obedient servants,

(Signed) RICHARDSON & BROWELL.

Since the occurrence of this accident the writer had some experiments made which are given below; the gas (ordinary illuminating coal-gas) was compressed in a locomotive boiler to the pressures mentioned, and a one-inch pipe fifty-five feet in length carried away from the boiler.

1.—An ordinary Davy-lamp was placed two and a-half feet from the end of the pipe and in a direct line; the flame passed and caused an explosion almost instantaneously. Pressure three and a-half lbs.
2.—Ordinary Davy-lamp, four and a-half feet off; pressure two and a-half lbs. In sixteen seconds the flame passed and caused an explosion.

3.—Gauze red hot about five seconds before explosion. In both of these experiments the shield was up.

4.—Davy-lamp four and a-half feet off; shield down; pressure three lbs. Exploded in five seconds.

5.—Stephenson-lamp, in same position as last; pressure three lbs. Lamp extinguished in three seconds.

6.—Stephenson-lamp, in same position as last; pressure three lbs. The result being the same as last trial in every respect.

7.—Stephenson-lamp, two and a-half feet off; three lbs. pressure. Lamp put out instantly.

8.—Clanny-lamp, two and a-half feet off; three lbs. pressure. Exploded in two or three seconds.

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9.—Clanny-lamp, two and a-half feet off; three lbs. pressure. Exploded in three seconds.

10.—Clanny-lamp, four and a-half feet off; three lbs. pressure. In twenty seconds the pressure was reduced, and the lamp extinguished.

11.—Davy-lamp, with copper gauze and shield down; four and a-half feet off. Exploded in three seconds.

12.—Stephenson-lamp, two and a-half feet off, and four inches above the line of the pipe; three lbs. pressure. The lamp went out in ten seconds.

13.—Davy and Stephenson's lamps, four and a-half feet off the pipe, and six inches out of the line; three lbs. pressure. A Stephenson-lamp went out, a Davy-lamp was nearly extinguished. There was no explosion.

14.—Davy-lamp, four and a-half feet off, in line; shield down; pressure three lbs. Exploded in eight seconds.

15.—Davy-lamp, four and a-half feet off; three lbs. Lamp smeared with oil and coal-dust. Exploded in two seconds.

From these experiments, it would appear that though the Davy-lamp is, under ordinary circumstances, a safe lamp, that in extraordinary circumstances the Stephenson-lamp is a more safe one, unless the Davy-lamp be enclosed in a lantern so as to prevent any current affecting it.

That the explosion occurred at one or other of the two perfect safety-lamps, there need not be a doubt, inasmuch as there was not a naked light within 600 yards of the point where the holing was made into the bore-hole.

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ON CERTAIN IMPROVEMENTS IN THE CONSTRUCTION OF THE WATER-GAUGE.

By JOHN DAGLISH, F.G.S.

Read at the Manchester Meeting, July 14th, 1865.

Every one who has been much occupied in conducting experiments on the ventilation of mines will have probably felt the inconveniences attending the use of the ordinary form of water-gauge.

The form of water-gauge introduced by the writer, and now extensively in use in the north of England, is constructed with special regard to portability, accuracy, and endurance (Plate XIII.).

As the maximum pressure seldom exceeds three inches of water column, it is not necessary that the travel of the index-scale should exceed this; the scale is divided simply on either side into inches and tenths, the pressure markings on the scale of the ordinary water-gauge being not only useless but confusing, and prevent the accurate determination of the difference of the level of the water in each tube. The upper end of one of the tubes is bent over, and open to the external air only by a contracted aperture, this prevents the passage of dust into the tube, which is a fruitful source of annoyance in the ordinary water-gauge when placed permanently in exposed situations in dusty mines. The scale is moved by a threaded rod working through a female screw attached to the scale, this ensures not only the accurate adjustment of the scale in the first instance, but its retention, in situ, when adjusted; in the ordinary form, if the brass spring clips, which attach the scale to the tubes be too strong, the scale cannot be accurately adjusted, especially when the water column vibrates much; if, on the other hand, they are too weak, the scale will not remain in situ, but falls when released, and this latter is always the tendency after much use; and unless the tubes are perfectly parallel the scale will be too stiff in one position, and fall in another. The upper end of the other tube is bent at right angles and fitted up with a short piece of flexible tubing, to the other end of which is attached a short brass tube to be inserted into the aperture to which it is required to attach the water-gauge; this short piece of interposed flexible tubing between the rigid brass and glass prevents the liability to fracture of the tubes, in fixing the apparatus, which is of such frequent occurrence with the ordinary form of water-gauge. The tube is contracted at the bottom bend to prevent the oscillations of the water column, especially when used near the ventilating shafts; in the original anemometer of Dr. Lind, which was similar in principle to the water-gauge, this contraction was used.

The tubes are fitted to the surface of a flat piece of wood, which entirely prevents liability to fracture, and the apparatus can safely be carried in the pocket; a small bulb-tube is fixed to the wood to allow of it being adjusted perfectly level when in use, and this is of considerable importance, for any deviation from the perpendicular is attended with an alteration in the level of the liquid in each tube. When in use, the writer generally mixes a drop of tincture of rose analine in the water, with this the position of the surface of the water in each tube is clearly distinguished, and the specific gravity of the fluid not appreciably altered.
Where any great accuracy is required, a vernier, worked by another threaded screw, could readily be attached to the present scale.

DISCUSSION ON MR. DAGLISH'S PAPER ON CERTAIN IMPROVEMENTS IN THE CONSTRUCTION OF THE WATER-GAUGE.

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

Mr. Daglish handed to the Chairman an ordinary gauge and one constructed on the above principles, and explained that the latter was not so long as the ordinary gauge, which was of unnecessary length.

Mr. Dickinson said, they were never used of greater length than Mr. Daglish's in this county (Lancashire), it being sufficient for the pressure.

Mr. Daglish said, the principle was exactly the same in the one gauge as in the other, but there was an alteration of form. In his, the scale was divided equally on each side; one of the tubes was bent over and had a small hole at the top, so as to prevent the dust from getting in; and the scale moved by a threaded screw. There was also a contraction at the bend, as in Dr. Lind's anemometer.

Mr. Dickinson had seen the advantage of this form of gauge, and knew that much less breakage took place than with the ordinary form.

Mr. Daglish—And the cost is the same.

OBSERVATIONS ON SAFETY-CAGES, WITH DISCUSSION THEREON.

By JOHN MARLEY.

Read at the Manchester Meeting, July 11th, 1865.

J. T. WOODHOUSE, Esq., Vice-President, in the Chair.

Mr. Marley, in introducing the subject, said, I think some little apology is due to you for these notes of mine being called a "paper;" because it was only at the beginning of last week that I had my attention called to the fact that "safety-cages" were not amongst the subjects put down for consideration; and I said I had expected that, coming to Manchester, we should have had at least two or three papers connected with this subject; more particularly after the remarks made by Mr. Dickinson, at Birmingham, in 1861, that, in connection with Lancashire and this district, we should find greater experience of them than in almost any other locality. But as it occurred to me that possibly the cage I wished to draw your attention to had not been much tried within this district,
and, therefore, not with the view of preparing an elaborate paper on "safety-cages" generally, but of putting a few statistics on record, I have hastily thrown a few remarks together; and I must beg your indulgence, inasmuch as several of the particulars with regard to the cage I shall now mention, have only been sent to me here in Manchester, instead of to Darlington, and I have never seen them till I came here this morning, Mr. Marley then read the following

OBSERVATIONS.

Although I have not had time to prepare an elaborate paper on the general subject of safety-cages, yet having had the subject under my notice for some time past, I think the present is a proper opportunity to
give a few statistics which should not be passed by, especially as others may have papers on the general subject.

Many years ago I was struck with the idea that the feeling or prejudice against safety-cages, which I then shared with my professional brethren, and as strongly as any of them, might be removed, and that we should give them a fair trial. Hence, about the year 1848, I tried Fourdrinier's in a shallow pit, but, after paying patent right and giving it a year's trial, I was obliged to take it off, as I found it a positive evil and source of danger. This and other failures in the district, as you may suppose, discouraged me and almost justified the verdict against safety-cages, which I have mentioned as then prevailing.

Owing, however, to a rope having slipped off the drum, at a colliery under my charge (and, although it did not break, two men's lives were lost), I was induced to try White and Grant's patent safety, but it also proved unpractical and not fit for general application, although much superior to Fourdrinier's. The subject had not afterwards much of my attention until 1862, when, of the numerous plans at the International Exhibition, I determined to try both Aytoun's and Calow's, but finally adopted only the latter; the following being my experience of this plan as tried at Shildon Lodge Colliery, in the county of Durham.

NOTES ON CALOW'S SAFETY APPARATUS AT SHILDON LODGE COLLIERY.

Plates XV., XVI., and XVII. represent the cage with the safety apparatus, under the various phases of being at rest and having caught—the parts coloured red having been put on since the meeting at Manchester, and are alluded to hereafter. The plates also show the detaching hook, which the cage can either be worked with or without, its weight being half a cwt.

The tons drawn by this cage, while the apparatus has been on, up to this time, are about 100,000 tons. The weight of the cage, with the apparatus, is nineteen cwt.s., tub six and three-quarter cwt.s., and coals about eleven cwt.s., making a total of thirty-six and three-quarter cwt.s. General speed of drawing forty-five seconds. Total depth of pit and heap-stead about 124 fathoms. Cost of apparatus about £15; and repairs, including several alterations in adjusting, not required hereafter, only between £1 and £2. It has been in use upwards of two years, and during that time has been twice brought into play. The cage which was then on was a single tub-cage, but it will shortly be attached to a double tub-cage and with a more powerful engine, which will draw the coals in
about forty seconds. On the first occasion, when the apparatus was useful as mentioned above, the cage was drawn up to the pulley, when the rope was detached by the detaching-hook (breaking the spring which must first give way before the hook can detach itself), and bringing the safety apparatus into play, and the cage was thus hung in the skews or slides, having at the time a full tub in, without any damage, and the whole delay, including readjusting the hook, only occupied thirty minutes, while it only fell ten inches.

The second case was precisely similar, except that the tub in the cage was empty.

These notes show, I think, that there are reasons for the removal of the prejudice against safety cages, and although, perhaps, no such proof is here adduced of their efficiency as yet to justify their compulsory adoption, along with other precautions for the safety of the men, I cannot let slip the present opportunity of laying before you what I have found to be the real merits of the case.

This morning there has come by post from Mr. Calow his specification; and there being time, I had better read a short description of the cage from him.

EXTRACT FROM CALOW'S PATENT, DATED 10TH MARCH, 1862. NO. 648. ON CAGES OR HOISTS.

My invention consists in manufacturing an improved safety apparatus, hereinafter described, to be applied to cages and hoists, which safety apparatus will, in the event of the rope or chain breaking or becoming otherwise detached from the cage or hoist, grip securely the slides, guides, or conductors, and thereby prevent the cage or hoist from falling, and will also prevent the over-winding of the cage or hoist. The apparatus is not attached to, or connected with, the rope or chain from which the cage or hoist is suspended, as is usual in other apparatus heretofore used for the like purpose; and, consequently, it is not affected by the tightening or slackening of the rope or chain, and has no tendency to come into action, or be at all moved by such tightening or slackening of the rope or chain when the cage or hoist is at rest on the props, or otherwise at rest, but is brought into action by the cage or hoist gravitating or becoming a falling body. The apparatus consists essentially of a spring or springs, and a weight or weights connected to, and acting upon, mechanism for gripping grips into action, while the cage or hoist remains suspended or supported. When the rope or chain the slides, guides, or conductors. In case of accident the said spring or springs, having a bearing or
foundation on the cage or hoist, while the weight or weights hang from or rest upon the spring or springs, so as to neutralise or counteract the tendency of such spring or springs to bring the breaks or becomes detached from the cage or hoist, the grips are brought into action by the law of gravitation, that is, by the cage or hoist becoming a falling body, and thereby releasing the spring or springs, which, on being free to act, instantly bring the grips in contact with the slides, guides, or

conductors, and thereby prevent the cage or hoist from falling. To prevent overwinding, I use a detaching-hook fixed at a convenient distance above the cage or hoist. This hook consists of two bars or legs jointed together at one end and hooked outwards at the other. These bars or legs are connected to the chain or rope by means of a shackle at the joint; the hooked ends carry a curved slotted plate, and are distended by the weight of the cage or hoist, by bearing down the joint of a pair of shorter bars or legs, jointed together and placed between the longer or outer bars or legs, which said shorter bars or legs have a shoulder bearing also upon the curved slotted plate. Between the bars or legs I insert one or more plate springs, to keep the hook in position when the weight of the cage or hoist is not bearing upon it. Under the pulley I fix a strong ring of such diameter that the hook cannot pass through unless the outer bars or legs are closed, so as to release the hooked ends from the curved slotted plate, thereby detaching the rope or chain from the cage or hoist, and thus prevent overwinding.

I may here remark that one of the essential differences between this and the various cages I have had my attention directed to, is that at the pit top and pit bottom this apparatus does not come into play. It does not use the spring every time; thus there is no wear and tear going on as is usual in other cages. Mr. Calow also says:—

I recommend that a reference index-plate be placed over the spring to indicate the state and condition of the spring, and the amount of pressure upon it.

I do not know that I need read further as to the detaching-hook, as it is much similar to those of other cages. Mr. Calow, in his letter, says:—

I have just now paid £50 for the Stamp-duty upon my patent; by doing so it has renewed it for a further term of four years. Some time since I wrote you, stating my position; that of my creditors being upon me. They have had a meeting, and it was agreed (be it to their credit) for me to renew the patent, and then wait a given time to see if it made anything. A person in Chesterfield is empowered to sell it, and is, he says, trying to form a company; but I have little faith in him, because if he succeeds I shall get very little, and the company might get the profit I have a reasonable right to. It has cost me upwards of £450 now, and has put me in an unenviable position with my creditors, besides keeping me in a continual fermentation wondering the result, because I am fast how to make the best of it in the meantime. If coalmasters would combine and purchase it, say for a mere £1 each, I am sure it would do them good and myself no harm, for as you know, sir, it has not been accomplished without a great deal of intense thought and trouble; and to me it appears a strange affair that there should be so much apathy on the part of coalmasters. Perhaps they don’t know it sufficiently. If you, sir, bring it before them at the meeting, they will then have little excuse. I doubt not but you will explain the principle upon which it is based, the motion being obtained by the difference in the speed of a body being let down by an engine and the same body gravitating; the difference being brought to bear on machinery at the time of falling, and then only, so that it is not constantly wearing itself out, but is always ready in case of accident. It will be seen from the
drawing that there is no connection between the rope and the apparatus, a feature which will be calculated to take the attention of those present.

He sends several testimonials, but I do not know that it is essential to read them. I will first call your attention to this diagram on the wall, which is the working plan of the cage as actually in use. Plate XV. represents the cage as at work, and plate XVI. represents the state of matters after the cage has been drawn up, the pulley and the rope disconnected, and the cage brought into play. After the occasion of one of the accidents, viz., on the 8th of April, 1864, a testimonial was given by our Mr. Watkin, the resident Mining Engineer:—

April 18th, 1864.

Dear Sir,—I have much pleasure in bearing testimony to your excellent safety-cage apparatus, for the prevention of accidents in shafts. It was well tested at Shildon Lodge Colliery, near Bishop Auckland, on the 8th instant. The brakesman neglected to take hold of the "hand gear" at the proper time, and the cage would have been drawn over the pulley, but for the "detaching hook" coming in contact with the ring, which at once separated the rope from the cage. The latter fell only ten inches, and was then stopped by your apparatus. Work was resumed thirty minutes after the accident took place. The guides were very little damaged.

Yours truly,

W. J. L. WATKIN.

Mr. J. T. Calow.

P.S.—The weight of the cage, tub and coals, was about one ton nineteen cwts.

I shall be very glad to show any of these testimonials to any gentleman in the room; but these are the principal points I have to bring before you, my object being (as I understand that Owen's and other safety-cages are much adopted in this neighbourhood) to bring other statistics before the institution, and have a discussion on the subject.

Mr. Higson asked whether it could be used with round wire-rope guides in a pit?

Mr. Marley—Perhaps not as well as to the others; although the patentee thinks he can contrive a plan for it. But I have not seen it in use with them. We have the ordinary wood slides and not wire-ropes.

Mr. Higson—In this county, or at least in the western part of it, there is a great desire to adopt wire-ropes in almost every case; and unless the safety apparatus can be used with these wire-ropes as guides it would not be employed.

Mr. Marley said, that of course this opened the question of the advisability of using round wire-rope at all; but he did not think the merit of such an invention as this should be judged, or the invention condemned, on such a ground as its suitability for use with these ropes.

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Mr. Best—I should like to know the greatest speed at which you can work the cage?
Mr. Marley replied that he could not exactly give the greatest speed at which it could be worked. The cage had been run with the view of testing and adjusting the weight. The weight had to be adjusted according to the speed at which the cage was expected to run; so that it was of sufficient weight to represent the maximum speed at which it could go until it became a falling body. But he could not give the exact speed at which it had been tried; he might say that the engine had been run at the greatest speed possible; with the view of adjusting the weight. He had not the figures by him.

Mr. Best—Do you think it is possible for the apparatus to come into play when the engine is travelling at the rate of from twenty-five to twenty-eight miles an hour, or more?

Mr. Marley—I think you can so adjust the weight as to meet any speed whatever. It has been proved by practice, that if, in descending you found you had not sufficient weight, and there was the slightest tendency to jumping or vibration, you could add the weight. You can adjust the weight to any speed short of positive falling.

Dr. Birkenhead said, he had paid some attention to the subject for some years past, as a letter which he had addressed to Mr. Nicholas Wood, and which was published in one of the volumes of the Institute's proceedings would show. It had been felt that the weak point about safety-cages generally was the spring. The springs were liable to get out of order. He had been much interested in hearing of a cage in which the motive power was not the spring; or, in which the spring was not brought into play till the rope broke. He asked, could Mr. Marley explain the actual mode in which the spring was brought into operation? He had wished very much, during the Exhibition of 1862, to examine the model of this apparatus which was exhibited there. For a day or two during the time he was there, Mr. Calow was present. One day, unfortunately, some person had been speaking of the safety-cage as being no better than others; and Mr. Calow was on that account not very well disposed to offer any explanation, being rather angry. The next day when he (the speaker) went again, the model was gone; so that he did not succeed in getting an explanation, and he was still unable to understand the mode in which the apparatus worked. The expression he wished to have explained, because it was used in the description of the apparatus, was "until it becomes a falling body." Mr. Marley said, the fact was that the bar, upon which the upright spring was resting until the cage attained a great speed, was a fulcrum or base upon which the spring rested. Its tendency was to leave the spring, and the weight was adjusted to keep the spring pressed upon that bar or base with sufficient tension to keep the arms from catching the slides. But as soon as the cage got to the speed belonging to a falling body, the base upon which the spring had rested was removed, so that it, i.e., the spring, rose. The moment the cage attained the speed of a falling body, the spring lifted the weight and brought the arms into play. This was the way in which it was done; but he confessed that, without a model, it was difficult to understand. He had passed Mr. Calow's model cage at the Exhibition on two days, very much in the same manner as Dr. Birkenhead; only that, having had a previous correspondence with Mr. Moody, who had adopted the cage at the West Staveley Colliery, and finding Mr. Calow there, he had the apparatus explained. It was very simple and easy to understand with a model, although it was difficult to understand it without a model. If they were to see the cage in action and descend in it, regulating the apparatus according to the speed, they would easily comprehend how it came into action. If they decreased the weight, it
would come into action at a less speed. If they increased the weight, the apparatus would not come into action until a greater speed was attained.

Mr. Mason said, if they took one trip at the rate of, say ten miles, and another at the rate of twenty miles, he supposed they would regulate the action for each rate of descent.

Mr. Marley—No; we regulate the weight at first at a point greater than the maximum speed of the engine. Although the apparatus had been tested and the springs measured, to see that they had been all right, the springs had not cost a halfpenny during the time it had been in use; and on the two occasions named, the one when the tub was empty, and the other when it was full, the apparatus had come into play the moment it was required.

Mr. Greenwell—I take it, that in practice speed is not so important as at first sight it appears; because when a man is going down, the speed is less than when the empty tubs go down. If the spring would break, it would be with the full tubs in coming up. I understand what you say about regulating the speed, but it is not of great practical importance.

Mr. Marley—But it is necessary to have the weights adjusted, in order that the apparatus may not come into play when it is not wanted; and it is necessary to have it made so as to meet any speed at which the engine would allow the cage to descend.

Mr. Greenwell said, he was looking at it as a question of the safety of life.

Mr. Bright had had the apparatus in use at 300 yards. It had never actually held the cage fast; but it had injured the guides very much. Consequently, they had been obliged to take it off. He believed Mr. Calow was still considering an improvement of it; and he had had a letter from that gentleman that morning, in which he had expressed himself very anxious to have further experience. He (Mr. Bright) thought that there was no doubt that this was the best principle. It had been spoken very highly of by Mr. Smyth and others, in the Exhibition.

Mr. Marley observed, that he had had a correspondence with Mr. Wright upon this subject. For the first three months or so, the apparatus no doubt required constantly watching and improving upon before it could be brought to its present state of perfection; but during the last year and a-half he had not had occasion to alter or touch it in any shape or form. The Jurors' Report, given at the Exhibition of 1862, was very interesting, and was to the following effect:

"A very ingenious method of releasing the clutches by a spring, which flies into action as soon only as the cage acquires the action of a falling body. The spring, instead of being held in tension as usual, by the means of the rope, is kept down by means of a weighted cap. If the rope breaks, the cage begins to fall, but the cap having the force of gravitation diminished by the upward pressure of the spring, allows the latter to expand, and thus to bring the clutches into action. Unless, therefore, the descent be very rapid, or in jerks, this modification appears little liable to catching when not required, a source of much inconvenience and danger."

The inventor has a system whereby he can overcome the result of rapid descent or "jerks," which has been practically tested at modern collieries where the average speed is about fifty feet per second.
Mr. Simpson asked, what they calculated as the velocity—sixteen feet per second?

Mr. Marley said, it was eighteen to twenty feet.

Mr. Simpson observed, that a body falling down the pit, would go sixteen feet during the first second.

Mr. Marley said, that from forty to forty-five seconds was the greatest speed at which coals were ever run. The weight was adapted to prevent the apparatus from coming into play at that speed.

Mr. Simpson meant to say that a body fell sixteen feet in the first second. If they had a greater velocity than that, the apparatus would not come into play suppose the rope was to break.

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Mr. Marley—Hence, of course, the distance the cage would have to fall before the apparatus would come into play would be very short.

Mr. Simpson thought, probably this could not be done until the velocity was equal to seventy feet.

Mr. Marley said, that in the first instance the full tub fell a greater distance than the empty one; in one case rather more than ten inches, and the other about two feet.

The Chairman—if I understand rightly, but I am not quite clear upon the point myself, for I am not quite sure whether Mr. Marley contemplates the cage breaking in the descent, but I think it is rather in the ascent that he thinks of its breaking, and in that case it will be for an instant in a state of repose after the breakage. If the cage is going up and the rope breaks, then the grip will be liable to catch before it attains the velocity that has been mentioned.

Mr. Simpson said, the speed of a falling body, after falling even ten inches, must be greater than had been spoken of.

Mr. Lancaster—Supposing the maximum speed to be fifty feet or forty feet per second, you would grip the conductor.

Mr. Marley said, the weight was upon the spring, so as to keep the catches from coming into action at the highest maximum speed.

Mr. Lancaster—Therefore, when it catches hold the cage must be travelling at more than the maximum speed?

Mr. Marley—Yes; but only for a small amount of time.

Mr. Lancaster—Therefore, you must have a power in the conductor to resist that velocity, which would be very considerable?

Mr. Marley—Yes; if it is for any distance. In the cases we have had in breaking and disengaging when we did not want it, there was not a shilling's worth of damage done to the skeats, which continued workable afterwards.
Mr. Lancaster—But the mechanical resistance of a falling body of thirty feet per second would take very powerful conductors to resist the action.

Mr. Marley—Yes; if it had fallen for any distance. I believe the conductors are either five or six inches in breadth.

Mr. Dickinson—These little matters are very important. It is in little matters of this kind that the practical utility of the invention really consists. Mr. Marley has described how these safety-cages originated, and how the progress of invention has gone on until the present one came into existence. What I find in practice is, that the point which fails when any safety apparatus should act, is that frequently the guides are too weak to sustain the weight. With regard to Owen's apparatus, it is a simple piece of mechanism; as simple as it is possible to get for such a purpose. It only acts when the rope breaks, the only time when it is wanted; and it runs at all speeds, up to the rate of twenty-five miles an hour; about as quick as a railway train, and at this high velocity it does not come into operation. It does not act till the cage becomes a falling body, and has accumulated a considerable velocity. The fact that Calow's apparatus, which is now brought forward, does not come regularly into operation, has been spoken of as showing that it is, therefore, not wearing itself out. But this is one of the best points of Owen's apparatus, that it comes into operation every time the cage rests on the bottom or the top of the shaft, which keeps it in working order.

Mr. Greenwell said, there was that point. Also, he maintained that the cage would not obtain the high velocity which had been mentioned in falling a distance of ten inches. The spring must come into operation from some other cause than the velocity. The velocity had not been attained in the instance which had been described when the catch operated, for the catch operated at the time when the cage had only fallen ten inches.

Dr. Birkenhead said, his first impression, on hearing that the safety-cage was to be brought into operation by the action of a weight, was that it was quite evident that, when the body fell, the cage and the weight were equally falling bodies, and the weight could not exert any power on any part of the cage as a weight, unless the cage itself were retained by friction, such as the friction on the guides; but as long as the cage was free, any weight attached to it could not have any force in bringing any part of the mechanism into operation.

Mr. Marley replied, that the weight itself did not bring the guides into operation; it was the spring that brought the arms into operation. He might call attention to this remark in the Jurors' Report:—

"The spring, instead of being held in tension as usual by the means of the rope, is kept down by means of a weight cap. If the rope breaks, the cage begins to fall; but the cap, having the force of gravitation diminished by the upward pressure of the spring, allows the latter to expand, and thus to bring the clutches into action."

It was the spring (Mr. Marley continued) that brought the clutches into action, and the weight prevented their coming into action.
Dr. Birkenhead asked, whether any experiment had been tried to show how the apparatus would act when the cage was in the middle of its course, and to ascertain whether, under those circumstances, it would act?

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Mr. Marley—Yes; I knew of one case where it came into play from not having been sufficiently weighted when going down; but I cannot speak of any instance of the rope breaking. However, this was a case in which the cage was going down at a greater speed than had been calculated for.

Dr. Birkenhead thought it would be advantageous to have such an experiment tried. On the general question, he thought it must be allowed that the object of those who had safety-cages in charge should be to adapt them to wire-ropes. There were very few, so far as he was aware, now in operation that were adapted to wire-ropes; and he was not aware whether Owen's apparatus was. It must be known, however, to all present, that wire-ropes were now employed very much; and it was desirable that the safety-cages at present in existence should be so modified as to be suitable to be used with them, or that some other form should be devised. Of all the cages with which he was acquainted, he thought Fourdrinier's arrangement was as suitable as any for this purpose.

Mr. Gilmore could confirm what Mr. Marley had said as to the catches coming into operation. He had known an instance in which Fourdrinier's cage was going down at a great speed, and the catches came into play and did great damage in the pit.

The Chairman—Was that a double or a single rope shaft?

Mr. Gilmore—Double.

The Chairman—Which was the rope?

Mr. Gilmore—The descending rope.

Mr. Lancaster said, he had had a similar case in a single shaft on Fourdrinier's patent. It failed in catching hold where the velocity was rather greater, or there was some little impediment.

Mr. Gilmore—that was the case with us.

Mr. Bassett asked, what provision Mr. Marley made in the case of a great quantity of rope falling down; whether there was provision in the shape of a bonnet to protect the men?

Mr. Marley said, yes, but whether they had a safety cage or not, in any circumstances, if the rope broke, they would have that difficulty to contend with. When this question should come up for discussion at Newcastle, if he could contrive to do so, he would bring one of the cages, or the top of one, either to Newcastle or to some suitable place where any gentleman could have the matter tested and see it in operation.

Mr. Matthews wished to know whether Mr. Marley thought that where rails were used, this apparatus would suit?
Mr. Marley thought it would, but it would have to depend more upon the question of friction, and as they had last adopted them it would be more on the principle of a wedge.

Mr. Matthews—You think it would grip?

Mr. Marley—Yes.

Mr. Knowles said, that as to the question of applying the apparatus to round iron rope, he might say that Owen's had been applied to round iron conductors. They had iron conductors in the Pendleton Colliery, and they had the points of the catches sharpened, but had not had the necessity to try it.

Mr. Marley said, the patent safety cage would catch equally on a round wire rope or on wooden guides.

The Chairman had no doubt that these different descriptions of safety apparatus might be applied either to wooden slides, or to round iron ropes, but at one conclusion he thought they might all arrive. It was very important to have their slides made of sufficient strength to carry any extraordinary shock that might arise from the breaking of the cages. One point was not so clear. Mr. Dickinson argued that Owen's apparatus was of great value because it was always in use. On the other hand Mr. Marley argued that Calow's invention was of advantage because it was never in use, and that, therefore, it was not liable to get out of order. He did not think that if they were to discuss that question for another day they would be likely to agree. The responsibility of settling that question must rest with those who had the question in hand. Unless any other observations were to be made, he proposed the usual vote of thanks to Mr. Marley for his kindness, and the paper which he had contributed would be appended to the proceedings of the day.

Mr. Marley observed that there was one point to which he wished to allude in reply to Mr. Dickinson. That gentleman had asked upon what he (Mr. Marley) had based his reasons for differing with him. First, he had been led to differ with him because he considered that in connection with Fourdriner's apparatus the constant coming into play at the top and bottom of the shaft caused the wedges to get out of order, and repairs would be required almost once a week. The same thing had occurred to him with respect to Aytoun's. He had experimented on that, and he had witnessed it in the presence of Mr. Aytoun himself with his cage in the Exhibition, and he thought still the great objection was that that apparatus was very likely to get out of order from constant wear and tear every time the cage came to the top or the bottom. With

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respect to that, of course, a great deal better than the theory was the practice as to Owen's. One object of his paper would be lost unless it should induce Mr. Dickinson, or some other gentleman who was in a position to do it, to give statistics as to how long these different apparatuses had been actually in use. It was not his object to uphold Calow's as the best invention that had been produced, but it was, in his opinion, the best he had seen. His object was that they might fully discuss the matter, and have information upon all sides of the question, and so be able to get at the best apparatus that they could possibly obtain.
The meeting then closed.

ADDITIONAL NOTES ON SAFETY-CAGES.

By JOHN MARLEY.

Since reading the paper at the Manchester meeting in July last, I have frequently had the springs examined in the cages at Shildon Lodge Colliery, as also at the Upsal Pit of the Eston Ironstone Mines, in Cleveland, the result being always satisfactory; but in order to meet the objections and wishes of some as to not being tested or brought into play every time of coming to bank, I have put on the plans, (Plates XV. and XVI.) the index plates and levers, coloured red, so that one can at any time lift the weight by hand, and so test the spring by the index; or if that be not sufficient, the lever can be made to come into contact with some fixture at bank, and so be tested every time the cage comes to bank, although I would not adopt such mode myself, preferring the special examinations. Mr. Calow has suggested other modes of indexing, but I like the arrangement shown by the drawings the best. Plate XVIII. represents the cage in its working position, and with the apparatus at rest. Plate XVI. represents it with hook detached, and the apparatus brought into action. The index-plate A is fixed in front of the grip, and the finger or pointer B is fastened on to the shaft, with the grip at C, and therefore travels in the same direction. The numbers on the index-plate correspond with the distension of the spring in inches when released from the weight D. The length of the spring, without any compression, is fourteen inches, and when compressed with the weight D is seven inches. Hence, for safe working, the cage-shoe ought always to be kept in good repair. The first tooth in the grip is fixed at such a distance from the skeat, as that, when the finger is at 4 on the index-plate, the apparatus

is brought into action, but in order to test the elasticity of the spring, the finger ought always, when released from the weight D, by means of the handle or lever E, to travel to No. 5 on the index-plate. Next, to meet the requirements for a round wire-rope, Mr. Calow suggests the plan shown in Plates XVIII., XIX., and XX., which he thus describes, as also comments on the indicator: — "The use of the indicator, as shown in figures 1 and 2 on the plan, is to remove an objection which has been raised to the present system of applying my apparatus, as it does not show when in or out of working order, which can only be known by examination. In my final specification, I made provision for the introduction of an index-plate if found necessary; and although the old adaptation has not been known to fail when required to act, yet there are parties who require a 'something' to indicate the constant condition of the apparatus."

Plates XVIII., XIX., and XX. show a form of grip applicable to iron guides. These grips are secured together at their centres at D, same as a pair of scissors, and a slot being cut at the ends EE, allows them to open or shut as occasion requires. In the drawing, they are represented as supporting the cage on the rope or wire-guide, by means of strong studs well secured in the levers, as shown at FFFF. These studs are made a little hollow on their surfaces to fit the guide.

Upon looking at the position of the levers, the cage rests upon the extreme ends of the levers at EE; therefore, the point or place of bearing being considerably below the studs or grips FFFF, the cage
cannot fall; but so soon as the cage is elevated, the grips fall and release their hold of the slide. The action of the spring is shown, and all it has to do is to suspend the centres D in case of accident, when the cage, through being fast to the levers at EE, takes the ends of the levers down with it at the time of gravitating, and at once applies the grips.

Vol. XV. Plate XVIII.


Vol. XV. Plan XX.


NORTH OF ENGLAND INSTITUTE OF MINING ENGINEERS.

GENERAL MEETING, SATURDAY, APRIL 7, 1866, IN THE ROOMS OF THE INSTITUTE, WESTGATE STREET, NEWCASTLE-UPON-TYNE.

C. BERKLEY, Esq., in the Chair, in the unavoidable absence of the President.

Mr. Doubleday read the minutes, after which, Mr. Dacres, Seaham Colliery, and Mr. Clarke, Shotton Colliery, were elected members of the Institute.

In the absence of Mr. Dickinson, the discussion upon his paper, which stood first on the list, was postponed.

DIRECT-ACTING, PUMPING, AND WINDING ENGINES.

Prior to the discussion of Mr. Knowles' paper, Mr. Lishman, of Etherley, read a paper, being a short description of a pumping engine in use at Lyon's Pit, Newton Cap Colliery.

Mr. Steavenson said, that, according to the calculation, a ton of coals would raise two millions of gallons, or twenty millions of pounds a foot high.

Mr. I. L. Bell said, that the Cornish boiler would raise fifty millions of pounds a foot high with a bushel of coals of 112 lbs. So that they were raising here—if Mr. Steavenson's figures were right—half the quantity with something like twenty times the coals.

The Chairman—Is there not something else besides the ton of coals to be taken into account? The machinery is more costly in the first instance; and that may cause a great deal more expense.

Mr. Lishman—I have taken the coal there at its commercial value.

Mr. Steavenson—The writer of the paper is entirely astray. What Mr. Knowles wishes to consider is—What is the economy of power
applied in the engine—not what is the quantity of coals used? On the form adopted you have to consider the class of boiler and whether there is any patent apparatus employed. Then there is the question of the engines, whether they are direct-acting or not? You will find in the table given that one is doing fifty per cent. more work than the others; and you will find some, perhaps, that are not direct-acting engines working better than those that are direct.

Mr. Lishman—This table is given to show that the work might be done cheaper by direct-action.

Mr. Steavenson—If you measure the number of gallons lifted, and then take a diagram, you will see how the machinery is acting independent of the boiler. I have done so, and I have found that sixty per cent. is as much as we can get of the power applied. I would suggest that a few members of the Institute should go into it in this way, and ascertain what are the actual conclusions with direct-acting engines as compared with other engines.

Mr. Willis—Looking at the proportion of power got at by the best mode of engine, you would not omit the question of cost.

Mr. Lishman—I have no objection to appending to this the details. This was taken over three months.

Mr. Steavenson—Of course we have a great number of valuable data given, but the actual matter we have not got.

Mr. Newall—There should be two diagrams; the first showing what the engine does itself; and then there should be a diagram giving the working with the pumps attached.

Mr. Steavenson—By measuring the actual water lifted you would arrive at the result.

Mr. Lishman—Do you mean by measuring the diameter of the pump?

Mr. Steavenson—Measuring by fifty-gallon buckets, or any other measure.

Mr. Bell—that ought to be over a considerable period of time. I do not know any more fallacious mode than by going at intervals—unless you have considerable intervals, and go once in half hours to see what the engine is doing.

The Chairman—Mr. Knowles has given the number of strokes for twenty years.

Mr. Bell—The question is whether the stroke gives solid water or not. I know we have gone into the quantity of water we are using at the Clarence Works by multiplying the number of strokes by the volume of each, and it gives a result so totally different from the quantity of water which we can possibly use, that I am sure you cannot by these indications arrive at the real quantity of water pumped.

Mr. Morrison—The consumption of blast furnaces is very variable.
Mr. Bell—With regard to economy, take any kind of pumping machinery employed in a mine, the interest on the first cost is so very small compared to the yearly expense of carrying it on. We have been too much guided by first cost instead of yearly expense. Coal, unfortunately, was so cheap that the last thing we thought of was any economy in its use.

The Chairman—There is a great difference between the wear and tear of different classes of engines.

Mr. Bell—Cheap engines are the dearest, because they entail a greater annual expense than those of a better and dearer description.

The Chairman—Perhaps one engine uses more coal and has less wear and tear.

Mr. Bell—The general rule is contrary. The more coal you use the greater is the wear and tear, you require more boiler room; and where there is imperfect machinery the wear and tear is far greater.

Mr. Newall—The more boiler room you have the cheaper you do your work. You are obliged to keep it at a high temperature. If taken care of, as in Cornwall, you have a different result. Your engine is the boiler. The cylinder is the means of measuring its power.

Mr. Bell—As a rule the engines in this neighbourhood are under-boilered; but yet in consequence of imperfect construction the engines are not capable of doing their work unless provided with an unusual boiler capacity which is of course a source of expense.

Mr. Morrison—No doubt the oftener you open the doors you lose power by cooling; and when you have inferior coals you have to open them oftener than you do with good coals.

Mr. Lishman—The coals mentioned there are good coals.

Mr. Morrison—There is enormous waste on account of open doors. It is much better if you coal through the teaze-holes as in puddling furnaces.

Mr. Bell—in every case with the puddler the teaze-holes have to be opened.

Mr. Morrison—Yes, but the man goes immediately and closes it up.

Mr. Steavenson—I wish to press the proposition that diagrams should be taken by different members. The arrangements, I believe, are of all descriptions in this neighbourhood.

The Chairman—I do not believe you have any of the Cornish engines.

Mr. Bell—You have the Cornish duty every month; in fact; every week.

Mr. Morrison—It is remarkable if the Cornish system is so efficient why the other districts do not imitate them.

Mr. Bell—I would like to ask whether any member of the Institute has ever set himself seriously to work to make a calculation—taking the first cost and diminished annual expenditure—in comparison with cheap engines and increased annual expenditure.
The Chairman—I do not think any one has done so.

Mr. Lishman—We have an idea of introducing Bastier’s Chain Pump at Newton Cap Colliery. We are trying to make up our minds to introduce it instead of the engine and pumps I have described.

Mr. T. Greener—I have offered the owners of Newton Cap Colliery to pump all their water for four years with Bastier’s Patent Chain Pump, and at the end of that time to let them have the pumps at a fixed price. I am connected with Messrs. Jackson and Co., engineers, London. Mr. J. W. Hackworth and I have given our attention to this mode of pumping for the past nine years.

Mr. Bell—What is the duty got by this kind of pump?

Mr. Greener—It has been used in Devonshire. During six months it was used in Wheal Concord Mine, with a five-inch tube lifting about 320 gallons per minute, with an engine of twenty-five horse power. I have not the particulars of the coal used. The depth was fifty-five fathoms. I can give the particulars of one proposed to work at eighty fathoms. It will be a seven-inch pipe, to lift 800 gallons per minute. The first cost, including engine and pumps, £2,500; and to use five tons per day of coals.

Mr. Bell—Why did you not bring the figures of those at work?

Mr. Greener—There is only one working; it is at Bromley-by-Bow; depth, thirty fathoms. The engine is driving a great deal of other machinery, and we cannot separate it. I now understand what is required, and against another discussion I shall be provided with particulars which I have not to-day.

Mr. Bell—What are the results relative to the wear and tear?

Mr. Greener—The pump at Bow has been working two years, and has not cost a farthing for repairs. As to the waste of water there can be none. Going at from 400 to 500 feet per minute, there is not time for any to escape. The bottom of the tube is contracted. They are made of malleable iron, with glass enamel inside and outside.

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Mr. Newall—What space is there between the disc and the side of the tube?

Mr. Greener—None. They fit exactly. It is an endless chain, and the chain fits on the top of the pulley. The discs are made of India rubber. There are three or four ply of India rubber; one narrower than another, leaving a little edge; an iron plate is keyed on each side of the India rubber.

Mr. Bell—All inequalities in the dimensions of the pipe are compensated for by the dimensions of the India rubber?

Mr. Greener—Just so.

Mr. Willis—At certain distances, ten or twenty feet, there are contractions?

Mr. Greener—Fifty yards.

Mr. Willis—If there was a contraction every twenty-four or thirty feet, each contraction, when the disc came to it, would be a force pump of itself. The advantage of having the contractions a less
distance than fifty feet apart would be, that their discs, in addition to simply lifting, would also, to use a convenient term, suck the water immediately below it.

Mr. Newall—Unless the discs fit the tube the whole way, there must be a leakage of water. In case you make these intervals fifty yards, there must be an enormous waste of water, unless your discs fit the whole length.

Mr. Greener—In practice it is not so.

Mr. Bell—I understand you fit the tube from top to bottom?

Mr. Greener—There is a difference between having a suction power and just fitting. The length of the contraction is ten feet.

Mr. L. Wood—The discs act as a bucket in the pump.

Mr. Bell—Then it is not that they fit in the pipe?

Mr. Greener—They do fit; and there is also the principle of momentum; it is felt when running a high uniform rate.

Mr. L. Wood—It is just the same as a bucket when going through the contraction. It sucks the water in behind it. The discs travel at the same rate as the water when in the pipe.

Mr. Greener—For very great depths this is what would be done. We have never lifted very great depths. For the lift of fifty fathoms we have only ten feet contraction at the bottom, and ten feet contraction in the middle; all the rest is lifted freely. At Bromley, where the lift is thirty fathoms, we have only a contraction of ten feet at the bottom.

Mr. Bell—You would only have a loss of water while the distance is run between one disc and the other. If you had more contractions that loss would be diminished.

The Chairman—You have always three discs continually in the contracted part of the pipe. The only advantage of making them fifty yards apart is, that you take off the weight of a column of water from one particular disc. The top disc has a fifty-yard column of water to carry.

Mr. Willis—Assisted by the bottom disc.

Mr. Greener—At the speed we run there is a reduction in the pressure of the water on the side of the pipes, and so the water sticks to the chain on its passage upwards.

Mr. Bell—Why not follow the example of Mr. Knowles, and write a paper upon it?

Mr. Morrison—It is hardly applicable to this country if you only pump fifty fathoms.

Mr. Greener—It would pump 200 fathoms.

Mr. Bell—I think a useful paper might be written on the subject. We know very little about Bastier's pump.
Mr. Greener—I shall be glad to prepare a paper, and to exhibit models.

Mr. Newall—You should bring a full-sized disc, a piece of chain, and a specimen of the pipe.

The Chairman—If you could bring the economic state of action of the pump it would be of use; the quantity and price of the coal used.

Mr. Greener—A gentleman in Derbyshire said he wished he had seen this before he had expended £10,000 in putting in Cornish engines and pumps.

Mr. Steavenson—It would be well to let Bastier’s pump alone until we have Mr. Greener’s paper, or else, I think, the principle is wrong. You ought to have fewer points of application. If you put in a single plunge, the per centage lost would be much less than at these discs—each disc being a plunger.

Mr. Greener—Allow me to make one reply. Mr. Steavenson forgets this—the immense amount of foreign matter daily tossed about by the present mode of pumping. If you take a seven-inch pipe, you have only one ton eleven cwt.s in the pipe of thirty-five fathoms; while in an eighteen-inch pump of the same length, you have ten tons six cwt.s. You also get the advantage of the water not pressing so much on the sides of the pipe. This is a great saving of power.

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Mr. Steavenson—But in the one case you may have twenty pumps of fifty feet apart, and in the other you have one pump lifting the whole length.

