

THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

=====

TRANSACTIONS.

VOL. LXI.

1910-1911.

EDITED BY THE SECRETARY.

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ADVERTIZEMENT.

The Institute is not, as a body, responsible for the statements and opinions advanced in the papers which may be read, nor in the discussions which may take place at the meetings of the Institute.

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THE NORTH OF ENGLAND INSTITUTE  
OF  
MINING AND MECHANICAL ENGINEERS.

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ANNUAL GENERAL MEETING,  
Held in the Wood Memorial Hall, Newcastle-upon-Tyne,  
August 6th, 1910.

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Mr. T. E. FORSTER, President, in the Chair.

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ELECTION OF OFFICERS, 1910-1911.

The Chairman (Mr. T. E. Forster) appointed Messrs. N. B. Ridley, A. M. Terry, and W. B. Wilson, Jun., as scrutineers of the balloting-papers for the election of officers for the year 1910-1911.

The Scrutineers afterwards reported the result of the ballot, as follows :—

President :

Mr. M. W. Parrington.

Vice-Presidents:

Mr. J. B. Atkinson.

Mr. T. Y. Greener

Mr. Henry Palmer

Mr. R. Donald Bain.

Mr. C. C. Leach.

Mr. F. R. Simpson.

Councillors:

Mr. R. S. Anderson.

Mr. Samuel Hare.

Mr. John Morison.

Mr. Cuthbert Berkley.

Mr. A. M. Hedley.

Mr. W. C. Mountain.

Mr. R. W. Berkley.

Mr. T. E. Jobling.

Mr. A. D. Nicholson.

Mr. W. Cochran Carr.

Mr. Austin Kirkup.

Mr. J. H. Nicholson.

Mr. Benjamin Dodd.

Mr. J. P. Kirkup.

Mr. Simon Tate.

Mr. Mark Ford.

Mr. Philip Kirkup.

Mr. E. Seymour Wood.

The Secretary read the minutes of the last General Meeting, and reported the proceedings of the Council at their meetings on July 23rd and that day, and of the Council of The Institution of Mining Engineers on June 2nd.

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The Annual Report of the Council was read, as follows:—

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ANNUAL REPORT OF THE COUNCIL, 1909-1910.

A great national sorrow, the death of His Most Gracious Majesty King Edward VII., has marked the past year. As loyal and faithful subjects, and as members of an Institute honoured by a Royal Charter of Incorporation, the Council forwarded an Address to His Majesty King George V. on May 14th, 1910. An acknowledgment from His Majesty was received through the Secretary of State for the Home Department, dated May 28th, 1910.

The following table shows the progress of the membership during recent years :—

Year ending August 1st.	1907.	1908.	1909.	1910.
Honorary members	21	21	22	26
Members	903	942	935	926
Associate members	108	105	103	106
Associates	194	209	210	214
Students	47	48	54	54
Subscribers	34	33	34	35

Totals	1,307	1,358	1,358	1,361
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The slight increase in the membership is a matter for congratulation. The additions to the register number 84, and the losses by death, resignation, etc., 81, a net increase of 3 resulting.

There were ten deaths, thirty-five resignations, and the names of thirty-six gentlemen were removed from the Register during the year, making a grand total of eighty-one.

The Library has been maintained in an efficient condition during the year; the additions, by donation, exchange, and purchase, include 324 bound volumes and 9 pamphlets, reports, etc.; and the Library now contains about 12,161 volumes and 405 unbound pamphlets. A card-catalogue of the books, etc., contained in the Library renders them easily available for reference.

Exchanges of Transactions have been arranged, during the year, with The Smithsonian Institution, the University of California, the University of Illinois, and the Victorian Institute of Engineers.

The courses of lectures for colliery engineers, enginewrights, and apprentice mechanics have been continued at Armstrong

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College, Newcastle-upon-Tyne. The lectures are delivered on Saturday afternoons, and the three years' course embraces the following subjects :—

1910-1911.—Michaelmas Term: (1) The Steam-engine, and (2) Theoretical Electricity. Epiphany Term: (3) Electrical Engineering, and (4) Haulage and Winding.

1911-1912.—Michaelmas Term: (5) Transmission of Power, and (6) Pumping and Ventilation. Epiphany Term: (7) Metallurgy of Iron and Steel, and (8) Mining Machinery (mainly machinery used underground).

1912-1913.—Michaelmas Term: (9) Machine Drawing, and (10) the Chemistry of Fuel. Epiphany Term: (11) Strength of Materials (with experimental illustrations), and (12) Experimental Mechanics.

Several colliery-owners have paid the fees (£1 10s. per annum) and railway expenses of pupils attending the classes from their collieries. During the past year, the lectures of the Michaelmas Term on Machine Drawing were attended by 34 students, and on the Chemistry of Fuel by 37 students, 34 of whom sat for examination and 34 passed; and during the Epiphany Term, the lectures on the Strength of Materials were attended by 32 students, and on Experimental Mechanics by 34 students, 30 of whom sat for examination and 25 passed. Certificates have been awarded to the following students, who have completed the three years' course :—Messrs. P. Bateson, H. Beardmore, T. C. Cook, and S. H. Wainwright. The first and second prizes for the Session 1909-1910, have been awarded to Messrs. P. Bateson and H. Beardmore respectively.

During the past year a supplementary volume to An Account of the Strata of Northumberland and Durham, as Proved by Borings and Sinkings, has been completed and published, and it is hoped that the members will complete their sets of this work by purchasing copies, and by so doing return to the Institute a portion of the great cost which has been incurred in preparing and publishing this exhaustive and valuable addition to the account of the strata of the two counties.

Mr. Thomas Douglas continues to represent the Institute as a Governor of Armstrong College, and Mr. John H. Merivale, in conjunction with the President (Mr. T. E. Forster), represents the Institute on the Council of the College.

Mr. Thomas Edgar Jobling has been appointed to represent the Institute upon the Board of Directors of the Institute and Coal Trade Chambers Company, Limited.

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The President continues a Representative Governor upon the Court of Governors of the University of Durham College of Medicine during his term of office.

Dr. P. Phillips Bedson and Prof. Henry Louis represented the Institute at the International Congress of Mining, Metallurgy, Applied Mechanics, and Practical Geology, held at Dusseldorf from June 19th to 23rd, 1910; whilst Mr. T. E. Forster acted upon the Committee of The Institution of Mining Engineers appointed to make arrangements for the representation of that Institution at the Congress, and, at the request of the Council, brought forward the question of the desirability of holding the next Congress in England.

Mr. T. E. Forster also represented the Institute upon the Committee of The Institution of Mining Engineers appointed to consider what evidence should be presented, and to arrange for a witness or witnesses to give such evidence, before the Home Office Committee on Electricity in Mines.

Mr. William Charles Mountain will represent the Institute at the Conference of the Delegates of the Corresponding Societies of the British Association for the Advancement of Science, to be held at Sheffield, commencing on August 31st, 1910; and Mr. Johan August Brinell will represent the Institute at the Eleventh International Geological Congress, to be held at Stockholm in August, 1910.

Under the will of the late Mr. John Daglish, funds have been placed at the disposal of Armstrong College for founding a Travelling Fellowship, to be called the "Daglish" Fellowship, candidates for which must be nominated by the Institute. Mr. Berent Conrad Gullachsen was in January, 1910, awarded the Fellowship, and suitable arrangements for his gaining knowledge and experience abroad have been made.

G. C. Greenwell silver medals have been awarded to Sir Henry Hall, I.S.O., for his paper upon "Coal-dust to date, and its Treatment with Calcium Chloride," and to Mr. Robert Nelson for his paper upon "Electricity in Coal-mines."

Prizes have been awarded to the writers of the following papers, communicated to the members during the years 1908-1909 and 1909-1910 :—

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"Sinking the John Shaft at Hamsterley Colliery, through Sand and Gravel, by means of Underhanging Tubbing." By Mr. John Cummings, M.I.M.E.

"The Geology of the Little Whin Sill, Weardale, County Durham." By Mr. William Morley Egglestone.

"A Natal Colliery Explosion, and Underground Fires in Fiery Mines." By Mr. William Taylor Heslop, M.I.M.E.

"The Ignition of Coal-dust by Single Electric Flashes." By Prof. W. M. Thornton, Hon. M.I.M.E., and Mr. E. Bowden.

The papers printed in the Transactions during the year are as follows:—

"Fence-gates for Winding-shaft Cages." By Mr. Charles Arthur Crofton, M.I.M.E.

"Sinking the John Shaft at Hamsterley Colliery, through Sand and Gravel, by means of TUnderhanging Tubbing." By Mr. John Cummings, M.I.M.E.

"Electric Shot-firing." By Mr. James Douglas, M.I.M.E.

"The Geology of the Little Whin Sill, Weardale, County Durham." By Mr. William Morley Egglestone.

"Some Results of Experiments made to Test the Effect of Sprayers upon the Moisture of Main Roads at Brandon Colliery." By Mr. T. L. Elwen, M.I.M.E.

"Automatic Cage Tub-stops." By Mr. T. Campbell Futers, M.I.M.E.

"The Cunynghame-Cadman Gas-detecting Device." By Mr. E. A. Hailwood.

"A Natal Colliery Explosion, and Underground Fires in Fiery Mines." By Mr. William Taylor Heslop, M.I.M.E.

"Electricity at the Shamrock I. and II. Colliery, Herne, Westphalia, Germany." By Mr. Henry Moore Hudspeth, Assoc. I.M.E.

"The Ignition of Coal-dust by Single Electric Flashes." By Prof. W. M. Thornton, Hon. M.I.M.E., and Mr. E. Bowden.

"The Electrification of Murton Colliery, County Durham." By Mr. E. Seymour Wood, M.I.M.E.  
"Blyth Harbour."

In connexion with the General Meeting held on June 11th, 1910, a visit was paid to the Electrical Engineering Theatre of Armstrong College, when Prof. W. M. Thornton and his assistants gave a number of demonstrations of the ignition of coal-dust by single electric flashes.

An Excursion Meeting was held at Blyth on July 7th, 1910.

The thanks of the Institute have been sent to the owners of collieries, works, etc., visited during the year.

The Committee appointed, with Mr. Stanley Smith as Secretary, to report upon the Carboniferous Limestone Formation of North of England, with Special Reference to its Coal Resources, is carrying out its investigations.

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The collection of safety-lamps has been lent to the Brussels Exhibition.

The Geological Society of London, supported by this and many other societies, has presented an appeal to the Lords of His Majesty's Treasury against the recent increase in price of the hand-coloured edition of the 1-inch maps issued by the Geological Survey of the United Kingdom.

The Institution of Mining Engineers has now entered upon its twenty-second year, and the members are to be congratulated upon its continued success. Meetings were held at Newcastle-upon-Tyne in September, 1909, and in London in June, 1910. The Twentieth

Annual General Meeting held at Newcastle-upon-Tyne was largely attended, and the best thanks of the members are due to the committee who made the arrangements, to the owners of collieries and works open for inspection, and to all those who by their services contributed to the holding of the meeting, which was in every way a success.

The Chairman (Mr. T. E. Forster) moved the adoption of the Report.

Mr. Thomas Douglas, in seconding the resolution, said that, with regard to the courses of lectures for colliery engineers, etc., he was not sure that they were being attended as well as they might be. The lectures were delivered upon Saturday afternoons, and he was informed that students found it impossible to get away from their duties on that day to attend. Newcastle-upon-Tyne was a distant centre for many who might take advantage of these lectures, and he would like to know what number attended, and from what part of the northern district they came. He did not know what the difficulties were which prevented students from attending, but he thought that the number might be materially increased by having centres for lectures in the County of Durham.

The Hon. Secretary (Mr. John H. Merivale) said that throughout the district, at the present time, there seemed to be a distaste for attending lectures. There appeared to be little inclination on the part of the younger lads to attend classes, and the few who did attend did so without inconvenience. From his

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collieries, which were certainly the farthest off in Northumberland they sent up three or four students. The lectures were as much as the district wanted, although they might not be as much as the district ought to require.

The Secretary said that the attendance at the classes during the past year showed an improvement over previous years; in fact, it was greater than it had been for the last 5 or 6 years.

The Report was unanimously adopted.

-----

The Annual Report of the Finance Committee was read as follows:—

#### ANNUAL REPORT OF THE FINANCE COMMITTEE.

The Finance Committee submit herewith a statement of accounts for the twelve months ending June 30th, 1910, duly audited.

The total receipts were £2,925 16s. 1d. Of this amount, £53 6s. represents subscriptions paid in advance, leaving £2,872 10s. 1d. as the ordinary income of the year, compared with £2,888 1s. 2d. in the previous year. The amount received for ordinary current-year subscriptions was £2,240 7s., and arrears £203 10s., as against £2,287 7s. and £222 8s. respectively in the year 1908-1909. Transactions sold realized £23 15s. 6d., as compared with £21 14s. 1d. in the earlier period; and the sum received for interest on investments was £353 17s. 7d., the amount in the former year being £356 12s. 1d.

The expenditure was £2,988 18s. 3d., that for the previous year being £2,994 18s. 3d. The sum of £108 expended in connexion with the Committee appointed to Report upon the Carboniferous Limestone Formation of the North of England, with Special Reference to its Coal Resources, £288 13s. 7d. for the publication of the Supplementary Volume to An

Account of Strata of Northumberland and Durham, as proved by Borings and Sinkings, and £44 19s. 4d. for expenses of meetings, may be regarded as special expenditure.

From the above figures it will be seen that the expenditure exceeded the income by £63 2s. 2d., and this amount

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deducted from the balance of £430 4s. 2d. brought forward from the previous year, leaves a credit balance of £367 2s.

During the year the Institute and Coal Trade Chambers Company, Limited, decided to issue new shares for the purpose of providing for the cost of the alterations to the building. These were offered to the shareholders in proportion to their existing holdings, and it was decided that the proportion allotted to the Institute should be accepted. This proportion amounted to twenty-eight shares of £20 each, which were issued at a premium of £5, or £25 in all. The first payment of £280 was made during the year, and this, deducted from the credit balance of £367 2s., leaves a sum of £87 2s. to be carried forward.