Mr. Newall—There is a point in Mr. Knowles paper which I wish to refer to. I mean as to the size of the pulleys he uses. At page twenty-four he describes the drawing of water out of his pits by wire ropes, and says:—"It is found that the wire-ropes are much worn with running upon iron," and he uses a lining of wood to get over the difficulty. Now the wear of the rope can only arise from its sliding on the pulley, which is fifteen feet in diameter. This is too large; for when going at a great speed it acts like a fly-wheel, and the rope is made a brake to stop it. The consequence is, that the rope is most worn at the stopping and starting points. When we first introduced wire ropes into use, we found the same complaint attached to hemp ropes. On examining into the cause of it, I found that the pulleys, though of small diameter, being of cast-iron, were very heavy, and moved after the rope stood still. I, therefore, in order to get rid of the weight of cast iron, introduced the light pulleys, with malleable iron arms, which are now so much used. Mr. Knowles has gone to the opposite extreme, and made his pulleys too large and heavy. If they had been ten feet diameter, this slipping would not have occurred.

Mr. Bell—That is a self-evident proposition. You get a great momentum in the pulley when it is so large; whereas, if the pulley was made very light, it could easily be stopped by the friction of the rope.

Mr. Newall—More damage is done by velocity after you get beyond a certain size. To have fifteen or eighteen feet pulleys, I think is a mistake. If you mark the pulley and the rope with a piece of chalk, you find, after a certain time, they do not come to the same point.

Mr. Willis—They often surge.
At this stage, at the suggestion of the Chairman, it was agreed that the discussion should be allowed to stand over until Mr. Greener's paper was before the Institute, or any other paper on the subject.

COAL WASHING AT INCE HALL COLLIERY.

The next subject for discussion was Mr. Gilroy's paper on the Coal-Washing Apparatus at Ince Hall Colliery. A letter was read from Mr. Gilroy, apologising for his absence.

The Chairman described the process. He said the coal was put into a long box, and a runner of water goes with it. There were certain traps at different points that catch the heavier stones and so forth, and the finer coal goes on. It is the same as we have seen. At different points there are different qualities of coal deposited.

Mr. Morrison—At different points of the sluices.

The Chairman—I saw the same principle practised in Bohemia. The water pumped out of the pit was allowed to run into wooden spouts; fifteen or twenty men and women were employed to shovel the small coal into these spouts and keep it in a state of agitation for a time. The water was then turned off, the top or lighter part of the coal was taken as good, the lower part of the deposit being slack or inferior; both were used for making coke.

Mr. Morrison—We have a coal-washing machine doing the work at a penny farthing per ton.

Mr. [blank space – name missing] Mr. Gilroy's gives one-third of a penny. I think there will be a great difference in the telling of it. You will have to have a special engine to lift the coal and the water; though it must be cheap when it is at work.

The Chairman (to Mr. Morrison)—Yours does not include wear and tear?

Mr. Morrison—No.

The Chairman—Mr. Gilroy's does.

Mr. Douglas—Is it a similar plan?

Mr. Morrison—No.

Mr. Douglas—I saw Mr. Gilroy's apparatus at work on one occasion. Mr. Gilroy was not present, but I happened to see two or three trucks into which the coal had been discharged, and I was surprised to see a large quantity of stony matter in the trucks, to which I drew the attention of the man in charge. He said it was owing to the large quantity of water passing, or from some carelessness on the part of the person in charge, whose attention seemed a necessity for the proper cleaning of the coal.

Mr. Morrison—The advantage or otherwise of any system of coal-washing depends on the economy of labour, and whether there is a waste of coal by the stream of water going over it. You want a method that will wash the dirt cleanest out and lose the least coal.
The Chairman—It is a fact Mr. Morrison can speak to. Machines, either on the principle of Mr. Gilroy's or any other, if put to do more work than they are fitted for, will allow the stones to go through.

Mr. Morrison—Yes; without great care.

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Mr. Steavenson—You should also be as little as possible at the mercy of the man in whose charge they are.

Mr. Morrison—We do 400 tons a day, and one man works regularly in one field.

Mr. Douglas—The like difficulty I mention might occur in the want of attention at the machine you use?

Mr. Morrison—It does not depend so much on the supervision of the man in charge. If it does not raise the sluices, it will go into the waggon.

Mr. Douglas—The larger the quantity of water that is going, the more likely it will be to carry a quantity of foreign matter.

Mr. Morrison—When there is little water, it washes dirt and all away, if not impeded by a given quantity of coal.

The Chairman—You might give us some particulars in a paper.

Mr. Morrison—When I hear what Mr. Gilroy has to say about it.

The Chairman—Coal-washing machines are coming more and more into requisition every year.

Mr. Morrison—Coke is becoming more valuable, and you cannot make good coke without separating the dirt from the coal.

The discussion was then adjourned. The discussion on Mr. T. Y. Hall's paper, on "The Progress of Coal Mining in China," was also adjourned; and the meeting shortly after separated.

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DESCRIPTION OF PUMPING ENGINES IN USE AT LYONS PIT, NEWTON CAP COLLIERY.

By WILLIAM LISHMAN.

There are two engines, with cylinders of the diameter of 28 inches and 26 inches respectively; one engine is in the engine-house, and is an ordinary four-double mitred-valved engine, with the ordinary hand-gear used in such engines. The beam is overhead, and, by means of a connecting rod, is attached to the fly-wheel shaft, at the same level as the bed-plate of the cylinder. This fly-wheel shaft is carried through the engine house wall, and, by means of an outside crank and connecting
rod, is attached to a large pumping beam which hangs over the back shaft. This, of course, causes loss of power; to restore which, another upright cylinder is placed within two feet and beneath the other end of this large beam, and is fitted with an ordinary slide valve, which is worked by an eccentric sheave and rod from the fly-wheel shaft of the in-door engine. The piston-rod is applied directly to the beam, to assist in raising it and the column.

There are two sixteen-inch sets of pumps, with five-feet and seven-feet strokes respectively, pumping between them eighty gallons per stroke, the speed being seven-and-a-half strokes per minute = 600 gallons per minute.

**DUTY OF THE ENGINES.**

600 gallons per minute = 25,920,000 gallons per month.

225 tons of coals are consumed per month.

Now, 25,920,000 [divided by] 225 = 110,000 gallons, lifted seventy yards high (which is the height of lift) by one ton of coals.

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**SUMMARY OF COST OF PUMPING WATER AT LYONS PIT, NEWTON CAP COLLIERY, FOR THREE MONTHS.**

<table>
<thead>
<tr>
<th>Stores</th>
<th>£16 7 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Six Buckets, changed</td>
<td>3 0 0</td>
</tr>
<tr>
<td>Wages</td>
<td>64 18 0</td>
</tr>
<tr>
<td>Coals—675 tons, at 4s. per ton</td>
<td>135 0 0</td>
</tr>
<tr>
<td>Leading Coals</td>
<td>45 0 0</td>
</tr>
</tbody>
</table>

\[ \frac{3}{264} = \frac{5}{3} \]

\[ £88 1 9 \]

**DETAILED ACCOUNT OF MATERIALS USED, AND WAGES PAID, AND COALS CONSUMED, IN PUMPING 25,920,000 GALLONS OF WATER PER MONTH, AT LYONS PIT, NEWTON CAP COLLIERY.**

| Oil | £5 8 9 |
| Tallow | 2 13 1 |
| Patent rings | 0 9 0 |
| Cotton waste | 0 4 10 |
| Lamp cotton | 0 2 8 |
Leather............................ 0 11 3
Gutta percha................................................ 4 10 6
Canvas packing......................................... 1 5 0
India rubber............................................. 0 2 6
White lead.............................................. 0 1 6
Spun yarn ................................................. 0 15 4
Sundries................................................... 0 2 10

£16 7 3

Six buckets, changed in three months,

costing as follows each, viz.:—

Six men, two hours............................... 0 4 0
Three horses, two hours...................... 0 3 6
Sundries.................................................. 0 2 6

0 10 0

= £3 for three months, or six buckets........ 3 0 0

Wages as follows, per fortnight:—

Two enginemen................................. 5 6 4
Two firemen........................................ 4 4 0
Two houses......................................... 0 16 0
Grathing............................................ 0 10 0

10 16 4

= £64 18s. for three months............... 64 18 0

675 tons of coals, at 4s. per ton............. 135 0 0
675 tons of coals, leading at Is. per load of 15 cwts. 45 0 0

For three months............................. £264 5 3

= For one month...................................... £88 1 9
DETAILED DESCRIPTION OF LYONS PIT PUMPING ENGINE, NEWTON CAP COLLIERY, 1866.

Diameter of cylinder inside, 26 inches.
Diameter of cylinder outside, 28 inches.
Diameter of fly-wheel, 18 feet.
Length of pumping beam, 32 feet. A pit at each end.
28 lbs. per square inch high pressure.
5 feet stroke inside piston.
7 feet stroke outside piston.
7½ strokes per minute.
Diameter of pumps, 17” and 16”.
Working barrels, 16”.
Length of pump trees, 70 yards.

Boilers—
1—34 feet + 6 feet.
2—32 feet + 6 feet.
1—32 feet + 5½ feet.
36 gallons of water per minute used for boilers.
7½ strokes per minute.
80 gallons per stroke, capable of going 10 strokes per minute.

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NORTH OF ENGLAND INSTITUTE OF MINING ENGINEERS.

GENERAL MEETING, THURSDAY, MAY 3, 1866, IN THE ROOMS OF THE INSTITUTE, WESTGATE STREET, NEWCASTLE-UPON-TYNE.

T. E. FORSTER, Esq., President of the Institute, in the Chair.
Mr. Doubleday having read the minutes of the Council, the following elections took place:—Sir William Armstrong was elected a member; Mr. C. N. Coates, of Skelton Mines, and Mr. Benjamin Dodd, of Seaton Delaval, were elected graduates.

BASTIER'S PATENT CHAIN PUMP.

Mr. Greener then read a paper "On the Improved Method of Raising Water Economically from Mines, by Bastier's Patent Chain Pump," which was illustrated by a working model.

The President—Would the pump go from top to bottom in a pit of 100 fathoms?

Mr. Greener—Yes; contracting the tube at every fifty yards. But as a matter of prudence, it would be as well if there was a possibility of dividing it into two lifts when the depth is very great.

The President—But there would be no difficulty in having a hundred fathom pipe?

Mr. Greener—None at all. We have tendered for 120 fathoms, and I would undertake to do it.

Mr. Greenwell—There is one question I wish to ask. They seem to be very powerful engines. You mention 300-horse power engines to

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lift a thousand gallons per minute. But they would do that with the common pump.

Mr. Greener—You must make a reduction for nominal horse power. These are indicated horse power. It is exactly what we tendered, and the engineers I am connected with in London are very cautious. They quoted more, I believe, than are necessary for working the pump.

Mr. Knowles—The best way would be to test the exact quantity of coal used. With regard to experiments, to be quite certain it will answer, I would ask whether it has been used in sinking a pit?

Mr. Greener—We think they can be used in sinking. These chains can be added every three feet three inches.

Mr. Knowles—How would you be able to get the water up to the first bucket? The disc has to be in the water, and the depth of the pit is altering every one or two hours.

Mr. Greener—These pipes are so light that they can be swung in the shaft, and they could be lowered as required.

Mr. Greenwell—What depth of water do you allow?

Mr. Greener—A foot or six inches covering the bottom of the pipe will do.

Mr. Greenwell—A man could not work in the water.

Mr. Greener—You might always have it low enough by keeping a good sump.

Mr. Knowles—You would have to make a hole in it; whereas, in the ordinary mode of sinking a pit, you can get the pump down to the lowest place that has to be kept dry.
The President—It is seldom that there is no water at the bottom of a sinking pit. The return stroke sends it back a couple of feet, so that the sinkers are always working in the water. The great point is to get the sump kept down.

Mr. Greener—Mechanical engineers seem to see their way to use it in sinking a pit, by the ease with which they can move about these pipes.

Mr. Lishman—They would be liable to damage.

The President—Cast iron pipes would bear a blow better than these do.

Mr. Greener—They can have always an extra strong one at the bottom. A blow on the discs would not hurt them.

The President—You might have brattice in to protect them. It requires little room, and would not be expensive.

Mr. Greenwell—This is all in favour of what Mr. Greener says.

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You raise a thousand gallons, of 33,000 lbs., one foot high per minute, with engines of 220-horse power. The engines have nothing to do but lift the water whichever way they can do it. I merely ask the question, how is it you take so high a power as 300-horse, whereas, a 220-horse engine would do the same.

Mr. Greener—Ours is not more than 200, the way you are calculating.

The President—Allowing for friction, you think it would not be more than 200.

Mr. Greener—We calculate that would be strong enough.

Mr. Greenwell—Fifty-five fathoms is the deepest you have worked.

Mr. Berkley—What is the sheave at the top?

Mr. Greener—About twelve or thirteen feet in circumference.

Mr. Berkley—A wheel four feet diameter at the bottom would be awkward, and likely to be broken.

Mr. Greener—The lower wheel is simply a small roller for the disc and chain to pass against.

The President—The roller is at the bottom, and the chain will go underneath it.

Mr. Greener—It seldom touches it.

Mr. Steavenson—You said you had ninety per cent, effective power in one pump.

Mr. Greener—Yes; several engineers carefully tested it, and it was quite clear that the pump utilised ninety per cent, of the power employed upon it. Since the last meeting, I have done all I could to obtain a separate account of the coal used at Bow; but they could not separate the pump from the other machinery.
Mr. Knowles—Do the chains wear, going through the water?

Mr. Greener—I have taken a great many people to look at the pump at Bow. The chain is as good as new. It seems rather oiled than anything else. It is quite greasy to the touch.

The President—There will not be much difficulty about this, if the water is good. If it is an old working, with a great many pyrites to pass over, it will be very bad.

Mr. Berkley—Like the water at Wingate Grange.

Mr. Knowles—I was thinking of the wearing of the chain with the water upon it.

Mr. Greener—There is nothing of wear about the chain that we have had in use two years. There is a little brightness on some of the links that do not fit well. But this is not so perfectly made as the chains we can get now.

Mr. Steavenson—If the chain broke at the top, all would go to the bottom.

Mr. Greener—At Tavistock there was an accident of that kind; but by grappling, they got it with little trouble. That in the pipe was so near the end that they could get hold of the last link with a grapnel.

The President—If the chain went down and got upon the men's heads, that would be against employing it in sinking a pit.

Mr. Knowles—What was the depth of water in the pit?

Mr. Greener—It was nearly full.

Mr. Knowles—Was the roller fastened to the bottom of the pipes?

Mr. Greener—Yes; between two pieces of wood. We just dropped it down ready for work. We can put twenty or thirty feet length of pipe on at once. We take two or three lengths, fasten them, and let them down. We fasten them at the top, just as it is lowered down.

Mr. Knowles—I think in sinking a pit they would have to lower the pipe from the top; they could not get at the bottom.

Mr. Steavenson—If the chain broke, it would require a great many hours to set her agoing again.

Mr. Greener—I can only say what has been done. Unfortunately, at Tavistock, they broke their chain. Still it is a useful fact to know that they could fish it up in two hours, though it was in upwards of forty fathoms of water.

Mr. Steavenson—if after the accident you had to join the links of the chain, it would be an awkward thing to get the chain up from a hundred fathoms depth.

Mr. Greener—I do not see the difficulty.
Mr. Steavenson—If a hundred fathoms of chain was lying at the bottom, you would have to put something down to fasten the chain, and draw it up.

The President—It would be in the shaft clear of the pumps.

Mr. Steavenson—If you did not catch hold at the end of the chain, you might have two discs coming together, suppose it had gone to the bottom?

Mr. Greener—It could not all get out.

Mr. Steavenson—Unless the pumps are at the bottom, all would go clean through.

Mr. Greenwell—When do you expect it will work on a large scale?

Mr. Greener—Unfortunately every one is waiting till everybody else tries it.

Mr. Greenwell—I thought they were trying it at Newton Cap?

Mr. Greener—They are, I think, waiting until you gentlemen say whether it is a useful experiment. I offered, on behalf of Messrs. Jackson and Co., in London, to work the patent for four years at Newton Cap for their present expenses and for an amount agreed upon for the engines and pipes at the end of that period. But that offer has not yet been accepted. It is probable the owners may put it in themselves.

The President—Suppose you had two sets of chains. If the depth was too great for one lift you might have two.

Mr. Knowles—The weight of the chain would be great.

Mr. Greener—Three hundred fathoms would be fourteen tons on each side.

Mr. L. Wood—It would also have to carry the weight of water?

Mr. Berkley—The chain only in one part carries something like fifty yards of water in one disc.

Mr. Wood—The top link of the chain has to bear the whole weight.

Mr. Greener—The question has been discussed whether it is so liable to break when the weight is divided on the chain, as when the whole weight is on the extreme end of the chain.

Mr. Greenwell—Five hundred and fifty fathoms of wire rope is stronger than the same length of chain. 550 fathoms of wire rope just carries its own weight safely. There must be a point at which the chain would break by its own weight, and that must be less than 550 fathoms. Now if you take 300 fathoms that leaves little margin to carry more than itself in safety.

Mr. Greener—You can divide the lifts by appliances from the top, or by other means.

Mr. Knowles—The depth at Bow is only thirty fathoms. We used the endless chain for winding coal, and we found it did well at the depth of 100 yards; but when it is above 200 yards the weight of the
chain is so heavy that it is liable to break. We had one of 217 yards, and we could only just manage to keep it in good working order.

Mr. Greenwell—We are going to draw 1000 gallons per minute, at a depth of 120 fathoms. We have not begun yet, and we want to fix on the best plan.

Mr. Greener—As far back as nine years, in conversation with Mr. John W. Hackworth, son of the late Mr. Timothy Hackworth, he said

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he saw his way quite clear to lift from 150 fathoms by a machine on this principle.

The President—The subject will require a little consideration. We are all very much indebted to Mr. Greener for bringing it forward. If it really does answer the purpose it will be a great boon to the trade. For slight depths, I have no doubt it will answer; but it will require a little consideration before applying it to great depths, and as to sinking pits there will be great difficulty in applying it. I beg to move a vote of thanks to Mr. Greener, and to propose that his paper be printed in the Transactions of this Society.

The motion was unanimously adopted.

ON A DIRECT-ACTING ENGINE, AT TOWNELEY COLLIERY.

In connection with the discussion on Mr. Knowles's paper, Mr. J. B. Simpson read a paper "On a Direct-acting Engine, at Towneley Colliery," with observations on the consumption of fuel in Cornish and other engines.

Mr. Boyd asked if Mr. Simpson had found any difficulty in drawing and putting in his spears.

Mr Simpson said, there was quite sufficient room to take off the spears at the top of the pit, and with respect to those in the lower set, if anything went wrong with them, the ram would have to be taken out, and to enable this to be done easily, there was an off-take joint immediately above the ram.

Mr. Knowles—That is the plan we adopted at Belfield Colliery fifteen years since. By having the ram fastened on the rods it answered very well. Afterwards we put on another engine, and used the ram at a lower place. We did not like to depend on one engine.

The President—What quantity of water do you raise?

Mr. Knowles—Seven hundred and fifty gallons per minute. It was only seventy-five yards deep.

Mr. Steavenson called attention to the importance of having some uniform method of stating questions of this kind; some giving gallons per day, some per hour, and some per minute. Again some gave it in gallons, some in yards, and some in feet. Suppose they were to say so many gallons raised one fathom per minute.
Mr. Greenwell—Say the number of gallons raised a hundred yards by a ton of coals. The way Mr. Knowles had put it was very simple.

Mr. Steavenson said, a great deal depended on the boilers, and he suggested that they should take a diagram and see exactly the horsepower they obtained with the pressure given by the indicator. With respect to this table we found that some of those direct-acting engines were performing three times the work of the others; but if he looked further down, the indirect-acting engines were doing as much work or more than the direct-acting. In the direct-acting engine they had either to have a cylinder very much larger in proportion, or they could not get through the same amount of work. The direct-acting engines, simply had high pressure, with an exhaust, forming a cushion of the returning spears. They could balance the spears by having two sets, and use both sides of the piston. The engine at Page Bank was pressed at thirty-two pounds, and was pumping twice the water at the same depth. The proper mode of going about these experiments was to get diagrams. There was an indicator experiment by Maddison; he let the water off, then found what friction was with it. When you have water pressing on the apparatus you have heavier friction. He would measure the number of gallons pumped every minute, and take the indicator. Then they would easily get what was the available horse power. The remainder they must allow for friction and loss. Maddison also showed that he obtained seventy-seven per cent. This was not a direct-acting engine. It took seven pounds to start the engine, but then he got a start of two and a-half. A direct-acting engine has this to overcome every time it makes a lift.

Mr. Knowles, in reply to Mr. Steavenson, said these particulars were got up at their own colliery for their own use to test the engines. He did not say that all were perfect; but by these means they were able to see what engines were not doing their proper work. The first four engines were a fair sample of what direct-acting engines could accomplish. It was found that the engine at Allen’s Green was working to a disadvantage; but it was now working a great deal better. They must not compare the working of this engine with that of a first-class direct engine. With respect to wheel-engines or running-engines, they had to transmit the power round so many corners that it could not be done with economy. Here the power was applied, as near as they could fix it to the work. The direct action was only applied at one side of the piston; but they were now applying it on both sides by having a balance-beam underneath it. The steam on the higher side can force the beam down, and it helps the lift up on the outside. By this means they got two vacuums. No doubt that would be more economical; and if they had another to erect they would do it in this way. They had had these engines erected for many years, and so far as their experience went they approved of them. They were very simple to set up. Though there had been a difficulty about connecting the rods with the piston, they had never found this to interfere with the working.

Mr. Greenwell remarked that the inertia had equally to be overcome whether they had a fly-wheel or a direct acting-engine.

Mr. Steavenson said, he thought there was some discrepancy in the figures given by Mr. Knowles.
Mr. Knowles said, they were only statements from their own engines. The very low ones he considered were in very bad order. He took 50,000 gallons as about the average work.

Mr. Steavenson—We require three times the amount from our engines.

Mr. Knowles—The direct-acting engine gives 144,000. The Cornishmen use a better class of engines.

The President—They economise the fuel very much; they have to pay so dear for it.

Mr. Knowles—From the discussion on these engines good will arise to the trade. We shall see where improvements can be made, not only in engines but in boilers.

The President—No doubt it will set people to think whether direct or indirect engines are the best. We have not had much experience in direct engines here. I think Mr. John Simpson's is the first, except at Burradon; but they did not get it to act at all there.

Mr. Berkley—The greatest difference will arise in the boilers. There is not so much difference in the actual work performed by the engines as in the boiler. There is so much more steam, per ton of coals, raised by the Cornish boiler. We are the most wasteful people in regard to boilers.

The President—My son has put up a winding engine at Cambois, and he has put up the Cornish boilers there. They work very well indeed.

Mr. Greenwell—Are they single or two-tube boilers?

Mr. Simpson—I think there are two tubes.

Mr. Greenwell—The kind of boilers generally used in Lancashire are two-tube boilers.

The President—Cornish.

Mr. Knowles—Twenty-six or twenty-eight feet long is considered the best. The smoke goes through the two flues, then underneath, and back up each side. We have three boilers forty-five feet long, but we have poor results from them.

COAL-WASHING APPARATUS.

Mr. Gilroy’s paper on “Coal-Washing Apparatus,” stood next for discussion.

Mr. Greenwell said, Mr. Gilroy could not be present, but he wished the discussion might go on notwithstanding, and he had requested him (Mr. Greenwell) to watch his interests. They got their coal from the screens to the coke ovens very much cheaper than before. The cost of washing was less than the actual conveyance of coal was formerly, so that they had the washing for nothing. It had also improved the coke from 2s. to 2s. 6d. per ton in price. There was one subject, he did not know whether there was anything in Mr. Gilroy’s paper about it, but it was very important, and that was the fresh air furnace. He had seen it at Ince Hall Colliery a short time ago, and it was well worth taking into consideration. A wall was built in the drift behind the furnace. Holes were made in it which acted as a regulator, and they work the furnace without any furnace doors at all.
Mr. L. Wood—How does he fire the furnace?

Mr. Greenwell—He fires from the front in the ordinary way.

Mr. Steavenson—How does he increase or reduce?

Mr. Greenwell—By making the tubes large or small. He has four small furnaces instead of one large one. Each of these he can put out. This enables him to clean a furnace without checking the ventilation.

Mr. Knowles—The wall at the back of the furnace will get very hot?

Mr. Greenwell—The fireman is at the front of the furnace.

ON TAIL-ROPES.

The next paper for discussion was Messrs. Greenwell and Berkley's, on "Tail-Ropes."

Mr. Berkley said, that Mr. Lindsay Wood asked at the meeting in Manchester, why they did not change the ropes at the different stations at the shaft, instead of stopping and changing? We do that now when we have only two stations at work. We did not find much saving when we had four stations. We might have a set ready at one station and not at the other. Boys were placed at different stations. At some stations we run with fewer tubs to a set than we do at others. We found it, for these reasons, more convenient to stop the set at the way end and change the ropes.

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Mr. L. Wood said, that these changes would take up about five minutes out of thirty-four each trip.

Mr. Berkley explained that No. 1 being a short run, the set would have to wait at the bank-head, and the men might as well change instead of waiting.

Mr. Wood—When we have to run the trains very hard, ten miles an hour, every stop is of much importance.

The President—We have to run our engine harder than one and a-half miles in eight minutes.

Mr. Wood—Yours is a straight road?

The President—It has two turns in it.

Mr. Knowles—How many wagons do you bring at once?

Mr. Wood—Twenty-one, and in some cases thirty.

Mr. Knowles—What is the weight?

Mr. Wood—Eight hundred-weight, and in some cases fourteen cwts.
The next subject for discussion was Mr. Daglish's paper on "Certain Improvements in the Construction of the Water-Gauge," but Mr. Daglish not being present, the discussion was postponed.

EXPLOSION AND STANDING FIRE AT NEWBOTTLE COLLIERY.

Mr. Lishman's paper on this subject stood next.

Mr. Greenwell said, might this question not bear on what had been brought before the Institute about the oil in gauze? There was oil used in the making of gauze, which, when the lamp became red-hot, would fire.

Mr. Lishman—None of the lamps had been red-hot.

Mr. Wood—I believe very little depends upon its being a new or an old gauze in that respect, for every gauze is smeared with oil during its use to a greater extent than a new one. Experiments go to show that the tendency to fire is rather reduced than increased when the gauze is smeared with oil. The mere fact of the volatilization of the oil on the gauze keeps it cool. Even paraffin, which is more volatile, has this effect.

Mr. Greenwell—Then, it would follow that a lamp is increased in safety by being dipped in oil?

Mr. Wood—I do not say it is safer, but the gauze does not get so soon red hot.

Mr. Steavenson—This state of things might exist, so that when the oil is evaporated it would burst into flame.

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Mr. Wood—It volatilizes at a lower temperature than flame will pass through the gauze.

The President—When the Davy-lamp was first in use, I was serving my time at Hebburn, where it was constantly in use. I remember that the top part of the lamp was always red-hot, and it never fired; so that I have full confidence in the Davy-lamp. Mr. Buddle saw it several times.

Mr. Boyd—It would help to accumulate coal-dust, being smeared with oil.

Mr. Wood—I do not think that would be liable to take fire merely by the heat of the wire.

The President referred to Messrs. Richardson and Browell's analysis.

Mr. Wood—I may state that the lamps that were in use at the place where the Newbottle explosion took place were tested in gas obtained from a blower in the Eppleton Pit, and were found to be in a perfect state.

Mr. Greenwell—in some experiments made in London, when they were tried in coal-gas, they exploded at much less heat. The strangest thing is that the Newbottle lamps had apparently not been red-hot.

The President—My idea was that a man must have put his pick through one of the lamps; but when found they were quite perfect.
Mr. Lishman—The gauze not being red-hot, might be accounted for by the fact that the flame as soon as it passed the gauze, would leave the face. The lamps would be put out immediately by the gas.

Mr. Wood—The question is, whether the lamp had got so hot as to pass the flame?

Mr. Lishman—There was no appearance of that.

Mr. Greenwell—You did not fire shots in the place at all?

Mr. Lishman—No.

The President—The great danger is when you beat the flame back. As long as they allowed the gas to burn it would be safe enough; but as soon as they beat it back to where there is plenty of gas—then to the flame, and away she went. These experiments are very interesting, but we must remember it was coal-gas and not pit-gas. With the exception of Stephenson's all the other lamps exploded.

Mr. Wood—What was the pressure per square inch of the gas that was given off the old workings.

Mr. Lishman—Two pounds previous to the fire.

The meeting then broke up.

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Vol. XV. Plate XXI.

Plan of Chain Pump (7 ins. diameter)

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ON THE IMPROVED METHOD OF RAISING WATER ECONOMICALLY FROM MINES BY BASTIER'S PATENT CHAIN PUMP.

By THOMAS GREENER.

Read at Newcastle, May the 3rd, 1866.

The necessity which has long been felt for some improved mode of raising water from mines of various depths has recently been strongly expressed in the papers read and discussed before the members of this Institute.

The desire for such improvement is daily experienced by all whose duty it is to superintend, or whose work it is to manage and keep in repair the complex, cumbrous, and expensive machinery up to this time employed; and to those who embark their capital in mines the necessity of some cheaper mode must be so apparent in their periodical balance-sheets, that they will be ready fully to appreciate any real improvement:—
1st. By smaller outlay in the erection of machinery; and,

2nd. In the reduction of regular working cost, by a decreased consumption of fuel, by less liability to accident, and by a diminution of wear and tear.

This subject is looked at, too, with great interest by those who see, or think they see, in the future, a probable necessity of raising water from still greater depths than the present, and that with the employment of a proportionately smaller amount of power than has yet been attempted; whether by the ancient plan of drawing water by tubs, the old beam pump, or the direct-acting pump.

It may, therefore, be expected that the advocacy of any attempt to meet this necessity of improving the method of raising water economically from mines is likely to be listened to with patience, the principles of that method, examined with care, and the appliance itself, fairly tested by experiment, before a judgment is formed on its merits, however much the peculiarity of that appliance may clash at present with the opinions of those gentlemen who have given the whole subject of raising water from mines their careful attention.

The other departments connected with coal mines have, during the last thirty years, been gradually improving, such as cages and tubs, instead of corves, including the small coal apparatus for raising coal; the use of wire ropes for shafts and on inclines, instead of hemp or chain; bridge rails and roley wheels, instead of the old trams and flat tramway; electrical signals, instead of large levers, wires, and hammers; not omitting the present attempts, in some measure successful, of hewing coal by the employment of coal-cutting machines. These have all advanced very considerably. Yet, while all this has been going on, the principle and modes of raising water from mines are the same as those that were in use before the oldest miner now living was born. Indeed, the only improvements that have been attempted in this department have been more in the quality of engines and boilers used to work the pumps, and in the mode of connecting the pumps to the engines, than in any radical change in the pumps themselves.

Until very recently no successful attempt was made to complete the construction of a pump to work in harmony with universal natural laws, and which should be simple in its mechanism, easy of application, uniform in its action, and economical in its results.

However, I have now the honour of bringing before the members of this Institute a machine which fully answers this description; for such, it may be asserted, is the apparatus known by the name of "Bastier's Patent Chain Pump."

After illustrating its principle, and after placing before you a few facts from actual results, I hope I shall be able to prove to this meeting that this pump is capable of doing more work, at greater depths, with less risk of accident, and doing it more economically, than any other description of pump known to be in use at the present time.

The apparatus, as shown by the drawings, and the model now in the room, consists of first, an iron glass enameled tube, reaching from the delivery drift to nearly the bottom of the sump (Plate XXI., a-c).
The mouth-piece at the bottom is in the shape of a funnel or bell; above which is a contracted tube, ten feet long, the diameter of which is about three-sixteenths of an inch less than the rest of the tube (a).

In great depths this ten feet of contracted tube is repeated every fifty yards.

2ndly. At the top of the pit is a cast-iron frame, bearing a shaft, on which is a pulley, for the purpose of guiding a chain for raising the water (I).

On this shaft there is also a driving wheel (F) for a belt or cog-gearing, as the case may be. Also, on the same shaft, there is a guard to prevent the weight of water carrying back the wheels in a contrary direction whenever the engine, employed in turning them, has occasion to stand.

The groove of the pulley is cast with openings for each link of the chain to fall into. On its outer rim there are gaps into which the discs fit; this arrangement also secures the grip of the chain upon the pulley, so that under ordinary circumstances it is impossible for it to surge.

3rdly. The chain is endless, passing over the pulley, down the open shaft and up through the tube which is to convey the water to the delivery.

It is made of links, exactly uniform in size to fit the openings on the wheel; at intervals of about three feet three inches, a disc or bucket of India rubber is fixed on a bar of iron (C) betwixt two links of the chain. This bar is so arranged as to be easily disengaged whenever the disc may need to be repaired.

The disc was at first made of three pieces of India rubber; but now it is made of one piece, as illustrated by the drawings.

On both sides of the disc there is an iron plate, which is keyed on. By tightening or slackening the keys, the India rubber can be enlarged or contracted in the tube.

4thly. The mouth-piece, which is in the sump, is fastened between two perpendicular pieces of timber (J), which are fixed into the bottom and secured to the side of the shaft.

Just opposite the bell-mouthed entrance of the tube, but a little below it, there is a wooden roller (E), as a guard to the tube and a guide to the chain and discs, to secure for them a proper entrance into the mouth of the tube.

When the pulley at the top is set in motion, the chain and its discs being equal in weight on each side of the pulley, nothing remains to be lifted but the water, and for this purpose the chain and its discs move up

the tube so that the discs may in the first place remove the air and create a vacuum.
The atmosphere, with its pressure of fifteen pounds to the square inch, is, in obedience to its natural law, ever ready to assist when arrangements are made to work in harmony with it. In this case there is that harmony.

The pressure of the atmosphere is uniform and constant, so is the motion of these discs. They pass rapidly through the lower contracted tube in which the discs are perfectly air-tight.

A vacuum is thus made; and as the action is continuous, the atmosphere has liberty to do its work continuously also, since it follows up its pressure without let or hindrance by any such periodic stoppages as occur from twelve to thirty times in every minute in pumps of the present mode. So that, without any interruption, this willing agent raises the water full five fathoms in the tube; and this is all it can do, but happily it is quite enough for the purpose.

This important start being effected, accumulated motion (momentum) is obtained, and with sufficient power to continue the motion and keep good what has thus been obtained, no fears need arise as to the result.

With that friendly ally, the atmosphere, moving on the surface of the water and ever continuing its powerful aid, the force once put into the water and carefully husbanded (added to all, a sufficient power above in the steam engine which is employed to supplement, not as by the present mode to destroy, those combined friendly forces), everything is now in favour of landing the water at the destination desired in whatever quantities required or at whatever depths the water may be found.

The above description will show that this apparatus is simple in its construction and very little liable to get out of order.

That it is easy of application will appear from the fact, that a space of fifteen inches cut off by a straight line from a ten feet shaft, is more than enough for a large-sized pump to work in.

Uniformity of action is the distinguishing characteristic of this pump.

With the use of the India rubber discs, these being air-tight only in the contracted parts of the glass enamelled tube, and in the other parts just as tight as to enable each disc to carry its own load of water, the chain being of proportionate substance and made of the best iron, the speed may be increased to almost any degree.

It will thus be seen that the motive power is so economised, and the wear and tear is so small, that there can be no other conclusion arrived at than that this apparatus is able to raise a larger quantity of water, from a greater depth, at a less cost, than any other kind of pump now in use.

The peculiar advantages of this pump in comparison with others employed, may be shown as follows:—1st. It is uniform and continuous in its action. 2ndly. There is much less loss of motive power, as the descending chain and discs are equal in weight to those ascending. 3rdly. Greater speed is gained than can be had with an alternating pump; and, therefore, less sectional area of pump is required to deliver equal quantities of water. 4thly. These buckets or discs being solid, but
elastic, will admit of foreign matter such as stones coming between them and the sides of the pipes without doing any injury.

Indeed, pieces of wood, stones, etc., small enough to get upon the discs, can be conveyed to the top and delivered there without any mischief whatever to the pump; so that gagged clacks, etc., will cease to annoy the "changer and grather," and to stop the pumping operation, when this pump is adopted. 5thly. There being no buckets with falls and separate clacks in this pump, as in the lifting-pump; or air-tight stuffing glands and chambers, as in the forcing or ram pump; this chain-pump will not "work on air," which is at present a great source of accident to the pipes, etc., etc.

6thly. This pump is less liable to break in any of its parts than the ordinary pump.

Moreover, it can be more easily repaired should any accident happen to it, as in the breaking of the chain, which kind of accident happened three times at the Wheal Concord Mine, near Tavistock, when the chain fell to the bottom of the shaft, fifty-five fathoms deep, which was nearly full of water. On each occasion the chain was fished up in two hours.

7thly. Another but minor advantage to be derived from the use of this pump is its easy application to raise water to be delivered at various heights in the same tube. This may be understood by reference to the drawings prepared for Newton Cap Colliery, where it is necessary to raise 800 gallons per minute from the mine, and about 120 gallons per minute of this quantity is to be raised above the surface, in all, about fifty fathoms from the bottom, to supply the coke ovens. It is shown that the remaining 680 gallons per minute can be left at the delivery drift, which is only thirty-five fathoms.

Indeed, by this arrangement, any proportion may be sent up to the

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top, or the whole of it may be sent away at the delivery-drift. This is a peculiarity which no other pump would admit of.

Now, as to actual experience to verify these assertions. Up to the present time there are very few facts; but few as they are, they are valuable and enough to inspire confidence for the further adoption of this pump.

There is first the pump which was fixed upwards of five years ago, and worked so successfully, for more than six months, at the Wheal Concord Mine.

This shaft was 351 feet deep, diameter of pump inside five inches, circumference of wheel thirteen feet. Speed per minute thirty-two revolutions, which, multiplied by thirteen, gives 416 feet per minute. The quantity lifted per minute, as measured by the engineer of the Birkenhead Water Works (ten gallons per revolution), was 320 gallons. This pump was worked by a water-wheel of twenty-five horse-power in winter, and by a twenty-five horse-power steam-engine in summer.

About seventeen days after starting, the first chain broke three different times; the iron of which it was made being very bad.
It was replaced by a new chain of the same dimensions, after which the pump worked night and day for upwards of six months, when the Mining Company stopped their operations for want of money.

The horse-power mentioned in this case is nominal. It would take about thirty-five horse-power indicated to do the work.

The next case is that of a pump 178 feet, fixed at the Patent Rice Starch Works of Messrs. W. Berger and Co., of Bromley-by-Bow.

Their engine, twenty-five horse-power, has to drive the machinery and pump the water. Up to February, 1862, the water was pumped by two ordinary pumps from the best makers, each six and a-half inches diameter.

It was found that the engine was not able to do all the work, and their engineer advised them to put in one of these pumps rather than buy a new engine. This was done. A four and a-half inch pipe, glass enamelled inside and outside, was adopted.

This now pumps more water than they require, and the engine is more than sufficient for all their work. The discs travel at about 180 feet per minute, raising about 120 gallons per minute.

This pump has now been at work upwards of two years, and never cost sixpence for repairs, and the discs are as good for the work they have to do as ever they were.

For some time after it commenced, the engineman thought it necessary to keep the discs tight in the contracted tube. During that time the works were stopped for repairs for nearly two weeks, and at the end of that period the column was still standing entire in the pipes. In practice, he found this a little inconvenient, having all the column to start on the first movement of the engine. He, therefore, eased the keys which press the iron plates upon the disc, and thus contracted the disc a little; so that now the column will run out in about half an hour, and the water is lifted quite as efficiently. The engineman says that they quite forget they have a pump at work.

It is to be regretted that in this case, as in the one already mentioned, no account has been taken of the quantity of coal consumed; but the power required for this pump cannot be very great, when the engineman scarcely perceives the fact of the pumps being taken from the engine, and the fireman cannot tell when it is on or off.

The only other case where this pump has been at work was at the Great Exhibition of 1862, where they ran the discs at 1,000 feet per minute, and utilised 90 per cent, of the power employed.

As an appendix to this paper, I give copies of certificates about the working of Wheal Concord Pump; also some calculations, comparing the cost of erecting and working this and other pumps.

After a careful consideration of the matter contained in this paper, I trust that this chain pump will, on its own merits, upon fair and patient trial, command the attention of mining engineers.

APPENDIX.
Bastier’s Patent Pump, to lift 1,000 gallons per minute 100 fathoms.

Diameter of pipe, 10 inches, cast iron, enamelled inside.

Price of pump .............................................................. £1,540

" 250 H P Corliss’engine ............................... 1,875

" Erection, carriage, etc........................................... 385

Total cost of pump for 100 fathoms......................£3,800

Apparatus cost 12s. 8d. per 100 gallons per foot per minute.

Fuel consumed,—

Seven tons of coals every twenty-four hours, to do six millions units of work per minute.

Particulars of cost of a Cornish pumping engine and pumps lately fixed at a colliery in the Midland Counties.

To lift 1,000 gallons per minute, 70 fathoms, fixed in a shaft 10 feet in diameter; two 18-inch setts.

Cost of engine.......................................................... £3,130 0 0

Four boilers and fittings........................................... 622 2 10

£3,752 2 10

Pumps.................................................................... 1,513 14 8

£5,265 17 6

Cost of apparatus, 25s. per 100 gallons per foot per minute.

Six tons of coal used every twenty-four hours, to do 4¼ millions units of work per minute; showing a saving of 1½ tons per day in favour of Bastier’s Chain Pump.

Extract of Letter from Mr. Trotter, Son of the late Secretary of Wheal Concord.

Dear Sir,—My late father, the secretary of the Wheal Concord Silver, Lead, and Copper Mining Company (limited), was, I know, thoroughly satisfied with your patent chain-pump, which, up to the time of his decease, had been at work for nearly a year without costing the company a penny for repairs, and utilising full eighty per cent, of the motive power.
The pit drained by your pump is 100 yards deep, into which the water of another pit drains at the rate of 250 gallons per minute. The tubes of your pump are five inches diameter, and each revolution of the wheel brings up ten gallons of water, occasionally with large pieces of wood and other materials which come within the current of the water, without any injury whatever to the pump.

(Signed) JOSHUA TROTTER.

T. W. Bastier, Esq.

Extract of Letter from Mr. John Eastcott, Esq., one of the late Directors of "The Wheal Concord Mining Company."

London, 20th May, 1862.

Dear Sir,—I beg to subscribe my testimony to the efficiency of your patent chain-pump, supplied by you for the purpose of raising water from a shaft about 100 yards deep, in Wheal Concord Silver, Lead, and Copper Mine, South Sydenham, near Tavistock, Devon.

Your pump was placed in the engine-shaft, the latter being at the time full of water, and within a very short period after the pump was set to work, speedily lowered the water about thirty-eight fathoms, that depth being required for prosecuting the works of the mine, although many levels and drivings (all full of water) also flowing into the same shaft, the whole forming a great body of water together, with the constant-coming supply from the lodes of the country.

I may here add, that in all my experience I have never seen any pump with equal motive power and diameter of tube, raise so much water at that depth within the same time.

I am sorry to say that in consequence of the unforeseen circumstances attendant upon speculative mining, that the company for want of capital were obliged to suspend operations; therefore, the pump is at present not being worked.

(Signed) JOHN EASTCOTT.

To T. W. Bastier, Esq.

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ON A DIRECT-ACTING ENGINE AT TOWNELEY COLLIER, WITH OBSERVATIONS ON THE CONSUMPTION OF FUEL IN CORNISH AND OTHER ENGINES.

By J. B. SIMPSON, F.G.S.

Read, May 3rd, 1866.
The application of direct-acting engines to the pumping of water from the mines in the counties of Northumberland and Durham, is only of recent date, and at present there are only a few on this principle. In connection with the discussion on Mr. Knowles' paper, I have thought it advisable to give an outline of one erected at the Addison Pit, Towneley Colliery, with a statement of the duty it is performing.

The engine is single-acting, and works in the same way as that at Cleggswood, described by Mr. Knowles. The cylinder is fifty-two and a-half inches diameter, and placed over the pit. The steam is applied below the piston, and after the completion of the up-stroke, it gradually escapes through a regulating-valve to the top of the piston, where it remains until the end of the down-stroke. It is then condensed, and the vacuum thus formed assists the next up-stroke of the engine. In the down-stroke, the valve mentioned regulates the speed of the descent by allowing the exhaust steam to go quicker or slower as may be required, to the top of the piston. It is intended to work expansively, but hitherto it has been considered more prudent to work with the steam wiredrawn. The diagrams appended, taken by the indicator, will explain the working of this engine. It will be seen that the steam enters the cylinder at a pressure of nineteen and a-half lbs. to the square inch, and diminishes gradually to the end of the stroke, where it is eleven and a-half lbs.

The mean effective pressure of steam applied is ........ 14.2 lbs,
To which add the average vacuum obtained.................. 11.2 “
The actual effective pressure required in the up-stroke is 25.4 lbs.