The names of thirty-six persons have been struck off the membership list in consequence of non-payment of subscriptions. The amount of subscriptions written off was. £191 8s., of which £81 17s. was for sums due for the year 1909-1910, and £109 11s. for arrears. It is probable that a considerable proportion of these amounts will be recovered and credited in future years. Of the amount previously written off, £39 17s. was recovered during the past year.

T. E. Forster, President.

August 6th, 1910.

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The Chairman (Mr. T. E. Forster) moved the adoption of the Report.

Mr. Thomas Douglas seconded the resolution, which was adopted.

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THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS :  
GENERAL STATEMENT, JUNE 30TH. 1910.

LIABILITIES.

	£ s. d.	£ s. d.
Subscriptions paid in advance during the current year		53 6 0
The George Clementson Greenwell prize fund	100 0 0	
Less, paid for medals	70 1 4	
	-----	29 18 8
Capital		12,541 13 9
		-----
		£12,624 18 5

ASSETS.

	£ s. d.	£ s. d.	£ s. d.
Balance in Treasurer's hands	89 7 4.		
Less. due to bankers	3 6 0		
	-----	86 1 4	
Outstanding accounts due from authors for excerpts		1 0 8	
		-----	87 2 0
Arrears of subscriptions			287 16 0
179 shares in the Institute and Coal-trade Chambers Company, Limited (at cost)		4,100 0 0	
28 new shares in the Institute and Coal-trade Chambers Company, Limited (first call)		280 0 0	
Institute and Coal-trade Chambers Company, Limited (mortgage)		1,400 0 0	
£340 consolidated 0 per cent. preference stock of the Newcastle and Gateshead Water Company (at cost)		499 17 6	
£450 ordinary stock of the Newcastle and Gateshead Gas Company (at cost)		487 13 6	
		-----	6,767 11 0
(Of the above amount. £1,710 is due to life-subscriptions account.)			
Value of Transactions and other publications. as per stock account		332 9 5	
Books, pictures, maps, furniture and fittings		5,150 0 0	
		-----	5,482 9 5
			-----
			£12,624 18 5

We have examined the above balance-sheet with the books, vouchers and securities relating thereto, and certify that, in our opinion, it is correct. We have accepted the assets, books, pictures, maps, etc. and Transactions and other publications, as valued by your officials.

JOHN G: BENSON AND SONS,  
CHARTERED ACCOUNTANTS.

Newcastle-upon-Tyne,  
July 23rd, 1910.

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The Treasurer in Account with The North of England Institute of Mining and Mechanical Engineers

For the Year ending June 30th. 1910.

Dr.

	£ s. d.	£ s. d.
June 30th. 1909.		
To balance of account at bankers	347 12 3	
“ in Treasurer's hands	80 19 9	
“ outstanding accounts due from authors for excerpts	1 12 2	
	-----	430 1 2
June 30th, 1910.		
To dividend of 7 ½ per cent. on 179 shares of £20 each in the Institute and Coal-trade Chambers Company,Limited, for the year ending June 30th, 1910	268 10 0	
” interest on mortgage of £1,400 with the Institute and Coal-trade Chambers Company, Limited	46 11 0	
“ dividend on £340 consolidated 5 per cent. Preference stock of the Newcastle and Gateshead Water Company	16 0 7	
“ dividend on £450 ordinary stock of the Newcastle and Gateshead Gas Company	18 11 6	
“ interest on deposit account	4 4 6	
	-----	353 17 7
To sales of Transactions		23 15 6
To Subscriptions for 1909-1910 as follows :—		
747 members @ £2 2s.	1,568 14 0	
81 associate members @ £2 2s.	170 2 0	
181 associates @ £1 5s.	220 5 0	
40 students @ £1 5s.	50 0 0	
40 new members @ £2 2s.	84 0 0	
9 new associate members @ £2 2s.	18 18 0	
18 new associates @ £1 5s.	22 10 0	
10 new students @ £1 5s	12 10 0	
	-----	
	2,152 19 0	
33 subscribing firms	117 12 0	
2 new subscribing firms	4 4 0	
	-----	
	2,274 15 0	
Less, subscriptions for current year paid in advance at end of last year	34 8 0	
	-----	
	2,240 7 0	
2 members, paid life-compositions	51 0 0	
	-----	
	2,291 7 0	
Add, arrears received	203 10 0	
	-----	
	2,194 17 0	
Add, subscriptions paid in advance during current year	53 6 0	
	-----	2,548 3 0
		-----
		£3,356 0 3

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Cr.

	£ s. d.	£ s. d.
June 30th. 1910.		
By salaries and wages	496 13 4	
„ insurance	13 5 9	
„, rent, rates and taxes	31 7 6	
„, heating, lighting, etc.	50 7 6	
„, furniture and repairs	8 13 3	
„, bankers' charges	21 0 0	
„, library	35 1 1	
„, printing, stationery, etc.	165 7 1	
„, postages, etc.	77 19 3	
„, incidental expenses	61 16 4	
„, travelling expenses	13 14 6	
„, prizes for papers	7 7 0	
„ reporting of general meetings	12 12 0	
„, library catalogue	9 0 0	
„ Committee to report upon the Carboniferous Limestone Formation of the North of England, with Special Reference to its Coal Resources	108 0 0	
„ supplementary volume to An Account of the Strata of Northumberland and Durham, as proved by Borings and Sinkings	288 13 7	
„, expenses of meetings	44 19 4	
	-----	1,445 17 6
By The Institution of Mining Engineers	1,335 14 3	
“ “ “ “ : Guarantee Fund	212 5 10	
	-----	1,548 0 1
Less, amounts paid by authors for excerpts	4 19 4	
	-----	1,543 0 9
		-----
		2,988 18 3
By balance :		
Paid on account of 28 new shares in the Institute and Coal-trade Chambers Company, Limited (first call, leaving to be paid £420)	280 0 0	
Balance in Treasurer's hands	89 7 4	
Less, due to bankers	3 6 0	
	-----	
	86 1 4	
Outstanding accounts due from authors for excerpts	1 0 8	
	-----	
	87 2 0	
	-----	367 2 0

-----  
£3,356 0 3  
-----

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The Treasurer of The North of England Institute of Mining and Mechanical Engineers in  
Account with Subscriptions, 1909-1910.

Dr.

	£	s.	d.	£	s.	d.	£	s.	d.
To 935 members, <u>51</u> of whom have paid life-compositions. 881 <u>3</u> not included in printed list. 887 @ £2 2s.	1,862	14	0						
2 paid life-compositions ---	51	0	0						
	-----			1,913	14	0			
To 103 associate members. <u>9</u> of whom have paid life-compositions 94 @ £2 2s					197	8	0		
To 210 associates, <u>1</u> of whom has paid a life-composition. 209 <u>5</u> paid as members. 204 @ £1 5s									
To 54 students @ £1 5s					67	10	0		
To 34 subscribing firms					119	14	0		
					-----			2,553	6
To 40 new members @ £2 2s					84	0	0		
To 9 new associate members @ £2 2s.					18	18	0		
To 18 new associates @ £1 5s					22	10	0		
To 10 new students @ £1 5s					12	10	0		
To 2 new subscribing firms					4	4	0		
					-----			142	2
To arrears, as per balance-sheet. 1908-1909					273	4	0		
Add, arrears considered irrecoverable, but since paid					39	17	0		
					-----			313	1
								-----	
								3,008	9
To subscriptions paid in advance								53	6
								-----	
								£3,061	15
								0	0

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Cr.

	PAID	UNPAID.	STRUCK OFF LIST.
	£ s. d.	£ s. d.	£ s. d.
By 747 members, paid @ £2 2s.	1,568 14 0		
106 „, unpaid @ £2 2s.		222 12 0	
1 „, excused payment @ £2 2s.			2 2 0
3 „, dead @£2 2s			6 6 0
30 „, struck off list @ £2 2s			63 0 0
887			
2 paid life-compositions	51 0 0		
By 81 associate members, paid @ £2 2s.	170 2 0		
12 „, „, unpaid @,£2 2s		25 4 0	
1 „ „, struck off list @ £2 2s			2 2 0
94			
By 181 associates, paid @ £1 5s.	226 5 0		
19 „, unpaid @ £1 5s.		23 15 0	
4 „, „, struck off list @ £1 5s			5 0 0
204			
By 40 students, paid @ £1 5s.	50 0 0		
13 „, unpaid @ £1 5s		16 5 0	
1 „, struck off list @ £1 5s.			15 0
54			
By 33 subscribing firms, paid	117 12 0		
1 „ „, excused payment		2 2 0	
34			
By 40 new members, paid @ £2 2s.	81 0 0		
By 9 new associate members, paid @ £2 2s.	18 18 0		
By 18 new associates, paid @ £1 5s.	22 10 0		
By 10 new students, paid @ £1 5s.	12 10 0		
By 2 new subscribing firms, paid	4 4 0		
	-----	-----	-----
	2,325 15 0	287 16 0	81 17 0
By arrears	203 10 0		109 11 0
	-----		
	2,529 5 0		
By subscriptions paid in advance	53 6 0		
	-----	-----	-----
	2,582 11 0	287 16 0	191 8 0
			287 16 0
			2,582 11 0
			-----
			£3,061 15 0

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ELECTION OF REPRESENTATIVES ON THE COUNCIL OF THE INSTITUTION OF MINING ENGINEERS, 1910-1911.

Mr. Thomas Douglas moved, and Dr. J. B. Simpson seconded, a resolution that the following gentlemen be elected as the representatives of the Institute on the Council of The Institution of Mining Engineers for the year 1910-1911:—

Mr. R. S. Anderson.	Mr. Tom Hall.	Mr. R. E. Ornsby.
Mr. William Armstrong.	Mr. A. M. Hedley.	Mr. M. W. Parrington.
Mr. W. C. Blackett.	Mr. T. E. Jobling.	Mr. J. J. Prest.
Mr. Frank Coulson.	Mr. J. P. Kirkup.	Mr. F. R. Simpson.
Mr. Benjamin Dodd.	Mr. C. C. Leach.	Mr. John Simpson.
Mr. T. E. Forster.	Prof. Henry Louis.	Mr. J. B. Simpson.
Mr. J. W. Fryar.	Mr. J. H. Merivale.	Mr. C. H. Steavenson.
Mr. Reginald Guthrie.	Mr. W. C. Mountain.	Mr. J. G. Weeks.
	Mr. J. H. Nicholson.	

The resolution was agreed to.

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

Members—

Mr. James Horace Maitland Cragg, Mechanical Engineer, 53, Manor House Road, Newcastle-upon-Tyne.

Mr. Thomas Bowman Dunn, Colliery Proprietor, Redburn House, Bardon Mill, Northumberland.

Mr. William Leonard l'Anson-Robson, Civil Engineer, 1, Eldon Square, Newcastle-upon-Tyne.

Mr. Thomas William Kennaway, Mining Engineer, Killingworth, near Newcastle, New South Wales, Australia.

Mr. William Lawson, Colliery Manager, Seaham No. 2 Colliery, West Wallsend, near Newcastle, New South Wales, Australia.

Mr. Charles Main Moir, Mining Engineer, Royal Colonial Institute, Northumberland Avenue, London, W.C.

Mr. Mark Arthur Wolff, Mining Engineer, 623, Salisbury House, London Wall, London, E.C.

Associate Member—

Mr. Scott Gunn, 21, Mosley Street, Newcastle-upon-Tyne.

Associate—

Mr. Roland Stewart, Mine Surveyor, 17, Normanton Terrace, Newcastle-upon-Tyne.

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#### G. C. GREENWELL MEDALS.

The Chairman (Mr. T. E. Forster) presented G. C. Greenwell silver medals, which had been awarded by the Council, to Sir Henry Hall, I.S.O., for his paper upon "Coal-dust to date, and its Treatment with Calcium Chloride,"\* and to Mr. Robert Nelson for his paper upon "Electricity in Coal-mines."†

#### DISCUSSION OF MR. E. SEYMOUR WOOD'S PAPER ON "THE ELECTRIFICATION OF MURTON COLLIERY, COUNTY DURHAM."‡

Mr. E. Seymour Wood (Murton) presented the following costs of electric haulage at Murton Colliery, which he said compared very favourably with those published in the "Report of the Tail-rope Committee."§ The steam cost at that time worked out at 0.682d. per ton-mile, and the cost of coal—that was, fuel for boiler consumption—at 3s. 6d. per ton.

Dr. J. B. Simpson (Wylam-upon-Tyne) asked whether capital had been taken into consideration, and what items were included in the cost. [

Mr. Wood replied that capital had not been taken into consideration, nor was it taken into consideration in the steam cost. The cost of labour, fuel, and maintenance of the boilers, etc., was included, but not labour on the engine-planes,

Mr. John H. Merivale (Broomhill Colliery) said that particulars of the several items included, such as enginemen's

\*Trans. Inst. M. E., 1908, vol. xxxvi., page 500.

† Ibid., 1909, vol. xxxvii., page 459.

‡ Ibid., 1910, vol. xxxix., page 226

§ Trans. N. E. Inst., 1868, vol. xvii., appendix i.

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wages, consumption of coal, cost per unit for electricity, repairs, etc., would be valuable; the information already given was of very little use unless they knew what was included.

The Chairman (Mr. T. E. Forster) said that the cost of labour must be very much higher now.

Mr. Emerson Bainbridge (London) thought that a comparison with something more modern than the "Report of the Tail-rope Committee" would have been better. He submitted that the only comparison that could be made was not between one series of experiments and another, but by comparing one distance with another; the cost of working a distance of 500 yards would form no comparison with a distance of 3,000 or 4,000 yards; and he hoped that Mr. Wood would be able to compare these electric-haulage costs of 3,000 yards with some steam installation of the same distance. It would be of great value and interest if the "Report of the Tail-rope Committee" could be revised and brought up to date, and comparisons made showing the great improvements that had taken place since 1868.