In the down-stroke, the diagram shows that the exhaust steam, as regulated by the equilibrium valve, exerts an upward pressure or resistance of.................. 8.2 lbs. per sq. inch.
But it also exerts on the top of the piston a downward average pressure of 5.2 “
Leaving ................................................................. 3.0 lbs. per inch as the pressure of steam required as a cushion to prevent the piston, rods, etc., descending too rapidly; and this amount of pressure on the area of the piston equals 2.7 tons.

The arrangement of the pumps, as shown on Plate XXII., was proposed by Mr. Robert Anderson, of the Aberdeen Water-Works, and is as follows:—A lifting set, with a twenty-inch working barrel, is placed at the bottom of the pit and raises the water seventy-six feet, above which, and in connection therewith, is a ram of twenty inches diameter and delivery pipes, by which the water is forced to the surface 204 feet further. The spear rods which work the bucket of the lifting set, are attached to the bottom of the ram by an ordinary Y-plate in the interior of the pumps.

In the up-stroke of the engine, the weight lifted is as follows:—
Weight of piston, piston-rod, spear-rods, plates, ram, bucket, air-pump beam, etc. ............................... 15.6 tons.

Weight of seventy-six feet of water column, twenty inches diameter.......................................................... 4.6 "

Total.......................................................... 20.2 tons.

The water lifted in the up-stroke fills the space occupied by the ram before its ascent, and in the down-stroke the water is forced from the ram to the surface. The weight of this column is 12.56 tons.

Excluding friction in both cases, it appears that in the down-stroke there is a weight of 15.6 tons to force a column of 12.56 tons, showing a difference of three tons preponderance of weight, which corresponds very nearly with the difference shown by the indicator; and as half a ton would have been sufficient for this excess, the surplus is an unnecessary weight, and represents about 2.5 lbs. per square inch of steam used for no purpose. The application of a balance beam will remedy this defect.

The friction of the engine and spear-rods, etc., in the up-stroke, is found by the following calculation:

\[
\begin{align*}
\text{Area of Cylinder} & \times \text{Lbs. per sq. inch} \times \text{Tons} = \text{Weight applied to piston} \\
2164.77 \times 25.4 &= 24.55 \text{ applied to the piston.}
\end{align*}
\]

The actual weight lifted is 20.20

Then the difference 4.35 represents what is lost by friction,
The engine has been at work since September last, and during that time neither the bottom clacks (of which there are two for safety), nor the delivery clack have been changed, and only one bucket has been renewed.

The following experiment as to the consumption of fuel may be taken as an average of the present working of the engine.

In-going, 4,320 strokes in thirty hours, or 2.4 strokes per minute, and pumping 100 gallons per stroke (276 feet high), the consumption of small coal was seventy cwt. (The length of stroke is seven feet six inches.) This is equal to a duty of 116,443 gallons lifted 100 yards with a ton of coal, which is below that of the Cleggswood engine, the duty of which was 144,881 gallons.

The nominal horse-power of the engine is 110, but, in the foregoing experiment the actual indicated horse-power applied was thirty. The consumption of coal was at the rate of 261 pounds per hour, making the duty eight and three-quarter pounds per horse-power per hour, or nineteen millions of pounds raised one foot high with ninety-four pounds of coal. One Cornish boiler, thirty feet long and six feet in diameter, with one tube, is sufficient to drive the engine four strokes per minute.

Another experiment, with unscreened coal, gave 141,390 gallons lifted 100 yards with a ton of coal. The duty being at the rate of seven pounds per horse-power per hour,

The chief causes which at present prevent this engine from being worked as economically as it ought to be, are, the want of standage for water in consequence of which the engine is required to be driven at a very slow speed; the proper balancing of the sets as referred to; the loss from uncovered boilers and from a long range of uncovered steam pipes, and the non-application of the expansion of steam in the cylinder. When these defects shall have been remedied, it is expected that a duty of about 5 lbs. per horse-power per hour, or about 200,000 gallons lifted 100 yards with a ton of coal, will be obtained.

At the Emma Pit, Towneley Colliery, the duty performed by a high pressure pumping engine (non-rotary), worked with two beams, is as follows:—The nominal horse-power of the engine is 100, but when going

8.65 strokes per minute and pumping 640 gallons per minute from a depth of 144 yards, the actual indicated horse-power is 118.8. The consumption of small coal is 1126 lbs. per hour, or 9.5 lbs. per horse-power per hour, or 17½ millions of pounds lifted one foot high with 94 lbs. of coals, or 109,615 gallons lifted 100 yards with a ton of coal. This engine is supplied with steam from common cylindrical boilers. If, however, Cornish boilers were used, and the steam worked expansively, this engine would work almost, if not quite, as economically as the direct-acting engine. It might be expected that the friction of the direct-acting engine would be considerably less than that of a beam-engine, but a comparison of the two engines mentioned does not show so much difference.

DIRECT-ACTING ENGINE.
Actual duty of engine = \( \frac{2164.75 \times 22.9 \times 18}{33,000} \) = 27.03 horse-power.

The indicated pressure of steam in this calculation is taken at 22.9 lbs., being 25.4 lbs. (the real indicated pressure) less 2.5 lbs., which it is fair to deduct for the steam which is used in excess in consequence of the unnecessary weight of spears.

Effective duty of engine in water lifted = \( \frac{240 \times 10 \times 276}{33,000} \) = 20.07 horse-power.

Loss... 6.96 horse-power.

Then, as 27.03 : 100 :: 20.07 = 76.6 per cent., the effective duty obtained from the power applied.

Area of cylinder. Indicated pressure. Feet per minute.

\( 1520.53 \times 22.55 \times 115.33 \)

Actual duty of engine = \( \frac{1520.53 \times 22.55 \times 115.33}{33,000} \) = 119.8 horse-power.

Effective duty of engine in water lifted = \( \frac{640 \times 10 \times 432}{33,000} \) = 83.7 horse-power.

Loss... 36.1 horse-power.
Then, as $119.8 : 100 :: 83.7 = 69.8$ percent, the effective duty obtained from the power applied.

The difference is, therefore, in favour of the direct-acting engine of 6.8 per cent. only.

Vol. XV. Plate XXIV.

Diagram of underside of Piston.

Diagram of upper side of piston.

The direct-acting engine described, works in a most satisfactory manner, but as far as economical working is concerned, it does not appear that this arrangement supersedes rotary- or beam-engines. Economy of fuel and effective duty are dependent more on the details of the construction of the engine and boilers than on the kind of engine. The best of the results given by Mr. Knowles of the duty of a direct-acting engine, when compared with the duty of the Cornish engines, shows a remarkable difference in favour of the latter almost in the proportion of three to one; but there does not seem any reason for so great a difference, if equal care were taken in the arrangements.

The following extract from one of the Cornish-engine reporters gives the result of the working of twenty-eight engines:—"They consumed 1,887 tons of coal, and lifted eighteen millions of tons of water ten fathoms high; (or, adopting Mr. Knowles' method, 427,345 gallons of water lifted 100 yards with a ton of coal) and the average duty of the whole was fifty-four millions of pounds lifted one foot high by the consumption of ninety-four lbs. of coal," or equal to three pounds per horsepower per hour. Some engines have been known to reach and even exceed the enormous duty of 100 millions.

From an inspection of colliery pumping-engines, in various districts, there does not appear to be a greater average duty obtained than ten or eleven pounds of coal consumed for each actual or indicated horse-power per hour. It must, however, be borne in mind that in the Cornish engines the best of coal is used; whereas, in colliery engines generally, only refuse or small coal. Still it cannot be denied that there is a great necessity for economy. Formerly, when small coal was of little or no value, the subject was not of so much importance; but now, when coal is everywhere more valuable, the matter assumes a different aspect; and if, in many places, economy of coal be not so much an object, it must not be forgotten that a less consumption of coal reduces very materially the cost of manual labour, and also the annual wear and tear.

It would be difficult to arrive at data which would give the amount of coal that might be saved, if our colliery pumping-engines throughout the country were giving such results as are obtained by Cornish engines; but could only a saving of three pounds of coal per horse-power per hour be effected, this would equal 1,200 tons of coal per year on every engine exerting 100 horse-power of actual duty; and, taking the whole of the engines into consideration, it may be conceived that a large quantity of coals might be annually saved.
NORTH OF ENGLAND INSTITUTE OF MINING ENGINEERS.

GENERAL MEETING, SATURDAY, JUNE 2, 1866.

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

A general meeting of the members of this Institute was held in the Lecture-room of the Literary and Philosophical Society, Newcastle-upon-Tyne, for the purpose of hearing a lecture by G. F. Ansell, Esq., Chemist to the Royal Mint, on "A new method of indicating the presence and amount of fire-damp and choke-damp in coal and iron-mines." There was a large attendance, the members of the Literary and Philosophical Society having also been invited. The lecturer explained at length the principles of the diffusion of gases, illustrating his lecture by numerous experiments, and exhibited the apparatus he had invented for the purpose of showing how the condition of the atmosphere in a mine could be indicated above-ground, either by the ringing of a bell or the motion of the electric needle.

Mr. Daglish inquired if time was an element to be regarded?

Mr. Ansell—You have to hold it forty-five seconds in any mixture. If you hold it too long you have effusion. That is different from diffusion.

The Chairman—Diffusion is an intermingling of the gases.

Mr. Ansell—Yes; but effusion is a mechanical oozing out, as of water from a sponge. That is the reason why this instrument does not give out so much force as according to the theory.

The Chairman said, they were highly gratified with Mr Ansell's lecture, and he begged to move that a vote of thanks be accorded to him, which was carried by acclamation.

Mr. Daglish moved a vote of thanks to the members of the Literary and Philosophical Society, for the use of their Lecture-room.

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

Mr. Clapham, secretary of the Literary and Philosophical Society, said, the committee were very glad that the room should be used for such a purpose.

The meeting was then adjourned to the rooms of the Institute, for the discussion of papers and general business. The following new members were elected:—Mr. James Humble, jun., Garesfield,
The following notice of alteration of the rules was announced:— That in consequence of the rapid development of Iron Manufactories and of other Engineering Works in this district, and of the recent considerable accession of members actively engaged in various mechanical pursuits, the council consider that an alteration of Rule XI. is desirable, and recommend the following amendment:

"That the officers of the Institute shall consist of a President; six Vice-Presidents, four of whom to be Mining Engineers; and eighteen Councillors, twelve of whom to be Mining Engineers," etc.

After a short conversation, the meeting was concluded.

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ON A NEW METHOD OF INDICATING THE PRESENCE AND AMOUNT OF FIRE-DAMP AND OF CHOKE-DAMP IN COAL- AND IN IRON-MINES.

By GEORGE FREDERICK ANSELL, of the Royal Mint.

Read June 2nd, 1866.

Mr. President and Gentlemen,—While introducing to your notice a subject which I hope will be found worthy your attention, I will endeavour to avoid what is known as book-knowledge, and, so far as I am able, place before you my proposition in a practical form; yet, as my plans are based on a purely natural law, it will be necessary to advert to that law that my ideas may be fully opened out to you. One part of my proposition is dependent on the law of diffusion, the other part of my proposition is dependent on a law yet to be discovered, but which I hope I may be permitted to develop [sic] in the future; at present the experimental facts are antagonistic to any known law. I refer to the behaviour of gases in relation to thin India-rubber.

Matter in every form, whether solid, liquid, or gaseous, that is, liquid in a higher sense, is formed of minute particles, just as the ocean is formed of particles of water; those minute particles have been called atoms or molecules, and there are reasons for believing that these atoms have motion amongst themselves in either the solid, liquid, or gaseous form of matter. In the case of gases the law governing one particular motion has been discovered by Mr. Thomas Graham, who has demonstrated that gases diffuse into each other, and into space in the inverse ratio to the square root of their densities; in other words, a light gas diffuses itself rapidly, while a dense gas diffuses itself slowly into space, or into another gas.

If we take the following substances and compare them with atmospheric air as the standard of specific gravity; they will illustrate my meaning, for
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<td>Air being taken as of</td>
<td>1.0000</td>
<td>100</td>
<td>31.0117</td>
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<td>Hydrogen.............</td>
<td>0.0691</td>
<td>&quot;</td>
<td>2.1400</td>
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<tr>
<td>Marsh-gas............</td>
<td>0.5590</td>
<td>&quot;</td>
<td>17.4100</td>
</tr>
<tr>
<td>Carbonic-acid ......</td>
<td>1.5240</td>
<td>&quot;</td>
<td>47.2600</td>
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the barometer being at 30 inches and the thermometer 60° Fahr. If, therefore, a vessel of a given capacity be filled with each of these different gases, under precisely similar circumstances, and weighed carefully, the variations of weight would be as indicated above.

If, then, we imagine the containing vessel to be made of such a substance as will admit of diffusion, we should find that the gas would diffuse out of that vessel in a period of time relative to its specific gravity; hydrogen most quickly, marsh-gas next in its place, air following, and lastly, carbonic-acid; each gas being replaced by its diffusion-equivalent of air, but in the case of air, although diffusion would take place, its amount would not be registered, because air would replace air, volume for volume.

To demonstrate this with one experiment will be sufficient. Thus, I will fill this glass tube, whose upper end is closed by a plug of Plaster-of-Paris, with coal-gas, and if I then place its lower end in water you will observe that the water will gradually rise in the tube, because the gas diffuses out into space, leaving a partial vacuum, while the atmosphere presses the water into that space.

But we find that the whole space is not exhausted, yet there is no coal-gas remaining, for while the coal-gas has diffused out, air has diffused into the tube (the gases have passed each other within the interstices of the Plaster-of-Paris), and thus we come to the relative movement of gases under the circumstances of diffusion—endosmose and exosmose, as it was formerly called.

The same gas diffusing through different substances occupies varying times, being quicker through unglazed Wedgewood pottery-ware than through Brockedon’s graphite. The force or power of diffusion is considerable, as will be evident if I place this little apparatus in an atmosphere of coal gas. The instrument consists of a porous cell, surmounted by a cylinder, in which is placed a piston of brass, the piston being free to move just as in the case of steam. Immediately that this instrument is placed in an atmosphere of coal gas, diffusion commences, the gas passing into the porous cell through its walls more rapidly than the air passes out, causes an increase of volume which exerts its pressure on the lower side of the piston and carries it up through the cylinder.

Upon this law, the nature of which I have endeavoured to explain, I have founded my proposition for indicating the presence of fire-damp, and of choke-damp, in coal- and in iron-mines.

Fire-damp is a mechanical mixture of carburetted-hydrogen, nitrogen, and carbonic-acid in varying proportions. The carburetted-hydrogen is the only substance with which we have to deal in fire-
damp, because it is this substance that, when mixed with atmospheric air, becomes explosive in the act of combustion, its carbon forming carbonic-acid, and its hydrogen forming water, both of which at the moment of formation are gaseous, and at a high temperature, and, therefore, occupy a larger space than was formerly occupied by the mixed gas; in other words, in the act of combustion it explodes and gives rise to all the facts so well known to you.

In speaking then, in future, of fire-damp, I allude only to the carburetted-hydrogen, or marsh-gas contained in the mixture, because that alone is the combustible substance, and this consideration is to be noticed, because my figures will appear to be different to those obtained by some members of your Institution, who have taken the compound substance, while I have taken only its combustible gas.

In the same manner while speaking of "choke-damp," "after-damp," "black-damp," "dampie," etc., I allude only to the carbonic-acid which is contained in the compound which passes under so many names, according to the source whence it occurs, for in all cases it is a mixture of carbonic-acid, watery vapour, and nitrogen, in varying proportions.

Fire-damp is a chemical substance, otherwise known by the name of mine-gas, or marsh-gas, and is composed of one equivalent of carbon, and two equivalents of hydrogen. It is a light substance of specific gravity 0.559, air being 1.000, and by its lightness has a tendency to rise to the uppermost part of a chamber, notwithstanding the law of diffusion; but I have found that the lower strata contain less than the top strata in a chamber. Yet this is not invariably the case, for I found in a return airway in the Hetton Colliery, a uniform atmosphere of three per cent. of fire-damp. Fire-damp is combustible, forming carbonic-acid and water.

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Carbonic-acid gas is a chemical substance, composed of one equivalent of carbon and two equivalents of oxygen. It is a dense gas of specific gravity 1.524, and of a poisonous nature; its density causes it to flow to and accumulate upon the floor of a chamber. In an atmosphere containing ten per cent. of carbonic-acid, life can be maintained for a short time only, and a candle for a still less time; indeed, Dr. Angus Smith has observed, that three per cent. is fatal if the percentage of oxygen falls below eighteen per cent. in the same atmosphere.

Possessing this information, I visited some pits, that I might see the precise conditions to be met, and I placed before myself the problem how to make known, by their own agency, the existence of substances so varying as carbonic-acid and fire-damp. It was perfectly manifest that the specific gravity, as specific gravity, which had been proposed by others must fail because of the dust and currents of air in the pits, but these thoughts developed the idea that specific gravity as a diffusion-agent would be the plan, and I have, up to this date, been unable to improve the first-formed idea, although I have been enabled to greatly simplify the mode of operation. I felt all along that if the existence of dangerous gases could be made known to the master without man's agency, then the servants would be more particular to observe the laws laid down by the master, and so conduce to the welfare of all.
The plans which suggested themselves to me, I now submit to you, hoping that you will be disposed to give them a fair trial in your pits for a year, because I feel that a new thing as the world calls it, takes some time before it becomes acclimatized.

Fire-damp and choke-damp accumulate slowly under some conditions and rapidly under others, there are, therefore, two main divisions to be met; and I will first explain how I propose to indicate the existence of a slowly accumulating mass of gas in a "goaf" or other place. For the purpose of indicating by signal a slowly accumulating mass of fire-damp or of carbonic-acid, I use a balloon of thin India-rubber, for, singularly enough, both these gases cause an expansion of the balloon. At first sight, one can understand how marsh-gas expands the balloon by the law of diffusion, but that carbonic-acid should also expand it, is so surprising that the effect will require to be explained by a law not yet discovered.

The balloon is filled with atmospheric air, and its neck tied tightly with silk or wax-end, and a piece of linen is bound round the equator of the balloon to prevent lateral expansion. The balloon so prepared is placed under a small lever, upon a stand of wood, so that it

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exerts a gentle pressure on the lever. If now any fire-damp or carbonic-acid accumulate round it, either of these gases pass through the substance of the India-rubber balloon, and, accumulating inside, causes it to expand, thus to press against the lever, and raising it releases a detent by which the terminal poles of a battery are connected, whereby we get telegraphic communication with a distant place, or a warning on the spot at will.* The action of gases through India-rubber has been explained by assuming that the gases dissolve in the outer coats of the India-rubber, and in solution pass through and evaporate from the inside. This proposition is rather fascinating, but I cannot regard it as the true explanation; I am, therefore, engaged in investigating the facts in a larger field, and at a future time hope to have the honour to bring the law, if I am permitted to discover it, to your notice. Until that time I must consider this paper incomplete; yet, this fact does not affect the action of the instrument. I am simply unable to say why the India-rubber behaves as it does. I somewhat claim your indulgence, because, although I have worked hard at this matter, I have found it impossible to do more than elaborate my plans to their present point. If you will consider that my duties at the Mint oblige me to leave home at seven a.m., and detain me from home till seven p.m., and that I have, therefore, the evenings and the early hours of the morning to work at my own pleasant studies, I feel sure that you will excuse me from any apparent disrespect in bringing to your notice an incomplete subject; therefore, I have explained why I have not completed my investigation, so full of other and startling results.

Gases which pass through India-rubber are retained within it so long as the outside atmosphere remains unchanged, that is to say, no effusion takes place as is the case through ordinary diffusion-septa, hence the balloon does not admit of the mechanical escape of its contents.

These balloon instruments can be so arranged as to tell if the accumulation be still free from danger, or if it be explosive.

In the event of a sudden irruption of fire-damp, I propose to apply the law of diffusion in all its simplicity; for, by this instrument, I show at once if there be gas, and I believe that no irruption can
be so sudden that this instrument cannot tell of its approach, in from five to ten seconds, according to the per centage of fire-damp contained in the dangerous irruption. It may be so delicately set as to give warning if

* It must be noted that the temperature of a given place in a mine, does not vary from year's end to year's end.

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the mixture be still below the explosive point. The instrument consists of an iron funnel, whose stem is U-shaped, the funnel being closed with a plate of unglazed Wedgwood ware (in my first experiments I used a broken flower-pot), the stem being closed by a cap of brass, through which is passed a platinum-tipped copper wire, capable of just dipping into the mercury previously placed in the bend of the funnel. The distance between the platinum-pointed wire and the mercury regulates the point at which the indication should be given as regards the irruption; that is to say, if a non-explosive irruption is to give its warning, the wire must be brought almost to touch the mercury; but if it be intended to give an alarm for an explosive amount, then it may stand a little farther off, but in no case to exceed the thickness of a shilling. If, when the instrument be ready, gas impinge on the porous tile, diffusion taking place, the pressure of the accumulating gas forces the mercury against the platinum-pointed wire, and the circuit being thus completed, telegraphic warning is given on the spot, as well as in the manager's room, if such be desirable, either by a needle or by a bell. I have on the table one of these instruments, and I now show its action.

The instrument just described is intended to meet such cases as are reported to occur occasionally where, in evidence, it has been stated that from the fall of coal, or the breaking into old workings, a volume of gas is suddenly released; and it would, therefore, be of use in the case of men working where such events are likely to take place. But if the accumulation be extended over half or even a quarter of an hour, then that instrument would be useless, because effusion would counteract the effect of diffusion. The case of gas accumulating in a working place during the absence of the men at dinner has been brought to my notice, and this case I will endeavour to meet but at present I am of opinion that the India-rubber balloon cannot be made to give its warning in so short a time. Therefore, I must find another substance, possibly cast-iron.

So far, I have endeavoured to provide for unknown accumulations; but in the case of known accumulations, I have considered that if the amount per cent, could be readily ascertained, then measures, in proportion, could be taken to sweep out by ventilation such a dangerous mass. I have tried instruments upon many plans, all acting by diffusion, and with many I have obtained splendid results; such, for instance, as with a column of water or of mercury; but in all cases changes of temperature would be fatal, unless in the hand of a scientific man. Then, again, there

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is another action depending on the exchanges of the proportions of the gases composing the atmosphere which leads to errors. I have, therefore, been led to use the Aneroid barometer, which, although far from being a perfect instrument, is still reliable, and may be depended on till a better is discovered. In this place, I may say that Mr. Short is now at work at a most beautiful pocket
indicator, which we have reason to believe will avoid all the difficulties of the Aneroid, and be simply an indicator, not a compound instrument, answering other purposes, as does the Aneroid-indicator.

I am aware that that marvellous arrangement, the Davy-lamp, gives magnificent indications; and I may be asked why attempt to go beyond it? I reply, I hope to supplement it by another indicator, for it must still be used with my proposed instrument; yet I am not without hope that I shall soon make my instrument self-registering, then I shall hope it will be even more useful than in its present form.

The instrument I now desire to explain to you is an Aneroid barometer of the most delicate construction, the brass back of which has been removed, and its place occupied by a porous tile. There are, beside, one or two minor alterations—such, for instance, as a small valve, to be used at pleasure. This instrument acts by pressure on the outside of an Aneroid chamber, which, by a system of levers, causes a hand to travel over a dial face, which is graduated to inches, just as the ordinary Aneroid is; so that it can be used as a barometer, and as such can be relied upon. If we desire to experiment for fire-damp, or for choke-damp, by means of this indicator, it must be taken into the neighbourhood of the suspected atmosphere, and laid on the floor or held by the ring-handle till it has become of the same temperature as the new place. It is absolutely necessary to follow these instructions, because when the valve is closed the instrument is affected by change of temperature. When the temperature is equalised, which is usually a short time, and may be known by the fact that the hand remains stationary after the valve is closed—(the valve is closed by screwing it tightly, and the position of the hand recorded)—then the brass cap, which protects the porous tile, is removed, and the instrument held up into the suspected atmosphere, when, in about forty-five seconds, the maximum effect is produced; and at this time it is necessary to read the barometer accurately, because the maximum point having been reached, effusion takes place, and the hand travels back to zero. Effusion is the mechanical passage of gas through the tile by pressure alone, and takes place in proportion to the specific gravity of the gas under experiments. This action proceeds with the diffusion. Hence we never obtain all the effect calculated upon; but directly diffusion ceases, effusion continuing empties the chamber of gas, so that if the instrument be held long enough in the same atmosphere, the hand will return to zero, whence it started, and remain there till the instrument is taken into a purer atmosphere, or into one more fully charged. If into an atmosphere more fully charged, the barometer will rise, and this increased reading must be added to the other reading, so as to obtain the amount present at the new place. Thus, in one reading, it gives three per cent. of fire-damp. This atmosphere remains, and the hand returns to zero; but the instrument is placed in an atmosphere which gives seven per cent, on its face, therefore the 7 + 3 = 10 per cent., which can be confirmed by taking the instrument into the intake gallery for a few minutes, and then putting on the cap carry back the instrument to the suspected atmosphere, and it will at once indicate the ten per cent.

All the time the valve is open the instrument is a barometer, therefore it indicates change of altitude, and at the spot one wishes to test, the valve is closed; a knowledge of this will preclude the possibility of mistaking change of altitude for gas. I feel sure that a few intelligent observations will make any man as perfectly acquainted with the indicator as with his watch.

It is imperative that the instrument be held by the ring-handle, else its action cannot be relied on. I have found that the following figures are to be relied upon for fire-damp and for carbonic acid:
I have much pleasure in offering to Mr. Thomas W. Short* my most sincere thanks for his valuable cooperation. I had considerable difficulty

* Of the firm of Marratt and Short, 63, King William Street, London Bridge, who are the makers of my instruments.

in meeting with any gentleman who would undertake to construct my instruments, in fact, attempt to carry out the ideas I endeavoured to convey to them; at last I met Mr. Short, and he with the true spirit of an Englishman faced all difficulties, determined only to overcome them; but not satisfied with this much he has given me most valuable advice and assistance in suggesting many, very many advantages, and I feel that it is not too much to say of Mr. Short, that unless he had assisted me, I could not have had the honour of appearing here to-day to render to you an account of my apparatus, and to beg you to adopt it in your pits if you shall find it worthy. In conclusion, allow me to thank you for your attention, and Mr. Doubleday for the extreme courtesy he has extended to me.

THE CHRONICLES AND RECORDS OF THE NORTHERN COAL TRADE IN THE COUNTIES OF DURHAM AND NORTHUMBERLAND.

By WILLIAM GREEN, Jun.

Having frequently experienced the want of a Book of Reference in matters relating to the Coal Trade, I have been induced to compile the accompanying Chronology.

In doing so, I have availed myself of all the information upon the subject within my reach, and have not hesitated to appropriate whatever met my views in local histories, records, newspapers, and Parliamentary reports; as also the works of various authors who have written upon the Coal Trade, including the late Mr. Thomas John Taylor, the Messrs. Nicholas Wood, Dunn, Greenwell, Hunt, and others.

I am aware that the compilation is exceedingly bald and imperfect, and that there are few members of the Institute who could not materially improve and enlarge it; such as it is, I have great pleasure in presenting it to the Institute.

To commence with the period of the Roman occupation of England, we have abundant proof, from the traces of workings and remains of coal found in and near their stations, that they were acquainted with the uses of this mineral.
Horsley remarks—"There is a coalry not far from Benwell, a part of which is judged by those best skilled in such affairs, to have been wrought by the Romans."

Lysons, in his Cumberland, when remarking upon the Roman station near Maryport, says, "Glass vessels, and even mirrors, were found, and coals had evidently been used in the fire-places."

Dr. Bruce, in his work on the Roman Wall, states—"In nearly all the stations of the line, the ashes of mineral fuel have been found; in some, a store of unconsumed coal has been met with, which, though intended to give warmth to the primeval occupants of the isthmus, has been burnt in the grates of the modern English. In several places the source whence the mineral was procured can be pointed out; but the most extensive workings that I have heard of, are in the neighbourhood of Grindon Lake, near Sewingshields. Not long ago, a shaft was sunk with a view of procuring the coal which was supposed to be below the surface; the projector soon found that though coal had been there, it was all removed. The ancient workings stretched beneath the bed of the lake."

In a paper read by Mr. Gibsone, before the Northern Institute of Mining Engineers, he remarks—"At Hallows Bridge, upon the Esk, is a small Roman post in a sort of angle formed by two steep rocks facing the water; and a deep ditch has been cut for defending the other side, with the usual military bank. On digging into this ditch, I found the coal cut out as well as the covering soil, and little doubt can be that the old Roman soldiers worked and burned coals during their weary and cold stay."

Numerous other instances might be named of coals and cinders being found in Roman stations, as at Caervorran and Borcovicus stations in Northumberland, and Brierly in the West Riding of Yorkshire.

The Saxons also, it would appear, by an extract from the Saxon Chronicles of the Abbey of Peterborō’, were not unacquainted with the use of coal, for in the year 852 occurs the payment of twelve loads of fossil or pit coal to the Abbey, probably required for smith work, for at this period, and for centuries after, the immense forests with which the island was covered, supplied the fuel required for domestic purposes.*

1180. Among the earliest notices we have of coal being wrought in the northern coal-field in Norman times appears the following from the Boldon Book, viz., the grant from Bishop Pudsey of a toft and croft to

Pennant mentions a flint axe or celt found in a vein of coal where it bassetts out at Craig-y-Parc, in Monmouthshire, and from this circumstance, and there being a British name (glo) for coal, it is supposed that the Britons were acquainted with the fossil.

* The Saxon name col (now coal) appears to have superseded the old British name glo, and if introduced into Britain at the colonisation of the country by the German tribes, it is in favour of the supposition that the art of coal mining was practised in Europe during the first centuries of the Christian era.—Hull’s Coal-fields.

a collier for providing coals for the cart-smith of Coundon. A similar grant was made to the smith of Sedgefield; and the smith at Bishopwearmouth had twelve acres for the iron work of the carts, and finds his own coal (carbonem).
1233-1238. We now come to the period when coal began to be worked in the neighbourhood of Newcastle. In "Ross' Book of Dates," 1233 is named as the time when coal was first discovered at Newcastle, but doubtless it was long antecedent to this date, for we find that coal was wrought in the high grounds at Fenham, near Newcastle, not far distant from the Roman coalry spoken of by Horsley.

1239. On the 1st day of December, 1239, in the twenty-third year of his reign, Henry III., upon the application of the good men (probi homines) of Newcastle, granted them license to dig coals and stones in the Castle Field and the Forth, and from thence to draw and convert them to their own profit, in aid of their own fee-farm rent of £100 per annum, and the same as often as it should seem good unto them.

Eddington, in his Treatise on the "Coal Trade" (1813), states, regarding the working of these mines:—"It may be seen to this day, where the water-course comes out to the surface at Gallowgate, from near the bottom of the Moor, the high-main runs out, the only coals they wrought were the metal-coal, which lies about five fathoms below the high-main, the seam about thirty-two inches thick, pretty good, and about four and a-half fathoms below lay the stone-coal, about thirty inches, pretty good."

1246. In an inquisition of this date, sea coal (carbo maris) is named, leading to the presumption that coal had become an article of export. A very few years later, Mathew Paris, not only speaks of carbo maris, but of the wages of the persons employed to dig it.

1272. Henry III. granted a charter to the town of Newcastle, in which he gave the inhabitants a license to dig coal in the Frith; but, as Gardner says, no land was granted above the said coal.

Extract from John Trotter Brockett's additions and corrections to Spearman's Enquiry into the Ancient and Present State of the County Palatine of Durham.

RANDALL MS.

Liberties claimed within the Manors of Barnard Castle, Raby, and Brancepeth, Circa 13th century.

"Tennants of Raby clayme to have their coles at 0.6 a corfe lode and the one rope till they be served."

"Tennants of Tudhoe to have their coles at 0.6 the corfe, and the corfe to conteyn 6 peckes upheaved Durham measure, which now is but 3, and they pay 0.6. Everie pitt ought to be filled and rayled or else well covered."

"And to have their coles at Hargill pitts for 1d. a wayne lode and 0.6 a corfe and at Brandon pitts at 0.6 a corfe, and at Thorneley pitts 6d. a wayne lode."

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1281. The coal-trade had, at this period, increased so much as to double the worth of Newcastle in the shape of revenue from £100 to £200 per annum.

1305. The artisans, brewers, and smiths in London were now in the habit of using coal for their crafts, because wood in populous districts was already becoming scarce. The High Court of Parliament formally appealed to Edward I. to prohibit the further consumption of coal, as the smoke
arising therefrom contaminated the atmosphere, and rendered it unfit for his leige subjects to breathe. In the next year, 1306, its use was prohibited by proclamation in London and its suburbs, to avoid the sulphurous smoke and savour of the firing, but little regard appears to have been paid to the prohibition, as we find that 10s. worth of coals were burnt at the coronation of Edward II.

1325. This year we have the first account of the foreign exportation of coal from Newcastle: a French ship having arrived in the port, laden with corn, and returned with a freight of coals.

1327. Brand remarks that at this time the measure and increase of sea-borne coals having become an object of consideration, we may infer that coal had become an important article of commerce.

1330. About this period two collieries near Elswick (Elstewyke) are mentioned as being let by the Prior of Tynemouth to Ada de Colewell, for £5 per year, and another near at six merks a year.

1333. At this date a colliery is spoken of as existing at Collierly, near Lanchester.

Marco Polo attests the general use of coal among the Chinese in the 13th century.

As a notice upon working coal, extracted from Captain T. W. Blakiston’s "Five Months on the River Yang-Tsy, China, in 1862," may not be uninteresting, I give it in full.

"In the gorge (at Ping-shan, 1,800 miles from Shanghai) we noticed a method of working the coal which we never observed before. Having to be got at a great height up in the cliff, very thick hawsers, made of plaited bamboo, are tightly stretched from the mouth, or near the mouth of the working gallery, to a space near the water where the coal can be deposited. These ropes are in pairs, and large pannier-shaped baskets are made to traverse on them, a rope passing from one over a large wheel at the upper landing, and down again to the other, so that the full basket going down pulls the empty one up, the velocity being regulated by a kind of brake on the wheel at the top. At some places the height at which the coal is worked is so great that two or more of these contrivances are used, one taking it to a landing half way down, and another from thence to the river. The hawsers are kept taut by a windlass for that purpose at the bottom. The quantity of coal worked in this gorge is very large, and numbers of boats are employed in transporting it to Su-chow."

In another part of this book, Captain Blackiston speaks of finding coke in use, also of coal being pounded up, mixed with loam and water, and then dried into bricks. He further remarks that the coal is bituminous, and has a micaceous sandstone cover.

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1338. Mention now occurs of coal-staiths.*

1343. Coal was, at this date, wrought in the neighbourhood of Merrington and Ferryhill.

1344. At this date Bishop Bury granted a lease of the mines, under the manors of Whickham and Gateshead, to Sir Thomas Gray, knight, and John Pudbore, Rector of Whickham, for twelve years, under 500 merks rent. The lease was renewed to the same parties by Bishop Hatfield in 1356.

1350. The late Mr. Thos. John Taylor, in his Archaeology of the Coal Trade, remarks, that the coal seams at Gateshead and Whickham were now being worked, these being situations where the coal approached the surface, for as yet no attempt had been made to win the deeper portions of the coal-field.
The mines were freed from water by day levels, and the coals were drawn up by the jack-roll. The produce was taken away from the pits by pack-horses, their load being about three cwts., carried at the rate of three miles an hour.†

1351. This year Edward III. granted a license to the freemen of Newcastle to work coals without the walls, in the castle-field.

Birtley district, about this time, appears to have been producing coals.

1354. Coal mines were leased, at this date, at Ferryhill, to the Prior of Durham for thirty years. The lessee bargains to be allowed half a cart load of coals every week, in which coals should be won and worked. Particular mention is made, in this lease, of drifts for the purpose of carrying off water.‡

The author of Fossil Fuel remarks, that in every period of the history of coal mining in the north, wayleaves have formed an important item of expenditure. A covenant for "sufficiens chiminum" occurs in the latter sense to the Prior of Durham in 1354. Chiminum is a term implying a right of way or road. §

"'Stathe,' ' stade,' or 'steed' are Anglo-Saxon terms, formerly applied to single fixed dwellings, or to places on the banks of rivers, where merchandise was stored up, and at which vessels could lie to receive it."—Picture of Newcastle.

†Within the last twelve years the Western Dales, in Yorkshire, have been supplied with coals from Butterknowle Colliery, carried on the backs of droves of mules.

Mr. Tone, the engineer, in a paper read before the British Association in 1863, says, that the pack-horses travelled upon an average about eight miles, with his load, and the cost of this mode of conveyance might be 1½ d. per cwt. per mile, or 30d. per ton per mile.

‡ Surtees.

§ In Bishop Hatfield's Survey it is stated that the Master of the Hospital of

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1358, May 10. Edward III. confirmed the license of the men of Newcastle to work coal in the Castle-field and Castle-moor, as they had immemorially possessed. He also issued orders concerning coal measures, etc. ||

1364. Mention now occurs of a coal mine in the fields of Gateshead.¶

1367. In this year the Bishop of Durham appointed a Nicholas Coke, of Newcastle, to be the supervisor of his mines, within the manors of Whickham and Gateshead, for which duty he was paid 13s. 4d. per annum.

1367. The accounts of Adam-de-Horeyndon, of this date, furnish some curious proofs of the difficulties which must have attended extensive building works in the fourteenth century. As in earlier times, all the metal work was executed on the spot, and forges and furnaces were built for the smiths and plumbers. These furnaces and forges required fuel, and it had already been discovered that coal was a more efficient material than wood. Owing, however, to the prejudice of the Londoners against that mineral, on account of its effect on the external appearance of their
habitations, no supply of it could be procured in the metropolis, and the King’s Master of the Works was compelled to buy a cargo at the pit’s mouth, in the county of Durham. According to the custom of the time, the King sent his writ to the Sheriff of Northumberland, ordering him to buy the coals and send them to London. The Sheriff purchased 576 chaldrons by the long hundred, which make 676 chaldrons reckoning by the lesser hundred, at Winlaton, in the county of Durham, at 17d. per chaldron (20 of these chaldrons went to the Keel, so that it would appear that they were little more than a ton each). From Winlaton they were conveyed in keels to Newcastle, and there shipped. The freight to the south was at the rate of 3s. 6d. a chaldron. On their voyage to London the colliers met with a “mighty tempest” at sea; and through that, and by reason of the excess of measure over that of Newcastle, a loss of 86¼ chaldrons was incurred, the greater part having been thrown overboard during the tempest. Arrived at London, the coals were put on board “shutes” or barges, and taken to Windsor, at the cost of 1s. a chaldron. The total expense of bringing this insignificant quantity of

St. Edmund the King (in Gateshead) holds one plot of ground “pro quodam chamino habendo,” or wayleave from the hospital to Freregose (now Friar's Goose), through the Lord’s meadows there, and pays 4d. Chaminum means “a road,” and, unless the context shows a wayleave is meant in its technical sense, it would not necessarily have that signification.

fuel to London, including the cost price, was £165 5s. 2d., to which must be added the barge hire to Windsor. *

1375. By an inquisition post mortem, taken at this date, Vavasour’s Colliery, on Cockfield Fell, is valued at 20 merks, when let to farm. This is only one instance of many, of the longevity of a colliery; coal being now worked, after a lapse of nearly 500 years, upon a larger scale than ever upon this Fell.†

1378. At this date we first find the name of keelers (keelmen) applied to the bargemen of Tynemouth Priory. The keels were manned by five hands, who had sixpence each for their work in taking the coals from Winlaton to Newcastle, with twelvepence for the line of each keel. ‡ Keels are now manned by three men and a peedee (boy), or even fewer hands.

1379. This year a tax of sixpence per ton, every quarter of a year, was imposed upon ships loaded with coals from Newcastle to foreign parts. This is the first notice we have of export duties in connection with coal. §

1384. Richard II. grants a charter to the Bishop of Durham for the mooring of ships, the loading and unloading of coals, etc., in the River Tyne, without molestation from the men of Newcastle. ||

1384. The Bishop of Durham appoints Thomas Hannsard supervisor of his mines of coal and iron, in his royalties of Norhamshire¶ and Bedlingtonshire. **

1395. A notice occurs at this date, of four chaldrons of coals being shipped at Sunderland for Whitby Abbey, for which was paid 13s. 4d.

1402. The price of coals about this period was 4s. 8d. per chaldron.
1404. By the fifth statute of Henry IV., of this date, Hostmen were established to provide and entertain "merchants and aliens," resorting to Newcastle, to buy coals or stones (grindstones).

1404. A receipt occurs to the Mayor, Aldermen, and community of Newcastle, bearing date March 4, 1404, for £12 10s., stating, in part payment of the sum of £37 10s., due the Michaelmas following, for rent of mines of sea-coal at Fenham, to the Prior of the Hospital of Jerusalem, in England.

* Extract from the "Pipe Rolls of Edward III." See the late Mr. T. J. Taylor's "Archaeology of the Coal Trade."

† Hutchinson's History of Durham.

‡ In early times, Gardner says, that ships were required to load as near Newcastle as possible.

§ Brand. ¶ Brand. ** Brand.

1407. An agreement, bearing this date, between the Sub-Prior of Durham and others, authorises the cutting of a trench for carrying off the water and winning the coal at Hett.

1427. By the ninth Henry V., keels were regulated to carry twenty chaldrons of six bolls each; some keels had been carrying twenty-two and twenty-four chaldrons, to defraud the King. Keels were now required to be sealed by the King's officers. Each chaldron of coals sold to persons not franchised in the port of Newcastle, was liable to a King's duty of twopence.*

1489. The Bishop of Durham this year attempted a negotiation with Sir John Paston, of Norfolk, for an exchange of coal for corn, wine, and wax, "whereby our familiarity and friendship may be increased."

1512. In the celebrated "Household Book" of the fifth Earl of Northumberland, of this date, mention is made of eighty chaldrons a year of sea coal, at 4s. 2d. and 5s. per chaldron, being allowed, as also sixty-four loads of great wood, to make the coals burn, "because," observes the writer, "colys will not byrne without wodd."

1529. This year, Cardinal Wolsey constituted William and Thomas Thornlyngson, clerks to his "mynes," by the following instrument: — "Thomas, by Divine mercy, Presbyter Cardinal of the title of St. Cecilia, in the Holy Church of Rome, Archbishop of York, Legate, as also de Latore of the Apostolical See, Primate and Chancellor of England, and Bishop of the Cathedral Church of Durham, to all to whom these our present letters shall come, greeting. Know ye, that we of our especial grace, and in return for the good and commendable services hereto performed, for us, by our beloved servant William Thornlyngson, of Gateshead, and henceforth shall faithfully execute for us, our successors, and the Church of Durham, do ordain, and have constituted William Thornlyngson himself, and Thomas Thornlyngson his natural son, clerk of all our mynes, as well of lead and iron as of coals, being wheresoever within the demesne lands of our Bishoprick of Durham, and by these presents we give and grant the said office of clerk of the mynes to the said William and Thomas jointly and separately, to have, exercise, and enjoy by themselves personally, or their sufficient deputy, for whose behaviour they shall be answerable, during the term of their lives, or of the
survivor, receiving yearly in the said office of us and our successors, during the term of the said William and Thomas, and the survivor of them, ten merks of English money, to be paid at our

* Brand.

Exchequer of Durham, at the Feast of Michael the Archangel, by the hands of our General Receiver who shall then be in office. We likewise give and grant to the said William and Thomas, and to the survivor of them, one chalder of coals of each coal mine belonging to us and our successors within our demesnes of Gateshead, Whickham, and Lynne-deanne, to be duly paid and delivered, together with all other profits, advantages, rights, costs, and expenses of old, accustomed and pertaining to the said office, and in as extensive manner and form as in the said office any clerk formerly had and received, or used to have and receive. And we firmly command all and singular, our bailiffs, farmers, and officers in the said mines, that they shall be observant, obedient, and assistant to the said William and Thomas, and to each of them, in the performance, execution, and possession of the aforesaid office, as in decency they ought. In testimony whereof, we have commanded these our letters to be made patent. Witnessed by Wm. Frankeleyne, our Chancellor of Durham, the 6th day of October, in the sixth year of our Pontificate, and in the year of our Lord 1529."

1530, May 20. James, Bishop of Durham, granted a lease of coal mines in Whickham, to Bertram Anderson, of Newcastle, merchant adventurer, for twenty-one years, at a yearly rent of £30.†

1530, June 24. The Prior of Tynemouth leased a coal-pit at Bebside and Cowpen for seven years, at the annual rent of 22s. 8d. The same year he leased Elswick Colliery to Christopher Mitford, for twenty-five years, at the yearly rent of £20; the lessee not to dig or draw more than twenty chaldrons of six bolls (2,000 lbs.) to the chaldron, for every working day in the year.‡

1530. A grant of wayleave occurs this year from Bishop Ruthall, for "carriage by wayne, coupe, or horses, from the coal-mines and pits now opened, or which shall be opened, in Ravensall and Eighton, through all the grounds, waists, and moors of the said reverend father, for twenty-one years, at 5s. rent.§

1536. Coals sold at Newcastle for 2s. 6d. per chaldron of six bolls each; coals sold at London for 4s. per chaldron of six bolls each.||

1538. Two pits were let at Elswick for eight years, at the annual rental of £50. In this lease, sufficient "wayleve and staith leve" were provided for.