The Chairman said that he agreed with Mr. Bainbridge's remarks: in actual practice one always had to fall back on that Report.

Mr. Wood said that a comparison of the figures in the "Report of the Tail-rope Committee" with those obtained within the last 12 months could be given. He would certainly give the members all the information that he possibly could on the subject.

DISCUSSION OF MESSRS. W. N. ATKINSON AND FRED. A. GRAY'S "REPORT TO THE RIGHT HONOURABLE THE SECRETARY OF STATE FOR THE HOME DEPARTMENT ON THE CIRCUMSTANCES ATTENDING AN EXPLOSION OF COAL-DUST WHICH OCCURRED AT DARRAN COLLIERY, IN THE CARDIFF INSPECTION DISTRICT, ON THE 29th OCTOBER, 1909."\*

Mr. Joseph Dickinson (Pendleton) wrote that whatever remarks criticism might suggest on the heading of the Report

\* 1910 [Cd. 5,112].

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definitely attributing the explosion to coal-dust, the time had gone by for doubt that a train of dry coal-dust properly laid and surrounded with a suitable atmosphere would convey flame forward notably when started by an explosive in a confined place. It had also been sufficiently proved that the flame would skip over breaks in the train of coal-dust, varying in length in accordance with the varying circumstances. The cause of the ignition happily did not admit of any doubt. It resulted from the firing of an explosive upon the surface of a triangular stone (which had fallen from the roof in the main intake airway) for the purpose of breaking it up for removal. The spread of the flame was, however, open for discussion, coal-dust having been assigned in the absence of other apparent means.

It was pointed out in the Report that the firing of the explosive was a direct breach of the regulations: it was uncovered and not in a drilled shot-hole, the place was unwatered, and, being in the intake air, it was fired without consent.

No fire-damp had been detected in the workings, either before or after the explosion, although there was black-damp in the old workings. Most parts of the roadways were either wet or damp, the other parts being, however, dry and dusty. The flame was traced from the point of explosion to the downcast shaft, about 500 yards against the air, and about 250 yards down the brow with the air-current—the flame on its way down the brow passing over a large issue of water from the floor. There was probably no great amount of fine upper coal-dust on any part of the road, and little timber on which dust could lie; comparatively, no part was excessively dusty, nor was the dust fine or dry. Something apparently helped to spread the flame, and, in the absence of anything else appearing, coal-dust was adjudged to be the cause.

Coal-dust had for three-quarters of a century been recognized as helping fire-damp in explosions; but something more was now being attributed to it. Was it entitled to be so classed, or was there something additional not sufficiently known or tested? The main thing to be considered was, he thought, the present greatly increased volume and compression of air in collieries.

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Dr. J. B. Simpson moved, and Mr. Thomas Douglas seconded, a vote of thanks to the Scrutineers for their services, and the resolution was carried unanimously.

Mr. E. Seymour Wood proposed, and Mr. William Latimer seconded, a vote of thanks to the President, Vice-Presidents, Councillors, and Officers for their services during the past year, and this resolution was cordially adopted.

Mr. Thomas Douglas proposed, and Mr. John Cummings seconded, a vote of thanks to the representatives of the Institute on the Council of The Institution of Mining Engineers for their services during the past year, and the resolution was carried unanimously.

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THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

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EXCURSION MEETING,

HELD AT BLACKHALL AND HORDEN COLLIERIES, SEPTEMBER 23RD, 1910.

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BLACKHALL COLLIERY.

Shafts.---There are two shafts, each 22 feet in finished diameter, and a staple pit.

[Diagram: Plan Showing Delivery Drifts, etc., at Blackhall Colliery.

The north shaft, which was commenced on January 25th, 1910, has reached a depth of 280 feet, the first 60 feet being boulder-clay, and the remainder strong broken limestone. The shaft is lined for a depth of 160 feet with 18-inch concrete walling, and for a further depth of 93 feet with cast-iron tubbing. The delivery drift is at a depth of 147 feet, being 15 feet above water-level.

The south shaft, which was commenced on October 31st, 1909, reached a depth of 258 feet. The strata, shaft-linings, and levels are identical with those in the north shaft, with the exception that the cast-iron tubbing only reaches a depth of 230 feet. In this shaft heavy feeders of water were encountered at a depth of 250 feet.

The staple pit, which is 9 feet in diameter and 180 feet deep, is used for drawing material deposited in the delivery drifts and

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catch-pit, as shown in the sketch, and for supplying water to a three-throw electric pump, which delivers to the works and village.

Boilers.—Steam is supplied from six Lancashire boilers, 32 feet long and 9 ¼ feet in diameter, working at a pressure of 170 pounds per square inch, each boiler being fitted with

a superheater. The water-softener, which is capable of treating 10,000 gallons of water per hour, is supplied with steam from an exhaust main, which obtains its supply from the south pit pumping-engines and the boiler feed-pumps.

Sinking-plant.—This consists at each pit of a sinking engine, two ground crab-engines, each with a pair of drums, a 30-ton main crab-engine, and a light jack engine. A Schiele fan supplies both shafts with air.

Pumping-plant.—There are four sets of 30 ½ -inch bucket-lifting pumps in each shaft, hung in pairs on the ground crab-engines, so as to balance each other. The dry spears, of 14-inch square pitch-pine, are carried down the shafts for a distance of 117 feet, at which point they are clamped with an oak spear to the wet spears, which are also of pitch-pine, 12 inches square. The ground spears, which carry the pumps, are again of pitch-pine, 11 by 8 inches, and are hung from the ground crabs with 1 5/8-inch flattened-strand non-twisting ropes. All the spears are in lengths of 36 feet. The pumps deliver into the drifts (as shown in the sketch), the shaft entrances of which are 24 feet in height and 12 feet in width, and this allows of their being lowered 18 feet before it becomes necessary to add a length to the rising-main. At present, with the sinkers at work, 13,625 gallons of water per minute are being pumped from the two pits.

Pumping-engines.—Each pair of pumps is worked by a tandem compound engine, with cylinders 21 inches and 36 inches in diameter respectively by 5 feet stroke, and a fly-wheel weighing 14 tons. The engine is provided with helical gearing, having a ratio of 3 to 1; and driving-discs on the second motion shaft, with three crank-pin holes, enable the stroke of the buckets to be altered to 4, 5, or 6 feet, when necessary.

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Concrete-mixing Plant.—This plant consists of two crushers and a half-yard Ransome mixer, driven by a vertical engine, together with a haulage-engine for drawing material up from the beach.

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#### HORDEN COLLIERY.

Descriptions of Horden Colliery having already appeared in the Transactions\* the present description is confined practically to the surface arrangements.

Shafts.—The North Pit, which draws from the Hutton Seam, and the South Pit, which draws from the Low Main and Main Coal Seams, are both fitted with wire-rope guides; the East Pit, which, in case of need, draws from any of the before-mentioned seams, being fitted with wooden guides.

Boilers.—Steam is supplied from nine Lancashire boilers, 30 feet long and 8 feet in diameter, working at a pressure of 150 pounds per square inch, eight of which are fitted with Galloway superheaters. A water-softener and heater, capable of treating 6,000 gallons of water per hour, supplies feed-water at about 190° Fahr.