1539. Gateshead coal mines let.

1539. The society or fraternity of keelmen instituted.¶

* Bourne, † Brand. ‡ Gibson. § Longstaffe. || Stowe. ¶ Brand.
the greadie covetous myndes of ye sellers of ye same, as well as by the untrue measures of coales
lytle and lytle continuallye mynished." *

The coaflowers were also charged with the mixing of coals, which they admit and justify, saying
"There is a necessitie for some myngelynge, for the best and chieffest coals are not useful without
some alloy or mixture."

1554. Queen Mary granted a lease of all the mines within the bounds of Elswick, at the annual rent
of £68.

1572. John Killinghall, Esq., mentions in his will, his leased "cole pittes" at Wyndleston and Ryton. †

1575. In a grant made by the Bishop of Durham, the lessee of certain mines is to have sufficient way-
leave to the water of Tyne, where he was to have a staith to lay the coals on. ‡

1577. The following extract, from Harrison's description of England, prefixed to "Hollingshead's
Chronicles," dated this year, is interesting:—"Of cole mines, we have such plenty in the north and
western parts of our island as may suffice for all the realme of England. And soe must they doe
hereafter indeede, if wood be not better cherished then it is at present, and to say the truth,
notwithstanding that very many of them are carryed into other countries of the maine, yet theyr
greatest trade beginneth to growe from the forge into the kitchen and hall, as may appear already in
most cities and townes that lye about the cost, where they have little other fewel excepte it be turfe
and hassocke. I marvayle not a little that there is no trad of these into Sussex and
Southamptonshire, for want whereof the smiths do work their yron with charre-coal. I think that farr
carriage be the only cause, which is but a slender excuse to inforce us to carry them unto the myne
from hence."

1579. The Mayor of Newcastle wrote to the bailiffe of Yarmouth to forbid their ships to come as
usual for coals on account of the plague.

1580. Coals sold at Newcastle at 5s. a chaldron.

1582, April 26. Queen Elizabeth obtained the lease from Richard, Bishop of Durham, of the manors
of Gateshead and Whickham, and

According to Stowe, "The nice dames of London would not come into any house or roome where sea-coales
were burned, or willingly eat of the meat that was either sod or roasted with sea-coale fire."

* Taylor. † Longstaffe. ‡ Fossil fuel.

all the coal mines within the said manors, at the rent of £90 per annum, for ninety-nine years; which
lease the Earl of Leicester procured from the Queen, and transferred to Sir Thomas Sutton, of the
Charter-house, who, for £12,000, sold the same to Sir W. Riddell and others, for the Mayor and
burgesses of Newcastle.* This lease was called the "Grand Lease," † and was understood to be of the
yearly value of £50,000. According to Brand, the annual rent to the Queen was £117 15s. 8d. This
lease was much complained of on the score of monopoly; for whilst Sutton held it, the price in
London was 6s. per chaldron, but on its assignment to the Corporation of Newcastle, the price rose to 7s., and soon after to 8s. per chaldron of six bolls. 

1590. Brand relates that the price of coals appears to have been advanced to 9s. per chaldron, upon which the Lord Mayor of London complained to Lord Treasurer Burleigh against the town of Newcastle; setting forth that the society there, called Free-hosts, on whom the "Grand Lease" (Gateshead and Whickham Manors) was fully assigned for the use of the town, consisted of about sixty persons, who had made over their right to about eighteen or twenty, who engrossed all other collieries, viz., Stella, the Bishop's Colliery, Ravensworth Colliery, the mines of Mr. Gascoign, and the colliery of Newburne, requesting that all the collieries might be opened and wrought, and that the price should not exceed 7s. a chaldron.

1599. Queen Elizabeth demanded such great arrears of the coal duty, that the people of Newcastle, finding they could not pay, agreed to charge themselves and their successors with 1s. per chaldron duty. At this period the duty upon coals exported beyond the sea was 5s. per chaldron.

Towards the close of Queen Elizabeth's reign, the duty of the town, at 4d. per chaldron, appears to have brought in £10,000 per annum to the Corporation.

* Gardner's Grievance.

† The title of "Grand Lease" is still retained in that held by the Stella Coal Company.

‡ Dunn.

§ In reference to this complaint Henry Mytforde and Henry Chapman, aldermen and cole-owners of the town of Newcastle, were called upon, for themselves and other cole-owners, on the information exhibited to the Right Hon. the Lords of Her Majestie's Privy Councell, by the Lord Maior and Aldermen of the city of London, to explain the causes of the excessive pryces of coles inhande at Newcastell aforesaid.—See Reprint, by Moses Aaron Richardson.

|| Brand

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In the latter part of the sixteenth century, the use of coal was pretty general for manufacturing and culinary purposes, but not for domestic fires.*

1600. The Society of Hostmen had existed as a fraternity from time immemorial, before their incorporation by Royal Charter, which took place March 22, 1600, when the Hostmen obliged themselves to pay 1s. per chaldron of coals exported from Newcastle to the free people of England. Forty-eight persons are named by the Great Charter of the town of Newcastle. 

1600. At this time waggon-ways had not been invented, and the coals were brought down from the pits in wains, of eight bolls each (lately several had only brought seven), all measured and marked at the staiths on the river, but maunds or panniers, carrying two or three pecks each, were used for horses.

1602. From books of the Hostmen, it would appear that there were twenty-eight acting fitters, who were to vend 9,080 tens, or 190,600 tons of coals, and find eighty-five keels for that purpose. Prices
were ordered to be not above 10s. per chaldron for best sorts; 9s. per chaldron for second sorts; and 8s. per chaldron for "meane coales."

1604. Charles Killgoure, the Farmer's Collector, complains that the ships are continually in the habit of clearing for a smaller number of chaldrons than the ticket expressed, by three, five, six, and ten chaldrons. In the bitterness of his heart he affirms, "That there is no truth in colliers." §

1606. Mr. Bowes, who died in 1606, remarks in his papers: — "There is coles gotten in five several places of the Biddick estate, the fur-

* Taylor. †Brand.

‡ The late Mr. T. J. Taylor, writing upon the measures in use about this time in his Archaeology of the Coal Trade, says—" The original chaldron was 2000 lbs. weight. In a lease of mines from the Prior of Tynemouth, the chaldron is rated at 6 bolls. 7½ bolls were equal to very nearly 2000 lbs. weight, modern Custom House measure. Keels were used as early as 1421 to carry 22 or 23 chaldrons of 2000 lbs. each. If from the London chaldron a right proportion is deducted for heaped measure, we shall have left almost exactly 2000 lbs. weight as above.

"The coal boll was probably derived from the corn boll, what a man could carry. The bowl tub of Newcastle is described to contain 22 gallons and a pottle, Winchester measure. A wain to contain 7 bolls each, a cart 3 bolls and 1 bushel heaped measure. Three wains or 6 carts to a chaldron.

"Wain x 3 = 21 bolls = 1 chaldron. 21 chaldrons x 10 = 210 bolls or 1 ten.

"It is manifest that the kele and the ten were at this period synonymous, and that the kele carried 10 of these chaldrons, the size of which is afterwards particularly specified in the Act of 30 Car. II., and which constituted the then Newcastle chaldron. It is also clear that the keel-load consists of 10 scores of the bolls of that period, 21 to a score, and we are thus enabled to trace the origin of that singular denomination of quantity and weight, the modern ten."

§ Taylor.

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thest place thereof is not three miles from the house; and I have sonke a shafte within the domaine, having only bestowed £4 charges, and have already gotten some coles, which if the seame of coles prove to be three-quarters of a yard thick, the same, with £200 stocke, will yield £200 per annum clear profit.

1609. Vend of coals from Newcastle at this period:—Coast, 214,305 tons; foreign, 24,956 tons; total, 239,261 tons. Sunderland:—Coast, 9,265 tons; foreign, 2,383 tons; total, 11,648 tons. Blyth:—Coast, 855 tons; foreign, nil; total, 855 tons.

1610. Sir George Selby, in Parliament, said that the coal mines of Newcastle could not hold out the term of their leases of twenty-one years. This was on account of the cost of draining them to any depth.

1612. Simon Sturtevant obtained a patent for making iron with pit and sea-coal.
1615. Four hundred ships are reported at this date to have been employed in the Newcastle coal trade, half of which supplied London, and the other half the rest of England, besides French and Dutch vessels, for the supply of their respective countries.

1616. This year 13,675 tens of coals were shipped at Newcastle. Brand states that the use of coal was now becoming general for want of wood.

1618. A notice of a colliery working in the Moncton (Hebburn) seam, near Jarrow, occurs at this date.

1622. The first mention occurs of Stockton as a coal-shipping port, ten chaldrons of coals having been exported.

The Fellowship of Hostmen were authorized to vend this year 14,420 tens of coals. At this period the French traded to Newcastle in fleets of fifty sail at one time.

1630. A duty of 5s. per chaldron was this year laid on coals sent foreign, and 1s. 8d., over and above, on such as were exported by any Englishman or denizen.

The coast vend at this time was 253,380 tons; foreign, 36,542; total, 289,922 tons.

1632. Wooden ways were now introduced; before their introduction we are told that the collieries of Kenton and Benwell employed between 400 and 500 carts and wains each, carrying coals from the pits to the Tyne.*

In 1619, Dad Dudley used pit coal for making iron in Worcestershire.

* The late Mr. T. J. Taylor stated the cost of the wooden rails, known in other parts of the kingdom as "Newcastle Roads," did not exceed from £400 to £600 per mile.

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On these ways three to four tons were conveyed from ten to twelve miles per day, or thirty to forty tons one mile per day; when cast iron rails were introduced, the quantity was increased from 120 to 140 tons one mile per day.

1632. The manor or lordship of Winlaton was formerly enjoyed in common by three lords. Sir William Selby had a moiety, and Sir Robert Hodgson and Mr. Robert Anderson, the remainder. About this time (1632) they came to a division of ye lordship, but the royalties, mills, and grounds therewith enjoyed, collieries and quarries were not divided.

1635. Price of coals at Newcastle, 10s. per chaldron; coals used at Shields Salt-pans, 7s. per chaldron, these being probably small coals.

1638. At this period the following well-known names appear among the coalowners, who (from a document of 1622) also appear to have been members of the Hostmen's Company, viz.:—Thomas Lydell, Sir Thomas Tempest, Sir Thomas Riddell, Knight, Sir William Selby, Sir Robert Shaftoe, Robert Bewick, John Clavering, Mrs. Barbara Riddell.
1638. Charles I., in the thirteenth year of his reign (1638), created a new Corporation of free Hostmen in Newcastle, and granted a lease for twenty-one years to Sir Thomas Tempest, Knight, with others, for the selling of all coals exported from the Tyne, with power to seize all coals sold by the owners of such coals.*

This year, when Newcastle was taken by the Scots, all the coal mines which had been wont to employ 10,000 people all the year long, some working underground, some above, and others upon the water in keels, were laid in, not a man to be seen, not a coal wrought, all absconding, being possessed with a fear that the Scots would give no quarter. More than 100 vessels which arrived off Tynemouth bar the day after the fight, returned empty. The same year, when the Scots besieged Newcastle, the Marquis of Newcastle ordered all coal mines to be fired, this was prevented by General Lesley surprising all the boats and vessels.†

1642. In January, an ordinance of Parliament prohibited ships from bringing coals from Newcastle, Sunderland, or Blyth; in consequence, coals were sold in London at £4 per chaldron, a price never known before that time; the poorer sort of people were almost "starved." On the

1640. We hear of coke being used in Derbyshire for drying malt.

Judging from the account of short measure sold by the coal dealers ("colliers") in London, given in a pamphlet published about this date (1640), entitled—"A Pleasant Discovery of the Coosenage of Colliers," it would appear that Charles Killyoure’s opinion of lack of honesty in colliers, need not to have been restricted solely to those engaged in the coal-trade in the north.

* Gardner. †Brand,

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21st March, a further order fixed the selling price of coals at 23s. the chaldron, and after the 1st of April next, at 20s. at the most.

1643. The Commander of the Parliament Forces at Newcastle sent up a quantity of coals for the relief of the poor in London.

1644. The trade with Newcastle reopened for coals, etc.

1644, November 17. Bourne states that the "Committee of both kingdoms, after many meetings and serious debates amongst themselves, and the hearing of sundry persons well experienced in the collieries and coal works about the town of Newcastle, and having taken into their serious consideration sundry propositions for the good of those works and the drawing on of the trade for the benefit of Parliament, and the pay of the army, have at length concluded and agreed amongst themselves, that some of the most notorious delinquents and malignants, late coalowners in the town of Newcastle, should be wholly excluded from intermeddling with any share or parts of collieries, or interest in any coals wharsomever that formerly they had laid claims unto." Then follow reasons for not ousting all those malignant coalowners at one time, and the prices that shall be allowed the coalowners for coals delivered to the ships, viz.—10s. sterling per chaldron; also, fixing the selling price of the coals to the merchant or shipper at 20s. per chaldron. The difference between the two prices to be applied to the public use by way of loan. The committee go on to
caution the coalowners to use all diligence in getting on foot their several coal works, under penalty in case of non-compliance of losing all benefit in them.

The malignant coalowners were Sir Thomas Marley, Sir Thomas Riddell, Sir Thomas Liddell, Sir Alexander Davison, Sir John Minns, and Sir Francis Anderson.

1644. The Colliery of Harraton, on the Wear, was at this time the property of Mr. Hedworth, and had been leased for a mere acknowledgment to Sir W. Wray, of Beamish, who, being a papist and recusant convict, the colliery was sequestered, when it was valued at £3,000 per annum, perhaps owing to the Tyne being shut against the rebel city of London.

This colliery was leased under the state to George Grey, of Southwick, and George Lilburn; but, in 1649, it was seized by Sir Arthur Hazelrigge, the Governor of Newcastle.

During the reign of Charles I., the coal-trade was continually subjected to monopolies and variations in taxes.

1648, August 1. By an extraordinary storm of wind and rain, two of the best collieries on the river Wear were drowned.

1649. Grey, in his "Chorographia" (published this year), speaking of the coal-trade, says:—" That many thousand persons are employed in this trade. Many men are employed in conveying the coals in keels from the staiths aboard the ships. One coal merchant employed 500 or 1,000 in his works; yet, for all his labour, care, and cost, can scarce live by his trade. Nay, many of them have consumed great estates and died beggars. Some south gentlemen, upon hope of benefit, came into the county of Durham to hazard their monies in coal mines. Mr. Beaumont, a gentleman of great ingenuity and rare parts, adventured £30,000 in our mines, who brought with him many rare engines not known in our parts, as the art to bore with iron rods, to try the deepness and thickness of the coal, rare engines to draw water out of the pits, wagons with one horse to carry down coals from the pits to the staiths, etc. Within a few years he consumed his money, and rode home upon his light horse.*

1649. A notice of this date shows that the keelmen were dependent upon the hostmen. †

1650. Total quantity of coals imported into London, 216,000 tons.

1651. According to Gardner there was computed to be at this time 320 coal keels, and every keel was accounted to have carried every year 800 chaldrons of coals to the ships.

1653. Ralph Gardner in his book "England's Grievance Discovered in relation to the Coal Trade," states, "that in or about the eighteenth year of King James, (1621) an information was exhibited in the Star Chamber, by the Attorney-General, against the Mayor and Burgesses of Newcastle by the name of Hostmen, for that they, having the preemption of coal from the inheritors in Northumberland and county of Durham, by their Charter of Free Hostmen, 42nd Queen Elizabeth, they having the sale of all coals, who force ships to take bad coals, or will not load them, unmarketable coals being bought for London, prove much to the damage of the people; which grief begot great suits between the merchants and masters of ships, to their disquieting and high charge, upon which this information was brought against the said hostmen, for selling bad and unmerchantable coals, and much slate amongst them; for which they
*Beaumont's wagons carried nineteen bolls or forty-two cwts., and ran upon wooden ways four inches square, laid upon sleepers.

†Brand.

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were all fined, some £100 apiece, some more, others less, being found guilty and ordered to do so no more; but it is proved they continue the same to this day." *

Gardner also charges the Corporation with hoarding up the corn, and the people not being able to buy the same by reason of its being so dear; "many country people were necessitated to eat dogs and cats, and to kill their poor little coal horses for food."

The Mayor and Burgesses in reply to the several charges brought against them, pleaded their rights "from the time of the contrary, whereof it is not in the memory of man."

The Hostmen about Gardner's time paid £8000 yearly to government. About the same time "poor collyers and colemen" numbered about 20,000.

1654. About this period the port of Sunderland began to rise into great importance. A meeting of keelmen took place for an increase of wages. †

1655. Coals sold in London for twenty shillings per chaldron. At this date it was decided that 136 Newcastle chaldrons should equal 217 London chaldrons.

1656. Whitley Colliery, near Tynemouth, supposed to be working at this time, and shipping its coals at Cullercoats. In the year 1848 it was laid in.

1658. It is recorded that two men were drowned in a pit this year, at Galla Flat, by the breaking in of water from an old waste; their bodies were not recovered for many years. This is the first fatal accident in coal mines of which we have any record.

1660. The yearly vend of Newcastle and Sunderland was now 537,000 tons.

Gardner gives the following account of the treatment of masters of ships who cast their ballast wrongfully:—"Whereas, there hath been an ancient custom in Newcastle, that every master of any ship, who is known to cast any ballast at sea, between Souter and Hartley, or within fourteen fathoms water of the haven, to the hurt of the said river, was brought into the Town Chamber; and there in the presence of the people, had a knife put into his hand, was constrained to cut a purse, with monies in it, as who should say he had offended in as high degree, as if he cut a purse from the person of a man, whereby he might be so ashamed that he should never offend again therein; and others by his example were terrified from trespassing in like kind, that now in the time of so general wrongs done to the river, and the great number of ships which come into that haven, this ancient custom be revived and put in execution."—See Stat. 8 Eliz., 4.

* Bourne, the historian, speaks of Gardner as a "bitter enemy to Newcastle." No doubt he was a bitter enemy to the monopolies claimed by that town.

† Brand.
1661. The Hostmen of Newcastle petitioned that a duty of 1s. per chaldron be imposed on coals exported from Sunderland.

1661. This year, Sir Kinelin Digby presented a memorial to the Crown, containing most serious allegations against the use of coal.

1662, August 20. A petition was signed by 2,000 colliers, in order to be presented to His Majesty; in this they complained of the wrongs done them by the coalowners and overmen. A redress of grievances, however, prevented it from being sent.*

1663. Bishop Cosins issued a commission for measuring the keels and coal boats of Sunderland.

1665. The use of gunpowder was introduced into pits about this time. Newcastle vend of coals, 194,000 chaldrons; Sunderland ditto, 62,000 chaldrons.

1665. The following curious document, dated Newcastle, April 27, 1665, was agreed to and signed by a number of the principal coalowners:— "At a meeting of several of the principal traders in coals at the said town, upon a serious debate and consideration, that there is a great quantity of coals now wrought and lying at the pits and staiths, which, if it should please God, trade should be open and free in a short time, cannot be vended in the ensuing summer; and that if more coals be wrought, it will not only bring such necessity upon the owners of the mines, as that they will not have money to keep on their water-charge, and other necessary charges for preserving the collieries from being utterly ruined, and rendered useless to themselves and the people in general, but the coals that are, and may be wrought will become unfit for fuel. They have, for the causes aforesaid, unanimously agreed and concluded that, from the first day of May next, no coals shall be wrought at all, or any of the collieries of the river Tyne, for ship coals, until the coals now at the pits and staiths, that are merchantable, be so near vended, that the trade may be supplied with fresh and merchantable coals"

1663. As showing the nature of law-suits relating to the coal-trade and mines about this period, in an Appendix will be found a variety of extracts, made from a book, in the custody of the Registrar of the Court of Chancery of the County Palatine of Durham, containing the Orders and Decrees of the Court of Chancery of the County Palatine of Durham and Sadberge; beginning in September, A.D. 1661, 13 Car. II., and ending August, A.D. 1670, Car. II., which may not be found uninteresting or out of place. For these I am indebted to Mr. John Booth, solicitor, of Shotley Bridge.

* Brand. Collier originally implied a charcoal-burner; but, in the course of time the term became applied to the coal-miner, the coal-seller in London, and the ships which carried the coals.

"I am content that my colliery wherein I am concerned shall lye until the 29th day of September next.—Fran. Liddell."

"For want of money I cannot carry on work, and therefore I am content to let mine stand till 29th September.—Jas. Clavering."
"I am resolved, and do promise you that my colliery shall not work, for some reason to myself best known, till the 29th September next.—Fras. Anderson."

"Having at this present more coals than, in all probability, I can possibly vend this eighteen months, am therefore resolved to lay in my colliery for five months ensuing.—Wm. Blakett."

"For want of money, I promise to work no coals till the 29th of September next.—Henry Maddison."

"I do promise to cause no ship coals to be wrought until the 1st of September, unless commanded from my master, Sir Thos. Liddell.—Jas. Bird."


1666, December 8. The following extracts from "Pepy's [sic] Diary," as referring to the supply of coals to London, will not be found out of place:—"In much fear of ill news of our colliers, a fleet of 200 sail, and fourteen Dutch men-of-war between them and us, and they coming home with a small convoy, and the city in great want, coals being at £3 3s. per chaldron, as I am told."

"1667, March 6. Everybody complains of the dearness of coals, being at £4 per chaldron; the weather, too, being become most bitter cold, the King saying to-day that it was the coldest day he ever knew in England.

"1667, March 8. This day was reckoned by all people the coldest day that ever was remembered in England, God knows; coals at a very great price.

"1667, April 27. This afternoon I got in some coals at 23s. per chaldron, a good hearing. I thank God having not been put to buy a coal all this dear time, that during the war poor people have been forced to give 45s., 50s., and 60s.

"1667, June 23. The great misery the city and kingdom is likely to suffer for want of coals, in a little time, is very visible, and is feared

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will breed a mutiny: for we are not in any prospect to command the sea for our colliers to come, but rather, it is feared, the Dutch may go and burn all our colliers at Newcastle, though others do say that they lie safe enough there.

"1667, June 26th. Such is the want already of coals, and the despair of having any supply, by reason of the enemy's being abroad, and no fleet of ours to secure them, that they are come this day to £5 10s. per chaldron.

"1667, September 13th. Called up by people come to deliver in ten chaldrons of coals, brought in one of our prizes from Newcastle. They sell at 28s. or 29s. per chaldron, but Sir William Button hath sworn that he is a cuckold that sells under 30s., and that makes us lay up all but what we have for our own spending which is very pleasant; for I believe we shall be glad to sell them for less."
1667, September 10th. The Common Council of Newcastle made an order that the custom of sending coals by way of presents to their friends in London should thenceforth be discontinued.*

1667, December 16th. Parliament made an order that the price of coals till the 25th of March following should not exceed 30s. per chaldron. †

1670. Heavy duties, to continue to 1687, were laid upon coal imported into London, to rebuild St. Paul's and fifty parish churches after the great fire in London.

1670. The Hostmen imposed a duty of 1d. per chaldron on all coals cleared at the Custom House, in order to support the men laid off work at the collieries, which had been laid in on account of the war, a great quantity remained on hand unsold.‡

1670. About 200,000 chaldrons of coals consumed annually in England at this period.

1671. Staith bills of Sir Thomas Liddell of this date, show that coals were led to the Team River, and that waggon ways were in use at Ravensworth Colliery.

1675. In the nineteenth year of Charles II. an Act was passed, entitled "An Act for the re-building the City of London." An imposition on coals was granted to the Corporation of London, for the purpose of repairing the ravages of the great fire of 1666, and the tax, under one pretence or another, has been levied ever since.

* Brand. † Brand. ‡ Dunn.

1676. By an extract from Roger North's Life of Lord Keeper North, it would appear that "His Lordship was curious to visit the coal mines in Lumley Park, which are the greatest in the north, and produce the best coal, and being exported at Sunderland, distinguished as of that place. These collieries had but one drain of water drawn by two engines, one of three stories, the other of two. All the pits for two or three miles together, were drained into these drains. The engines were placed in the lowest places, that there may be the less way for the water to rise; and if there be a running stream to work the engines it is happy. Coal lies under the stone, and they are twelve months in sinking a pit. Damps or foul air kill insensibly; sinking another pit that the air may not stagnate is an infallible remedy.

"They are most affected in very hot weather. An infallible trial is by a dog, and the candles show it. They seem to be heavy, sulphurous airs, not fit for breath, and I have heard some say that they would sometimes lie in the midst of a shaft and the bottom be clear.

"The flame of a candle will not kindle them so soon as the snuff, but they have been kindled by the striking fire with a tool. The blast is mighty violent, but men have been saved by lying flat on their bellies. When they are by the side of a hill, they drain by a level carried a mile underground, and cut through rock to the value of £5,000 or £6,000; where there is no rock it is supported with timber.

"Some of the Aldermen (of Newcastle) relate strange histories of their coal works, and one was by Sir William Blacket, who cut into a hill in order to drain the water, and conquered all difficulties of stone and the like till he came to clay, and that was too hard for him, for no means of timber or walls
would assist, but all was crowded together; and this was by the weight of the hill bearing upon a clay that yielded. In this work he lost £20,000.

"Another thing that is remarkable, is their wayleaves, for when men have pieces of ground between the colliery and the river, they sell leave to lead coals over their ground, and so dear that the owner of a rood of ground will expect £20 per annum for this leave.

"The manner of the carriage is by laying rails of timber from the colliery down to the river, exactly straight and parallel, and bulky carts are made with four rowlets fitting these rails, whereby the carriage is so easy, that one horse will draw down four or five chaldrons of coals, and is an immense benefit to coal merchants."

At some collieries thin plates of iron were nailed upon the upper surface of the wood, more especially round curves.

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About this period, Sir William Petty estimated the coal-shipping of Newcastle at 80,000 tons.

1677. Charles II. this year granted the duty of 1s. a chaldron to Charles Lennox, Duke of Richmond, his natural son, which was purchased by Government, in 1799, for £400,000. The following year it produced £26,889 13s.

About this date the water was drawn from Lumley, Heaton, and Jesmond collieries by chain-pumps worked by water-wheels.

This year (1677) died George Lilburn, of Sunderland, who, as stated before, contrived to obtain the lease of Harraton Colliery in the year 1644, which cleared him £15 per day.

1680. At this time the cog and rung gin was in use, and the coals were drawn up the pits by horses. For a pit forty fathoms deep, eight horses were required every day to draw twenty-one scores (ninety tons) of coals.*

I have seen a calculation as to whether it was cheaper to draw coals from a depth of eighty fathoms by means of horses or by an engine. †

1683. The coal-trade at "Color Coats" excited the jealousy of the Newcastle Hostmen.

1684. In a lease of this date, from Tempest to Emmerson, a ten is specified of 40 fother, each fother 7½ boll = 300 bolls. ‡

1687, January 29th. In a lease of Greenfield Colliery, near West Auckland, from Nl. Crewe, Bishop of Durham, the score is described to consist of twenty-one twenty peck corves, which even at this time is, or very recently was, the one most generally used in the coal-trade.

1687. From an indenture of lease made the 20th June, in the third year of the reign of James II., between Nathaniel Crewe, Lord Bishop of Durham, and Thomas Langley, ye elder, of the city of York, the following extracts are made :—
"The bishop demises all his 'cole mynes, cole pitts, and seams of cole' within ye parks of Eavenwood, and within all and singular ye copyhold lands of Eavenwood, towne, and townships, and within all and singular the townships, hamlets, places and villages of Ramshaw, Gordon, Morley, and Toft Hill, according to their antient moots and courts within ye barony of Eavenwood, in the county of Durham, and within all ye copyhold and copyhold lands whatsoever within ye sd barony of

* Taylor.

† Warrington Smyth, in a recent lecture, stated that horses were employed in South America in raising minerals from a depth of 200 fathoms.

‡ Taylor.

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Eavenwood, together with full power and authority to break ye ground and soyle, and digg and sinke within ye said parks, and within all and singular the sd copyhold and copyhold land and premises, as well as for the diggi
g of so many cole pitts as shall please him, ye sd Thomas Langley, to digg and sinke for ye winning and getting of cole there, as for drawing and conveyng away of water and styhe, etc.

" Together with all and singular liberties privilgedes for carriage with free way, liberty of passage, egress and regresse for all manner of persons, carts, carriages, horses, oxen, to or from those cole mynes through all wastes, commons, demesnes, and copyholds, belonging to the said Lord Bishop of Durham, for carrying away of the coles.

"And that the sd Thomas Langley shall have and take sufficient and convenient wood for the making, timbering, maintaining and upholding of the shafts, pitts, water-gates, hovils, and lodges, as also wattels and wands for the curves fit and necessary to be used and occupied in and about the cole mynes, pitt or pitts, there to be had and taken in ye woods of ye said reverend father next adjoining to the sd cole mynes.

"To have and to hold for the longest of three lives, yielding and paying 20s. yearly for the time being, and for every pit 33s. 4d. yearly, from which coals shall be wrought."

1690. This year Winlaton Iron Works were founded by Sir Ambrose Crowley, Knt., and employed at one time 1,500 people. Doubtless his choice was guided by the accessibility of coal suitable for smith purposes, and which still retains its character. Whickham Colliery, at this period, was worked, and employed 600 wains in leading the coals to Derwenthaugh.

1693. The Bishop of Durham let Blackburn Fell to Sir J. Clavering and Thomas Siddell, for £40 per annum. The coals were led to Swalwell, and afterwards by waggons to Dunston, where large staiths were erected.

1693. Waggon ways were now first introduced in the River Wear Collieries by Thomas Allan, Esq., of Newcastle and Allan's Flat Colliery, near Chester-le-Street.*

1695. An Act for the better admeasurement of keels and keel boats in the port of Newcastle, received the Royal Assent.
1695. An export duty of 5s. per chaldron of thirty-six bushels, Winchester measure, was laid upon coals sent abroad, in addition to former duties.

1698. In this year we first find mention made of shaft tubbing.†

* Hutchinson. † Taylor.

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1699. An order was made by the Hostmen's Company, for the payment of 4d. each tide, by every trading brother of the fraternity, towards the hospital, to be stopped off every keelman.*

1700. During the seventeenth century, a coal mine near Benwell, in Northumberland, took fire at a candle, and burned nearly thirty years. Its progress was so small at first that a person offered to extinguish it for half-a-crown, which was refused him; but it afterwards acquired so great strength as to spread into Fenham grounds, and burst out in the manner of a volcano in near twenty places. It covered the furze in its way with flour of sulphur, and cast up pieces of sal-ammoniac six inches broad.†

1700. The yearly vend of Newcastle and Sunderland at this time was 653,000 tons.

Best coals were now selling in the port of London at from 18s. to 18s. 3d. per chaldron, out of which was deducted between 7s. and 8s. for duties and metage.

At Newcastle, good coals sold at from £4 to £4 4s. per keel of fifteen chaldrons.

400 keels, manned by 1,500 or 1,600 keelmen, were employed at this time on the Tyne.

1700. Total quantity of coals imported into London, 428,000 tons.

1703. In an undertaking of Mr. Silvertop's of this date, the ten is stated to consist of twenty-five wagons of fifteen bolls each—375 bolls. The late Mr Taylor remarks that the present ten appears to have been fixed towards the middle of the last century.‡

1703. It was stated to the House of Commons by the Masters of the Trinity House, that at this period 600 ships, one with another, of the burthen of eighty Newcastle chaldrons, employing 4,500 men, were requisite for carrying on the Coal-trade.

1709. A mutiny occurred among the keelmen, which continued for some weeks.

1709. At this period the depth of pits varied from twenty to sixty fathoms.

1710. The vend from Newcastle, for some years up to this date, averaged yearly 475,000 tons; and from Sunderland, 175,000 tons.

1710. This year, Newcomen and Crawley first rendered the steam-engine suitable for practical application.

1710. About this time Bensham Colliery exploded, by which seventy

* Brand. † Phil. Trans. ‡ Taylor.
or eighty lives were lost. At this colliery the first attempt was made to work the Low-main seam in the neighbourhood of Newcastle.

1710. A combination of the coalowners, formed this year to raise the price of coals, was prohibited by 9 Ann, c. 22.

1712, January 26th. The Hostmen repealed their former order of 19th May, 1699, because the money collected in pursuance thereof had not been applied to the purposes for which it had been originally designed, but had lately been spent in encouraging mutinies and disorders among the keelmen.*

17 J 3. This year the first engine, north of the Tyne, was erected at Byker Colliery; engines had previously been erected at Oxclose and Norwood Collieries, in the County of Durham. These were atmospheric engines, on Newcomen's principle, having open-topped cylinders.

1715. In a suit of this date, relating to coal-mines in Evenwood Barony, between William Palmer, Esq., and Henry Young, complainants, and Sir Robert Eden, Bart., and John Hodgson, defendants,

The following extracts from the Bill and Answer show what were then considered the relative rights of the Lord of the Manor, the Bishop of Durham, and the Copyholders.

The Bill sets forth " That the Bishops of Durham in right of their See, are entitled to all coalmines under all copyhold lands held of them, and that their tenants or farmers of the collieries by themselves, their workmen, servants, or agents, time beyond memory, have enjoyed and ought to enjoy the right to sink pits, work ye colemines and collieries under ye same, and to lead away the coles gotten, and to do every other needful and necessary act for the winning and working thereof, paying reasonable damages to the owners of such lands."

In the Answer, " That the Bishops of Durham in right of their See are entitled to all colemines in their copyhold lands, and time beyond memory have enjoyed and ought to enjoy the right and privilege to sink pits and work the mines and to do every needful and necessary act thereabout, paying reasonable satisfaction for damages, but believe copyholders in fee should have a recompence for damage done the inheritance as well as for corn and grass."

1718. About this time, Beighton of Newcastle, made engines self-acting. †

1718, August 18. On this date occurs the explosion at Fatfield Colliery, by which sixty-nine lives were lost. This is the earliest explosion in our coal-fields of which we have an authentic record.

Cullercoates is mentioned at this time as possessing a good coal. Though now only possessing a small haven barely sufficient to shelter the fishing boats, old ballast heaps, and the remains of wooden framing projecting from the sand, here and there, proclaim that coals were formerly shipped here.
1718. As illustrating the mode of working coal at this time, we shall quote largely from the tract, called the

"Compleat Collier," published at this date:—

"And now, as to drawing of water, we generally draw it by tubs or buckets, whilst sinking with jack-rowl, or by men winding up the rowl, or otherwise, if the pit be sunk more than thirty fathoms, then we use the horse engine, which engine being wrought with one or two horses at a time, as the water requires, serves also, after we have coaled the pit, to draw up the wrought coals. Which engine, though it be but of a plain fashion, yet is found by experience to be more serviceable and expeditious to draw both water and coal, than any other engine we have seen in these parts yet, notwithstanding we have many pretenders, in many kinds and methods, though we would be glad any ingenious artist could show us a better or more effectual way for expedition and service than we now use hereabouts. In some places we draw water by water, with water-wheels on long axel-trees,* but there is not that conveniency of water everywhere; and, as for the windmills, 'tis sure the wind blows not to purpose at all times, and therefore, whereas we cannot sink pits, but still will have some water to draw, and many times so much as takes up all (or most of) the spare time we have from coal work; it follows we must have a method whereby to draw the water when we please, or at any time, or otherwise we must continue this plain method we now have, if it would be made apparent that, as we have it noised abroad, there is this and that invention found out to draw out all great old waists, or drowned collieries, of what depth soever. I dare assure such artists may

When, in 1708, windmills were wanted to try and drain certain Scotch coal mines, John Young, the millwright, of Melrose, was found to be the only man in the country who could erect windmills. He had been sent, at the expense of that town to Holland, in order to inspect the machinery of that country; and it was suggested, that if this millwright could not be procured, application should be made to the Mechanical Priest in Lancashire for his advice.—Jevons' Coal Question.

* Within recent years a gigantic water-wheel might have been seen situate by the side of Beamish Burn, where it had been used to pump the Beamish Colliery water.

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have such encouragement as would keep them their coach and six, for we cannot do it by our engines, and there are several good collieries which lie unwrought and drowned for want of such noble engines and methods as are talked of, or pretended to, yet there is one invention of drawing water by fire which we hear of, and perhaps doth to purpose in many places and circumstances, but in these collieries here away, I am afraid, there are not many dare venture of it, because nature doth generally afford us too much sulphurous matter to bring more fire within these our deep bowels of the earth, so that we judge cool inventions of suction or force would be safest for this concern."

The "Compleat Collier," discourses equally fully upon the working of coal, and to the following effect:—"And, again, if the roof or cover of the coal be too tender or soft, though dry, we must not take so much of the top of the coal away as when the roof is strong,* but leave, perhaps, a foot thick of the coal top for a roof, least, by the softness of the mettle roof, that roof should fall down and kill your miners; or, what is also bad, bring a thrust or general crush in one of your collieries, to close it quite up, and thereby loose the colliery."
A good day's work, for a pit sixty fathoms deep, he fixes at twenty-one scores of corves of fourteen or fifteen pecks each corf—about ninety tons. Such a pit, he remarks, "will require, at least, eight hours every day to perform that work, which is always customary; four shifts of horses, at two in at a time, and, indeed, you should have a spare shift, or two horses more ready. These ten horses must at least, in these parts, stand you in £6 or £7 a-piece. We must have two more horses of a less value, bought to sledge out with." With regard to the cost of working, he says, "It is most usual to agree with your hewers of coals by the score of corves, by chance, for 10d. or 12d. for each score, according to the tenderness or hardness of the coal, and not by the day or shift work, for it is common to give about 12d. or 14d. for each shift; sinkers, 12d. or 14d. per day." The overman of the tree, or chief banksman, had about 16d. per day; barrowmen, about 20d. per day. Viewers' wages, 15s. or 20s. per week, or more, as he has pits to look after; overmen's wages, 8s. per week.

* The exploring of old workings, or the workings of the "old man," show that it was the custom to leave top coal generally arched for a roof. Those accustomed to old workings cannot but have been astonished at the water level drifts driven by the "old men." Many of them have been driven for very long distances, in a perfectly straight line, of a width scarcely exceeding two feet, or shoulder breadth. These drifts were frequently ventilated by a longitudinal excavation, or "rit," cut in one of the sides. We may, in vain, attempt to imitate such work in these days.

Winnings, our "Collier" states, to be about seven yards, viz., three yard boards and four yard pillars; and goes on to say, "When the workings have got about 200 yards on all sides from the shaft, it is time to sink another."

He advises, "To have a good stock of coal provided against the time of sale, which is chiefly in summer, by reason of the weather, which makes it hazardous for ships to sail in winter on these coasts."

He evidently has no high opinion of fitters, for he describes them, as "Those persons who live at the ports and have keels; their pretence is, to have and get no more than 2s. 6d. per chaldron of the shipmaster for fittidge, which, because a keel carries no more than seven chaldrons a-piece, at Sunderland, is but 17s. 6d. per keel."

1721. Brand remarks that the steam-engine was not in common use at the collieries in the north for drawing water. Eight or nine of Bolton and Watt's engines were in use in the neighbourhood of Workington in Cumberland.

1725. At this period a large proportion of the coals wrought, came from the districts west of Blaydon and Whickham, and were shipped on the river Derwent, between where it flows into the Tyne and Swalwell. Here there were fifty-five "keel-rooms." *

It may not be out of place to remark, that collieries in the western districts referred to, which were supposed to be exhausted many years ago, have recently been re-opened to work seams of coal formerly considered of little value, but which are now, owing to the demand for coke and coal for manufacturing purposes, of great consequence.
1726, June 27th. The copartnership deed of the celebrated Grand Allies, viz.:—Lord Ravensworth, Lord Strathmore, and Lord Wharncliffe, originally Col. Liddell, the Hon. Charles Montague, and Lord Strathmore bears the above date.

* Many of these "keel-rooms" belonged to Axwell Colliery. Among the lessors and lessees names appear, George Pitt, Esq., Sir James Clavering, Mr. Shaftoe of Whickham, Mr. Blackiston of Durham, and Mr. Montague.

1723, March 15th. George Bowes, Esq., of Gibside, who himself had been apprenticed for seven years to Anthony Tullie, Hostman, writing from Gibside at this date to Mr. Gibson, apparently acting in London as his agent there, says, "I hope I have so settled all my coal affairs in ye countrey, that my commodity will both come clean and round to the market, and do not doubt your diligence in giving them their deserved character. I have made great alterations amongst my fitters, and believe very much to my advantage and to their satisfaction. I may safely say that I have the best and honestest fitters in Newcastle, viz.:—Mr. Scott, (father of Lords Stowell and Eldon) Mr. Simpson, Mr. Henry Atkinson, and Selby, the latter being upon his good behaviour.—From Pamphlet. Extracts from the Letter Book of William Scott.

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1726. An extraordinary feature connected with the working of collieries at this date, was the enormous number of carts and horses required to lead their produce to the Tyne. Jesmond Colliery was said to employ upwards of 700 wains in leading its coals to the Ouseburn, and from 600 to 700 carts were engaged in leading the produce of Benwell and Fenham Collieries to Scotswood Quay.

1727. This year the coalowners of Durham entered into an agreement for seven years not to sell coals for less than 11s. 6d. per chaldron.

1727. At this date Tanfield Arch, frequently called Causey Arch, was built by Col. Liddell and the Hon. Charles Montague, the founders of the partnership called the Grand Allies, to obtain a passage on the level for coal waggons. The span of the arch is 103 feet, height 60 feet, and the cost of erection £12,000. It has long been disused, and now exists as a picturesque ruin.

1729. We here extract somewhat largely from "An Enquiry into the Ancient and Present State of the County Palatine of Durham," printed in the year 1729. These extracts will bear principally upon the rights claimed by the Bishop of Durham, which rights have recently been revived by the Ecclesiastical Commissioners, the Bishop's successors, and stoutly withstood by the surface proprietors.

"It is very remarkable that the person (John Spearman, gent., who was deputy-register of the Court of Chancery of Durham, for forty-two years) who composed the abridgement of the royalties of the Bishop of Durham, in the year 1687, and had collected and examined all the records of the said County Palatine, hath not taken any notice of the Bishops of Durham ever claiming or enjoying the mines, within the inclosed copyhold and ancient leasehold lands of that see, which he certainly would have done, if there had been any evidence or records thereof.

A Bill was brought before Parliament in the year 1723, which was strongly supported by the Bishop of Durham and his friends, to enable bishops, deans and chapters, parsons, and others having spiritual promotions, "to make leases of their mines, which have not been accustomably

1726, June 27th. In a viewer's report upon Butternowle Colliery of this date, occurs the following passage relating to the engine, which appears to have been driven by a water-wheel:—
"It is necessary to have a house over ye engine to prevent idle persons from doing any damage to ye same, also it preserves the engine from ye drought in summer, and by having a house there may be a fire made on in winter, to prevent frosts which hath often hindered engines from performing their proper use."

Some pumps recently lying near where the engine stood were merely trees bored out.

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letten, not exceeding the term of twenty-one years, without taking any fines upon the granting or renewing the same."

This attempt alarmed the whole nation, and a vigorous opposition was made to it, and the following petition was presented against it:— "The humble petition of diverse leasehold and copyhold tenants of and within the bishoprick of Durham, sheweth among other things, " that upon perusal and consideration of the said Bill, your petitioners do humbly conceive and are advised that in case the said Bill should pass into law, your petitioners' undoubted right and properties will be greatly prejudiced, if not utterly destroyed and taken away."

The following notes and observations were made upon the Bill:— "That there have been former attempts made by some Bishops of Durham, to destroy the wood and timber in the bishoprick under the pretence of its being of use to them in the working of their coal-mines."

"By this Act (as conceived) a power may be claimed to grant wayleaves, lay waggon ways, and use other liberties within the inclosed grounds of all such copyhold and leasehold tenants, and not only for the leading and carriage of such coals as shall be wrought within the said tenements, but for the carriage of coals from other places; and without making satisfaction for any damage done therein, although they have at present no manner of right to any such liberties or power to grant the same."

"The claim of mines under inclosed copyholds and leaseholds, is modern, and set up within the memory of man, and as to any claim of right for laying waggon-ways, fixing frames of timber, laying stones or rubbish upon the soil, cutting the soil, making trenches or levels for waggon-ways, erecting buildings or hovels for workmen upon inclosed copyholds, was never pretended to, and indeed waggon-ways are of a modern invention."