Ventilation.—The fan, 22 feet in diameter, is rope driven by a cross-compound Corliss engine, which has a high-pressure cylinder, 21 inches in diameter by 3 ½ feet stroke, taking steam at a pressure of 140 pounds per square inch, and a low-pressure cylinder, 37 ½ inches in diameter by 3 ½ feet stroke, the engine running at 60 revolutions per minute. The fan, when running at 150 revolutions per minute, produces 300,000 cubic feet of air per minute at a water-gauge of 6 inches.

Winding-engines.—At each of the three pits there is a pair of semi-Corliss high-pressure winding-engines, fitted with Whitmore overspeed and overwinding automatic brake-gear, and with automatic cut-off gear. The North and South Pit engines have cylinders 36 inches in diameter by 6 feet stroke, and take steam at a pressure of 140 Pounds per square inch. The winding drums are 18 feet in diameter and 11 ½ feet in width, the

\* Trans. Inst. M. E., 1904, vol. xxviii., page 149; and 1906, vol. xxxii., page 4.

[22]

patent flattened-strand winding-ropes being 6 inches in circumference. The weight of the winding-rope, cage, chains, tubs (full), etc., is in each case 18 tons 15 hundredweights, the balance-rope weighing 4 tons 10 hundredweights. The depth of wind is, at the North Pit, 1,200 feet, and at the South Pit, 1,080 feet, the time of wind being 33 seconds in both cases, and the maximum and mean horsepower developed 2,100 and 1,260 respectively. The East Pit engine has cylinders 30 inches in diameter by 6 feet stroke, and takes steam at a pressure of 140 pounds per square inch. The winding drum is 16 feet in diameter and 8 ½ feet in width, the Lang's lay plough-steel winding-rope being 6 inches in circumference. The weight of the winding-rope, cage, chains, tubs (full), etc., is 18 tons 15 hundredweights, and there is no balance-rope. The depth of the wind is 1,200 feet, and the maximum and mean horsepower developed is 2,260 and 1,800 respectively.

Power-house.—(a) Air-compressing Plant.—Nos. 1 and 2 compressors are of the Ingersoll-Rand horizontal compound two-stage intercooling type, and have high- and low-pressure steam-cylinders, 21 and 32 inches in diameter respectively, and high- and low-pressure air-cylinders, 20 ¼ and 32 ¼ inches in diameter respectively, with a stroke common to both of 24 inches. Each compressor is capable of producing, when running at 100 revolutions per minute, 2,180 cubic feet of free air per minute, at a steam-pressure of 140 pounds and an air-pressure of 80 pounds per square inch, the horsepower being 331. No. 3 compressor, which is of the Sentinel vertical compound high-speed self-lubricating two-stage intercooling type, has high- and low-pressure steam-cylinders, 25 and 37 inches in diameter respectively, and high- and low-pressure air-cylinders, 22 3/8 and 37 inches in diameter respectively, with a stroke common to both of 16 inches. When running at 182 revolutions per minute, it is capable of producing 3,300 cubic feet of free air per minute, at a steam-pressure of 140 pounds and an air-pressure of 80 pounds per square inch, the horsepower being 580.

(b) Electrical Plant.—For power purposes, the Nos. 1 and 2 direct-coupled generators, each of 365 horsepower, supply continuous current of 450 amperes at 550 volts. They are driven by vertical compound self-acting lubricating high-speed engines,

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Having high- and low-pressure cylinders 15 and 26 inches in diameter respectively, with a 12-inch stroke, taking steam at a pressure of 140 pounds per square inch, and running at 340 revolutions per minute. For lighting purposes, the Nos. 3 and 4 direct-coupled generators, each of 220 horsepower, supply continuous current of 763 amperes at 220 volts. They are driven by vertical triple-expansion self-lubricating high-speed engines, having high, intermediate-, and low-pressure cylinders, 9, 14 ½, and 23 ½ inches in diameter respectively, with a 10-inch stroke, and take steam at a pressure of 140 pounds per square inch, and run at 380 revolutions per minute.

Hydraulic Decking-gear.—At the North and South Pits, the top deck of each cage is unloaded and loaded by hydraulic rams, power being derived from two steam-driven duplex pumps, which are controlled by the hydraulic accumulator. The hydraulic pressure is 650 pounds per square inch.

Screening.—All the tipplers, six in number, are automatic. There are seven picking-belts, and three conveying-belts for small and nut coal, all being electrically driven.

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The thanks of those present was unanimously accorded to The Horden Collieries, Limited, and to Mr. J. J. Prest.

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THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

-----

GENERAL MEETING,

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

October 8th, 1910.

-----

Mr. C. C. LEACH, Vice-President, in the Chair.

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The Secretary read the minutes of the last General Meeting, and reported the proceedings of the Council at their meetings on September 24th and that day.

The Secretary presented the Report of Profs. P. Phillips Bedson and Henry Louis, the Delegates of the Institute at the International Congress of Mining, Metallurgy, Applied Mechanics, and Practical Geology, held at Dusseldorf in June, 1910, which was taken as read.

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

Members—

Mr. Charles George Padfield Haines, Mining Engineer, 10, Picton Place, Swansea.

Mr. Benjamin Nicholas, General Manager, Levant Mining Company, Levant Mine, Pendeen, Cornwall.

Mr. John Alexander Peterkin, Mining Engineer and Surveyor, 66, Cawdor Road, Fallowfield, Manchester.

Mr. Melville John Hastings Pockson, Electrical Engineer, Kenilworth, East Avenue, Benton, Newcastle-upon-Tyne.

Mr. Robert Patrick Sloan, Engineer, Craiglea, Graham Park Road, Gosforth, Newcastle-upon-Tyne.

Mr. Gedeon A. Voskule, Consulting Geologist and Mining Engineer, P.O. Box 1242, Johannesburg, Transvaal.

Mr. Richard James Weeks, Mining Engineer, Bedlington, Northumberland.

Associate Member—

Mr. George Blagdon, Framwellgate Leather Works, Durham.

Associate—

Mr. Ernest Chicken, Assistant Overman, 21, Pilgrim Street, Murton, County Durham.

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Students —

Mr Jasper Geoffrey Browell, Mining Student, East Boldon House, East Boldon, County Durham.

Mr Vernon Merivale, Mining Student, Togston Hall, Acklington, Northumberland.

#### DISCUSSION OF PROF. HENRY LOUIS' PAPER ON "A LOCKING HOOK FOR SINKING PURPOSES."\*

Mr. T. Campbell Futers (Monkseaton) wrote that his attention had been again drawn to this subject by an article in one of the technical journals,† wherein some thirty different designs of hooks in use in the various mining districts of Prussia were described.

[Diagrams: Fig. 1. -Front View. Fig. 2.-Side View.]

In all these hooks, as also in that described by Prof. Louis, the opening was closed by a tongue or other device, to prevent any possibility of the kibble accidentally slipping out. He (Mr. Futers) now ventured to submit a design (Figs. 1 and 2) in which no tongue was necessary, and which was simply an adaptation

\* Trans. Inst. M. E., 1907, vol. xxxiv., page 56.