The copyholders of all the Bishop's Manors, are copyholders in fee. A small fine paid upon an admittance. The widow has her frank Bank, durante viduitate et castitate, but cannot have it, if the husband does not die seized, as if he hath surrendered to trustees, and the estate be in them at the time of his death.

The Bishop of Durham is Lord of Copyhold Manors, viz.:—of Bondgate in Darlington, of Bondgate in Bishop Auckland, of Cornforth, (of West Auckland, of Evenwood, one manor), of Easington, of Wolsingham, of Whickham, of Lanchester, of Chester-le-Street, of Houghton-le-Spring, of Sedgefield, of Stockton, of Bedlington, of Gateshead. In this manor, leased 1749, to Henry Ellison, of Park House, Esq., and to Henry Thomas Carr, Esq., who died at Durham, out of his senses, April 15th, 1770. The surrender must be presented to the homage or it is not good.—111 p. Third Part of the "Enquiry into the Ancient and Present State of the County Palatine of Durham," by Gilbert Spearman. John Trotter Brockett's Additions and Corrections.

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The whole book from which these extracts are made is interesting, from showing the overgrown power of the bishops, and the flagitious use made of it.
A case is named where a water-course, out of Sir Francis Clavering's mines at Beckley, through Mr. Dawson's colliery at Tanfield, was charged at the rate of £2,000. A considerable sum at that period.

1730. With regard to working pillars about this period, the late Mr. Nicholas Wood makes the following remarks:—"I have taken some trouble to inquire into the facts regarding this operation. I find that previous to 1730, pillars had been worked, and they were, moreover, worked as a system, by extracting all the coal and allowing all the superstrata to fall."

1732. Fire-lamps or furnaces in use at Fatfield Colliery. †

1738. Mr. Dunn, in his work on the Coal-trade, states that the working away of pillars in fiery collieries was first introduced at Chatershaugh Colliery, on the Wear, in 1738. Previous to this time, the quantity of coal left in pillars in fiery mines amounted to at least two-thirds.

1738. An Act passed this year empowered the Corporation of London to fix the price of coals sold in their jurisdiction.

1738. The first cast-iron rails are supposed to have been laid down at Whitehaven about this time.

1740. In this year the mischievous practice of screening coals was first introduced at Willington Colliery, by Mr. Wm. Brown. The screens were first made very narrow, but were a good deal enlarged towards the year 1770. ‡

1740. The coal in Tanfield Colliery took fire this year from a boy's carelessness. The pit was changed into a terrible volcano, thundering out eruptions of hot cinders of considerable weight into the open air, to an incredible height and distance. The flames were extinguished by closing the pits up.

1740. About this period hewers earned from 1s. 6d. to 1s. 10d. per day.

1740. Upon February 11th, of the above date, the principal coal fitters, under Sir Henry Liddell, Edward Wortley, and George Bowes, Esqs.,

* Mining Institute Discussion, December 2nd, 1858.

1746. Mr. Taylor remarks that at this date, judging by a report upon Byker Colliery, pillar working was not pursued.

† Dunn.

‡ At this date there were only fifty-nine furnaces in England, producing 17,350 tons of iron per annum. — Wood.

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with 200 men, cut away the ice and opened a channel from below bridge to their staiths above bridge, being nearly one and a-half miles in length, by which keels passed to load ships.*

1744. A disturbance took place at this time with the keelmen, who refused to work, and would not allow any keels to pass down the river, in consequence of the fitters loading the keels with ten instead of eight chaldrons of coals, which was the statute measure. †
1745. The twelve peck corf was commonly used at this time for the convenience of drawing by gins.

1745. Coals selling in London at 36s. and 38s. per chaldron.

1748. Sunderland vended this year 147,403 chaldrons. ***

1749, August 28. A grant passed the Great Seal this year, to Mr. Wm. Newton, of Burnopfield, and Mr. Thomas Stokoe, of Bryan's Leap, in the county of Durham, both gentlemen of great experience in the coal works, for a newly invented method of drawing coals, stones, etc., out of deep pits or mines.§

In the year 1760, we find a rather stringent lease of Pontop Pike Colliery, recommended by a Wm. Newton, probably the person named in the preceding paragraph.

The term in this lease is for twenty-one years, with a certain rent of £900 per annum, and a tentale rent of 16s. Twenty bolls were to be allowed to the wagon, and no coals were to be allowed for lessees' or workmen's firing.

1750. This year a serious riot occurred with the keelmen, who struck work for seven weeks.

1750. The yearly vend from Newcastle and Sunderland at this period was 1,193,467 tons. ||

1750. Total quantity imported into London, 688,700 tons. ¶

1752. About 297,000 Winchester chaldrons of coals were this year shipped in the port of Sunderland. The number of ships loaded in that

According to extracts from the letter-book of William Scott, father of Lords Eldon and Stowell, it would appear that about this time (1745) wooden rails and wagon-wheels were largely imported into Newcastle from Sussex and Hampshire. The rails of oak, ash, and beech sold at from 5d. to 7d. per yard, and the wheels, made of birch, at from 5s. to 7s. each. In a letter, dated 8th January, 1747, Mr. Scott says, "Beech rails will not be wanted as formerly, I mean not so many, the long wagon-ways being on the decrease."

* Local Records. † Local Records. ‡ Dunn. § Gent.'s Mag. || Taylor. ¶ Jevons.

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harbour, principally with coals, were—coasters, 3,424; foreign ports, 173 —total, 3,597.

1753. At this date the number of persons employed in and about the coal-mines of Durham and Northumberland, were estimated at 30,000. This calculation included the wives and children of the workmen.

1753. A machine was going at this time at Chatershaugh Colliery, invented by Michael Menzies, Esq., by which coals were drawn by the descent of a bucket of water, lifting a corf of about 600 lbs. weight out of a fifty-fathom pit in two minutes.*

1754, October 14. As illustrating to some extent the habits of the pitmen at this date, we introduce the following account of one of their weddings from Local Records:—
At the above date, "William Weatherburn, pitman, belonging to Heaton, was married at All Saints' Church, in Newcastle, to Elizabeth Oswald, of Gallowgate. At the celebration of this marriage there was the greatest conourse of people ever known on a like occasion. There were five or six thousand at church and in the churchyard. The bride and bridegroom having invited their friends in the country, a great number attended them to church; and being mostly mounted double, or a man and woman upon a horse, made a very grotesque appearance in their parade through the streets. The women and the horses were literally covered with ribbons." There are no such doings among the colliers now-a-days. On this occasion, doubtless, the "poor little coal horses," as Gardner calls them, had been released from the wains to take a part in the pageant.

1754. According to Mr. Dunn, brick stoppings were first introduced at Fatfield Colliery at this date.

1755. In an estimate of this date, to work Brunton Colliery, the ten is stated to consist of twenty-two wagons of twenty bolls each = 440 bolls. Mr. Taylor remarks, that about this period the ten appears to have become fixed at the above measure; but in 1756, the succeeding year, a ten at Hartley Colliery is stated to equal ten scores of eighteen peck corves = 450 bolls.

1756. Denton Colliery was now won by Edward Montague, Esq.

1760. About this time, Mr. Spedding, of Whitehaven, invented the steel-mill; † he also introduced the coursing of the air through the wastes, which, prior to this date, had not been ventilated.

* New Gentlemen's Magazine.

† The steel-mill consists of a brass wheel, about five inches in diameter, with fifty-two teeth, working a pinion with eleven teeth; on the axle of the latter is

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Mr. Wood, in a discussion at the Mining Institute, stated, that previous to this date, ventilation was by the system of shething. This appeared to consist of building stone stoppings in every third wall.

1760. This year the moors in the townships of Hamsterley, South Bedburn, Lynesack, and Softley, in the manor of Wolsingham, were divided; the Bishop of Durham, as Lord of the Manor, claiming all the mines of coal and quarries.

1763. The earliest period at which coke ovens are mentioned.

In a work, published in 1774, a drawing is given of "nine kilns at Newcastle for destroying sulphur, and reducing coal to cinder and coaks."

1763. Beamish Colliery commenced working at this date.

1763. By an explosion at Fatfield Colliery, fifteen people were killed. Upon this occasion the first steel-mill (brought from Whitehaven) was used in this district.

1763. A Mr. Joseph Oley obtained a patent this year for a machine for drawing coals.

1763, October 22. In a colliery bond, of this date, made between Lady Windsor and John Simpson, alderman of Newcastle, owners of Harelaw, Pontop Pike, Harperly, and Collierly Collieries, and their
workmen there are several noteworthy particulars, and certainly some conditions and restrictions much more severe than many complained of by the pitmen in the present bonds: as, "The parties hired shall continue at work, without striking, combining, or absenting themselves; shall deliver one corf of coals gratis every pay, or fourteen days; shall be fined one shilling for every corf sent to bank less than wood full, and shall be immediately drawn to bank, if the banksmen call him, and shall deliver one corf of coal gratis for every corf of coals set out; and for the true performance of all and singular these conditions, the hewers, drivers of sledge horses, drivers of gin horses, onsets, and bankmen, bind themselves severally and respectively, their and each of their several and respective heirs and assigns, in the penal sum of £18."

To this bond, which is stamped, is attached the names of 110 hewers and fifty-five drivers, all opposite to seals. As now, very few of these parties appear to have signed their own names. The period of binding commenced on the 3rd of December. Sixpence each appears to have fixed a thin steel wheel, from five to six inches in diameter. The wheels are fixed in a light frame of iron, which is suspended by a leathern belt round the neck of the person who plays the mill. Great velocity is given to the steel wheel by turning the handle of the toothed wheel, and the sharp edge of a flint applied to the circumference of the steel immediately elicits an abundance of sparks, and emits a considerable light. — Greenwell.

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been the hiring money. Two seams were working at these collieries at this time, the Second or Hard coal, and the Hutton.

1764. This year 3727 vessels cleared from the Tyne to the coast, and 365 to foreign parts, all coal laden.

1765. March 19th. An improved engine was at this time erected at Hartley Colliery, by Thomas Delaval, Esq., for drawing coals by fire; by it coals were drawn out of the mine at the rate of a corf a minute. This was the second machine which had been erected at this colliery, and was of so simple a construction, that the whole worked upon two axletrees of about five feet long. The first engine was erected October 12th, 1763, and was looked upon as the greatest improvement in the Coal-trade since the fire (pumping) engine.*

1765. Down to this period two wooden and two cast-iron wheels were mostly in use for the wagons, the wooden ones being retained for the application of the brake.†

1765. In the month of October this year the pitmen returned to work after a strike of several weeks. The difference between the pitmen and the coalowners was, that most of the pitmen were bound the latter end of August and the remainder the beginning of September, and the coalowners would not free them until the 11th of November, making their term of servitude upwards of fourteen months.

1765, November 27th. At this date Long Benton street opened and closed again from end to end, and some fields sunk about two feet, occasioned by the colliery at Long Benton having been wrought entirely out. The coal pillars had been worked away, and slight wooden ones fixed in their stead, which not being sufficient to support the rock, the whole sunk together. ‡
Mr. Nicholas Wood, in a discussion upon pillar-working, at a meeting of the Mining Institute, in November, 1860, referred to Benton Colliery, and stated—"I have reports as far back as 1740 or 1750, and upwards, as to the mode of taking away the pillars, and have travelled in the Old Benton waste where large districts of pillars have been worked entirely away.

"Benton Colliery was abandoned sometime before 1765, so that before that period there must have been a very extensive system of taking away pillars. If you enquire of old people, they say it was the practice to leave

* Gilhespy's Collection. † Taylor. ‡ Local Records.

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pillars till they got to the extremity, and then they came back and took them away. The records of the very old collieries show that it was the practice to take away pillars."

Mr. Wood further remarks upon this subject, in December, 1858:—"My experience, derived from examining old workings of several collieries, would show that, generally a much larger proportion of coal was taken away (than one-third). My notion is, that the principle laid down, was only to leave the pillars of sufficient size to support the superincumbent strata, the intention having been, in the very early period of working coal, to support the superincumbent strata, and to leave pillars only just sufficient to accomplish this, and in some cases mere shells of coal appear to have been left over large areas of workings"

1766. Coal was this year won at West Denton, and considered equal in quality to Long Benton coal, which was then worked out.

1768, June 14th. Tanfield Moor Colliery, the property of the Earl of Kerry, was won, the coals being shipped at Derwenthaugh.

1769. William Brown, of Throckley, a viewer, at this date, enumerates upwards of ninety fire-engines in the Northern Coal-field, including Cumberland. Of these Tynemouth Moor and Benwell Collieries' engines had each cylinders of seventy-five inches in diameter. — Old MS.

1769. Arthur Young, in his tour through the northern counties, in the year 1769, remarks that "The people employed in the coal mines are prodigiously numerous, amounting to many thousands, the earnings of the men are from 1s. to 4s. a day and their firing, The coal waggon roads, from the pits to the water, are great works, carried over all sorts of inequalities of ground, so far as the distance of nine or ten miles. The track of the wheels are marked with pieces of timber, let into the road, for the wheels of the waggons to run on, by which means one horse is enabled to draw, and that with ease, fifty or sixty bushels of coals." He further remarks, "That Crowley's works used annually 7,000 bolls of coals."

1770. About this period a remarkable undertaking was completed by Christopher Bedlington, an eminent viewer of that day. It was the driving of an underground drift from the Tyne, near Scotswood Bridge, to OldKent Colliery, a distance of nearly two miles, with the intention, not only of winning the colliery, but bringing the coals by it to the river. It was found, in a great measure, to be ineffective, as it only cut
the rise part of the colliery. It is now known as "Kitty's Drift," and drains Denton and other colliery workings.

1770. It is reported that only twenty-one collieries were working at this period. About this time the width of the screens was considerably enlarged.

1771. The first regulation of the Coal-trade took place this year, fixing the price of coals on board ship at 12s. and 15s. per Newcastle chaldron.

The original basis for the coal-trade, as apportioned between the two rivers, was:—For the Tyne, 386,000 chaldrons, or about three-fifths; for the Wear, 254,000 chaldrons, or about two-fifths; total, 640,000 chaldrons; issues for the year, 890 per 1,000.

1771. Upon the 17th of November, in this year, occurred the great floods. By them, Wylam (to the extent of 300 acres), North Biddick, Chatershaugh, and Low Lambton Collieries, were inundated.*

1771. According to Jevons, the average shipping price of Newcastle coals was, this year, 5s. 4d. per ton.

1772. The only best coal colliery working below Newcastle Bridge at this period was Walker.

1772. Elvet Moor, near Durham, was divided, the mines being reserved by the Dean and Chapter of Durham, as Lords of the Manor.

1772. 5,585 ships sailed from the port of Newcastle this year, laden with 330,200 tons of coals, showing a large increase over 1764, when only 4,092 were loaded.

1773. Witton and North Bedburn Moors Division-Act was passed, the Bishop of Durham, as Lord of the Manor of Wolsingham, retaining the mines and minerals.

1773. To a report upon South Birtley Colliery, dated August 17th, 18th, and 31st, 1773, no less than ten viewers attached their names, viz. : —Christopher Bedlington, Peter Donnison, Thomas Bedlington, Anthony Waters, John Bedlington, Edward Smith, John Daglish, John Donnison, John Allison, and William Gibson. They state that they have examined the condition of seventeen pits, which, however, do not appear to have had more than thirty acres each of royalty attached. Some districts they speak of as having been wrought in both the whole mine and pillars.

* It was estimated that there were 1,728,000 hogsheads of water in the several seams of coal in Wylam Colliery.

1775. Scotch colliers, until this date, were accounted adscripti glebae, and were sold, with their wives and families, with the property, as part and parcel thereof. An Act was passed this year which declared that colliers and salters were no longer to be transferred with the collieries and salt works.

1775, November 2nd. Wellington Colliery, near Howdon Pans, was won at this time by Messrs. Bell and Brown.*
1776. An underground engine for the purpose of working lying sets of pumps, was at this period in use at a colliery eighty fathoms deep, at Whitehaven, in Cumberland. †

1776. From Custom House returns, upon an average of six years, 380,000 Newcastle chaldrons were shipped from the Tyne, 260,000 of which went to London.

1777. In this year Mr. Carr, of Sheffield, introduced iron rails underground, and so superseded sledges; he also invented the flat-rope, which however, from want of suitable machinery, was not brought into use at that time.

1778. November 6th. A newly invented machine for drawing coals by water was set going at this time, at Willington Colliery, on the Tyne; its performance exceeded the most sanguine expectations, uniformly drawing thirty corves of twenty pecks each in a [sic] hour, from an depth of 101 fathoms. ‡

1778. About this time, or perhaps rather later, low-pressure steam engines, of a very rude construction, were erected at Chopwell Colliery, and at the Stella Grand Lease or Townley A Pit, for the purpose of pumping water from large ponds, constructed for the purpose, to a cistern fifty-two feet high; and was then made to turn a wheel, with ropes, drums, and a brake, by which the brakesman could draw the men as well as the coals up the shaft. These two engines were put up by the late Mr. James Hall, of Greenside; they were the last employed in this manner in the North of England, one being abandoned in 1800, and the other in 1808.—Fordyce.

1779. April 30. Felling Colliery was won this year by Charles Brandling, Esq.

1779, July 10. Mr. Smeeton, speaking of engines at this date, says— "That of four chaldrons of coals consumed in the fire-engine in the year 1772, his improvements upon Newcomen reduced them to two, and the new principles of Messrs. Bolton and Watt have reduced them to one." A picture of the water-engine will be found in the late Mr. T. J. Taylor's Archaeology of the Coal-trade.

1779, September 20. This day the first coals were led from Waldridge Fell Colliery, the property of William Jolliffe, Esq., to be shipped at Fatfield Staith.

* Local Records, † Fossil fuel. ‡ Local Records.

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1781, June 9. The birthday of the celebrated George Stephenson, who was born in a labourer's cottage at Wylam.

1782. Fire-engines were this year erected at Killingworth Moor and Walker Collieries, by the use of which a considerable number of horses were rendered unnecessary.

1784. The Wear vend this year was 244,485 chaldrons, of which the Lambton Collieries furnished 41,247, and the Tempest 31,000 chaldrons.

1785, May 9. Upon this day a man lost his life at Wallsend Colliery by an explosion. This was the first explosion which was distinctly known to have taken place by the use of the steel-mill. Some doubt existed up to this time as to whether the fire-damp would explode by the spark of the steel-mill or
not, but the fact was clearly ascertained on this occasion, as the person, John Selkirk, who was "playing" the mill, survived the accident.*

1787. Brand gives a list of twenty-nine collieries on the Tyne at this date, the deepest of which was Wallsend, being 105 fathoms.

1790. The number of keels on the Tyne at this period were 338; and on the Wear 412. †

1790. About this time, Mr. Dunn remarks, "The principal scene of operations of the trade had greatly changed. The collieries delivering at Derwenthaugh had mainly declined, as well as those at Throckley, Team, Dunston, etc."

1791. As before remarked, colliery bonds up to this period contained much more severe clauses than those of the present day. In one of West Rainton Colliery, dated 1791, the fine for any fault in driving boards or headings, was 3s. Considerable fines were exacted for foul coal or splint sent to bank.

The workmen were only allowed ten fother of fire coal yearly, for which they paid 8d. per load.

1792. Mr. McNab, at this date, estimated the number of persons employed in and about the Tyne collieries, including their families dependent on them, at 38,475; and on the Wear, 26,250; total, 64,725. And the capital employed in the collieries at £1,030,000; and in shipping, £1,400,000.

1792. This year the winning of Hebburn Colliery commenced. Owing to the quantity of water met with, it was considered the most difficult up to this time attempted.

1794. Malleable iron rails were partially laid down at Walbottle

* Local papers. † Dunn.

Colliery, they were plain bars of an oblong section, the narrow edge, not more than three-quarters of an inch wide, being presented for the wheels to run upon.*

1794. Average shipping price of Newcastle coals 7s. 6d. per ton. †

1795. Up to this period, the pillars of the deep collieries below Newcastle bridge were given up as lost; but the robbing of them was now introduced by the late Mr. Thomas Barnes, of Walker Colliery, viz., taking away to the extent of one-fourth of what remained, one-half of every alternate pillar. This plan having proved successful, was speedily adopted at the Bigge's Main and Wallsend Collieries. Mr. Barnes also introduced at this time cast iron tubbing at Walker Colliery, consisting of circular rims the size of the shaft. ‡

1796. This year Mr. Buddle adopted segments (4 feet by 2 feet) fastened together by screw bolts, in sinking Percy Main New Pit. §

1796. Previous to this date two descriptions of wood tubbing were used, the one called plank tubbing, and the other solid tubbing. As might be supposed, the latter was much the superior in strength, besides requiring neither spikes nor planks. Mr. Dunn states, in his work upon the
"Winning and Working of Coal Mines," that tubbing of the latter description will sustain a pressure of fifty fathoms.

Plank tubbing was the spiking of two and a-half or three-inch planks (properly dressed to the sweep of the pit) to cribs of six or eight inches square, placed at intervals of two or three feet. With this description of tubbing was effected the winning of Hebburn, Jarrow, and South Shields Collieries.

1796. The following curious charge (significant of the times) appears in a pay-bill of Pontop Pike Colliery of this date. "The overseers of the poor of Kyo Township. An additional assessment upon the pits sunk therein for the purpose of hiring a man for the navy. Rental £410 at 3d. = £5 2s. 6d."

1797. A paper, entitled "Hints for establishing an office in Newcastle for collecting and recording authentic information relative to the state of the collieries in its neighbourhood," was read before the Literary and Philosophical Society, by William Thomas, Esq., of Denton.

1797. At this date Mr. Barnes introduced the first self-acting incline-plane at Benwell Colliery.

1797. Mr. Taylor remarks that there were still numerous water-* wheels with rope-rolls on the same axle at this period at work in the coal districts of Durham and Northumberland.

1798. The quantity of coals cleared this year from Newcastle was coastwise 395,960 chaldrons; foreign 44,460 chaldrons; total 440,420 chaldrons.

1798. At this time the coals from Pontop Pike Colliery were led to Derwenthaugh by horses, costing from 2s. 2d. to 2s. 6d. per waggon. It was customary for the tenants of the coalowners to find horses, according to agreement, to lead the coals.

1798. Lighting by gas, destined so greatly to influence the coal trade, was at this period introduced at Bolton and Watts', Soho Works.

1799. At this date there were only forty-one collieries, and the number of keels employed on the Tyne was 319; on the Wear, 520.*

1799. Percy Main Colliery won to the Bensham Seam, at a depth of 160 fathoms, being at this time the deepest that had been sunk. The sand was passed, and the water dammed back, by a cast-iron tub, the first used in the coal-trade for sinking through quicksands.

1800. The price of coals on the Tyne was 20s. 6d., on board ship, including all charges, 26s. 5d. per chaldron; on the Wear, 18s., on board ship 25s. 9d. per chaldron.

In the above year, the "Richmond Shilling" was purchased by Government for an annuity of £19,000 per annum.
Coke ovens at this period were in existence on the outcrops of the Brockwell Seam, at Cockfield, Woodland, and Old Woodifield, in the county of Durham; but the ordinary way of burning coke was in the open air, in what were called "cinder rows."

1800. In a Parliamentary Committee of this date, appointed to enquire into the alleged high price of coals, and the existence and effect of the coal regulation, the late Mr. Nathaniel Clayton, the Town Clerk, was examined as to the profits of the coalowners, when he gave evidence to the following effect:—"I have possessed the means, and have had frequent opportunities of adventuring in speculations of that nature. I have ever declined doing so, upon the principle that the average profits resulting from these adventures were inadequate to the employment of so much capital as they required, and to the risk attending them." Among others who gave evidence before this committee were Messrs. Charles Brandling, John Martindale, and Thomas Ismay; the latter of whom stated that rye was the chief bread of the pitmen, the market price of which was then 11s. per bushel, but was sold to them by the coalowners at 5s. per bushel. No effectual legislation resulted from the labours of this committee.

1800. This year the late William Chapman took out a patent for the "drop," now universally used in shipping coals. It was not, however, brought into use until applied by Benjamin Thompson, at Wallsend Staith, in 1810.

1800. Garesfield Colliery commenced working.

1800. The first employment of self-acting inclined planes underground was this year introduced by Mr. James Hall, at Townley Colliery.*

1800. Total quantity of coals imported into London, 1,099,000 tons.

1800. Tanfield Moor Act passed for allotting and enclosing; the Marquis of Bute, the Marquis of Hertford, and the Earl of Windsor being entitled to the mines and minerals, except the coal; and William Morton Pitt, Esq., being entitled to the collieries and coal-mines; and Sir John Eden, as Lord of the Manor, claiming the waifs and estrays.

1801. Framwellgate and Charlaw Moors Enclosure Act passed; the Bishop of Durham's rights, as Lord of the Manors of Chester and Lanchester, to work mines, lay waggon ways, erect engines, etc., being reserved, upon paying suitable damages.

1801. Average shipping price of Newcastle coals, 10s. 6d. per ton. †

1802, September 3. Percy Main Colliery commenced shipping coals.


1804. Before this date, two or three guineas per hewer had been given as binding money; but this year, owing to the extraordinary demand for coals, from twelve to fourteen guineas were given per man on the Tyne, and eighteen guineas per man on the Wear, besides increasing the rate of wages thirty or forty per cent. ‡

1805. Mr. Carr, of Sheffield, applied fixed engine power on a railway leading from Birtley over the Black Fell.

1805. Coast vend this year, 2,426,616 tons; oversea vend, 147,146 tons; total, 2,573,762 tons. Of this quantity, London took about 1,350,000 tons. §

1805, October. An address to the owners and agents of coal-mines, on destroying the fire- and choke-damp, was published by Thomas Trotter, M.D., of Newcastle.

* Fordyce. † Jevons' Coal Question. ‡ Dunn. § Taylor.

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1806. Willington Colliery on the Tyne commenced about this year.

1808. Upon Wylam wagon-way, one of the oldest in the North of England, the wooden way was replaced by cast-iron.

1809. Pannel working in pits introduced by Mr. Buddle.

"1809. The Rooms, Newcastle, September 30. At a general meeting of coalowners, holden here this day (Mr. Chapman in the chair):—

" 1st, Resolved—that this meeting think it expedient to change the time of binding to the 21st January, and that the men shall be bound, at the ensuing binding, for three months only, viz., from the day on which their present bonds expire, to the 21st January next, and that the binding be opened on Saturday, the 7th October next.

" 2nd, That the binding money shall be, for the above period:—

<table>
<thead>
<tr>
<th></th>
<th>Tyne.</th>
<th>Wear.</th>
</tr>
</thead>
<tbody>
<tr>
<td>For the hewer, being a householder</td>
<td>£0 5 0</td>
<td>£0 10 6</td>
</tr>
<tr>
<td>Ditto, a single man</td>
<td>0 8 0</td>
<td>0 13 6</td>
</tr>
<tr>
<td>Hewer Driver</td>
<td>0 4 0</td>
<td>0 8 0</td>
</tr>
<tr>
<td>Driver</td>
<td>0 3 0</td>
<td>0 5 6</td>
</tr>
<tr>
<td>A Tram</td>
<td>0 16 0</td>
<td>1 1 0</td>
</tr>
</tbody>
</table>

The wages of drivers to remain as at present, viz., 1s. 10d. per day on the Tyne, and 2s. on the Wear; the drivers on the Tyne to work fourteen hours to the shift or day's work, in single shift pits, unless the coals can be filled and put out in a shorter time. And that the above sums shall not, on any
pretence, be exceeded; nor shall anything in lieu of money be given to the parties employed, directly or indirectly, or to any of their families or connexions. No binding money to be given to any off-handmen, bankmen, or horsekeepers, nor flannels allowed to bankmen or horsekeepers; and where cows or Galloways are fed by the owners, a full and fair price to be paid by the workmen for the same.

"3rd, That the binding shall take place at each respective colliery office, or other usual place of binding, and nowhere else; and that no treat nor drink be given, except the usual allowance of liquor, which shall be given at the colliery office, or usual place of binding, and on the days of binding only.

"4th, That no person, of any description, shall be sent from one colliery to another, to tamper with, or hire the men of such other colliery.

" 5th, That in case the workmen refuse or decline to be bound for the space of a week after the expiration of their present engagement, and after that time continue to be unbound, such men so remaining unhired, shall not be employed either by their late masters, or any other proprietors of collieries, so long as they remain unbound.

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"6th, That the penalty for lying idle upon each hewer, deputy, craneman, onsetter, sinker, driver, or off-handman, shall be 2s. 6d per day for lying idle, and 10s. 6d. for misdemeanours. The amount of such penalty to be left to the discretion of the principal viewer or agent.

"Twenty-four men only must be bound to Garesfield, in the first instance; and progress must be reported to the committee, at my office, on Tuesday next, the 10th inst., at 11 o'clock, stating the number of men bound, as also the number remaining unbound on each colliery. Oct. 3, 1809.—JNO. BUDDLE.—Pontop, 43 men."—MS.

1810, March 15. At this date, a self-acting plane, 1600 yards in length, was opened from Bewicke Main to the Tyne. It conveyed fifty wagons an hour, at a speed of ten miles an hour.

1810, April 23. Manor Wallsend Colliery, the property of Simon Temple, Esq., shipped its first coals.

1810, June 1. The bill for regulating the loading of ships with coals in the port of Newcastle-on-Tyne came into force at this date.

1810. The following paragraph appeared in the Tyne Mercury, June 12th, 1810:—"The night office lately established here for taking on ships to load coals, presented a very singular scene of confusion on Sunday night. With a tender and pious regard for the souls of these sacrilegious men called coal-fitters, who were in the habit of walking the quay all the Lord's-day, neglecting all religious duties; intent, like the barbers of former times, on nothing but the gain of filthy lucre, in pursuit of which they were often tempted by the devil to break all the commandments in the decalogue, the framers of the late Coal Bill enacted, that in future no business should be done until twelve o'clock on Sunday night, and that then ships should be taken on by two men appointed by the Commissioners of the Act to attend this office.
"It is now, therefore, decreed as of old, 'That in six days the fitters shall do all that they have to do, but on the seventh day shall rest from their labours.' In conformity with these wholesome regulations, this office was opened on Sunday night at twelve o'clock. Through the day an immense number of vessels came into Shields, which made the number of applicants at the office in the course of the night very numerous. About eleven o'clock the crowd of captains became very great, which soon occasioned, when the office opened, much wrangling about the turns; and as they are in general men who have not the 'fear of God before their eyes,' they began abusing the attendants, and though one of them was actually a Bishop, they absolutely, in defiance of all order

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and decency, uttered the most horrid imprecations in his sacred presence; and in the end, to such a height did their impious rage proceed, that they broke his mitre (alias his desk) over his head; and from all appearance, the Pope himself, had he been present, would have been treated with as little ceremony. This Reverend Prelate, seeing his authority thus scorned and set at naught, though 'slow to anger,' could not forbear making use of the power lodged in his hand for the support of his authority against such blasphemous intruders. He, therefore, excommunicated and anathematized the whole crew of offenders; and though not in such detail (for he had not time) as the form set forth in "Tristram Shandy," it was fully as comprehensive, and must have had an equal effect, being delivered in the most impressive style. We have not heard that any of the agents of the Vice Society have taken any steps in this business; but certainly neither they nor the Reverend Bench will suffer such a daring outrage upon religion and social order to pass unnoticed."

This humorous paragraph, doubtless, described a scene of frequent occurrence. James Bishop was the name of one of the clerks.

1810. According to Mr. Wilson, from whose notes to the "Pitman's Pay" and other pieces, these extracts are made, the sailors riding for their "turns" (to Newcastle before railway times) was perhaps one of the most laughable scenes that can well be imagined. The poor hacks had a sorry time of it when they had such customers on their backs; and when a large fleet arrived, it was not unusual to see these miserable animals appear on the quay two or three times from Shields during the day.

Both the rider and his steed were often pictures of real distress; so much so, that when some one was astonishing Bold Archy with an account of the transmigration of souls after death, he replied—"That was very queer; but I don't care what shape I appear in next, provided it is not that of a Shields hack."

"The yen airm gannin' like a flail,

The tother bizzy steerin',

(But whether by the heed or tail,

The course was oft a queer un.)"

*The Captains and the Quayside.*
Any one anxious to acquaint himself with the Doric of Tyneside, or the pitman's dialect, cannot do better than read the late Mr. Wilson's "Pitman's Pay" and other pieces, all admirable in their way.

1810, October 18. The pitmen struck work in consequence of the

masters wishing to bind them from the 18th October (the usual binding-day) for a year and a-quarter, or up to the latter end of December. Great numbers of pitmen were imprisoned, and the old Gaol of Durham was so full, that 300 of them had to be confined in the Bishop's stables. By the intervention of the Rev. Mr. Neshfield, the differences between the masters and the pitmen were accommodated, and from this time the binding day was fixed on the 5th of April.

1810. Mr. Bailey, in his Agricultural Survey of Durham, of this date, remarks that there were sixty-nine collieries in that county, viz.:

<table>
<thead>
<tr>
<th>Tons.</th>
<th>Men.</th>
</tr>
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<tbody>
<tr>
<td>35 Landsale...12 in the Tyne and Wear district, producing 59,360 and employing 74</td>
<td></td>
</tr>
<tr>
<td>23 &quot; Tees &quot;</td>
<td>146,552 &quot; 308</td>
</tr>
<tr>
<td>35 &quot; Total Landsale Tons.....</td>
<td>205,912 &quot; 382</td>
</tr>
<tr>
<td>34 Watersale (River and Seasale).........................</td>
<td>1,866,200 &quot; 7011</td>
</tr>
<tr>
<td>69 Collieries. Total...........................</td>
<td>2,702,112 &quot; 7393</td>
</tr>
</tbody>
</table>

He estimates the number of pitmen employed in Durham and Northumberland at about 10,000, and the produce of the pits in chaldrons of thirty-six Winchester bushels of twenty-eight cwts. each.

Speaking of the wagon-ways, he says that a new way, including timber, levelling, gravelling, and workmanship, will cost about 5s. per yard, or £440 per mile.

He also remarks, that the coals in the western part of the county are of the best quality, and leave the least quantity of ashes, especially those of Railey Fell, Witton Park, Bitchburn, West Pits, Lonton Hill, and Copley Bent.*

1810. The coast vend for this year was 2,783,404 tons; the oversea vend for the same period was 50,922 tons—total, 2,834,326 tons. †

1811. Burdon Main Colliery commenced working this year. Coals, however, had been worked here during the last century.

1811, May. The High-main coal-seam won at Fawdon Colliery.

1811. Average shipping price of Newcastle coals, 13s. per ton.

1812. In the winter of this year (Napoleon's winter) £6 6s. per chaldron was paid for coals in the suburbs of London.
1812. At this period, and for some time after, it was the general custom on the Wear to sheth the waste and not to course it. ‡

* All these collieries produce excellent coking coal.

† Jevons.

‡ Mr. Barkus, sen., at Mining Institute discussion, December, 1858.

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1813, March 13. Mr. William Hedley, viewer to Mr. Blackett, of Wylam, took out a patent for a locomotive engine, which succeeded so well as to draw eight loaded wagons at the rate of four or five miles an hour, and completely superseded the use of horses. It would thus appear that to Mr. Hedley belongs the honour of first making the locomotive engine of practical use. This engine has been in constant use until recently, when it was removed to the Patent Museum at Kensington.

1813, July 27. This day Stephenson's engine was placed upon the Killingworth Colliery Railway, and on an ascending gradient of 1 in 450 it drew eight loaded wagons of thirty tons weight, at the rate of four miles per hour. By the application of the steam blast the power of the engine was doubled.

1813, September 2. One of Blenkinsopp's engines was placed upon the Kenton and Coxlodge Railway; it drew sixteen loaded chaldron wagons (a weight of about seventy tons) about three miles per hour. The boiler of the engine shortly blew away, and was not replaced.

1813, October 18. The late Mr. Buddle addressed Sir Ralph Milbank, Bart., President of the "Society for Preventing Accidents in Coal-mines," which had been established on the 1st of this month, and described an air-pump able to draw 8,000 cubic feet, or 778 hogsheads, of air through the mine per minute; or, allowing one-fourth off for inaccuracy of piston, valves, etc., 584 hogsheads per minute. It, however, might be increased at pleasure.

Mr. Buddle goes on to say, "The exhausting-pump has always been found preferable to the forcing-pump;" and also, "Although the inflammable air has frequently fired at the sparks of the steel-mill, it only happens, from all the facts which I have been able to collect, when the mills are played near the place where the hydrogen gas is discharged."

"The standard air-courses in the collieries under my care are from thirty to forty feet area. The air moves with a velocity of three feet per second, which equals from 5,400 to 7,200 cubic feet per minute," etc.

"In concluding this letter, I beg the indulgence of observing that as colliers are exposed to many accidents beside fire, it may not, perhaps, be deemed improper to combine, with the objects of this society, the formation of a general permanent fund, for the relief of the widows and orphans of such colliers and others as may lose their lives in the collieries on the Tyne and Wear, and for the support of such as are maimed and disabled.

"On an average, through this district, I believe that the ordinary

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and unavoidable casualties in collieries occasion more calamity than explosions of inflammable air. Should the society think proper to turn its attention to this suggestion, I shall have much pleasure in submitting the outline of a plan for its accomplishment to the committee, the basis of which is, to raise the fund principally by a proportionate contribution on the earnings of the workmen, to be aided by a subscription from the coal- and landowners of Durham and Northumberland."

1814, September 13. We here insert part of an address of this date to the proprietors of collieries, by John Bedlington, colliery viewer, Sheriff Hill Colliery.

"I now beg leave to revert to the lack of attention in those viewers who are said to inspect two or more (even to the number of six) collieries; any one of which requires their sole and not divided attention, as they seldom, if ever, from observation, know the actual state of any one of them. The information they possess is chiefly from the reports of their under-viewers, and in many collieries they are very worthy, intelligent men; but why are they consigned to that situation, when it would be more to your interest were no such men as upper-viewers known? I am convinced, to have a resident sole viewer of ability, unshackled by those whose knowledge of the colliery must be greatly inferior to his own, is the first step towards a total emancipation from the chaos in which the management of collieries seems to be enveloped."

Mr. John Bedlington appears to have been a member of a family, several of whom, judging from old reports, seem to have been extensively engaged as colliery viewers.

1815, February 28. Stephenson took out a patent for an improved locomotive engine.

1815, August. Stephenson requested Mr. Nicholas Wood to prepare a drawing of a lamp according to a description he gave him.

1815, August 28th. Upon this day Sir Humphrey Davy visited the collieries near Newcastle to investigate the nature of the gases produced in them.

1815, October 16, and again on November 20. The first safety-lamp, invented by Dr. William Reid Clanny, of Sunderland, was tried in the Herrington Mill Pit in the county of Durham, in an inflammable atmosphere; though successful, it was found too unyieldy for use.

From 1810 to 1814 inclusive, the duty on round coals exported to foreign parts mounted to 25s. 2d. per Newcastle chaldron.

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1815, October 19. Upon this date, Sir H. Davy writes—"I have already discovered that explosive mixtures of mine-damp will not pass through small apertures or tubes; and that if a lamp or lanthorn be made air-tight on the sides, and furnished with apertures to admit the air, it will not communicate flame to the outward atmosphere."

1815, October 21. Stephenson's lamp,* with one tube to admit air, tried at a blower in Killingworth Pit, and found to burn well.

1815, October 25. Sir H. Davy announced his discoveries to the Chemical Club of London, and describes a lamp on the principle of tubes above and below.
1815, November 4. Another lamp of Stephenson's, with three capillary tubes to admit air, tried and found to burn considerably better than the previous one.

1815, November 9. Sir H. Davy read his celebrated paper on firedamp before the Royal Society of London.

1815, November 24. Stephenson's third lamp was completed this day and tested on the 30th.

1815, November 30. Stephenson's third lamp, in which the air was admitted by means of a double row of small perforations, was tried in the mine, and found to be perfectly safe and burn extremely well.

1815, December 5. Stephenson's third lamp was tried with inflammable air before the Literary and Philosophical Society of Newcastle.

From the above it is difficult to say whether George Stephenson or Sir H. Davy had the priority in the invention of the safety-lamp; probably, as frequently happens with important discoveries, the same subject had been occupying the minds of these great men at the same time, and simultaneously they arrived at the same conclusion.

1815. In the course of this year coal screens were reduced from five-eighths and half-an-inch to three-eighths' inch-spaces between the bars, and Mr. Benjamin Thompson introduced malleable iron rails down the Ouston Pit.

1815. According to Mr. Barkus, senior, "split air" was first introduced this year by the late Mr. Hill, at Felling Colliery.

1815. The coast vend this year was 2,717,509 tons; oversea, 159,174 tons—total, 2,876,683 tons.

1815. Mr. Wm. Chapman, C.E., this year read an essay to the

* This lamp was a month at least in making, owing to the necessity of having the glass made and well tempered before the lamps could be begun to be made.

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Literary and Philosophical Society—" Observations on the Necessity of adopting Legislative Measures to diminish the probability of the recurrence of Fatal Accidents in Collieries, and to prolong the Duration of the Coal-mines of the United Kingdom."

In this essay, he stated that the following collieries shipping below bridge have been wrought out* since Mr. Thomas's paper in 1797:—

Walker—High Main Seam, wrought out.
St. Anthony's—High Main, wrought out; Low Main Seam, relinquished.
Lawson's Main—Low Main Seam, relinquished.
Felling—High Main Seam, wrought out.
Gateshead Park—High Main Seam, wrought out.

Flatworth—High Main Seam, wrought out.

Bigge's Main—High Main Seam, wrought out.

Long Benton—High Main Seam, wrought out.

Kenton—High Main Seam, relinquished.

To the westward of Newcastle, Baker's Main, Throckley, and Heddon Hill had ceased to work.

At this period (1815), Mr. Chapman estimated the annual consumption of pit coal at 13,040,000 tons, and remarks,

"According to the above estimate, which I conceive in some parts to be underrated more than sufficiently to compensate for any error on the opposite side, the annual consumption of Great Britain will amount to the enormous quantity of thirteen millions of tons of coals, exclusive of the waste, which is beyond all reasonable comprehension, and can only be restrained by legislative authority; which may, I conceive, be so exerted as to produce beneficial results, not only to the future, but to the present times."

1816, January 1. The first safety-lamp, invented by Sir H. Davy, was brought into use at Hebburn Colliery. This lamp is said to be preserved in the Museum of Practical Geology, in Jermyn Street. The following extract from the "Book of Days," showing Sir H. Davy's disinterested conduct, when urged to remunerate himself for his valuable invention, merits insertion:—" Mr. Buddle advised Sir Humphrey to take out a patent for his invention, which he was certain would realise £5,000 to £10,000 a-year. But Davy would have none of this; he did not want to be paid for saving miners' lives. 'It might,' he replied, 'undoubtedly enable me to put four horses to my carriage; but what could it avail me to have it said that Sir Humphrey drives his carriage and four?'

1816. The Gillegate, or Gilesgate Moor, near Durham, Enclosure Act, received the Royal Assent, the Right Hon. Lady Frances Anne Vane Tempest, afterwards Marchioness of Londonderry, as Lady of the Manor, being entitled to the mines and minerals.

1817, October 11. The committee of the Coal-trade presented Sir H. Davy with a service of plate, valued at £2,000, for his invaluable discovery of the Davy-lamp.

As the opinions of competent witnesses upon the safety and utility of the Davy-lamp are important and interesting, a letter, written by the late Mr. Buddle, upon the subject, in August, 1831, is here inserted, followed by some evidence bearing on the same point, given by Messrs. T. J. Taylor and Mr. Darlington, in more recent years. Mr. Buddle writes as follows:—" If the Davy-lamp was exclusively used, and due care taken in its management, it is certain that few accidents would occur in our coal-mines; but the exclusive use of the Davy is not compatible with the working of many of our mines, in consequence of their not being workable without the aid of gunpowder. In such mines, where every collier must necessarily fire, on the average, two
shots a day, we are exposed to the risk of explosion from the ignition of gunpowder, even if no naked lights were used in carrying on the ordinary operations of the mine. This was the case in Jarrow Colliery at the time the late accident happened. As the use of gunpowder was indispensable, naked lights were generally used, and the accident was occasioned by a bag of inflammable air forcing out a large block of coal, in the face of a drift, from a fissure, in which it had been pent up, perhaps, from the creation; and firing at the first naked light with which it came in contact, after having been diluted down to the combustible point by a due admixture of atmospheric air. As to the number of old collieries and old workings which have been renovated, and as to the quantity of coal which has been and will be saved to the public by the invention of the Davy, it is scarcely possible to give an account, or to form an estimate. In this part of the country, Walker Colliery, after having been completely worked out according to the former system, with candles and steel-mills, and after having been abandoned in 1811, was re-opened in 1818, by the aid of the Davy, and has been worked on an extensive scale ever since, and may continue to be worked for an almost indefinite period. Great part of the formerly relinquished workings of Wallsend, Willington, Percy Main, Hebburn, Jarrow, Elswick, Benwell, etc., as well as several collieries on the Wear, have been recovered, and are continued to work by the intervention of the Davy. The late Mr. T. J. Taylor, in his "Archaeology of the Coal-Trade," states that four Davy-lamps were equal, in illuminating power, to one of the candles, thirty to the lb., and that the phosphorescent gleam of dried fish had been used formerly to work by in dangerous parts of mines. The same gentleman, in Professor Phillip's Report of 1850, expresses himself on safety-lamps as follows:—" Without giving a preference to any particular lamp, the experience of above thirty years in the mines of the North of England has proved the common Davy-lamp to be a practically safe lamp. The expense of lighting mines with safety-lamps is, on the whole, less than that of lighting with candles; and though it is desirable to exclude naked lights as much as possible, yet the use of gunpowder, under proper regulations, is not inconsistent with that of safety-lamps." Evidence to a less favourable effect was given by Mr. Darlington, before the Committee of the House of Commons, in 1852, viz.:—"I can state, from my own practical knowledge of the Davy-lamp, and from opinions of miners who have for years worked with the Davy-lamp, that it is not a safe instrument in an explosive mixture, under a strong current." According to the late Mr. G. Clark, of Wallsend Colliery, who made various experiments with safety-lamps in 1848, the weight of a Davy-lamp is 1 lb. 5 oz.; Stephenson's ditto, 2 lb. 4½ oz.; Clanny's ditto, 2 lb. 13 oz. Compared with a miner's candle, 30 per lb., 4½ Davy lamps, 8½ Stephenson's, and 1¾ Clanny's, were required to produce an equal light."

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1817, November. In this month was issued a report upon the claims of George Stephenson relative to the invention of his safety-lamp, by the committee appointed at a meeting holden in Newcastle on the 1st of the month.

1818, January 12. A party of gentlemen, with Charles John Brandling, Esq., in the chair, presented George Stephenson with a large silver tankard; and this, added to a former donation of the Coal-trade at large, amounted to nearly £1,000.

1818. During the course of this year, steamboats were applied to towing vessels in and out of harbours. This gave an impetus to trade and led to the abolition of lying up collieries during the two winter months.

1818. Mr. Croudace at this time, agent for the Lambton Collieries, to avoid the breakage of coals, fitted up keels with eight square tubs, containing a Newcastle chaldron each.

1819. A strike occurred among the keelmen this year.
1820. May. By a series of experiments made at this time by Mr. Benjamin Thompson, the floating
power at various places on the Tyne, as ascertained by keels, was found to greatly vary.

The difference between high water at Newcastle New Quay, and low water at Shields Quay, was
found to be ten and a-half cwts. in the keel, and the difference at high water between Newcastle
and Shields New Quay, was twenty-seven cwts.

1820. About this year steam traction underground begun to be introduced.

1820. Coast vend, 3,244,885 tons; oversea vend, 158,340 tons; total, 3,403,225 tons.

1821, April 19. Upon this day occurred the interview between the late Edward Pease, the Father of
Railways, and George Stephenson, relative to the making of the Stockton and Darlington Railway, for
which an Act was this year obtained, but the first rail was not laid until the 23rd of May, 1822.

1821. This year the Hetton Colliery, Blossom and Minor Pits were won. The original pit was
commenced by Mr. W. Lyons, in 1810, but abandoned, not being able to pass through the "friable
sand." *

* Mr. Thomas Wood, in his evidence given before the Committee of the House of Commons, in 1857, stated
that he disposed of his share in Hetton Colliery at the rate of £324,000 for the whole.

Wrought-iron rails, invented by Mr. Birkenshaw, were rolled at Bedlington Iron Works, near Newcastle.—
Jevons.

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1821. Average shipping price of Newcastle coals 12s. 8d. per ton.*

1822, October 24. One of the frequent strikes among the keelmen occurred, which lasted till
December 22nd.

1822, November 18. On this day the Hetton Colliery Railway was opened, and the first coals from the
colliery were shipped. Five of George Stephenson's patent travelling engines were used on the
railway, of which Robert Stephenson, his son, was resident engineer.

1825, September 27. The Stockton and Darlington Railway, of which George Stephenson was
engineer, was opened for twenty-five miles in length, from Stockton to Witton Park.

In the early days of this railway the passengers were conveyed in ordinary coaches mounted upon
railway wagon wheels. Upon Sundays it was usual for the "Friends" residing at Shildon to go to
Darlington in a car drawn by a horse along the line.

About the same period an ordinary stage coach, drawn by a horse, was used for passenger traffic
upon the Clarence Railway.

1825. This year Mr. Nicholas Wood published his work on the "Establishment and Economy of
Railways."
1825. Guides, now universally used in pit shafts, were this year first introduced into shafts in the neighbourhood of Chesterfield, at Duckmanton Colliery; they were also in use at Radstock Colliery, in Somersetshire, shortly after this date.

1825. Up to this period, the Marquis of Londonderry's Hutton seam coal, which had sold for many years at the place of shipment at 36s. 6d. per chaldron, or 13s. 9d. per ton, was reduced to 32s. 6d. per chaldron, or 12s. per ton.

1825. The "Small Coal Act" passed, reducing the duty upon small coals exported abroad.

1825. The Wear vend for this year was 502,043 tons.

1825. In this year was published a pamphlet, entitled "A Voice from the Coal Mines, or a plain statement of the various Grievances of the Pitmen of the Tyne and Wear." In it they complain of the low prices, fines, bonds, and bad ventilation. They say, "Sir H. Davy's invention of the safety-lamp has been an advantage to the coalowners, but a great injury to the comfort and earnings of the pitmen, for while the former remain indifferent about the safety of the mine, and neglect

* Jevons.

1823.—The net produce of duties on coal, cinders, and culm in the United Kingdom, amounted this year to the large sum of £1,167,767 17s. 11d.


1826, The Pitman's Union formed this year for an increase of wages, upon which occasion they struck work for seven weeks.

1827, May. The first coals drawn at Wideopen Colliery.

1828, August 15. The following curious verdict was this day delivered in the case Rex v. Russell and others, owners of Wallsend Colliery, which was tried at Carlisle:—

"We find that part of the navigable channel of the river Tyne, opposite to Wallsend, has been straitened, narrowed, lessened, and obstructed by the gears described in the indictment, but we find, nevertheless, that the trade of Newcastle and the harbour of the Tyne have, at the same time, been greatly improved."

The late Mr. T. J. Taylor remarked that the export of coals may be considered to have commenced as a great trade about this year.

1828, November 28. The late Marquis of Londonderry laid the foundation stone of Seaham Harbour.

1828. Moorsley Pit, North Hetton Colliery, was sunk.
1829, February 6. This day, a ball was given at the bottom of Gosforth shaft, at a depth of 1,100 feet, to celebrate the winning of the colliery. Between 200 and 300 people were present, nearly one-half of whom were females.

1829, May 1. A committee of the House of Lords sat (before which Messrs. R. W. Brandling, John Buddle, Hugh Taylor, and others, were examined), the following matters were deposed:—

By Mr. Buddle, that there were on the river Tyne 41 collieries, 23 on the north side, and 18 on the south side; on the Wear, 6 on the north side, and 12 on the south side, making 18—the whole number on both rivers being 59.

That the collieries on the Tyne, with respect to their machinery, were capable of raising double their present quantity.

Speaking of the introduction of Davy-lamps, he remarks as follows: "I beg to state that this introduced quite a new era in coal-mining, as many collieries have been re-opened, producing the best coals, which must have lain dormant, but for the invention of the Davy-lamp."

That the deepest working-pit at this time was 180 fathoms, and the shallowest twenty-three fathoms.

That the capital employed by the coalowners of the Tyne, exclusive of craft in the river, amounted to £1,500,000, and on the Wear from £600,000 to £700,000.

That the colliers could make 5s. per day, but for want of employment had not earned more than half that sum during the last year.

"That in 1795, when collieries became exhausted in the whole mine, an attempt was made at partial working by removing one-half of every alternate pillar. There was just about fifty-seven, or from fifty to sixty per cent, obtained, and the rest was totally abandoned. In 1810 another improved system was introduced; the coal-mines were exhausting so very rapidly, that an attempt was made by which every intermediate pillar was taken, and also a portion of the adjoining ones; by this plan we succeeded, by working in small divisions, in obtaining between eighty or ninety parts out of 100; still, the ultimate effect was that creeps took place, the danger was increased, and great loss of coal was the consequence."

Upon the difference in value between working stock and stock to be moved, he remarks, "we seldom calculate to be less than forty per cent. deterioration and frequently more," and upon coalowners' profits he says, "according to the best of my knowledge, taking a run of years, from the time I have been in the trade, I should think that by no means ten per cent. has been made as simple interest, without allowing any extra interest for redemption of capital."

That the positive waste by screening, added to the waste on small coal stowed underground, would amount to a loss of from one-fourth to one-third of the whole mine.

That the number of men employed in the Coal-trade on the two rivers were, underground on the Tyne, 8,491, aboveground, 3,463—making the total of 11,954; upon the Wear, 9,000—making
21,000 in all. At the same time, there would be 1,400 vessels, which would require 15,000 seamen and boys.

Mr. Buddle gave the following abstract of charges upon a London or imperial chaldron of coals:—

Charges in the River Wear.

For seven miles carriage, loading and unloading, &c. … £0 4 9¾

" Government duty…………………………………… 0 6 0

" Freight ……………………………………………… 0 11 0

Carried forward ................ £1 1 9¾

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Brought forward………………£1 1 9¾

For Municipal dues—London ……………………… 0 4 9½

" Charges of delivery from the vessel into the cellar of the consumer ……………………………… 0 13 7

" Original price received by the coalowner............ 0 12 9

£2 12 11¾

Mr. Hugh Taylor informed the committee, that he estimated that the Northern Coal-field would supply the present annual vend of 3,500,000 tons for a period of 1,727 years.*

1829, August 31. The Coal-trade determined to re-establish the vends.

* Table of Coal Measures used in Durham and Northumberland,

COMPILED BY Mr. HUGH TAYLOR.

[Table]

By the above, it appears that a Newcastle chaldron of twenty-four coal bolls ought to contain 232,243½ cubic inches, whereas, in reality, the standard weight of fifty-three cwts. requires only 217,989 cubic inches, which is the Custom-house measurement, being a difference of 14,254 ⅕ cubic inches = 6.14 per cent., or 22.526 instead of twenty-four bolls.

Upon the Ten Mr. Buddle, in his evidence, stated—" That it is a local or customary measure and very arbitrary. It varied in different periods, but it seems now to have settled itself to a certain standard, and more particularly with the Dean and Chapter of Durham.

"The usual Ten is 440 coal bolls of thirty-six gallons Winchester measure, which equalled in weight forty-eight tons eleven cwts. two qrs. and seventeen lbs., and a decimal .9, that is a fractional measure.
"The Dean and Chapter, at my suggestion, found it more convenient to adopt a measure which is not fractional, and they made theirs 432 bolls, which equals forty-seven tons fourteen cwt.

Upon the weight of coal, Mr. Buddle informed the committee, "That all our bituminous coals range from about seventy-six lbs. to eighty lbs. per cubic foot. Also, that five cubic feet of coal, if in one block, would, if broken into the ordinary state in which they are sent to market, fill a measure of eight cubic feet."

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1829. The area of the Northern Coal-field has been computed by various authorities as under—

In 1829—By Hugh Taylor at 837 square miles.

Less excavated 105 square miles, leaving 732 square miles.

T. Y. Hall at 750 square miles.

G. C. Greenwell at 800 square miles.

B. Hull at 685 square miles.

I. S. Bell at 700 square miles.

The length varies from 47 to 58 miles, and its breadth from 15 to 24 miles.

1830. This year the state of the Coal-trade was investigated by a committee of the House of Commons, being the third Parliamentary Inquiry. Among the witnesses examined were Messrs. R. W. Brandling, John Buddle, John Clayton, Dr. Buckland, and Professor Sedgwick.*

The burning of small coals, the duties, the regulation, and the abuses in London, were the chief objects of inquiry.

Mr. Buddle, among other things, informed this committee, that five per cent. was the average profit of collieries after returning the capital. The highest rate of profit he knew of was fourteen per cent., including redemption of capital, viz.—five per cent, profit, and nine per cent, redemption.

This committee came to the following conclusions:—That the present regulation, with various interruptions, had continued since 1771.

Regret was expressed at the waste of coal by screening. They recommended that weight should be substituted for measure.

With regard to interference with the regulation. That "the trade had better be left to the control of that competition which appears already to have affected it.

" That every means of promoting a new supply of coals be encouraged, as furnishing the most effectual means of counteracting the combinations of the coalowners and factors; and that the Act of 28 George III. be repealed, so as to leave the Coal-trade free in the port of London, and conclude by advising the removal of all duties on coal consumed in this kingdom, whenever financial arrangements can be made for effecting such removal with security to the public revenue."
During the investigation, Professors Sedgwick, Conybeare, and Buckland, expressed considerable doubt of the existence of any great body of good coal underneath the extensive district of Magnesian-limestone lying to the eastward of Hetton.

1830. Coast vend this year, 3,289,241 tons; oversea, 341,062 tons; total, 3,630,303 tons.

1830. At a meeting of viewers, held March 13, 1830, the following prices to be paid to colliery workmen were fixed:—Putting a twenty-peck corf, 1s. 2d., until the average distance exceeds 100 yards, and 1d. for every twenty yards beyond that distance. Putters to find their own candles, grease, and soames. Rolley-drivers, 1s. 2d. per day; trappers, 10d. per day; overmen, 28s. per week; back-overmen, 4s. per day; wastemen, 20s. per week; deputies, 3s. 6d. per day; shifters and coal workmen, 3s. per day of eight hours; banksmen, 3½ d. per score, when separated; 3d. per score when together; stick odds, 3s. per week; brakesmen, 18s. per week; fourteen hours per day and upwards, 20s., including attending pit on Sunday mornings, and cleaning boilers; enginewright, 18s. per week; common enginewrights and joiners, 16s. per week; blacksmith, 3s. per day; masons, 2s. 10d. per day; cartmen, 2s. 2d. per day; labourers, 2s. per day. 1830. The Marquis of Londonderry presented a petition to the House of Lords, from the coalowners and others interested, for a repeal of the duties on coal.

1831, February 26. This day, eight or ten thousand pitmen met on the Black Fell, when they entered into resolutions to demand higher wages. Frequent notices occur after this time, in the "Local Records," of large gatherings of pitmen, amounting occasionally to many thousands. * Seeing that Mr. Buddle had, shortly before this time, estimated the total body of men and boys employed in and about the collieries, upon the rivers Tyne and Wear, at 21,000, we have good grounds for believing the numbers stated to be present at these meetings to have been greatly over estimated.

1831. Average shipping price of coals, 12s. 4d. per ton. †

1831, March 1. The "Richmond Shilling" ceased to be levied after this date. When relinquished, the whole amount of its cost in 1799, with five per cent, interest, and an overplus of £341,900, had been realised by Government.

1831, March 21. Nearly 20,000 pitmen assembled on Newcastle Town Moor, to consider measures for improving their condition.

1831, April 5. The pitmen struck work, but recommenced about the middle of June.

* Local Historian's Table Book. † Jevons.
1831, August 13. 10,000 or 12,000 pitmen met at Boldon Fell.

1831, December 24. 1,000 pitmen riotously assembled at Waldridge Colliery, stopped the pumping-engine while thirty or forty men were down the pit, and threw tubs and corves down, with the intention of killing those at work. Five hundred guineas were offered for the apprehension of the parties concerned in these outrages. Six men were tried at the ensuing Durham Assizes, and sentenced to imprisonment for various terms.

1831. This year Wallsend Colliery became exhausted in the Main-coal seam, which originally extended over an area of 1,200 acres. It commenced working in the year 1778.

1831. Middlesborough dock was opened, when a block of coal, wrought at Black Boy Colliery, and weighing three and a half tons, was shipped. This was probably the largest mass of coal ever shipped from the Northern Coal-field.

1831. The coastwise duty of 12s. per Newcastle chaldron was repealed this year.

1832, March 3. Between 7,000 and 8,000 pitmen met at Boldon Fell, for the purpose of arranging not to agree with their masters for the next twelve months, unless some of the clauses were struck out of the bonds; also, to urge the support of the Union.

1832, April 14. 9,000 pitmen met upon the Black Fell, for the same purpose as the meeting held the previous month.

1832, April 21. A riot occurred at Hetton Colliery, when a bound man, named Errington, was murdered, being shot with two marbles, by the Union men.

1832, May 1. A riot occurred at Friars Goose, near Gateshead, occasioned by turning the pitmen out of their houses. It was found necessary to call out the military, in order to quell the rioters.

1832, June 11. Mr. Nicholas Fairless, a magistrate of South Shields, was attacked and ill-treated by two pitmen, named Jobling and Armstrong, in consequence of which he died. Jobling was tried and executed at Durham, and hung in chains upon Jarrow Slake, on August 3rd, succeeding. Armstrong succeeded in making his escape.

1832, September. In the latter part of this month the Pitmen's Union was dissolved, and the men recommenced work, after a loss of £80,000 in wages.*

1832. An Act of Parliament was passed this year, substituting weight for measure in the buying and selling of coals; thus doing away with a system of uncertainties.

1832. Rules for the establishment of friendly societies were submitted to the coalowners and pitmen of the Tyne and Wear.

1833, March. The Main-coal seam was won at St. Helen's Colliery, Auckland.

1833, June. The Hutton-seam was won at the Eppleton Pit, Hetton Colliery, at a depth of 155 fathoms.
1833, August 5. South Hetton Colliery was opened, and shipped its first coals at Seaham Harbour.

1833, August 7. The first cargo of coals was shipped from St. Lawrence Colliery, the produce of the Low-main seam, at a depth of ninety-four fathoms.

1833. The Coal-trade was open this year, in consequence of which best coals became a drug upon the market. †

1834, January 16. The first cargo of Crowtrees Wallsend coals was shipped at Stockton.

1834, February 15. The Bensham or Maudlin-seam, at Monkwearmouth Colliery, was won at a depth of 264 fathoms, and at an expenditure of £100,000; since which the Hutton-seam, at a considerably further depth, has been sunk to and worked. The first cargo was shipped on June 13, following. The sinking of this colliery commenced in May, 1826. The tub first used for drawing coals was of iron, seven feet high, circular in shape, and contained 105 pecks, weighing 30 cwts. ‡ In a few years' time, these tubs gave way to the ordinary ones, now generally used.

1834, March 1. The regulation of vends was recommenced.

1834, September 10. This day the first vessel was loaded by the Stanhope and Tyne Railway, which, upon this occasion, was opened for traffic.

* Fordyce. † Dunn.

‡ In the early period of mining, coals were drawn in corves. The trams had broad, wooden wheels, and the tramways were constructed of three planks, the upper one forming an elevated edge for the guidance of the tram.

1882. Cobbett, who visited this part of the country in 1832, inserted the following astounding passage in his "Political Register" shortly afterwards:—"Here is the most surprising thing in the whole world; thousands of men and thousands of horses continually living underground; children born there, and who, sometimes, never see the surface at all, though they live to a considerable age."—Hair's Sketches of the Coal-mines.

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1834, October 8. Gordon Colliery, near Evenwood, was won.

1834, December 23. The late Mr. Buddle read to the Natural History Society a paper, entitled "Suggestions for making the Natural History Society a place of deposit for the Mining Records of the District."

1834. At this time there were sixty-four collieries, having an aggregate basis of 4,618,287 tons.

1834. Importation into London, 2,078,685 tons.

1835, March 11. Haswell Colliery was won to the Hutton-seam, at a depth of 155 fathoms. The first cargo of coals from it was shipped at Seaham in July succeeding. A few years ago, Mr. T. J. Taylor stated that the annual production of this colliery was 200,000 tons of coals, to obtain which 289 men and 139 boys were employed underground.
1835, July 9. Hartlepool Dock and Harbour was opened; the first coals shipped in it being from Thornley Colliery.

1835, Aug. 12. The winning of Pelton Fell Colliery was commenced.

1835. Coast vend this year, 3,290,511 tons; oversea, 494,485 tons; total, 3,784,996 tons.

1835. In this year a committee of the House of Commons was appointed (being the fourth Parliamentary Inquiry) of which Mr. Joseph Pease was chairman, for the purpose of examining into the causes of explosions, and devising suitable remedies. This committee was enabled to ascertain that, during the twenty-five years previous to their inquiry, 2,070 persons had perished from colliery explosions, and they considered the number much understated,* and that during the last ten years the rate of loss of life from this cause had certainly not diminished. This committee pointed out that more persons had lost their lives from colliery explosions for the eighteen years succeeding the introduction of the Davy-lamp in 1816, than in the eighteen years preceding the invention; and accounted for this fact by the working of numerous fiery seams of coal, which had, in consequence of the assumed security of this lamp, been undertaken, and by the abandonment of many precautions considered requisite, when candles were commonly employed in collieries.

The Report ends as follows:—"In conclusion, your committee regret that the results of their inquiry have not enabled them to lay before the House any particular plan by which the accidents in question may be avoided with certainty, and, in consequence, no decisive recommendations are offered. They anticipate great advantage to the public and to

* See Appendix on Accidents.

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humanity from the circulation of the mass of valuable evidence they have collected. They feel assured that science will avail itself of the information, if not for the first time obtained, yet now prominently exhibited; and that the parties, for whose more immediate advantage the British Parliament undertook the inquiry, will not hesitate to place a generous construction on the motives and intentions of the Legislature."

The steam jet, for ventilating purposes, about which much will be heard hereafter, was originally proposed by Goldsworthy Gurney at this committee.

1835. Wear vend this year, 410,872 tons.

1836, August 30. The Durham and Sunderland Railway was opened.

1836, October 13. Belmont Colliery commenced shipping coals.

1836. About this year coal tubs and guides in shafts were introduced at South Hetton Colliery, by Mr. T. Y. Hall. Previous to the introduction of guides, the coals were brought up the shaft in large iron tubs, holding upwards of a ton, similar to those used at Monkwearmouth Colliery. The coals were brought from the face in six cwt. tubs, placed upon rolleys capable of carrying two or three each, and drawn by horses to the shaft, where they were discharged into the iron tubs. After a few years the rolleys were universally discontinued.
1836. The use of wire ropes in collieries commenced about this time.

1837, January 7. Woodhouse Close Colliery was won to the Main-coal seam, at a depth of seventy-four fathoms.

1837, March 31. The pitmen of the Tyne and Wear resumed work, after a strike of some months, upon the same terms they had previously been paid.

1837, June 20. Whitwell Colliery was won to the Hutton-seam, at a depth of fifty-nine fathoms.

1837, January 30. Two pitmen, named Storey and Surtees, in consequence of a wager, undertook to hew coals against each other, at Thornley Colliery. The wager was won by Storey, who hewed thirty-three and a half tubs, of twenty pecks each, and Surtees thirty tubs; the former being ten tons and one cwt., and the latter nine tons. The time of working was eight hours, and the amount of earnings, according to the price paid for hewing, was—Storey, 11s. 2d.; Surtees, 10s.; from the hardness of the seam, the feat was supposed to be unprecedented.—Latimer’s Local Records.

1837, July 30. Workington Colliery, in Cumberland, inundated by the sea, in consequence of the stupidity of the agent. Thirty-six lives were lost; but as no body was ever recovered, no inquest could be held.

1837. About this period it is stated that a landsale colliery was in operation at Brandon, near Brancepeth, at which the coals were drawn by a gin, in which a bull was harnessed, instead of a horse, as is usual. Much about the same period, a landsale was in existence near Witton-le-Wear, where the coals were drawn by an ass, and the coals banked out and sold by an old woman.

1837, July. South Tanfield Colliery was won to the Main-coal seam.

1837, September 11. Blaydon Main Colliery was won.

1837, October 3. The first coals from Ratcliffe Colliery were shipped in Warkworth Harbour.

1837, November 1. The Monkwearmouth Dock was opened. In 1846 it was purchased by the York, Newcastle, and Berwick Railway Company for £85,000.

1837. In a Parliamentary document, the number of tons of coal and coke exported from the North in the year is thus stated:—

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<th>Coals.</th>
<th>Coke.</th>
<th>Total.</th>
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<tbody>
<tr>
<td>Newcastle</td>
<td>2,385,192</td>
<td>...</td>
<td>7,302</td>
</tr>
<tr>
<td>Sunderland</td>
<td>931,944</td>
<td>...</td>
<td>191</td>
</tr>
<tr>
<td>Stockton</td>
<td>1,145,827</td>
<td>...</td>
<td>10</td>
</tr>
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FOREIGN.
Newcastle ....................... 471,150 ... 5,007 ... 476,157 tons.
Sunderland....................... 242,252 ... 211 ... 242,463 "
Stockton ......................... 46,407 ... 109 ... 46,516 "

1838, May 10. A new winning was this day commenced at Seaton Delaval. Ground was broken for six pits, all within the compass of 600 yards.

1838, June 18. The Newcastle and Carlisle Railway was opened from Redheugh Station, near Gateshead, to Carlisle.

1838, August. The Durham Junction Railway was opened.

1838, December. West Auckland Colliery was won.

1838. This year the Durham County Coal-, and the Northern Coal-Mining Companies, with a capital of £500,000 each, commenced operations. Through their instrumentality many collieries were opened out prematurely. Both companies succumbed in the course of a dozen years, after losing their capital and seriously embarrassing their shareholders.

1839, March 18. The Clarence and Hartlepool Junction Railway was opened, the first coals shipped by it being from Kelloe Colliery.

1839, May 28. The first coals shipped from Garmondsway Moor Colliery.

1839, June 28. Hilda Wallsend Colliery exploded, by which fifty-two lives were lost. This accident led to the appointment of the South Shields Committee, with Robert Ingham, Esq., as chairman. This committee sat occasionally for three years, and in 1843 issued a report of great value. Among the conclusions arrived at, were—that within the last twenty years 680 miners had been destroyed in the districts of Tyne and Wear. That the upcast should be larger than the downcast shaft. That the Davy-lamp has been found by experiment and practice to explode the external gas by the passage of the flame through the gauze; and that no doubt can remain that it has been the cause of some of the hitherto unaccountable accidents which have occurred. That the velocity of the air-current is found to traverse in the galleries, sometimes, at a rate not exceeding two feet; and in some of the most extensive mines, it is reduced so low as one foot, and even .66 of a foot per second. The committee strongly recommended the adoption of Goldsworthy Gurney’s high-pressure steam for ventilating purposes, government inspection, etc.

1839, August 19. Dr. Clanny read a paper to the members of the South Shields Committee, explanatory of his lamp, which he stated gave five times as much light as the Davy.

1839, August 29. Sacristan [sic] Colliery Railway was opened.

1839, August 30. Brandling Junction Railway was opened from Gateshead to Monkwearmouth.
1839, December 30. Medomsley Colliery commenced working.

1840, June 1. Seghill Colliery Railway was opened to Howdon.

1840, June 2. The first cargo of coals from Cassop Colliery was shipped at Hartlepool.

1840, June 12. The West Durham Railway was opened.

1840, July 20. Andrew's House Colliery commenced shipping coals. At this period there were 101 collieries in operation. According to Latimer nineteen collieries were opened from June 1833 to this date.

1840. Coast vend, 4,391,085 tons; oversea vend, 1,196,299 tons; total, 5,587,384 tons. Steam coal vend this year included in the above, 198,583 tons.

1841, January 4. The Great North of England Railway was opened for coal traffic from York to Darlington.

1841, May 5. Framwellgate Colliery commenced shipping coals.

1841, July 10. Whitworth Colliery was won to the Hutton-seam at a depth of eighty-six fathoms, at a cost of £40,000, by the Durham County Coal Company.

1840. An Act was passed this year to do away with female labour underground in Scotland.

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1841, July. Westerton Colliery commenced shipping coals.

1841, December. Shotton Colliery was won by the Haswell Coal Company.

1841. About this period the plan of drawing the tubs along the rolley ways in pits upon their own wheels, now universally followed, was adopted.

1841. Average shipping price of Newcastle coals 10s. 6d. per ton.*

1842, February. Houghall Colliery commenced shipping coals.

1842, April 7. Spital Tongues Colliery tunnel was opened to the Tyne. It is nearly two miles in length, and is six feet three inches in width by seven feet five inches in height. It is cased throughout with strong masonry and brick work, and took nearly three years in construction.

1842, May 12. Middlesborough New Dock was opened.

1842, May 27. Coal was won at Oakwellgate Colliery, Gateshead.


1842, September 17. The Hutton-seam was won at Castle Eden Colliery.

1842, November 15. Brancepeth Colliery shipped its first coals.
1842. In consequence of a Commission of Inquiry appointed in 1840, to enquire into the state of the mining population, and for the purpose of devising means for preventing accidents, an Act was passed this year to regulate the employment of boys, to prohibit the employment of women and girls in mines and collieries, and the payment of wages in public-houses, etc. †

1843, February 25. Trimdon Colliery commenced shipping coals.

1843, April 17. Murton or Dalton Colliery was won to the Hutton-seam at a depth of 248 fathoms. Ground was broken for the first shaft on the 19th February, 1838. Extraordinary difficulty was experienced in passing through the "friable sand" owing to 9,306 gallons of water per minute having at one time to be lifted from the depth of ninety fathoms. This winning is said to have cost from £250,000 to £300,000. ‡

* Jevons.
† The bearing system by females was still common in Scotland at this period. The ordinary load was from 200 to 246 lbs. each. The only recorded instance of a woman having been employed in the northern coal mines, is in Gateshead Burial Register, about 1705, where the daughter of Jackson, who had three pits in the front field, at the head of Jackson’s Chare, is recorded as killed, with a number of the opposite sex, by a blast in one of the pits.—T. Y. Hall.
‡ In the Report on Coal, Coke, and Mining, read before the British Association

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1843, July 8. A meeting of 20,000 pitmen took place at Shaddon’s Hill, to uphold restriction.

1843, August 4. A trial of some importance took place at the Northumberland Assizes, at this date, between Williamson and Taylor and others, owners of Holywell Colliery, involving the question, Whether the legal construction of the agreement, commonly called the "Pit Bond," enabled the men to claim reasonable wages when the pit is laid off work? A verdict of 30s. damages was given for the plaintiff.

1843. The Special Committee of the Coal-trade, about this time, reported that an ordinary workman could earn 3s. 8d. in eight hours.

1843, October 10. Mr. Buddle, the celebrated viewer, died at Wallsend, aged seventy. As a mining engineer, he stood in the first rank of his profession. An immense cortege of private carriages, horsemen, and workmen, accompanied his remains to the grave.

1843. Before the close of this year, a strong feeling of dissatisfaction spread among the mining population, in consequence of what they considered their grievances, resulting in frequent conflicts with their employers, in which they were advised and represented by their Attorney-General, Mr. William Prouting Roberts. His proceedings against the employers did much to augment the irritation which prevailed.

1844, February 7. The first shipment of coals from Coxhoe Colliery took place.

1844, March 27. A deputation of coalowners submitted the following statements to Sir Robert Peel:—That the capital embarked in the Coal-trade was £9,500,000; that 33,920 men and boys were
employed in it as follows, viz., on the Tyne, 15,556; Blyth, 1,051; Wear, 13,172; Tees, 4,211; of whom 25,383 were employed underground, and 8,607 were employed aboveground. That there were 4,031 ships engaged in the home Coal-trade, and 2,842 ships engaged in the foreign Coal-trade, and that the annual produce of coals was 9,623,922 tons.

1844. The late Mr. Thos. John Taylor estimated that there would be 12,874 hewers in the Coal-trade at this date, and allowing each man to

in 1863. On the Drainage of Mines it is stated that Hartley, Walbottle, and Wylam Collieries each had upwards of 1,200 gallons of water per minute. That the general cost of pumping water from the Durham and Northumberland Mines, exclusive of interest and redemption of capital, is about ¼d. per ton of water raised 100 fathoms. In the case of Murton Colliery winning, the leather for the buckets for some time cost £11 5s. per hour. An elaborate Paper was read upon the Sinking of this Colliery to the Members of the Mining Institute by Mr. Potter in 1856.

produce three tons of round coal per working day, and 800 tons a-year, we have 10,299,200 tons for the extreme powers.

The returns to the Coal-trade Office at this time show that the pumping-engine horse-power was 10,919; and of drawing-engine horsepower, 8,285; and that it is capable of raising 57,713 tons daily, the proportions for the different districts being nearly as three on the Tyne, two on the Wear, and one on the Tees.

1844. An important trial occurred this year, known as the Wingate Colliery Wire-Rope Trial. The decision of the jury fully demonstrated the superiority of the wire-rope over that manufactured of hemp.

1844, April 5. A universal strike took place among the pitmen, which did not terminate until the beginning of August, when the men resumed work at their old prices, after having undergone great hardship and privation, from being turned out of their houses.* Numerous large meetings took place between the times of striking and resuming

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<td>Wear ..................</td>
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<td>Tees...................</td>
<td>3   9.500</td>
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After the close of the strike, it was estimated that the cost of the Union and Mr. Roberts to the pitmen was........................................... £441,850
Made up as follows (first money paid):—

Mr. Roberts, one year's salary and expenses in removal...... £1,120

Do. other expenses........................................... 330

Do. for Wingate trial........................................ 600

Union fund, say 20,000 men, at £1 each,..................... 20,000 £22,050

Second—Money Lost:—

From restriction on wages, which caused 33,002 hands to
be employed when 22,000 was necessary—11,000 extra

can, for forty-eight weeks, from 1st May, at 10s. each

per week . £264,000

Wingate strike—thirteen weeks, at £400 per week ........ 5,200

Thornley „ twenty „ at £800 „ ........... 16,000

Jarrow and other strikes, say.............................. 2,600

Present strike, 33,000 hands at 10s. each for eight weeks...132,000 £419,800

Total lost .................................................... £441,850

And beside this large amount, the coalowners suffered to the extent of £200,000.

Among numerous threatening letters of this date, the following specimen, addressed to an overman at
Monkwearmouth Colliery, is selected:—"I am put to a stand to know how thou dost offer up prayers to the
most high God when thou knowest how thou defecting thy fellow creature of their rights or at least trying to do
it. Man be ashamed of thyself. God will pour his vengeance down upon thy head, & if it is not seen soon the
vengeance of earthly man will shall fall upon their work, and a newspaper, called the "Miners' Advocate," was commenced and carried on for
some time, to discuss and advocate their claims and supposed grievances. Among their demands
were an average advance of twenty-eight per cent, upon the hewing prices; working-hours per day
to be ten instead of twelve; to be allowed to retain possession of their houses for sixty-six days after
the termination of the period of hiring; work guaranteed for five days a-week, or fifteen shillings in
money; hiring to be for six months, expiring on the 5th October. To these demands, with other
resolutions, the following was passed at a Coal-trade meeting, held 13th April, 1844:—" That it is
incumbent on the coalowners to act unitedly and determinedly in resisting these demands of the
workmen; and that a special committee be named to sit at the Coal-trade Office, to whom all
communications are requested to be addressed."
1844, June 18. The Newcastle and Darlington Railway was opened; this was the last link between Newcastle and London.

1844, July 8. Harton Colliery was won to the Bensham-seam, at a depth of 215 fathoms.

1844, September 28. In consequence of an explosion at Haswell Colliery, by which ninety-five lives were lost, † Professor Faraday and Sir Charles Lyell were deputed by Government to attend the inquest and report upon the explosion, and on the means of preventing similar accidents. To consider their report, a special committee of the Coal-trade was appointed, who, while exposing the impracticability of their suggestion of conducting the gaseous contents of the goaves to the upcast shaft, by means of cast-iron pipes, twelve inches in diameter, express the hope that "much good may be done, when the attention of eminent men is directed towards the prevention of pit explosions. The trade is deeply indebted

the, depend upon this letter to be a true one, I wearn you to alter your discurse fore the futer & I request the to read the second chap of Habbakus prayer this comes to show & such as thou & youl all be plunged out of time into etermty [sic] before long if it contines as it is licley to do So preper fore a nother World thou will be deprived of thy life when thou little thinks of it and spedley. Men not a bove a hundred miles of has not been Ded to all thy words and transections before the strike and since it took place. The hand of vengence is uplifted at the & a hevy wepon in it to plunge the out of time into Etermty [sic]. a good name is rather to be chosen than grate riches, and loovings favour rather then silver & gold Chap xxii of prov"

"Read the iv CHP. of Ecclesiasties. So I returned & considered &c thou ventursom vagabond thouil be remembered all the days of thy Life As a tyrant towards thy fellow creture"

†A subscription for the sufferers on this occasion amounted to £4,264.

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to Messrs. Lyell and Faraday for the labour and consideration they have bestowed towards the attainment of this desirable end; and your committee trust that those gentlemen will not give up the investigation of a subject, in relation to which, when its practical difficulties come to be fully appreciated by them, their eminent acquirements may prove highly beneficial."

1845, March 12. Byers Green Colliery was opened.

1845, May 20. The first shipment of coals from Croxdale Colliery.

1845. This year, Sir H. De-la-Beche, Dr. Lyon Playfair, and Mr. Warrington Smyth, were appointed by Government to report on gases and explosions in collieries. These gentlemen recommended the compulsory use of safety-lamps in all fiery mines, and the appointment of Government Inspectors.*

1845. The late Mr. Thomas John Taylor, speaking of the capital now embarked in collieries, railways, and harbours for colliery purposes (nine or ten millions) says, of which it may be safely calculated that six millions have been embarked since 1828.

1845. At this date there were 129 collieries, having an aggregate basis of 10,635,703 tons.

1845. The coast vend was 5,059,880 tons; oversea, 1,731,113 tons; total, 6,790,993 tons.

1845. About this time Mr. Edward Foudrinier invented the patent grip or safety-cage.
1845, August 12. The winning of Seaham and Seaton Colliery was commenced.

1845. Wear vend, 533,713 tons.

1846. This year saw the opening out of the coking-coal district near Crook, known as Pease's West Collieries.

1846. Messrs. N. Wood and the other gentlemen who prepared the Report on Coal, Coke, and Mining for the British Association, held in Newcastle in 1863, state that, "The Coke-trade in the northern counties may be considered as established previously to this date only at Garesfield and Wylam, and it was made from the Busty, Harvey, and Brockwell coal-seams."

1846. Under this date the late Thomas John Taylor published an able pamphlet, "Observations addressed to the Coalowners of Northumberland and Durham on the Coal Trade of those counties, more especially

* The Report was published in 1847.

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with regard to the cause of, and remedy for, its present depressed condition." *

1847, June 1. The West Hartlepool Dock was opened.

1847. Coast vend, 5,921,037 tons; oversea, 1,806,637 tons; total, 7,727,674 tons.

1847. This year a correspondence took place between Mr. A. Spottiswood and the late Marquis of Londonderry. The former gentleman proposed to form the whole of the collieries in the North of England into a Joint Stock Company, with a capital of £16,000,000, which project was scouted by the noble marquis in somewhat plain terms.

1848, August 12. George Stephenson died at Tapton House, near Chesterfield, Derbyshire, aged sixty-seven years. †

This year, according to Mr. Marley, saw the first practical application of the discovery of the thick bed of ironstone in Cleveland.

Mr. Forster introduced the steam-jet for ventilating purposes at Seaton Delaval Colliery this year.

1848, December 30. Died at Brussels, aged seventy-four, Robert William Brandling, Esq. The deceased, for a lengthened period, was chairman of the Northern Coal-trade.

1849. This year Government appointed Professor Phillips and Mr. J. Kenyon Blackwell to report on the ventilation of mines and collieries. These two gentlemen made separate reports in 1850, the former of the mines in Northumberland and Durham, Derbyshire and Yorkshire; the latter of those in Lancashire, Shropshire, and South Wales. These gentlemen recommended practical and scientific acquirements for the managers of mines, well-appointed provincial mining schools, and a systematic inspection under the authority of Government.
A series of Reports on the Coals suited to the Steam Navy, by Sir Henry De-la-Beche and Dr. Lyon Playfair, was this year concluded and published. The results were questioned, and further experiments have since been made upon a practical scale.

1849, June. A committee of the House of Lords (the fifth Parlia-

* Mr. Taylor in his pamphlet, speaking of the Coal-trade regulation, says— "We can establish, therefore, a full period of 180 years during which this arrangement has existed, with intermissions, originating, as they do now, among the coal-owners themselves."

† The following remark of George Stephenson's evinces his great shrewdness: — "The strength of Britain lies in her iron- and coal-beds; and the locomotive is destined, above all other agencies, to bring it forth. The Lord Chancellor now sits upon a bag of wool, but wool has long ceased to be emblematical of the staple commodity of England. He ought to sit upon a bag of coals."—Smiles' Engineers.

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mentary Inquiry), Lord Wharncliffe, chairman, was this year appointed to inquire into explosions and accidents in collieries. This Committee sat for eighteen days and received a mass of evidence bearing upon the steam-jet and furnace ventilation. No legislative measure was recommended to Parliament by this committee. In their Report they do not take upon themselves to pronounce an opinion upon the comparative merits of the furnace and steam-jet, or of the safety-lamps, which they say "can only be decided by practical experience." The Committee direct attention to the evidence bearing upon the appointment of Inspectors, on which nearly every witness expressed an opinion more or less favourable.

1849, September 5. The first cargo of coals was shipped from Broomhill Colliery at Amble.

1850. The first charge of Eston ironstone was smelted at Witton Park Iron Works.

1850, January 3. On this evening a body of men, fifteen in number, made their appearance at Burnopfield Colliery, drove away the enginemen who where [sic] employed at the steam-engine, and placed a cask of gunpowder under each of the boilers, having previously thrown upon the fires a sufficient quantity of fresh coals to enable them to perpetrate their hazardous outrage in security. The boilers in a few minutes were blown up with tremendous violence, and the machinery connected with them was entirely destroyed. This diabolical act was supposed to have been committed by some recently discharged workmen. *

1850, February 15. Died at Dipton, in the County of Durham, Thomas Fenwick, many years Mining Agent for the Dean and Chapter and Bishops of Durham, the Marquis of Bute, and others.

1850, June 20. The South Dock at Sunderland was opened.

1850, July 30. Robert Stephenson was entertained at a public dinner in Newcastle, at which about 400 gentlemen were present. It was stated that Mr. Stephenson had up to that time been engaged in the construction of 1790 miles of railway in England alone.

1850, October 22. The Coalowners of Durham and Northumberland entertained Hugh Taylor, Esq., of Earsdon, at a sumptuous dinner in the Assembly Rooms, Newcastle, in recognition of his valuable services as Chairman of the Coal-trade Committee for a lengthened period. †
1850, November. Four Mining Inspectors appointed under the

* Latimer.       † Latimer.

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recent Act, Mr. Matthias Dunn being entrusted with the Northern District.

1850. Average shipping price of Newcastle coals, 9s. 6d. per ton.

1851, March 22. The coal-miners of Durham and Northumberland presented Mr. James Mather, of South Shields, with an elegant piece of plate as a mark of their gratitude for his talented and praiseworthy exertions in promoting measures to diminish the dangers arising from bad ventilation and other causes in the mines of the kingdom.

1851, October. This month Jarrow Colliery was inundated with water from some colliery on the other side of the river.

1851. Coast vend this year, 5,707,736 tons; oversea, 2,180,070 tons; total, 7,887,806 tons.

1852, May 27. Accidents still happening, notwithstanding the appointment of Mining Inspectors, a committee of the House of Commons, solicited by the advocates of the steam-jet (being the sixth Parliamentary Inquiry), was appointed, of which Mr. Cayley was chairman. Before it Messrs. Darlington, T. E. Forster, Professor Hann, Messrs. Mather, Goldsworthy Gurney, Wood, Dickinson, and others were examined. The course pursued by this committee showed that they were strongly biased in favour of the steam-jet. In their report are the following recommendations and opinions:—"Your committee are unanimously of opinion that the steam-jet is the most powerful, and at the same time, least expensive method of ventilation;" and, again, "your committee, however, are unanimously of opinion that the primary object should be to prevent the explosions themselves, and that if human means (as far as known) can avail to prevent them, it is by the steam-jet system as applied by Mr. Forster (at Seaton Delaval Colliery)." *

1852, June 16. After an explosion, which occurred at this date, at Seaton Colliery, by which seven lives were lost, the first suggestion for the formation of the Mining Institute originated at a meeting of gentlemen interested in and connected with the colliery. Among those present were Messrs. H. Morton, G. Elliot, E. Sinclair, and M. Dunn.

1852, July 3. The North of England Institute of Mining Engineers

* This report and the proceedings of the committee, as also the results obtained by the application of the steam-jet at Seaton Delaval and other collieries, were very fully reviewed by Mr. Matthias Dunn in a pamphlet published in 1854, and entitled "A History of the Steam-jet, as applicable to the Ventilation of Coal Mines."


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was established, of which Mr. Nicholas Wood was, at a subsequent meeting, chosen President.