† "Kibble Hooks," Colliery Guardian, 1910, vol. c, page 410.

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of the well-known Gedge hook, so much used on railway-wagon couplings. It consisted of a plain hook, with an opening smaller than the diameter of the kibble shackle or bow, which was provided with a flattened part near one extremity to allow the hook to pass over it.

In his (Mr. Futers') opinion it was difficult to imagine how such a hook once placed in position could by any means become accidentally dislodged, and it had the advantage that it was easily and quickly slipped on and off. There was no tongue to fix by a hoop or other locking arrangement, and there was nothing to get out of order.

Prof. Henry Louis (Armstrong College, Newcastle-upon-Tyne) said that the form of hook described was, he thought, well known, and that there were plenty in use for coupling up haulage-ropes; in fact, he had one at Armstrong College.

The Chairman (Mr. C. C. Leach) said that he thought the old spring hook quite good enough and safe enough: he had never known a kibble to become detached. If the spring were kept next to the breast, it could not possibly get loose.

Prof. Louis remarked that that would not, of course, apply in the case of a loaded kibble—the man was at the bottom of the shaft.

Mr. Futers wrote, in reply to Prof. Louis' remarks, that it was not suggested that the appliance was something entirely new, but he (Mr. Futers) was unaware that this type of hook had ever been used for the purpose for which it was now suggested it should be employed.

In reply to Mr. Leach's statement, that he had never known a kibble to become detached, this did not alter the fact that kibbles had become detached, and with fatal results; consequently, any suggestion which rendered it practically impossible for such an accident to occur was certainly worth at least consideration. With regard to his remark respecting the spring, he (Mr. Futers) would point out that if the spring and the loose tongue could be done away with, surely that would simplify the construction of the hook, and would be in its favour.

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THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

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GENERAL MEETING,

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

December 10th, 1910.

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Mr. M. W. PARRINGTON, President, in the Chair.

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The Secretary read the minutes of the last General Meeting, and reported the proceedings of the Council at their meetings on November 26th and that day, and of the Council of The Institution of Mining Engineers on September 14th.

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

Members—

Mr. Frederick Edson Birkinshaw, Mining Engineer, Marbella, Province of Malaga, Spain.

Mr. Arthur Bertram Climas, Mining Engineer, Botallack, St. Just, Cornwall.

Mr. Cecil Ralph Darlington, Mining Engineer, c/o Messrs. Tata, Sons, & Company, Nausari Buildings, Fort, Bombay, India.

Mr. Francis Edmond, Mining Engineer, Clock Face Colliery, near St. Helens.

Mr. John Thomas Manderson, Colliery Manager, Siddick Villa, Workington.

Mr. Alexander Gilchrist Marshall, Inspector of Mines, Westport, New Zealand.

Mr. John Thomas Middleton, Civil and Mechanical Engineer, 28, Victoria Street, Westminster, London, S.W.

Mr. Robert Reginald Thompson, Mining Engineer, Portland House, Jesmond Road, Newcastle-upon-Tyne.

Associates—

Mr. Thomas Walter Adam, Mine Surveyor, Messrs. Andrew Knowles & Sons, Limited, Pendlebury, Manchester.

Mr. Edward Taylor Cheesman, Jun., Back-overman, Clara Vale Colliery, Ryton, County Durham.

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Mr. Guy Clephan, Under-manager, Killingworth Hall, near Newcastle-upon-Tyne.

Mr. Charles Young, Deputy-overman, Laburnum House, Rowlands Gill, Newcastle-upon-Tyne.

Students—

Mr. James Wilson Daghish, Mining Student, Blaydon Burn Colliery, Blaydon-upon-Tyne, County Durham.

Mr. Ralph Victor Hare, Mining Student, Howlish Hall, Bishop Auckland.

Mr. Richard John Oliver, Mining Student, 9, Fleet Street, Torquay.

The Secretary read the following; paper, by Mr. Ralph D. Cochrane, on "A New Method of Testing for Gas in Mines with Safety-lamps ": —

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#### A NEW METHOD OF TESTING FOR GAS IN MINES WITH SAFETY-LAMPS.

-----  
By RALPH D. COCHRANE.  
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Although the writer is somewhat diffident in submitting his idea to a body of practical mining engineers, he is, nevertheless, sure that no excuse is needed for bringing forward a new method of testing for gas with a safety-lamp.

The detection, the presence, and the estimation of the percentage of gas in mines is a matter of national interest and importance. It is needless to give a history of what has been done to solve the problem, as mining engineers are fully cognizant of such of the facts as have any bearing on modern mining practice.

The writer's device embodies certain features which there is good reason to believe are absolutely novel. It provides a simple, accurate, scientific, and quick means of ascertaining the presence of gas, even in cases of less than 1 per cent., without any of the ordinary risks and disadvantages associated with a safety-lamp when used for that purpose.

The lamp (Fig. 13) is of the ordinary bonneted Marsaut type, with the important addition of a diaphragm, with a central opening, rigidly suspended over the wick-tube by depending rods. These are screw-threaded at their free ends, and, as each is furnished with two nuts, they afford a simple means whereby the position of the diaphragm may be adjusted relatively to the wick-tube.

The disc can, of course, be supported from below, and means may in either case be provided for its adjustment from outside lamp; but the writer finds that such a refinement is unnecessary, and that it is best to ascertain definitely the proper position for the diaphragm, and to fix it there.

There should, no doubt, be some definite relation between the size of the opening in the diaphragm, the size of the wick-tube, and the height at which the diaphragm is fixed above it.

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The diaphragm, being rigidly held in the best position, not only provides for uniformity in the height of the flame for ordinary lighting purposes, but also forms a permanent datum from which the spires can be measured, and to facilitate observation a vertical scale is attached.

As the diaphragm is fitted at such a distance above the wick as to afford the maximum of light, the user is not tempted to endeavour to obtain a larger flame, as any attempt in that direction would defeat its own object.

In use, the lamp should be trimmed so that the top of the flame reaches the level of the diaphragm, and it should be kept in that position.

It will be observed that no special trimming of the lamp is needed other than that necessary for the exercise of its proper functions as a source of light, and consequently there is no risk of the lamp going out, a contingency which is a ground for constant anxiety when the flame has to be reduced to a minimum when a test is being made.

[Photograph: Fig. 13.—Bonneted Marsaut Safety-lamp fitted with Diaphragm and Gas-indicator.]

Lamps so fitted thus combine the triple functions of an ordinary miner's lamp, a testing-lamp, and a means for lighting the user from place to place, without any special adjustment being necessary. There is also no fear of being left in darkness,

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and therefore no necessity to carry a second lamp, as has been suggested by some who are fully aware of what may at any moment happen during the usual process of testing.

The attachment in no way interferes with the ordinary lighting properties of the lamp; it affords means for ensuring a standard height of flame under all normal conditions, and provides a sensitive indicator of any departure from those normal conditions.

Tests made with the lamp by Prof. G. R. Thompson, of Leeds University, are noted below.