1852, July 30. With this date commenced a new era in the carrying trade of coal; for upon this day the first screw collier, the John Bowes, commenced running. She was built by the Messrs. Palmer to
carry 650 tons of coals, and to steam about nine miles an hour. "On her first voyage she was laden with 650 tons of coals in four hours; in forty-eight hours she arrived in London; in twenty-four hours she discharged her cargo; and in forty-eight hours more she was again in the Tyne; so that in five days she performed successfully an amount of work that would have taken two average sized sailing colliers upwards of a month to accomplish." *

1852, December 27. An extraordinary fire broke out at St. Hilda Colliery, South Shields. The pit had not been worked for some time, owing to defective ventilation, and this morning, as a workman was passing by the mouth of the shaft with a shovel full of red-hot cinders, the gas that was coming up suddenly ignited and burst into an immense body of flame. The adjoining wood-work immediately caught fire, and burnt with great fury until about half-past four, when a portion of the materials fell down the shaft, and another explosion took place at the bottom, throwing up a vast body of flame to a great height. This, however, assisted in extinguishing the fire, which, owing to a high wind, had previously assumed an alarming aspect. †

1852. The late Mr. T. J. Taylor estimated the number of persons employed in and about the Coal-trade at this period as follows:—Men and boys employed underground, 29,669; men and boys employed aboveground (including smiths and joiners) 7,899; men and boys employed shipping coal, 1,365; seamen and boys employed in the Coal-trade, 22,500; total, 61,433.

1852. Coast vend this year, 6,000,337 tons; oversea vend this year, 2,334,546 tons; total, 8,334,883 tons.

1852. Imported into London by rail and canal, 411,820 tons, of which 196,865 tons were carried by the Great Northern, and 137,978 by the North Western Railway. ‡

* Mr. C. M. Palmer's Paper on Iron Shipbuilding, read before the British Association, 1863.

† Latimer's Local Records. In this year (1852) the number of Mining Inspectors was increased from four to six.

‡ Adelaide Wallsend coals, the property of Mr. Joseph Pease, were the first coals sent by rail to London.—Fordyce.

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1853. In consequence of the prominent position given to the steam-jet by the Parliamentary Committee of last year, an elaborate series of experiments were undertaken by Mr. N. Wood and other members of the Mining Institute, which are fully reported in the Transactions of the Society for this year. The comparative merits of the two systems, steam-jet and furnace, may be considered as settled in favour of the latter after the discussion of April 1st, 1853, when the late Robert Stephenson, M.P., observed as follows:—"I referred to the subject of the steam-jet as one that had been exhausted, but I did not apply that observation to the ventilation of coal-mines, for I am very far from thinking that has been exhausted; but so far as the comparison between the merits of the furnace and the steam-jet goes, I think it has been exhausted by the very able and elaborate experiments that have been made."

In the paper read by Mr. Wood before the British Association in 1853, furnace ventilation is thus remarked upon—"That many means of ventilation have been devised from time to time, but it has
been found that rarefaction, by the use of the ordinary furnace, possesses the advantages of greater cheapness, regularity, and efficiency over all other systems."

1854, March 24. Another Committee of the House of Commons, appointed to inquire into the causes of the numerous accidents in coal mines, with a view of suggesting the best means for their prevention, this day commenced sitting, with Mr. Hutchins as chairman (being the seventh Parliamentary Inquiry). Before this Committee were examined Messrs. G. Elliot, J. Darlington, T. J. Taylor, N. Wood, J. T. Woodhouse, and others. Unlike the previous Committee, many valuable suggestions resulted from the labours of this.

They report "that the preponderance of evidence is decidedly in favour of the furnace."

That since the Committee of 1852, "Investigations and experiments on a much larger scale have been instituted by Mr. Nicholas Wood and others, the results of which, together with the evidence before your Committee, lead them to an opposite conclusion, and induce them to think that, especially where the coal lies at a considerable distance below the surface, and the shafts are consequently deep, the furnace is most effective, as well as the most economical mode of ventilation."

1853. According to Mr. Hunt, there were 2,397 collieries at work in the United Kingdom this year.

1853. In this year occurred the celebrated Boghead coal trial in Scotland, to determine whether the mineral was coal or not.

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"That safety-lamps, however valuable, should not be relied upon for the prevention of explosions."

"That the ventilation of mines should be kept so good, that under ordinary circumstances it would be safe to work with naked lights."

"That the number of inspectors be increased, and their salaries augmented."

The Committee looked upon the objections raised against the furnace, under the title of furnace limit, furnace paradox, and natural brattice, as theoretical views.

In consequence of the desire expressed by the Committee, that a meeting of the Coalowners of England should take place, and that the deputies of the men and the Government Inspectors should attend, meetings were held in London on the 25th, 27th, 28th, and 29th of April, and the result of their deliberations was laid before the Committee.

1854, August 3. The Sunderland and Seaham Railway opened for coal traffic.

1854, August 5. The Astronomer Royal, Professor Airey, commenced a series of experiments in Harton Colliery, near South Shields, with a view of ascertaining the density of the earth. This pit is the deepest on the Tyne, the workings being 1260 feet below the surface; and the observations occupied about three weeks. Professor Airey afterwards published the result of the operations, which he said had been most successful.*
1854. A strike occurred this year at Seaton Colliery, and though the men agreed to have the working prices settled by arbitration, they refused to act upon the award.

1854, October 14. Gosforth and Coxledge Collieries, the property of the Messrs. Brandling, were offered for sale. The former became the property of John Bowes and partners, and the latter of Mr. Joshua Bower.

1854, November. Oakenshaw Colliery, near Willington, Durham, was won, as was also Bebside Colliery, near Blyth, Northumberland.

1854. Total vend for this year, 15,420,615 tons.

1854. The number of sea-sale and land-sale collieries at this date was 225, viz., sea-sale on the Tyne and Blyth, 94; on the Wear, 30; on the Tees, 60; land-sale, 41.

1854. The coke-trade was now making considerable progress in the

* Latimer.

1854. According to Mr. Hunt, 64,661,401 tons were raised from our coal mines in the United Kingdom this year.

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Northern Coal District, and a class of coal, which was formerly of little value, was now becoming an important article of commerce. From returns recently published, it appeared that in 1833 the whole of the coke exported from this country only amounted to 4,008 tons, 3,275 tons of which were manufactured on the banks of the Tyne, and seventy-three at Sunderland. The quantity exported from the Tyne this year, exclusive of that sent coastwise, was 75,204 tons. Exclusive of the shipments from the Tyne and other ports, was the large quantity sent to the principal railways in England by land carriage.

1854. In consequence of the shrinking of Lambton Castle, which had been built over coal workings, wrought so far back as the year 1600, it was found necessary to fill up the old workings with solid brick, which was done at a cost of upwards of £20,000.

1855. In the latter part of this year the number of Government Inspectors was increased to twelve, Mr. J. J. Atkinson being appointed to the South Durham district.

1855. A short strike occurred this year at Hetton Colliery, when the men brought Mr. Roberts down to defend their cause.

1856, January 19. The Duke of Northumberland offered £5,000 towards a College of Practical Mining and Manufacturing Science, provided £15,000 was raised by other means; or £10,000, if £30,000 was raised. It is to be regretted that this noble offer did not meet with a corresponding response.

1856, February 15. Willington Colliery, on the Tyne, was suddenly inundated with water. The horses and workmen were saved with difficulty, and the colliery was abandoned.

1854. Ships entered by each coal-factor in London during this year:—
Hill, Wood, and Hughs .................. 2286
Harris and Dixon ..................... 1037
Marshall and Page ..................... 881
Hugh Taylor ......................... 839
Stephenson Clarke .................... 691
Charlton and Watson .................. 673
Smith, Scurfield, and Co.............. 587
Milnes and Co.......................... 500
Miller and Potter ..................... 430
Fenwick, Laroche, and Stobart ........ 346
F. D. Lambert ......................... 326
W. E. Bell ............................. 135
Metcalfe and Son ...................... 134
Carr, Lamb, and Co.................... 129
By Agents ............................. 1170
8944
10,114

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1856, February 20. A public dinner was given at Hetton-le-Hole to Mr. Nicholas Wood, in token of the high esteem entertained for that gentleman by the inhabitants of the neighbourhood; 160 gentlemen were present.

1856, March 1. The Marchioness of Londonderry entertained upwards of 3,000 pitmen and workpeople, employed in her ladyship's collieries, to a substantial dinner, at Chilton, near Fence Houses.

1856, September 23. The Jarrow Dock was founded.

1856. About this period, Black Boy, Coundon, Westerton, and Leasingthorne Collieries were sold to Mr. Nicholas Wood.

1857, April 1. The Durham and Bishop Auckland Railway was opened.

1857, May 19. His Royal Highness the Prince of Wales, after being equipped in a suitable dress, descended the shaft of Houghton Colliery, belonging to the Earl of Durham, and was conducted through the workings.
1857. A committee of the House of Commons was this year appointed to inquire into the rating of mines (being the eighth Parliamentary Inquiry). The committee examined thirty-three witnesses from various mining districts upon the subject of rating mines. They conclude their report as follows, on August 5:—" That in making the assessment on mineral property, of whatever description, all plant and machinery, locomotive or stationary, in any way connected with or belonging to the mines, and which is incidental and necessary to the working thereof, should be assessed as a whole, together with and as part of the mine, and not separately." Mr. T. J. Taylor being asked by the abovenamed committee, How many years' value do you calculate you ought to give, if you were going to open a mine? replied, " There are two distinct circumstances which arise for consideration in answer to this question. The first is, that where the freehold of a mine is purchased, it is usual to allow eight per cent, upon the perpetuity; that would be twelve and a half year's purchase. The duration of a mine is less than a perpetuity—say, ten or eleven years' purchase; the allowance for that depends entirely upon the length of time the mine has to last. The other case is the case of the purchase of a lessee's interest in a mine; the purchase of the interest of the occupier of the mine in distinction from that of the lessor. Then an annuity has to be purchased, subject not only to the mining risk, but also to occasional risk; it is calculated

1857. According to Mr. Hunt, 65,394,707 tons of coal were produced in the kingdom this year; 15,826,525 tons being from Durham and Northumberland.

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as an annuity for the term of the lease. It varies from twelve to eighteen per cent.; that gives from five to eight years' purchase."

1858, July 20. The Messrs. Carr's steam coal collieries sold, Seghill Colliery bringing £93,000; Cowpen, £120,000; Burtradon, £50,000; Hartley Colliery being reserved.

1858, July 31. Died at Darlington, Edward Pease, one of the originators of the Stockton and Darlington Railway.

1858, September 30. In consequence of the firing of the brattice in Page Bank Colliery shaft, ten men were suffocated. At the coroner's inquest some rather singular causes of the fire were broached.

1858. In this year three reports, "On the use of the Steam Coals of the Hartley district of Northumberland in Marine Boilers," were made by Messrs. W. G. Armstrong, James A. Longridge, and Thomas Richardson, to the Steam Coal Collieries Association. These gentlemen conclude their report as follows:—" And we cannot but congratulate you upon the fact, that whilst the experiments which you instituted have entirely established the practicability of using north country coal, without the production of smoke, they have also, as we trust, restored it to that high position as a steam fuel, from which it ought never to have been displaced."

1859, October 12. Robert Stephenson died, aged fifty-six years, and was buried in Westminster Abbey. For some years he represented Whitby in the House of Commons.

1859. Under the authority of the Coal-trade committee, it was stated, about this time, that the trade contributed, as individuals, largely towards the general purposes of education, and for the relief of those suffering from accidents at the collieries, to the extent of about £30,000 per annum.
1859. The quantity of coals produced this year, in the counties of Durham and Northumberland, amounted to 20,704,077 tons.

1859. In consequence of the high price of coke, locomotive engines were, on many railways, adapted for consuming coals.

1859. From experiments made upon the London and South-Western Railway, with the best Newcastle coke and Welsh coal, the conclusion arrived at was that there was a clear saving of 10.8 lbs. per mile, when coal was reduced to its coke value. The coke used was Ramsay's Garesfield, and the coal Griff and Llanguathog Merthyr.*

* At a meeting of the Society of Arts, Mr. B. Fothergill, engineer, read a paper to prove:—1st. That coal was decidedly superior to coke in respect to heating power, and, consequently, more economical. 2nd. That a plentiful supply of steam

1860, March 12. Burtradon Colliery exploded, by which seventy-four lives were lost. This accident created a great amount of excitement, and Serjeant Ballantyne was specially retained by some gentlemen to attend the inquest. The sum of £6,104 14s. 5d. was subscribed for the relief of the widows and orphans, numbering 113. †

1860, April. Ryhope Colliery commenced working. The sinking was begun in 1856, in the prosecution of which, under the charge of Mr. John Taylor, sixteen fathoms of "friable sand" were passed through in the extraordinary short space of seven weeks, and the Maudlin-seam was finally won at a depth of 254 fathoms.

1860, December 20. A rather unusual explosion occurred at this date at the engine-fire of the East and West Minor Pits of Hetton Colliery, by which twenty-two lives were lost, besides nine horses and fifty-six ponies. At the time of the accident 180,000 feet of air per minute were said to be circulating in the workings. According to Mr. Wood this accident cost the company upwards of £10,000. In the words of the Coroner's jury, when returning their verdict, this accident was occasioned "by an explosion of inflammable gas, accumulated in the flue leading from a boiler fire to the upcast shaft, which gas was not generated in the workings of the pits."

1860, December 31. In the ten years ending at this date, in the two northern Mine-inspectors' districts, there were 184,922,978 tons of coals wrought and 1,614 deaths, or one death to every 114,574 tons of coals wrought.

1860. Average shipping price of Newcastle coals, 9s. per ton. ‡

1860, September 18. Died, Joseph Locke, Esq., M.P., aged fifty-five years, one of the Vice-presidents of the Mining Institute.

1861, April 3. This day, died after a very brief illness, Thomas John Taylor, aged fifty-one years, one of the Vice-presidents of the Mining Institute. Taking all his varied abilities and acquirements into account, he may safely be considered to have been the most able of the mining engineers of the Northern Coal-field.
could be generated by the use of coal, for working engines at high velocities, and for drawing heavy trains. 3rd. The capabilities of coal-burning engines for consuming their own smoke. 4th. The increased durability of fire-boxes and tubes when coal was used.

† An account of this accident, by the late Mr. T. J. Taylor, appears in the Mining Institute Transactions.
‡ Coal-trade Committee of Newcastle.

Note.—In 1859, the Commissioners of Harbours of Refuge, in their report, estimate the annual loss of life on our own coasts to be 780.

1860. Collieries in the United Kingdom, 3,009; tons of coals raised, 80,042,698.

1861. It was intended this year to have obtained a Bill called "The Tyne Coal Drainage Bill," having for its object the draining of the drowned out collieries below Newcastle bridge, at the joint expense of the lessors and lessees. This important scheme was for the time abandoned in consequence of the untimely and lamented death of Mr. T. J. Taylor, who was the originator of it.

1861, July 16, 17, and 18. Upon these days an important and interesting meeting of the North of England Institute of Mining Engineers was held at Birmingham.

1861, September. The following rather important case was decided at this time: — A number of boys belonging to Broomhill Colliery, in Northumberland, were brought before the county magistrates, at Morpeth, for leaving their employment without giving legal notice. The manager of the colliery stated that the boys all worked under a monthly agreement, and that he was entitled to a month's notice before they could leave their employment; that the conditions were exhibited in a conspicuous place at the pit, where all the parties employed in the colliery had access to at all times, and that all the contracts were verbal. On the 2nd of September, the boys applied for an advance of wages, and on being refused, they struck work on the following day. For the defence it was contended that infants were not competent to bind themselves by their contracts, and that, therefore, the boys were not liable to punishment. The court ruled that infants are entitled by law to make contracts which are beneficial to their personal interests; and that such a contract subjects them to all the legal regulations applicable to masters and servants. Three of the boys were convicted, and committed to prison for one month, with hard labour.

1861. The produce of coal from the Durham and Northumberland Coal-field for this year, was estimated as follows:—

<table>
<thead>
<tr>
<th>Tons.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>House Coal</td>
<td>4,493,450</td>
</tr>
<tr>
<td>Gas Coal</td>
<td>1,717,000</td>
</tr>
<tr>
<td>Steam Coal and Manufacturing</td>
<td>4,317,120</td>
</tr>
<tr>
<td>Passed over the North-Eastern Railway</td>
<td>2,180,000</td>
</tr>
<tr>
<td>Coke Consumed in the Iron Trade</td>
<td>5,000,000</td>
</tr>
</tbody>
</table>
Coke Consumed in Alkali and other Manufactures... 1,250,000
Passed over the Carlisle Railway ......................... 120,000
Colliery and Home Consumption ........................... 2,200,000
Duff and Waste ............................................... 500,000

Total...................................................... 21,777,570

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1861. According to the census, there were 53,524 coal-miners in the counties of Durham and Northumberland.

1861. Number of collieries in Durham and Northumberland, 283; under Mr. Dunn's inspection, 142; Mr. Atkinson's, 141.

1861. A strike at Cassop Colliery occurred this year.

1862, January 16. At eleven o'clock on the forenoon of this day (Thursday) occurred the most serious calamity that ever happened in the Northern Coal-field, in the closing up of the shaft of the New Hartley Colliery, the property of the Messrs. Carr, caused by the breaking and falling down the shaft of half the immense pumping-beam, weighing forty-three tons. By this accident 204 lives were lost. The whole of the bodies, except the five found in the shaft, when reached on the Wednesday succeeding the accident, were found in positions showing that they had died quietly and without pain, the gas (carbonic oxide) having evidently produced a sleep which ended in death. This frightful accident created an intense excitement, extending from the Palace downwards, and the large sum of £83,733 8s. 4d. was subscribed for the relief of the widows and children, numbering 407. Mr. J. Kenyon Blackwell was sent by the Home Office to attend the inquest. He reported that if the beam had been trussed with iron rods, no part of it would have fallen down the shaft. That in future winnings single shafts should not be allowed. In consequence of this accident and Mr. Blackwell's Report thereon, an Act was passed in July following, setting forth that—"After the passing of this Act it shall not be lawful for the owner of a new winning, and after the first day of January, 1865, it shall not be lawful for the owner of any existing mine to employ any person in working within such mine, etc., unless there are in communication with every seam of such mine for the time being at work at least two shafts, or outlet, separated by natural strata of not less than ten feet in breadth." Previous to this legislation, the Home Secretary sent a circular letter to the inspectors for their opinion of bratticed and single shafts.*

1862, March. At the Assizes held in Durham, at this date, the important cases of Blackett v. Bradley, and Scarr v. Summerson, in which the manorial rights of the Ecclesiastical Commissioners, in the county of Durham, were involved, were entered for trial. The plaintiff's counsel, in opening his case, stated as follows:—" It was a startling

* A Paper on this accident was read by Mr. G. B. Forster before the Institute of Mining Engineers.

1861. Total coals produced in the United Kingdom, according to Hunt—83,635,214 tons; according to Hull—85,817,324 tons.
fact that the Ecclesiastical Commissioners now sought, throughout this great county, they being the owners, to an enormous extent, of the mines lying under estates in this county, to set up, that there had been a custom from time immemorial that they might go under any gentleman's estate in this county, be it freehold or copyhold, and let them all down, and destroy them for purposes of cultivation.” The Judge suggested that as the two cases would probably be taken to the House of Lords, a special case should be stated for the superior court. In accordance with this suggestion, an arbitrator (Mr. Grant) was appointed, who sat in the following August, at Darlington, when numerous witnesses were examined, both as to the custom of burning coke, mode of working coal, and paying for pit damage in the chapelry of Hamsterley. Unfortunately, these cases were "hung up," in consequence of the death of the arbitrator before he had prepared them.

1862, May 20. At a public meeting, held in the Town Hall, at Newcastle, a sum of £509 and medals were presented to the Messrs. Coulson and the thirty-six sinkers who opened out the Hartley shaft.

1862, May. Mr. Nicholas Wood stated to a committee of the House of Commons that the annual quantity of coals raised at Hetton Colliery, was 500,000 tons; and Lambton Colliery, 800,000 tons.

1862, July. In the discussion in the House of Commons upon the Mines Prevention of Accident Bill, the Attorney-General, Sir William Atherton, stated that the Judges had decided that masters were not to be liable to their work-people for injuries, if it were proved that they had employed competent persons as managers; also, that courts have decided that a master was not responsible to his servant for injuries done by a fellow-workman.

1862, September 19. On this day, Mr. William Anderson (aged seventy-seven years), one of the oldest and most respected of the Mining engineers, died. From the commencement of the Mining Institute, he had been one of the Vice-presidents.

1862. This year the Messrs. Corry fitted up a float in the Thames, with a hydraulic crane for discharging screw colliers. It is said to be capable of discharging 1,200 tons of cargo in ten hours.

1862. According to Mr. Hunt’s Mineral Statistics, 19,360,356 tons of coals were this year wrought in the counties of Durham and Northumberland.

1862. Out of 4,973,823 tons of coals sent to London market this year not less than 1,531,421 tons were sent by rail.

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1863, May 25. In the Court of Exchequer, the case of Fenwick and another v. Hedley and others, came on for a new trial. This case was raised to try the right of the Ecclesiastical Commissioners or their lessees to carry freehold coals over Lanchester Common land. The case was tried at Durham at the last Assizes, when a verdict for 40s. was entered for the plaintiffs upon all the issues, leave being reserved to the defendants to move. As the case involved questions of very great importance, it was taken into the Exchequer Chamber. The decision of the Court was, that the defendants had no power to lead such coals over Common Lands, and directed them to pay compensation, which was afterwards assessed at 1s. 9d. per ten.
1863, June 4. Messrs. T. E. Forster and John Taylor, at the request of the Tyne Improvement Commissioners, reported upon the extent of unworked steam coal; the increase that may be expected in the produce of such coal; and in the annual shipments thereof in the river Tyne; as to the probabilities of the Northern Coal-field maintaining its ground against competition with the Welsh coal, etc., as follows:—"We find that there is sufficient Low-main seam still remaining to endure on the present rate of shipments of steam-coal on the Tyne, in addition to the portion diverted to Sunderland Docks, for a period of 110 years. We have to observe that the existing steam collieries could produce from twenty to twenty-five per cent. more than they do at present. Considering, however, the large number of screw-steamers which are building annually, coupled with the ordinary increase of trade, and that this huge fleet requires several hundred thousand tons annually, we think that

1862 Vends of coals, coastwise and foreign, from 1791 (from Messrs. Wood's and others British Association Paper):—

<table>
<thead>
<tr>
<th>Year</th>
<th>Tons.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1854</td>
<td>1,485,833</td>
</tr>
<tr>
<td>1855</td>
<td>1,172,701</td>
</tr>
<tr>
<td>1856</td>
<td>1,241,188</td>
</tr>
<tr>
<td>1857</td>
<td>1,326,889</td>
</tr>
<tr>
<td>1863</td>
<td>1,269,887</td>
</tr>
</tbody>
</table>

1863, July 6. The following document was signed and issued by a majority of the leading mercantile firms of Newcastle:—

"We, the undersigned merchants, shipbrokers, and shipowners of Newcastle-upon-Tyne, recognising that the keel has long been obsolete, and does not now in reality exist as a standard measure, that it bears no relation to foreign weights and measures, but one that is most difficult and
tedious to establish (the reduction having first to be made in tons and cwts., and subsequently into keels); and furthermore that coal and coke are now sold by the ton, and not by keels and chaldrons, hereby pledge ourselves and agree to commence at an early date, to conduct all our chartering operations, whenever and wherever practicable, on the basis of the established and legitimate weight of the realm, viz., the ton, in order to simplify calculations, which as hitherto conducted, cannot have failed to be a source of great inconvenience to foreigners having business with this port.”*

1863, August. At the British Association meeting, held at this time in Newcastle, Messrs. N. Wood and Charles M. Palmer, in their papers read before the Association, gave the following particulars of the performances of screw colliers, viz.:—In the year ending January 9, 1863, the "Killingworth" made sixty-five voyages from West Hartlepool to London, and delivered 38,738 tons 19 cwts. of coals, or an average of 596 tons per voyage. Again, in one year, the "James Dixon" made fifty-seven voyages to London, and delivered 62,842 tons of coals, and this with a crew of only twenty-one persons. This vessel frequently

* Other measures and denominations used in the Coal-trade, as the peck, boll, and ten, could advantageously be done away with or simplified.

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received 1,200 tons of coals in four hours; made her passage to London in thirty-two hours; there, by means of hydraulic machinery, discharged her cargo in ten hours; returned in thirty-two hours—thus completing her voyage in seventy-six hours.

Table by Mr. C. M. Palmer of the quantity of coal sent to London by screw colliers, since their introduction to June 30, 1863:—

<table>
<thead>
<tr>
<th>Year</th>
<th>Cargoes</th>
<th>Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>1852</td>
<td>17</td>
<td>9,483</td>
</tr>
<tr>
<td>1853</td>
<td>123</td>
<td>69,934</td>
</tr>
<tr>
<td>1854</td>
<td>345</td>
<td>199,974</td>
</tr>
<tr>
<td>1855 (Crimean war)</td>
<td>174</td>
<td>85,584</td>
</tr>
<tr>
<td>1856</td>
<td>413</td>
<td>238,597</td>
</tr>
<tr>
<td>1857</td>
<td>977</td>
<td>547,099</td>
</tr>
<tr>
<td>1858</td>
<td>1127</td>
<td>599,527</td>
</tr>
<tr>
<td>1859 (Italian war)</td>
<td>899</td>
<td>544,614</td>
</tr>
<tr>
<td>1860</td>
<td>1069</td>
<td>672,476</td>
</tr>
<tr>
<td>1861</td>
<td>1299</td>
<td>851,991</td>
</tr>
<tr>
<td>1862</td>
<td>1427</td>
<td>929,825</td>
</tr>
</tbody>
</table>
1863, September 24. Died this day, Mr. Thomas Crawford, colliery-owner and viewer, aged eighty-three years. He was a self-made man, and for many years was principal Mining-agent to the Earl of Durham.

1863, October. A strike occurred at this time throughout Messrs. Straker's and Love's collieries in the Brancepeth district. After much agitation and a prolonged resistance, the men returned to work, but not before several had brought themselves within the talons of the law for intimidation and riotous conduct. There is little doubt that the leaders of the Union selected these collieries for a strike, with the intention, if successful in obtaining their demands, of striking at other collieries in detail. Fortunately for the coalowners, the Messrs. Straker and Love resisted their somewhat unreasonable claims, which, according to a letter of Mr. Love's, of 31st October, would make a difference to the owners of £20,000 a-year, and, in so doing, doubtless fought the battle of the trade. The owners, in a notice to miners issued in December, state that in their collieries the wages generally vary from 4s. to 7s. per day; but there are good workmen making from 8s. to 9s. per day at the present time.

1863. In the latter part of this year, the new ratings under the Parochial Assessment Act came into operation, when, as a rule, the rateable value of the collieries was very considerably increased, in some instances, in the Durham Union, to double the old amount. In addition to this augmentation, the engines at each pit were rated at £50 each, miners' cottages at £3 12s. each, coke-ovens where the smoke is not consumed at £2, and £1 10s. where it is.

A considerable number of disputes as to the proper rateable value naturally resulted from the course taken by the Assessment Committees, the most noteworthy of which was that with Ryhope Colliery. An extract from a letter of Mr. Hedley, the valuer to Mr. John Taylor, the viewer, will show the principle gone upon.

"I will adopt your suggestion and take thirty years as the period for refunding or paying off the capital invested in the shaft, buildings, machinery, and plant of Ryhope Colliery, and six per cent, for interest and to provide for the repayment in thirty years. The buildings, machinery, and plant will certainly be worth more at the expiration of thirty years than they will at the end of fifty years. I, therefore, assume that at the end of thirty years they will be worth twenty-five per cent, of their original cost, or £31,250, instead of twelve and a-half per cent., which will leave £93,750 to be provided in thirty years by a sinking fund, which will require two per cent, per annum, or £1,875 to be invested annually to reproduce that amount. On this principle the valuation of Ryhope Colliery will stand thus:

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Royalty rent as before</td>
<td>£3,120 0 0</td>
</tr>
<tr>
<td>Royalty of land as before</td>
<td>600 0 0</td>
</tr>
</tbody>
</table>

Gross rent of shaft, buildings, engines, and plant at six per cent, on £125,000 £7,500 0 0

Lessor’s repairs.... £750 0 0

Redemption fund............ 1,875 0 0

2,625 0 0

4,875 0 0

Rateable value ................. £8,595 0 0

1863. In the paper read by Mr, Wood before the British Association, it is stated that the present make of coke in Durham and Northumberland is estimated to be 2,519,945 tons per annum, for which is required an annual consumption of 1,000 acres of a four-feet seam of coal. In the same paper the number of people employed in the Northern Coal-trade is estimated as follows:—Men and boys employed underground, 36,000; men and boys employed aboveground, 9,700; men and boys employed shipping coal, 1,600; total, 47,300;—seamen and boys employed in the coasting trade, not including those in the oversea trade, 25,000; total, 72,300.

1863. Mr. Hunt gives the production of the Northern Coal-field for 1863 at 22,154,146 tons.

1863, August. Sir William Armstrong, in his address as President of the British Association, remarked as follows upon the duration of our Coal-fields:—"Assuming 4,000 feet as the greatest depth at which it will ever be possible to carry on mining operations, and rejecting all seams of less than two feet in thickness, the entire quantity of available coal, existing in these islands, has been calculated to amount to about 80,000 millions of tons, which, at the present rate of consumption, would be exhausted in 930 years, but with a continued yearly increase of two and three-quarter millions of tons, would only last 212 years."

1863. Coal and coke imported into London this year:—Seaborne, 3,335,174 tons in 9,687 ships; road, rail, and canal, 1,791,932 tons; total, 5,127,106 tons *

1864, March 3. An adjourned meeting of the Steam Collieries' Association was held at the Coal Trade Office, when, after taking into consideration the prices of work given during the past year, it was resolved, "That no advance shall be given unless the seam shall go below its usual height; and that the owners of the colliery which shall be required by the Coal Trade Association to resist unjustifiable demands of the workmen, and thereby be put on strike, shall be indemnified by the united trade, pro rata, for all expenses and losses of profit or otherwise, arising out or incurred during the period of such strike; the same to be ascertained and awarded by two impartial viewers, one to be chosen by the owners of the colliery on strike, and the other by the Steam Coal Association, with an umpire, as usual, to be chosen by the arbitrators."
1864, March. Elaborate reports were published of the North of England and Welsh Steam-coal, tested at Her Majesty's Dockyard, Davenport. From the experiments it was evident that the introduction of North Country coals, to be burnt in combination with Welsh coals in equal proportions, would be attended with desirable results.†

* Of the above importation into London, 656,760 tons were re-exported.

† By these experiments the following results were arrived at:—

<table>
<thead>
<tr>
<th>Lbs. of water evaporated</th>
<th>Cubic feet of water evaporated per hour.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hartley Coal...................... 10.71</td>
<td>43.6</td>
</tr>
<tr>
<td>Welsh Coal ...................... 10.14</td>
<td>38.6</td>
</tr>
</tbody>
</table>

1863. According to Mr. Hunt, 86,292,215 tons of coals were wrought in the United Kingdom this year, being an increase of more than 4,500,000 tons upon the produce of 1862. The same authority gives the number of collieries at 3,160. Another authority gives the quantity of coal raised, including duff and waste, at 90,000,000 tons.

1864, April. A grand banquet was given by the chairman and members of the Steam Collieries' Association, in honour of W, S. Lindsay, Esq., M.P., for his exertions in obtaining a fair trial, and a proper recognition by the Admiralty of the North Country Steam-coal. Up to this time Welsh coal had been exclusively used,

1864, May 11. This month the Hunwick and Newfield Collieries, being part of the West Hartlepool system, were offered for sale by auction. Newfield was sold for £20,000; for Hunwick, £45,000 was offered, when the reserved bid of £60,000 was put in.

1864, June 2. In the Court of Common Pleas the following action was tried at this time:—The Guardians of the Society of Keelmen of the Tyne v. Davison.—This was an action brought by the plaintiffs to recover the amount of ¼d. per chaldron on all coal shipped, under the provisions of an Act of Parliament, and was made subject to the opinion of the Court on a special case. The Chief Justice thought that the sum was due, and that the defendant's colliery was near enough (thirteen miles) to the Tyne, to be within the enactment of 1 Geo. IV. The other learned Judges were of the same opinion.—Judgment for the plaintiffs.

1864. During the latter part of this year measures were taken to enforce the Coal Turn Act against some coalowners, who had given an undue preference in loading to screw-colliers over sailing-ships.

1864. Considerable efforts had now been making for some time to perfect and introduce coal-cutting machines, but so far only with imperfect success.*


1864. According to the Coal Trade Report of this year, the average price of best coals was 20s. 1d. per ton; second best, 18s. 2¼d.; rate of freight, 6s. 11¼d. The general result is, that in company with
an average increase in freight of 5¼d. per ton, there is upon best coals an advance of 1s. 10¾ d. per ton; and upon second coals an advance of 2s. 4d. per ton.

1864. Production of Durham and Northumberland, 23,248,367 tons. †

* Mr. Jevons has the following remark upon coal-cutting machines:—"Even in the West Ardsley Colliery, belonging to the patentees of the coal-cutting machine, who naturally carry out its use to the utmost possible extent, this machine is found to diminish the staff only ten per cent."

† Hunt.

The production of pig-iron at Middlesborough in 1864 was 904,000 tons, for the smelting of which 1,286,350 tons of coke were used. Coal raised this year, according to the Mining Inspectors' Return, 95,122,919 tons; according to Mr. Hunt, 92,787,873; Collieries in the United Kingdom, 3,268; coals sent to London by rail and sea, 2,351,342 tons.

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1864. Strikes occurred this year at Ravensworth, Walbottle, and Seghill Collieries; the one at the last colliery being somewhat protracted.

1864. According to the Mining Inspectors' Return for this year, Northumberland, Cumberland, and North Durham had 24,423 male persons employed in the collieries, and raised 10,156,000 tons: and South Durham employed 33,115 male persons, and raised 13,835,544 tons.

1865, January 25. A case in the County Court was decided in favour of five miners of Cassop Colliery, who each claimed £2 8s. for time lost in consequence of the bad state of the ventilation of the pit.

1865. The Times newspaper devoted a leading article to a short account of Timothy Hackworth's, George Stephenson's, and William Hedley's old engines, the Sanspareil, the Rocket, and the Wylam Puffing Billy, all now placed in the Kensington Museum.

1865, May 9. Vice-Chancellor Kindersley decided in the cause Bell v. Wilson, that in the construction of a reservation in a deed of conveyance of land at Long-Benton, Northumberland, the words "all mines and seams of coals, and other mines, metals, or minerals, with liberty to dig, bore, work, lead, and carry away the same," did not include freestone wrought in an open quarry, and that the grantor had liberty only to get it by underground mining; this decision was confirmed by the Lords Justices.

1865, June 12. Died at Hetton, the eminent sinker, William Coulson, aged seventy-four years.

1865, June 23. The Cramlington Colliery strike commenced in consequence of an application by the men for an increase of wages being refused.


1865. In an arbitration case, held this month, between the Durham Guardians and the Weardale Iron- and Coal-Company, the Assessment Committee's estimated rental of £5,000 was reduced to £3,000, and the rateable value from £3,750 was reduced to £2,250.
1865. In the cases Blackett v. Bradley, and Scarr v. Summerson, commenced in 1862, an award was made by Mr. Tomlinson, Q.C., the arbitrator, as follows:—In Scarr v. Summerson, "the Coke Oven" case, the award was absolutely in favour of the plaintiff. In Blackett v. Bradley, "The Pit-falls" case, the jura regalia plea was adjudged bad in law.

1865, March 30. A Bill, entitled "Metalliferous Mines Bill," was read a first time in the House of Lords, and dropped.

and fact. On the general question in this case, the arbitrator reserved his award for further consideration. Subsequent to the above decisions, a meeting of landowners, interested in the questions pending, was held at Bishop Auckland, when "the meeting warmly congratulated the owners and occupiers of allotment lands on the uninterrupted success that had attended their efforts to vindicate their surface rights whenever they had been brought to the test of a legal tribunal." About half-a-dozen cases, in which they had been successful against the Ecclesiastical Commissioners, were enumerated, among which was that of Shafto v. Stobart, where 130 ovens and twenty-six cottages had been recovered, and rent was now paid for them.

1865, October 9. John Dixon, C.E., died. He was the right-hand man of George Stephenson, when constructing the Stockton and Darlington Railway.

1865, October 11. The owners of Cramlington Colliery commenced turning the men, who had been on strike since June, out of their houses, when a riot ensued, which resulted in several of the rioters being committed to prison for several months. Large sums of money were contributed by various collieries towards the support of the men on strike,* especially from the adjoining steam-coal collieries; from Sleekburn alone, £190 7s. 2d. was received in the three months ending the 30th September. This prolonged strike may be said to have terminated in December, by the importation of a large number of Cornish miners.

1865, November 21. At the Miners' National Conference, held in Newcastle, at this date, Mr. Rymer, the sole delegate from the county of Durham, in the bitterness of his heart, in consequence of having so few constituents ("they numbered about 1,000 members, but only seventy-four were represented there"), described his fellow-workmen as follows:—"He was sorry to say that the county of Durham, in a mining and unionistic point of view, appeared as a black blot upon the map of England. The ignorance, cowardice, and drunken habits of the people led them to plunge into misery, ruin, and despair." †

* The following notice, dated 24th November, 1865, was extensively advertised:—"Fellow-workmen.—Beware! beware!!—The iron hoof of despotism is again anxious to trample out of the country every vestige of manhood and liberty! Whereas, notice has been given that none need apply for work at Cramlington Colliery, which is now on strike, who has the manliness to unite with his fellow-men for the protection of his labour. But every one who chooses to sell his birthright (liberty) for a mess of potage, can do so by applying to the owners of Cramlington Colliery."

†If some statements which appeared in the Durham Chronicle about Mr. Rymer were correct, it did not become him to belie his fellows.

1865, December 5. Two boys, respectively aged thirteen and fifteen years, were charged before the magistrates with absenting themselves from the service of the owners of Washington Colliery. Eventually it was agreed that the solicitors of the respective parties should agree upon the facts, in order to submit a case to a superior court.

1865, December 19. A miners’ mass meeting held near Shankhouse, in the steam-coal collieries district.

1865, December 19. Mr. Nicholas Wood, President of the North of England Institute of Mining Engineers, and one of the largest coal-owners in the district, died, aged seventy years. He had been for upwards of half a century connected with the Coal-trade, having gone to serve his time as a colliery viewer, at Killingworth Colliery, in the year 1811. The last Institute meeting he presided over was that held upon the 3rd of June, when, to the general regret of the members, he stated that his health was failing.

A committee of the House of Commons sat for a short time to investigate the condition and alleged grievances of the coal-miners, but owing to the late period of the session when appointed, after examining two or three witnesses it dissolved.

Owing to the universally prosperous state of trade, especially the iron manufacture, the Coal-trade this year received a considerable impetus. Each colliery endeavoured to extend its working powers, but for the most part without obtaining the desired result, in consequence of the workmen, now in the enjoyment of large wages, limiting their hours of labour. Notwithstanding, however, all drawbacks, owing to the high price obtained for their produce, the coalowners must have found the working of their collieries to be highly remunerative.*

1865. Seaborne coals imported into London this year, 3,161,683 tons; coals imported by railways and canals, 2,748,257 tons—total, 5,909,940 tons.

* A general agitation this year pervaded the working-classes for diminishing the hours of labour, and for an increase of wages.

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APPENDIX A.

The seventeenth century appears to have been rather prolific in lawsuits connected with the Coal-trade; and as showing the nature of the causes of action at that period, I am tempted to append the record of several, for which I am indebted to Mr. John Booth, of Shotley Bridge, who extracted them from the Bishoprick Halmot Court Books.

The complainants in this bill set out their title to seams of coal

1663, Sept. 15. (the colliery was called the Grand Lease Col-

Georqius Vane miles et alii (ley) as lessees of the Bishop of Durham,

et lying under the copyhold lands, wastes, moors,
Johannes Marley et alii. and commons within the Manors of Whickham and Gateshead. They then set out defendants' title to coal-mines within a freehold tenement, called Brenkbourne freehold, and that they had sunk therein three shafts, by which they had wrought great quantities of coal out of complainant's liberty, concluding with a prayer for relief, and for the appointment of a commission to go down defendants' pits to view and measure the coal-mines wrought by the defendants.

The decree empowered William Lyddell, Trystram Fenwick, John Emerson, and Ralph Haggerston (to whom a commission was awarded for the purpose), to view the defendants' workings, and from time to time to ryde the shafts of the pits wrought by the defendants, and to go into and return out of their coal works, until they had perfected the view; and in order thereunto to make use of the standard rowler, ways, and other like instruments, and also to carry with them spades, shovels, hacks, picks, and other tolls and instruments, to remove all such lettes, obstructions, and impediments, above or underground, as should hinder of viewing the said defendants' collieries and their doings therein. The decree directed they should certify to the court.

The complainant, by this bill, sets out that in March, then past, the

1664, Sept. 7. defendant brought his ship to the port of Sunderland,

Conyers laden with salt fish, and that it was agreed the com-

v. plainant should take 108 of them, at the rate of £13,

Rogers. and defendant was to take of the complainant all the coals he was in need of during the summer, at the rate of 14s. per chaldron. Whereupon the complainant took the fish, and gave his bill for his £13, to be paid in money or in coals.

That on defendant next coming to the port, a keel of coals, amounting to £4 18s., was delivered to him, and the remainder was ready to be delivered, but the defendant refused them.

By the decree, it would appear that the coals to be delivered were derived from Lumley Park Colliery.

The complainant in his bill sets out a bond which he had given defendant about two years before,

Blakestan in which it was recited that the complainant, being employed as overman in the

v. wyning and working of coals out of the collieries of Crawcrook, in the county

Dikes of Durham, was in arrear twenty tenns for which he had received money, and ought

March 27,1665 to have paid the defendant, who was a joint owner of the colliery, his proportion thereof; he therefore became bound to the defendant in a penal sum of £40, that he would deliver to the defendant out of the pits in the colliery of Crawcrook, the said twenty tenns of good merchantable ship coles accompling twenty waggons to a tenn, every waggon to contain fifteen
bowles usual cole measure," at any time, on demand, after the date thereof, and before the 1st August then next. The complainant then sets out performance of the conditions of the bond; nevertheless, the defendant, though thereunto requested, had refused to deliver up the bond to be cancelled, and had vexatiously, without a cause, by a writ of justices, issued forth of the court and process thereupon, arrested the complainant upon the said bond, and proceeded thereupon with all possible violence in the County Court. Prayer for relief.

The defendant by his answer confessed the obligation and condition as above, and admitted the delivery of a portion of the coals as agreed, but denied they were good and merchantable ship coals, "but bad and foul." He also averred four tens and eleven waggons then remained due and unpaid, and they were of the value of £15 12s. 5d., and for badness of quality of those delivered he claimed as his loss £12. Decree that,

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" It appearing to this court to be a matter of great intricacy and trouble, and yet of no great weight," and the parties assenting, the matters in difference between them be referred to Sir Francis Anderson, Knight, and Sir Nicholas Cole, Knight, as auditors and arbitrators, and that a commission be awarded to them for that purpose.

The information sets out the title of the Bishop of Durham to certain collieries, coal-mines, and Attorney-General, ex relatione, seams of coal called "Edderley Colliery," and in

Sir Paul Neile et alii, consideration of a fine of £1,100,

Smelt et alii, granted a lease thereof to the relators for three lives

June 10, 1667 That the relators had been put to great charges in winning and working the said colliery, and in clearing the same from water. That the defendants being seised of a freehold colliery adjoining, had sunk pits very near "to the bounders" of the said Bishop's colliery, and had secretly worked thereout great quantities of coal which they had brought out at their own pits, and had also worked great part of the walls purposely left by the relators for the purpose of keeping the water from coming into the said Bishop's colliery; also that the defendants had driven drifts into the Edderley Colliery, whereby the water ran in and would inevitably drown the same. On the motion of counsel for the relators, the Court directed a Commission to issue for the examination of the workings, unless the defendants should show good cause to the contrary to the Chancellor, at his chambers in Lincoln's Inn, on a future day.

A Commission was directed to issue to Commissioners to be named by the Registrar, who were to make a return of the damage done to the Bishop's colliery on the 1st August then following.

22 June, 1667
The Commissioners who had made the view certified that several workings within the defendants' colliery had been stoped up in several places towards the relators' colliery, and (as they conceived) it was done to prevent a view under the August 1, 1667, Commission, by reason thereof they could not view the workings of the defendants towards the Edderley Colliery, neither could they certify the damage sustained by the relators, but all the watercourses tended towards their colliery. A new Commission was thereupon directed to issue, with power to remove the stoppings and fillings up of the workings within defendants' colliery, and with power to use the roller, ropes, shafts, and engines of the defendants, and in default thereof with liberty to erect others necessary for the view, and to remove them again.

The former proceedings are set out, and a demurrer by the defendants to the information, on the same ground that the matters complained of were properly triable at Common Law and by action of trespass. The Court overruled the demurrer, as the information was for discovering if the defendants had entered Sept. 5, 1667, the Bishop's colliery and worked thereout. The last Commission was directed to be renewed with powers as before. The defendant, Smelt, who was principally concerned, was ordered at his own charges to remove the rubbish and other obstructions in defendants' colliery, and allow the Commissioners "with instruments, lights, lynes, compasses, and utensils, as well to remove obstructions without endangering or drowning defendants' colliery, as to view and measure the workings aforesaid." An attachment was further ordered to issue against such of the defendants as should obstruct the execution of the Commission.

The complainant, in her Bill, set out that the defendant, about three years before, demised Watson to her (the complainant's) late husband, George Watson, "all those mynes and seames of coles usually called the maine cole seame or myne," within the Townfields of Great Lumley, for a term of three years, at a rent of 15d. yearly for every twenty-one corves of coal wrought, each corve not to exceed ten pecks. It was covenanted that during the first year Watson should win 2,000 score of coals, and in the second, 3,000, the defendant to find such gins and engines as then were upon the land, on condition, by Watson, he would leave them in as good repair as he found them, and
that for working the Five-quarter coal the defendant was to have one of the gins or engines during the last two years. It was further agreed that on failure by Watson to pay the said rent, he would confess a judgment of £200 to the defendant. The defendant agreed to find sufficient horses and drivers, with furniture to the said horses, for drawing the coals to bank.* The complainant then set out

* From the tenor of the agreement it would seem the colliery was worked at the same time by the defendant and Watson, the former working the Five-quarter-seam, the latter the Main-coal.

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that her said late husband became bound to the defendant in £2,000 for the performance of his part of the agreement—his death in 1666 and grant of administration to her; that a sum of £56 4s. 1d. was due to defendant for rent, and £5 for repairs to the gins, and she prayed that defendant might be compelled to accept that sum and give up the bond to be cancelled.

The defendant answered and confessed the agreement, but insisted that Watson had not kept it, as he had drawn coals in corves containing more than ten pecks each; and that he did not deliver gins for defendant to work the Five-quarter coal at the end of the first year. Also, that more rent was due than admitted in the bill. Further, that by irregular working of the said mines he had occasioned "divers thrusts of cole," which hindered him from working the mines, and did not satisfy the defendant for the same according to his agreement.

The breaches appearing many and intricate, and the damages therein uncertain, the court directed a trial at law by an action of covenant, for ascertaining the damages, and on return of the verdict would finally determine the cause, and granted an injunction for staying proceedings upon the bond.

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APPENDIX B.

COLLIERY ACCIDENTS IN THE COUNTIES OF DURHAM AND NORTHUMBERLAND.

The earliest accident of which we have any record occurred in a pit at Galla Flat, in May, 1658, by the breaking-in of water from an old waste. Two men lost their lives.

The "Compleat Collier" speaks of thirty lives being lost by an explosion, near Newcastle, in 1705. Possibly this is the explosion mentioned in Gateshead Church books, as having taken place in a colliery in a field at the head of Jackson's Chare, when Jackson's daughter,* with sundry men, lost their lives. This is the only woman ever spoken of as having worked in the mines of these counties.

Upon August the 18th, 1708, Fatfield Colliery exploded, causing the loss of sixty-nine lives. This is said to be the earliest explosion in our coal-field of which we have an authentic record.

About the year 1710, Bensham Colliery exploded, by which seventy or eighty lives were lost.

On January the 18th, 1743, an explosion occurred at North Biddick Colliery, occasioning the death of seventeen persons. This accident resulted from holing into a drift which communicated with an old waste.
From about the middle of this century some sort of record of colliery accidents appears to have been kept, doubtless very imperfect, which may in some degree be explained by the ensuing extract from the *Newcastle Journal* of March 21, 1767:—" As so many deplorable accidents have lately happened in collieries, it certainly claims the attention of coal-owners to make provision for the distressed widow and fatherless children occasioned by these mines, as the catastrophes from foul air become more common than ever. Yet, as we have been requested to take no particular notice of these things, which, in fact, could have very little good tendency, we drop the further mentioning of it."

* Up to this time (1865) women are still employed in screening the coals at the Cumberland pits.

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In November, 1850, the Coal-mines Inspection Act came into operation, when Mr. Matthias Dunn was appointed Government Inspector. The principal accidents from this date to the year 1865 have been:—

<table>
<thead>
<tr>
<th>Year</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1851</td>
<td>160</td>
</tr>
<tr>
<td>1852</td>
<td>155</td>
</tr>
<tr>
<td>1853</td>
<td>151</td>
</tr>
<tr>
<td>1854</td>
<td>127</td>
</tr>
<tr>
<td>1855</td>
<td>148</td>
</tr>
<tr>
<td>1856</td>
<td>140</td>
</tr>
<tr>
<td>1857</td>
<td>151</td>
</tr>
<tr>
<td>1858</td>
<td>159</td>
</tr>
<tr>
<td>1859</td>
<td>181</td>
</tr>
<tr>
<td>1860</td>
<td>242</td>
</tr>
<tr>
<td>Total</td>
<td>1614</td>
</tr>
</tbody>
</table>

From the reports of Messrs. Dunn and Atkinson, Government Inspectors of Mines for the Northern District, we obtain the following account of fatal accidents in the ten years ending with 1860: —

<table>
<thead>
<tr>
<th>Year</th>
<th>Tons of coal per death</th>
</tr>
</thead>
<tbody>
<tr>
<td>1851</td>
<td></td>
</tr>
<tr>
<td>1852</td>
<td></td>
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<tr>
<td>1853</td>
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<tr>
<td>1859</td>
<td></td>
</tr>
<tr>
<td>1860</td>
<td></td>
</tr>
</tbody>
</table>

Mr. Dunn in his report, named above, made to the House of Commons for the ten years ending with 1860, gives the following synopsis of fatal accidents in his district of North Durham, Northumberland, and Cumberland. §

<table>
<thead>
<tr>
<th>By explosion</th>
<th>Shaft accidents</th>
<th>Falls of coal and stone</th>
<th>Miscellaneous</th>
<th>Total</th>
<th>Tons of coal per death</th>
</tr>
</thead>
</table>

---
From this statement we obtain the following percentage of causes of death:

From explosions and choke-damp........................... 25.22
Falls of stone and coal............................................ 30.09
Shaft accidents .................................................. 15.27
Miscellaneous..................................................... 29.42

100.00

* The gas fired at the underground engine fire. Besides the men's lives lost, were nine horses and fifty-six ponies. Mr. Nicholas Wood stated the cost of this accident to have been upwards of £10,000.

† This accident, the most fearful that ever occurred in the Coal-trade, resulted from the closing of the shaft, caused by the breaking and falling into it of the half of an immense pumping engine beam.

‡ This year includes Burradon and Hetton accidents.

§ From this return for the coal-mines in Great Britain, it appears that the total fatal accidents in the ten years, amounted to 9,090, being at the rate of one life lost for every 66,573 tons of coal raised, while from a similar return confined to the Northern Coal-field (Messrs. Dunn and Atkinson's districts), the total fatalities are represented as amounting to 1614, or one death to every 114,574 tons of coals raised (total tons 184,922,978), a return highly favourable for the north, compared with other districts.

Mr. Greenwell, in his compilation of the deaths in all the coal-mining districts for the five years, including 1858, states the total at 5,065, of which 1,269, or twenty-five per cent., were caused by explosion or suffocation, which result accords with that obtained from Mr. Dunn's synopsis. But taking the Inspector's reports of all the districts for the years 1860, 1861, and 1862, the percentages are found to somewhat vary.

<table>
<thead>
<tr>
<th>Year</th>
<th>Explosions</th>
<th>Falls of stone</th>
<th>Surface</th>
<th>Sundries.</th>
<th>Total deaths.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>and coal</td>
<td>accidents</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1860....</td>
<td>363</td>
<td>......</td>
<td>388</td>
<td>......</td>
<td>304</td>
</tr>
<tr>
<td>1861....</td>
<td>119</td>
<td>......</td>
<td>427</td>
<td>......</td>
<td>70</td>
</tr>
<tr>
<td>1862....</td>
<td>190</td>
<td>......</td>
<td>422</td>
<td>......</td>
<td>52</td>
</tr>
<tr>
<td>Percent..</td>
<td>21.10</td>
<td>......</td>
<td>38.84</td>
<td>......</td>
<td>5.53</td>
</tr>
<tr>
<td></td>
<td>100.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Referring to the percentages obtained from Mr. Dunn's analysis, which may be taken to fairly represent the relative proportion of accidents in the Northern District, and applying them to the number of accidents recorded in this paper, the total deaths, instead of being 2,238, would be
increased to 8090, and doubtless this number very imperfectly represents the total. Again, comparing the per centages of the two statements, it will be seen that comparatively few accidents have been formerly recorded except those arising from explosion, and these no doubt in the absence of any authoritative reports, have been very imperfectly noticed. This opinion is confirmed by the following extract taken from a paper by the late Mr. Thomas John Taylor, who had given great attention to the statistics of the Coal-trade, and which appeared in Professor Phillips' Report in 1850:—

"It may be necessary to remark that this account* (referring to one he had furnished) in common with others we possess is very defective,

*This remark of Mr. Taylor's is strongly illustrated by the following extract from "Defoe's Travels in the Counties of Durham and Northumberland," in 1727: —"Here (at Chester-le-Street) we had an account of a melancholy accident, which happened in or near Lumley Park, not long before we passed through the town. A new coal-pit being dug or digging, the workmen workt on in the vein of coals till they came to a cavity, which, as was supposed, had formerly been dug from some other pit; but be it what it will, as soon as upon the breaking into the hollow part, the pent-up air got vent, it blew up like a mine of a 1,000 barrels of powder, and getting vent at the shaft of the pit, burst out with such a terrible noise, as made the very earth tremble for some miles round, and terrified the whole country. There were near threescore poor people lost their lives in the pit." Of this accident we have no record.

According to Mr. Dunn, the number of lives lost in the counties of Durham and Northumberland, from 1799 to 1840, has been 1,468. And in a paper read by Mr. Nicholas Wood, before the British Association in 1863, the deaths from explosion in the above counties from 1755 to 1815, the date of the introduction of the Davy-lamp, were 734, and since its introduction from 1815 to 1845, they have been 968. And that since the appointment of Government Inspectors they have averaged 161 per annum.

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and far short of the number of explosions which have actually occurred. In general the minor cases are forgotten, the great ones only being remembered."

Taking all the circumstances into consideration, we cannot be thought to be overstating the fatalities previous to the year 1850, when estimating them to have amounted to at least 10,000.

Referring to the colliery accidents to this date, it will be seen that the collieries at which there has been the greatest sacrifice of life, have been Wallsend, Fatfield and Harraton, and Hartley, where in each case it has amounted to upwards of 200, and at Felling, Haswell, Hebburn, and Jarrow, to 100 and upwards.

Since 1880, the loss of life has been in the two Northern Inspectors' districts, in—

<table>
<thead>
<tr>
<th>Year</th>
<th>Mr. Dunn's</th>
<th>Mr. Atkinson's</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1861</td>
<td>99</td>
<td>76</td>
<td>175</td>
</tr>
<tr>
<td>1862</td>
<td>325</td>
<td>56</td>
<td>381</td>
</tr>
<tr>
<td>1863t</td>
<td>99</td>
<td>88</td>
<td>187</td>
</tr>
<tr>
<td>1864</td>
<td>69</td>
<td>89</td>
<td>158</td>
</tr>
</tbody>
</table>
After the dreadful accidents at Burradon and Hartley Collieries, great exertions were made by many miners and others interested in their welfare, to set on foot and maintain a permanent fund for the relief of the widows and orphans of those who had lost their lives in and about coal-mines.

At a meeting held at Durham for this object, on January 31st, 1862, Mr. William P. Shield, a miner, made the following statements:

In the three counties of Durham, Northumberland, and Cumberland, in ten years, ending with 1860, there had been 1,597 deaths by colliery accidents, or 159.7 per annum out of 51,000 persons, equal to a death-rate of 3.13 per 1,000. Nearly 184,000,000 tons of coals were raised during these ten years, so that the average number of lives lost in the production of 1,000,000 tons was 8.7.

From a return made to the Coal-trade Office, and upon papers laid before a Select Committee of the House of Commons in 1861, it was estimated that the following persons were employed in the three counties—

- Underground: 44,600
- Aboveground: 15,400
- In all: 60,000

* Mr. Dunn’s includes the accidents in Cumberland, but they are not numerous,

† This year, in South Wales, one life was lost to every 45,390 tons raised.

Of which 44,443 were above the age of 18, at a contribution of

- 1d. per week: £9,629 6 4
- And 15,557 were under the age of 18, at ½ d. per week: £11,314 13 2

The expenditure upon the above data of deaths, 188 out of 60,000 workpeople per annum, would be—

- An annuity of 5s. per week to 75 widows for five years: £4,221 5 0
- An annuity of 2s. per week to 225 widows for four years: 4,143 18 1½
- Allowance of £25 for 45 single men: 1,125 0 0
- £15 for 68 boys: 1,020 0 0

10,510 3 1½
Practically, it has been found that barely a tithe of the workpeople have availed themselves of the society, and also that the scale of payments was too low.

Mr. Towers, an agitator, and an ostensible friend of the pitmen, at a meeting held at Leeds in May, 1862, stated that there were 300,000 coal-miners in Great Britain. That 1,000 were killed annually, and 10,000 permanently disabled. This latter statement is quite at variance with practical men's opinion. Upon this subject, Mr. W. P. Shield remarked as follows:—"With regard to permanent disablement, the committee believed, from their own knowledge and what they could gather from others, that such cases were not numerous, the instances being rare where a man or boy was incapacitated for more than six months.*

In a pamphlet, recently published by M. Guillaume Lambert, Ingénieur des mines, he draws a comparison between Belgian and English mining engineers, and comes to the conclusion that the latter are fifteen years in the rear of the former in respect to ventilation and the working of the coal. For the last fifteen years the mining engineers of Belgium have discontinued the furnace as a means of ventilation, and substituted for it a mechanical ventilation of one power or another, with manifest advantage.

* It is a well-known fact that, as a rule, pitmen recover from accidents sooner than any other class of workmen.

NORTH OF ENGLAND INSTITUTE OF MINING ENGINEERS.

ANNIVERSARY MEETING, ON THURSDAY, AUGUST 2, 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 Secretary having read the minutes of the Council, the President delivered the following

INAUGURAL ADDRESS.

Gentlemen,—It is with mingled feelings of sorrow and pride that I take the chair of this Institute today; of sorrow when I think of the loss we have sustained through the death of our late President; and of pride at your choice having fallen on me as his successor. I can assure you I feel the honour very deeply, and, though I cannot promise to discharge the duties of the office as efficiently as he
did, yet I will do my best, and I trust you will all lend me your aid and assistance as far as you possibly
can to maintain the prestige of the Institute; and where practicable, to increase its scope and
usefulness. I consider this is most important at the present time, for I feel that in losing our late
President, the Institute lost a moving power which cannot readily be replaced.

When the Society was formed in 1852, it consisted only of about eighty members, and its objects
were comparatively limited, but during the fourteen years which have since elapsed, it has, by the
energy and fostering care of our late President, expanded into an Institute numbering more
members on its books, and having a wider scope of action than any provincial association of a similar
kind.

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I think you will not consider that I am going beyond the mark in saying that it is to Mr. Wood's
exertions that we owe this satisfactory result. No one who witnessed his untiring zeal, his courteous
tact, and ready appreciation of the necessities of any case, can for a moment doubt that he was the
prime mover in all that concerned the prosperity of the Institute, and that he also most ably guided
and directed the exertions of others, so as to make them most conducive to the same end.

I think no one can hesitate to acknowledge that the Institute has done its duty and has answered the
purpose for which it was founded. During the fourteen years it has been in existence it has regularly
held its meetings in this town, and has thus been the means of bringing together parties interested
in the objects of the Society. Meetings have also been held in Birmingham and Manchester, and the
reception given us by the gentlemen of those towns proves that the Institute holds a very high place
in their estimation.

The volumes of Transactions attest the industry of members in the production of papers on the
various subjects coming within the scope of their observation. These, from their practical character,
will always prove a source of valuable information, as well as an interesting record of many events
which have occurred in the course of those years. And I cannot help observing that if the Institute
had done nothing beyond producing these Transactions, it would have accomplished no mean work.
We in England have not an extensive literature bearing on mining subjects in general, and still less
on coal-mining. There is scarcely one standard treatise on it of recent date, and if any one requires
information on the practical details of this great branch of our national industry, I know of no books
in which he can find such an accumulation as in our volumes.

The discussions on these papers, though not so numerous as could have been wished, have brought
out many valuable and interesting facts and opinions, but I am inclined to think we might improve
our practice in this case by managing our discussions after the manner of several older and kindred
societies, that is, by making it an invariable rule to discuss the paper as soon as it is read. I am aware
that many members like to have a paper printed, so that it may be carefully read over at home
before it is discussed, and these will no doubt object to the above proposal. To such I would suggest
that the great point in these discussions is to strike whilst the iron is hot, and to let us hear what
people know about the subject, not what they may read up about it between the publication of the
paper and the discussion on it.
It has been thought that by some alteration in the Rules a more extended basis would be given to the Institute. I think this is highly desirable, and the proposition will be brought before you for discussion this day.

Accidents in mines are unfortunately still more numerous than we anticipated. The more remarkable ones have been fully described in our Transactions, special papers having been devoted to those of Burradon, Lundhill, Hetton, and Hartley, whilst a great many points in ventilation, etc., have been so elucidated and brought into notice that I trust we may say we have done our duty in endeavouring as far as possible to aid in preventing these unhappy occurrences.

The accident at Hartley was as unusual in its character as it was appalling in its effects. It is highly improbable that anything of the kind will ever occur again, but I think the Legislature has done very wisely in enacting that in future all coal-mines should be provided with a second shaft or other outlet, and I think another good result of this unfortunate affair has been to extend the practice of making large pumping beams of malleable iron, which had before that been introduced at one colliery in this district.

I have said that accidents have not diminished in number to the extent we formerly expected they would have done. This at least is numerically the case; but when we look more closely into this class of statistics, and compare the number of accidents, either with the quantity of coal raised, or with the number of men working, we see, that in reality, the sacrifice of human life is decreasing.

The winning and working of coal-mines have also received due attention at your hands, although I think the comparison of the long-wall and the board and pillar methods of getting coal should be a little more gone into, with a view of determining which is really the best, or whether each is not most adapted to the circumstances of the district in which it has received its full development. This question is the more interesting at the present time as it is intimately connected with the new element of cutting coal by machinery. For some time past various machines for assisting in getting coal have been brought out, and though their introduction has not yet become so general as was anticipated, they are now used to some extent, and there can be no doubt that they will ultimately be brought to such perfection that their application will be very largely extended.

The two principal engines used for this purpose have been described in your Transactions.* The one works with compressed air and uses a pick as a cutting tool; the other is moved by water-pressure and cuts by a slotting action. Both are at work in this district, so that we may hope soon to hear the results of their practical working from the gentlemen who are using them. I am not aware that either machine has been applied to board and pillar working, but modifications will probably be introduced to effect this object, so that they can be used in collieries where the long--wall system of working is not carried out.

Amongst the many improvements which have been made of late years, may be mentioned the superior manner in which shafts are now finished and fitted up, more especially in the case of tubbing through water-bearing strata. When tubbing was first largely used in the shafts of this coal-
field, the thickness of metal seems to have been determined almost entirely by the strength required, and little or no allowance was made for the deterioration of the iron itself, which is, of course, considerable, especially in damp upcast-shafts. In fact, one might almost say that at that time we considered iron indestructible. Recent experience and experiments have, however, proved the fallacy of this system; and in most cases where tubbing is now put in, a very considerable allowance is made on this head. Various systems of inner casings of fire-brick, or some other material, have also been devised, by which the tubbing of upcast-shafts is to a great extent protected from the action of the acids produced by the smoke.

Many contrivances have been brought out for the purpose of avoiding accidents in shafts, arising from the breakage of rope or from overwinding; but though they have been used to some extent in Lancashire and N Scotland, they do not seem to have been regarded with much favour in this district; in fact, accidents of this nature are fortunately so rare that the want of such an apparatus has scarcely been felt.

In the matter of boring tools and appliances, I fear we have not made so much progress as our continental neighbours, but the apparatus of Messrs. Mather and Platt, which was used to bore the deep bore-hole at Middlesborough, is an exceedingly ingenious, and, as far as mere boring is concerned, a very efficient piece of machinery. For trial bore-holes, that is, for bore-holes to prove the existence, or, at all events, the thickness of beds of coal or other minerals, many of us will, I think, prefer the old system of boring by hand; but if we can add to Messrs. Mather and Platt’s borer the French apparatus for bringing out cores of the

* Trans., vols. XII, p. 63; XIV., p. 83.

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material bored through, I have no doubt we shall find it a great and sure advantage in making deep bore-holes.

Boiler explosions have, unfortunately, been very frequent during late years, and of all casualties which we have to investigate, they are the most difficult to explain. From the nature of the accident, it commonly happens that nearly all the data from which we could judge of the state of the boiler are destroyed, and it often happens that the persons in charge are killed, so that we have very small evidence on which to found an opinion. Numerous theories have been advanced to account for cases in which, according to what evidence remained, boilers ought not to have exploded. Some of these will be found in our Transactions, and though I have no wish to throw doubt on these ingenious ideas, I cannot help thinking that care in construction and working is the main thing to be depended on, and that if we make our boilers of the very best materials and most careful workmanship, supply them with good water, and do not allow them to serve us too long, and, above all, if we see that every attention is paid to the working of them, explosions, if not altogether avoided, will at all events be reduced to a minimum.

Gun cotton has been long brought before the scientific world, but the deficiencies of manufacture have prevented its being introduced into practical work. The improvements of Lenk’s process have, however, obviated this difficulty, and it has recently been considerably used in England, and more especially in the lead and copper mines, where the hardness of the rock causes it to act to the
greatest advantage, whilst its comparative freedom from smoke is a great boon in those imperfectly ventilated mines. Nitro-glycerine has also come partially into use for blasting, and there is no doubt that its great power and the facility with which it can be used in wet places, and even with nothing but water for tamping, render it a most powerful agent. As it is at present manufactured, it seems to be, unfortunately, a very hazardous thing to deal with, both from the great tendency to accidental explosion, and from the poisonous effects which follow the use of it in blasting. This latter is said to arise from the dissemination of very fine particles of the material unconsumed by the explosion, and not from the gases it produces. If this cannot be obviated by improvements in the manufacture, I fear it will prove an insurmountable obstacle to its use in close workings, though in quarrying or open work it will not be so much felt.

The question of which is the best ventilating power may now be said to rest between the Furnace and the Fan, and whilst the former is

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very generally advocated for deep pits possessing large airways, there can be no doubt that the fan is very advantageous for shallow mines, and for those in which, from any cause, the area of the return airways is contracted.

M. Guibal's fan apparatus appears to be the best in point of efficiency and economy, and it has been introduced in several places in this district. Messrs. Atkinson and Dickinson, two of Her Majesty's Inspectors of Coal-mines, have been engaged for some time in an inquiry into the various systems of mechanical ventilation. This investigation has extended over several years. It comprises examinations of every system used both in England and on the Continent, and has been conducted with the greatest care. I believe the report containing the results of their experiments will shortly be published, and it will without doubt be a most valuable addition to our knowledge on the subject.

We have recently had a very interesting communication from Mr. Ansell, of the Royal Mint, in which he describes his application of the beautiful law of the diffusion of gases for the purpose of constructing fire-damp indicators to warn us of the approach of gas in our underground workings. The subject is still open for discussion by the Institute, and I shall, therefore, offer no opinion on it at present, beyond observing that whether capable of practical application or not, the invention is an exceedingly ingenious one and reflects very great credit on Mr. Ansell.

It was observed in a recent public discussion on accidents in mines, that practical men are always unwilling to adopt scientific inventions; but when it is remembered how readily Sir Humphrey Davy's lamp was taken up in this district, and how quickly its use spread to all parts, not only of England but of Europe, I think it must be acknowledged that the above statement is unfounded. The truth is, that men of science often entirely ignore the practical difficulties which prevent the introduction of their inventions, and are very apt to ascribe all such difficulties to our unwillingness to work out their ideas. If, however, scientific men would come more amongst us, as Sir Humphrey Davy did, and as Mr. Ansell has lately done, I am quite sure they would soon feel the truth of what I have said, and would find that we are always not only ready but eager to avail ourselves of all the resources of science, more especially in the case of any invention which may conduce towards the prevention of accidents affecting the safety of human life.
The question of the possibility of flame passing through the gauze of the safety-lamp was investigated by Mr. Wood, in 1853, and the results of his experiments shewed that at a certain velocity of current flame would immediately pass through apertures of the ordinary size; such a danger is, of course, partially guarded against by having a shield on the lamp, and by keeping it as much as possible protected from the current, but some accidents and observations have of late years caused many to suspect that there are several conditions under which the Davy-lamp is not so safe as it is generally considered to be. This was eminently a subject for investigation by this Institute, and was also one which required to be decided without delay; and accordingly a committee was appointed to carry out certain experiments which it was hoped would prove something definite. These gentlemen have now, I believe, concluded their labours, and the results will shortly be laid before the Institute.

What is the best form of engine for draining mines is a question of great importance in all districts where feeders of water of any amount are met with, either in sinking or exploring for coal or other minerals. It has long been acknowledged that the Cornish engine (of which the recently introduced direct-acting engine is only another, though modified form) is productive of the greatest economy of power, i.e., that it can raise the greatest quantity of water to a given height with a certain allowance of coal. In former years such an engine has been known to raise 120,000,000 pounds of water to the height of one foot with an expenditure of one bushel of coal; and even now, when Cornishmen do not pay so much attention to the subject as they used to do, there are many engines reported as doing a duty of 70,000,000. Of course, in this district the amount of coal used is not a matter of such importance as in Cornwall, and may be said to be comparatively neglected; and further, it is also a question whether the slow motion of the Cornish-engine is not a serious drawback to its efficiency, more especially where accidents or increased feeders render a variable speed necessary. I am inclined to think that the tendency of recent engineering decidedly shows the advantage of smaller engines travelling at a much greater speed. It would, I think, be very advisable that we should have more papers from our members on this subject, with descriptions of work done by the various forms of engines, both horizontal and vertical, and in positions both at the surface and at the bottom of the shaft.

The question of the duration of our coal-fields has lately engrossed a considerable amount of public attention, and without doubt deservedly so, for it cannot but be acknowledged that the present greatness of this country is mainly due to its superiority in the production and cheap supply of fuel, without which not only would our manufactures at once begin to retrograde, but our mercantile navy, of which we are so justly proud, would both directly and indirectly be deprived of a great part of its employment. The subject was investigated by Mr. Hull, in his work on our Coal-fields, published in 1861, and was first publicly alluded to by Sir W. G. Armstrong, in his inaugural address as President of the British Association in 1863. Since then Mr. Jevons has published an elaborate treatise on it, and Mr. J. S. Mill and the late Chancellor of the Exchequer have spoken on it in Parliament. The latter gentlemen have, however, treated the matter more as a question of political economy than of engineering, and have assumed the estimates of former writers as
accurate or approximately so. I do not think we are at present in a position to say what amount of
workable coal yet remains. Such an estimate can only be correctly made by combining the reports of
a number of people each of whom has a clear knowledge of the resources of his own district. I am
inclined to think that sufficient allowance has not been made for the extension of our coal-fields
under the Permian and other newer formations, nor for the quantity we may be able to work under
the sea.

With regard to the working of coal as the supply decreases, it has been assumed that seams of less
than two feet are to be altogether left out of the calculation as unworkable, but the fact should not
be overlooked that seams of less thickness are already worked in some districts of the kingdom, and
if the use of machinery for coal-cutting progresses, I have no doubt we shall secure a considerable
addition on this head. The limit of the depth to which our mines can be sunk mainly depends on the
increase of temperature, which is known to take place as we descend. According to the data now
relied on, this would increase so rapidly that, at the depth of 4,000 feet, it would reach 106°Fahrenheit, which is evidently as high a degree of heat as can be conveniently borne by men
engaged in hard labour. I doubt not, however, that means will be devised of artificially decreasing
this temperature by the use of compressed air, evaporation of water, and other contrivances, so that
we may be able to obtain coal lying at a greater depth than that mentioned above. Much importance
is attached to the increase of cost in working deep pits, which is not, I think, justified by experience.
 Doubtless, the amount of capital required to open out deep mines is much larger than in shallow
ones, and the expenses of working and maintaining the shafts and winding apparatus are greater;
but in other respects the increase of

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expense is certainly not in the ratio of the depth. In fact, the difficulty of having to contend against
large feeders of water in the workings, is generally diminished, if not altogether got rid of.

The great question of duration depends, however, on the rate of consumption. In former times we
have been accustomed to talk of the quantity of coal remaining, and, on comparing it with our
annual consumption, we congratulated ourselves that even after making a liberal allowance for
profitable increase, we had yet a store of coal sufficient for many generations to come. The series of
mineral statistics commenced by Mr. Hunt in 1854, has rapidly dispelled this illusion, and to some
extent has established the fact of our coal production increasing in such a geometrical ratio that it
will be doubled every twenty years. It may, however, be observed that these statistics, though
compiled with great care, are rather open to doubt as regards the earlier years of their compilation;
and it is even supposed that their greater accuracy of late years has added to the per centage of
increase they show, that is, that the returns for the last few years being more complete, show a
relative increase which is not wholly due to actual increase of production, but really arises in part
from a portion of the consumption having been omitted from the earlier years of the series.
Notwithstanding these considerations, it is evident that the consumption of coal has increased in a
marvellous way; and that it will do so in the future is equally certain, for as long as our coal remains
reasonable in price, England will maintain her superiority in manufactures, and as long as her
population increases these will extend more and more to all parts of the world. A slight limit will no
doubt be put to this increase by the growing disposition of the labouring classes to curtail their hours
of labour. Twenty years ago, a man would work twenty to twenty-five per cent. more coal than he
now produces under the same circumstances. All these circumstances have so much impressed the minds of men, both in and out of Parliament, that when, on the 12th June last, Mr. Vivian, the member for Glamorganshire, in a very able and interesting speech, moved the appointment of a Royal Commission to inquire into and report on the subject, his motion was at once agreed to. This Commission has commenced its labours, and will no doubt elicit much information of a practical and useful nature.

During the past and present year, a Select Committee of the House of Commons has been engaged in investigating a petition presented to Parliament by the miners of Northumberland and Durham. Their attention has been directed more to the social condition of the workmen, and to the question of the hours of labour of the boys, than to any engineering points connected with coal-mines. They have taken a large mass of evidence, but have not yet made any final report.

In conclusion, I would address a few words to the graduates of the Institute. The advantages they now enjoy in the greater facilities for the attainment of knowledge are infinitely superior to those existing forty or fifty years ago. But it must also be borne in mind that with these increased facilities comes a higher standard of excellence and a greater amount of competition. The special knowledge required in mining engineering is, perhaps, greater than in any other branch of the profession; and the acquirement of a practical insight into the working of mines occupies a large portion of a young man's time during his apprenticeship. It is, therefore, of the utmost importance that he should have a liberal education as a boy, and should, before beginning his pupilage, have acquired some knowledge of those scientific branches which will be most useful to him in his future career.

With this view, our late President laboured long and earnestly to provide a College of Practical Science for this district, but, unfortunately, this very desirable project did not meet with sufficient support, and was eventually abandoned. I cannot say whether the scheme will ever be revived and carried out. In the meantime, it is the duty of all young men who are about to enter the profession, to make the most of such facilities as are afforded them, and, above all, to use the greatest diligence in making themselves thoroughly conversant with the practical part of their business, more especially the underground department of it. They are the material out of which our successors are to be made, and on them depends not only the prosperity of this Institute, but also the position and standing of our profession.

Mr. I. L. Bell begged to move a vote of thanks to the President for his excellent and luminous address. He ventured to express a hope that the suggestions which the President had so ably laid before the meeting would not be allowed to sleep, and that the advice tendered to this body, and to the mining interest at large, in the North of England, would find a response from them.

Mr. Morrison said, he rose with great pleasure and diffidence to second the motion. This was only the second time he had attended a meeting of the Institute, and he had never been more interested, and he
might say, more instructed, than he had been in listening to the excellent and luminous address they had just heard. Their President was no stranger. They all knew that every suggestion which had fallen from him, not only bore a scientific character, but had the advantage of being soundly practical. If for one thing more than another they esteemed their President, it was for his sound, practical intelligence on every question relating to mining.

The motion was adopted by acclamation.

**ALTERATION OF RULE XI**

The meeting then proceeded to discuss the following notice of motion:

"That in consequence of the rapid development of the iron manufactures and of other engineering works in this district, and of the recent considerable addition of members actively engaged in mechanical engineering, the Council consider that an alteration in Rule XI is desirable, and recommend the following, viz.:— 'That the officers of the Institute shall consist of a President, six Vice-presidents (four of whom to be mining engineers and two mechanical engineers), and eighteen Councillors (twelve of whom to be mining engineers and six to be mechanical engineers')."

Mr. Morrison said, any gentleman like himself would hardly assume the position of either mining or mechanical engineer; but there might be, unlike himself, many gentlemen connected with an institute like this, who might be very useful members of the Council, but who, not enrolling themselves under either of these denominations, might be excluded.

Mr. I. L. Bell said, he was of opinion that they would commit a fatal mistake if they forgot the origin of their body so far as to lessen the representation and influence of that class of gentlemen who were its originators. They all understood what was meant by the appellation of mining engineer, and he thought two-thirds of the Council should belong to that body. If they fixed that proportion at twelve, then they might consider whether the other six should be mechanical engineers, or whether along with them they would admit other gentlemen who did not belong to either profession.

After some further discussion the alteration was made to stand as follows:

"That the officers of the Institute shall consist of a President, six Vice-Presidents (four of whom only to be mining engineers); and eighteen Councillors (twelve of whom only to be mining engineers)."

The President begged to propose Earl Vane as a patron of the Institute. Like all the other patrons he would subscribe ten guineas a year.— Agreed to.

Mr. J. Daglish read the Treasurer's Report.

The President read a letter from Mr. Ansell, requesting that the discussion on his paper be postponed till the meeting in September.
The following new members were elected:—Mr. D. Greig, Leeds; Mr. W. E. Garforth, Lord's Field Colliery, Ashton-under-Lyne; Mr. Samuel Lees, Barrowshaw Colliery, Greenacres Moor, near Oldham; Mr. B. B. Glover, mining engineer, Newton-le-Willows, Lancashire; Mr. Henry Hall, Haswell Colliery, Fence Houses; Mr. Jonathan Piggford, Haswell Colliery, Fence Houses; Mr. Thomas Taylor Smith, Oxhill, Chester-le-Street; Mr. Christopher Fisher Clark, Garswood, Newton-le-Willows; Mr. Edmund Clarke, Colliery Guardian Office, Wigan; Mr. Thomas Whalley, Orrell Mount, Wigan; Mr. Henry Lewis, Swannington Colliery, near Ashby-de-la-Zouch, Leicestershire; Mr. James Ronaldson, Clough Hall Coal and Iron Works, Stoke-upon-Trent; Mr. James Burn, Rainton Colliery, Fence Houses; Mr. R. O. Lamb, Axwell Park; Mr. Barnabas Fenwick, Broomhill Colliery, Acklington; Mr. J. F. Spencer, Newcastle; Mr. F. C. Marshall, Jarrow; Mr. T. W. Benson, Cowpen Colliery; Mr. Arthur Hill, and Mr. B. Murray.

DIRECT-ACTING PUMPING ENGINE.

After the reading of a letter from Mr. Greenwell relative to the working of Bastier's chain-pump, the meeting proceeded with the discussion of Mr. J. B. Simpson's paper "On a Direct-acting Pumping Engine, etc."

Mr. Steavenson said, the engine had a cylinder fifty-two inches in diameter, and the result was only twenty-seven horse power. Those who had any practice with engines must consider it rather an anomaly to apply so large a cylinder to do so little work. It was admitted that it was not running at more than 2.4 strokes, whilst it was competent to run at six. He did not think it was safe to run faster; though he had known engines to have run at ten. He thought in practice, however, that six was about the proper rate. That would give two and a-half times as much, or sixty-seven horse power. It would be very easily seen that the result was still much below what might be expected from an engine of such a size. They must take into consideration that to work at a higher speed does away with the advantage that might be looked for in working at slow speed, which Mr. Simpson seemed to think was an objection to its economy. He was inclined to think that if it ran faster they would get less vacuum, and, consequently, they would lose economy. He did not know whether Mr. Simpson had made experiments at a higher speed. He would be glad to see any diagrams and the result taken at five or six revolutions. Mr. Simpson obtained 76.6 per cent. efficiency, and he admitted that the non-direct acting-engine gave not much less. In May last he (Mr. Steavenson) made experiments at Page Bank, with a thirty-four-inch cylinder. The efficiency he obtained was seventy-seven per cent., which was superior to the direct-acting method. There was no reason to suppose that the experiments were made with the view of depreciating the qualifications of the direct-acting engine. They were made before he had taken any steps to estimate the value of the different engines.

Mr. J. J. Atkinson—Would it not be well if you could put down the results, and get them reported?

Mr. Steavenson said, he proposed to make some experiments to elucidate the results obtained with the assistance of a gentleman who had engines which he desired to have examined. The shaft was forty-six and a-half fathoms, and the quantity of water obtained by measurement was 301 gallons
per minute. This gave 839,790 pounds. He was really inclined to think there was no great efficiency in the direct-acting engine, but he hoped to go on making experiments.

Mr. Atkinson—I think, if you please, you might state that the engine is horizontal.

Mr. Steavenson—Yes, it is worked with two quadrants. There are two lifts, and the weight is equalized as much as possible.

Mr. Armstrong said, with regard to the direct-acting engine, he found that a great many of his young friends were apt to take up with new notions. He did not deny that there were some situations where direct-acting engines were found to work economically; but if they looked at Mr. Simpson's engine what did they find? Here was a fifty-two-and-a-half inch cylinder on the surface, to draw what? 250 gallons, or 100 gallons two and a-half strokes—a height of 204 feet; but instead of requiring an engine of thirty-three horse power, if Mr. Simpson would divide his column into two, having 102 feet on the one side, and 102 feet on the other, all that he would find necessary would be (excluding friction) an eleven-horse engine to do the work. He would find the old fashioned plan of dividing the column and putting the motive power at

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one end of the beam the most economical arrangement that he could adopt. He (Mr. A.) did not object to putting up a large engine, but he did quarrel with the notion of making any sort of case like this in favour of a particular mode of working. If Mr. Simpson contemplated the pumping of some large feeders of water there was wisdom in providing a large engine to meet the case, but certainly there was no necessity for such an engine to do the work reported.

Mr. Simpson said, the engine was not put up for the purpose of pumping simply 240 gallons per minute, but for the purpose of pumping 900 or 1000 gallons per minute, which they expected to get when they communicated with another pit. Even at present the engine was working satisfactorily, and certainly as economically as any they could erect. The pit has just been completed, and as soon as standage is made the engine will only be driven in the day time until the large feeder is met with. It is true that the engine now exerts only thirty horse-power, but in course of time it would require to go nine or ten strokes per minute, which he was quite sure the engine would do, and then the indicated horse-power exerted will be probably 110 or 120 horse-power. The nominal horsepower is 110, so that for the ultimate work of the engine they were not beyond their power. As to the amount of fuel consumed, this engine would bear comparison with any engine in the neighbourhood, as only seven pounds per indicated horse-power per hour were used, and that, by-and-by, would be reduced to five pounds. At the same time, he had mentioned in his paper that he was not wedded to the direct-acting engine, because he was satisfied that other kinds of engines could be put up that would be just as efficient in economy of fuel and duty performed as a direct-acting engine. Mr. Steavenson spoke of the vacuum. They had driven the engine quickly and still kept a vacuum of eleven and a-half pounds per square inch. He had brought forward the subject in connection with the discussion on Mr. Knowles' paper, as it contrasted favourably with the engines alluded to by Mr. Knowles, and also because the engine, although not working to its full power, was more economical, not only in the consumption of fuel but also in the cost of labour, than almost any engine in the district. The experiments were all carefully performed.
Mr. Atkinson—Are you willing that I should ask Mr. Crawford to allow me to try his engines at Houghall, test them, and compare notes with you at some future meeting?

Mr. Simpson—Quite willing.

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Mr. Armstrong said, in this case the surface of the strata water was half way down the pit, and the pumps could have easily been divided into two equal columns, both lifting-pumps, and the engine could draw one-half the total column of water, pumped alternately; the one half at one end of the beam and the other half at the other. With such an arrangement of pumps practicable, it was simply absurd to introduce a forcing-pump, which, he thought in itself, an objectionable form of pump for fluctuating quantities of mine water. The peculiar contrivance in this case of having the spears to work through the force-pump, and then be attached to the light lifting-set in the bottom, he thought most objectionable. In form it assimilated closely to the patent taken out by Mr. Charles Carr, at Seghill, and which met with no success. The boiler may be improved for any form of engine, and applies to any; and the fuel may be economised without relation to the arrangement of the engine. I contend that in situations like this, where the water-column could be divided into two lifts, one at either end of the beam, the arrangement was the most perfect which could be devised. If a mine-feeder has to be pumped 100 fathoms, and the lift divided into two-fifties where the division was practicable, then, unquestionably, the cost of pumping would be reduced to a minimum.

Mr. Southern said, Mr. Cochrane was getting nine strokes per minute at New Brancepeth Colliery.

Mr. Cochrane said, he did not wish to refer to this engine, as at present it was only used for sinking, and, owing to peculiar circumstances, very imperfectly applied; but when he did get it in proper working order he would give the result. He was working up to nine strokes, and he had gone to ten strokes. The depth was about sixty fathoms.

Mr. Atkinson said, he did not quite agree with Mr. Armstrong. He understood him to say that the lift, in the case he had supposed, was only equal to one-fifty fathom lift.

Mr. Armstrong said, the ordinary state of a pumping-engine consisted of one part effective, the other non-effective. If a beam be placed between two sets, the pumps attached to either end of the beam would be alternately at work; the one during the one-half of the stroke, the other during the other half; and this in effect threw but one-half of the mine-feeder upon the engine at one time, and in the case assumed but one-half of the water-column. To use a direct-acting engine, as is done in some cases to pump from the bottom, under the case assumed was absurd.

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Mr. Cochrane—The steam is on one side only, and you allow the weight of the spears to do the work.

Mr. Armstrong—That is objectionable.

Mr. Simpson said, the great point in pumping-engines was the economical effect. If Mr. Armstrong could show him ten engines out of twenty in the neighbourhood that were doing better duty, he would be satisfied that this direct-acting engine, and its arrangements, were wrong.
The President said, they had better adjourn the discussion to the next meeting. There were one or two remarks of Mr. Armstrong’s with which he did not agree. He did not think that forcing sets were useless.

Mr. Armstrong—I said objectionable.

The President—As to your having two sets; in that case you must have two pits, which we have not.

Mr. Armstrong—I said in case it could be done.

The President—If you have only one pit must you not have a forcing set? I mean with a common pumping-engine. You must have a pit and a staple, and one at each end of the beam. If you have only one shaft to balance your engine, you must have a lifting set and a forcing set.

Mr. Armstrong—I have already stated, where practicable, the division of the pumping column is the most economical arrangement. When this cannot be effected, then to balance the engine a forcing-set must be introduced; the lifting-set being at the bottom.

Mr. Simpson said, that in his case the pumps were arranged so that a large proportion of the water which is met with at the seam, fifteen fathoms from the bottom, would be taken in below the ram, instead of allowing it to go to the bottom of the pit as at present. Considerable economy will result when this shall have been carried out.

Mr. Atkinson said, that some Cornishmen whom he employed in South Wales, said there was less difficulty with the forcing sets than with the lifting sets. It would be imprudent to put in a bottom set as a forcing set. He said this from his own experience, and more particularly from the experience of trustworthy men who had seen such cases.

The President—A bottom set you must have.

Mr. Simpson—There is no doubt that forcing sets at the bottom of a pit are objectionable, especially if you have little standage for water. At our Emma Pit, however, it was unavoidably necessary to put in a forcing set at the bottom, and it has worked satisfactorily for several years, costing less in repairs than the lifting set. From 700 to 800 gallons per minute are pumped from a depth of seventy-two fathoms—the forcing set pumping it half the distance.

The discussion was then adjourned, and the meeting proceeded to the election of officers.

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