The flame was trimmed to the height of the diaphragm after the lamp had been burning for some time, and was carefully observed to see that it steadily maintained its size. The lamp was then drawn up into a testing-chamber, into the top of which a known mixture of inflammable gas and air was sent—the stream of gas being constant during any test. The gas-supply had been previously calibrated, so that the indications given on a lamp were equivalent to those of known percentages of fire-damp in air. After the test, the lamp was lowered into pure air again, and the light observed to see that it became the proper size. The tests were made with two diaphragms and with three different illuminants. A statement of the details of these tests is presented as follows: —

Diaphragm No. 1.—Opening, oblong in shape,  $17/32$  by  $1/4$  inch; height above top of wick-tube,  $7/16$  inch; illuminant, ordinary paraffin oil. With the equivalent of 1 per cent. of fire-damp in the chamber, the flame spired up to a lurid yellow cone, feebly luminous at the tip, which reached to  $5/8$  inch above the top of the diaphragm; with 2 per cent., the spire increased in height to  $3/4$  inch above the diaphragm; and with 3 per cent., the spire increased to slightly over 1 inch (Figs. 1 to 4, Plate V.).

Diaphragm No. 2.— Opening, oblong in shape,  $9/16$  by  $9/32$  inch; height above top of wick-tube,  $7/16$  inch; illuminant, ordinary paraffin oil. With 1 per cent. of gas, the flame increased in height and reached to about  $3/16$  inch above the diaphragm (the tip was, however, bright and the flame did not spire); with 2 per cent., the flame reached  $1/4$  inch above the diaphragm, being still bright at the tip, but at times tending to spire and becoming

Then lurid yellow at the tip; and with 3 per cent., the flame spired

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up into a lurid yellow cone, rising-  $3/4$  inch above the diaphragm (Figs. 5 to 8, Plate V.).

Diaphragm No. 1.—Height, as before; illuminant, lamp oil, evidently a paraffin oil of high flash-point. With 1 per cent. of gas, the flame spired up to  $5/8$  inch above the diaphragm ; with 2 per cent., the flame spired up to  $3/4$  inch: and with 3 per cent., the flame spired up to slightly over 1 inch. It will be noticed that the indications with this oil were the same as those given by ordinary paraffin with the same diaphragm.

Diaphragm No. 2.—Height, as before : illuminant, colza oil. With 1 per cent. of gas, the flame increased in height, reaching to about  $1/16$  inch above the diaphragm (the flame was clear and bright, and did not spire); with 2 per cent., the flame increased in height, reaching from  $1/8$  to  $3/16$  inch above the diaphragm, heaving slightly, but being bright and not spiring; and with 3 per cent., the flame increased in height to about  $1/4$  inch above the diaphragm, sometimes heaving up to  $3/16$  inch above, and showing then a slight tendency to spire (Figs. 9 to 12, Plate V.).

It will be noticed that the indications with colza oil differed from those given with paraffin oil. The colza oil, being less volatile, required the wick to be pushed higher above the wick-tube, and thus the flame when adjusted to the height of the diaphragm was smaller than that produced from the more volatile oil.

The writer feels that he is submitting a distinctly new departure from all previous practice, and is introducing an absolutely novel principle into the methods of testing for the presence of gas in mines, a principle which permits of much more being done than has heretofore been possible.

For the photographs of Figs. 1 to 12 (Plate V.) the writer is indebted to Mr. W. M. Tweedie, of Rotherham.

[Plate V., Photographs of the lamp flames.]

Mr. John H. Merivale (Acklington) said that Mr. Cochrane had lent him a lamp with which to experiment in the mine, but unfortunately during the time that he had it, which was several weeks, he was unable to find any gas; in fact, the mine with which he was connected made very little. He should like to ask Mr. Cochrane whether he had had the lamp tested below ground

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by practical men—deputies, for example—and whether it was found as efficient in practice as it appeared to be in theory. Mr. Cochrane spoke of inflammable gas, but he did not state what the gas was, whether ordinary illuminating-gas or methane; nor did he mention what gas was used in the experiments carried out by Prof. G. R. Thompson. He (Mr. Merivale) understood that the lamp had also been subjected to experiment in a similar manner in the North of England, and perhaps Mr. Cochrane could give the members some particulars of the results. He thought that they would all agree that, if Mr. Cochrane could succeed in producing a simple arrangement which would give indications down to 1 per cent. of gas, he would have solved a very important problem.

Prof. Henry Louis (Armstrong College, Newcastle-upon-Tyne) said that, like the last speaker, he had had one of the lamps lent him by the kindness of Mr. Cochrane; but, not having a colliery at his disposal, he had used a gas-tap, and with that he was able to get a sufficient supply of combustible gas for experimental purposes. He thought that Mr. Cochrane was in error in saying that the principle was in any way novel. That a lamp-flame spired up in a mixture of gas and air had been known for many years, and many attempts had been made to utilize the fact for detecting gas in mines. Mr. J. G. Patterson had submitted a lamp to him in January, 1909, in which exactly the same principle was employed—namely, both lamps, as gas-detectors, depended on the elongation of the flame in a mixture of gas and air. The only difference was that Mr. Patterson's lamp had a little camera lucida, by which the length of the increase could be measured outside the lamp, while the measuring scale in Mr. Cochrane's lamp was inside. It was perfectly well known that when a flame was introduced into a mixture of gas and air, two different phenomena occurred: (1) a cap due to the combustible portion of the atmosphere above the flame was produced, and (2) an elongation of the flame was obtained. A cap, on account of its feeble illuminating power, could only be seen, as everyone knew, when the light in the lamp was very feeble; the spiring of the flame, on the other hand, was only seen when there was a full-sized flame, when the increase of length was distinctly measurable; and

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that constituted the difference between these two principles of detection of fire-damp. When Mr. Patterson's lamp was submitted to him, he objected to it, and the objections which he had then made held equally good with respect to Mr. Cochrane's lamp. The elongation of the flame was not produced only by the presence of combustible gas—it could be got by a draught, by the presence of carbonic acid, and possibly by a deficiency of oxygen; by a number of different causes elongation could be obtained even when no gas was present, and, on the other hand, might be more or less masked by other causes. His main objection to the principle upon which the lamp was constructed was owing to that fact that it indicated gas when none was present. Furthermore, another objection lay in its practical application in the pit. The only way in which the lamp could be used in testing for gas was by setting the flame to a definite standard height in pure air, and then ascertaining whether the flame elongated. When testing at the coal-face, a supply of pure air was not available in order to obtain a datum-line, and therefore, in practice, the lamp was unreliable. Mr. Cochrane had worked the principle out in a neat and handy way, and, so far as that went, his lamp was probably an improvement on Mr. Patterson's; but as, in his opinion, the principle was faulty, he did not think that there was much need to dwell upon the manner in which the details were worked, out.

Mr. W. C. Blackett (Sacrison) said that he was very sorry that he had to take practically the same line as Prof. Louis, because he never liked to say anything which would discourage efforts of the kind. Mr. Cochrane's attempt to make use of this particular principle was an excellent one, and Mr. Cochrane had been good enough also to allow him to test the lamp. He regretted that he could not give him a kinder word, but the truth was that the principle was a great deal older than anyone present, because it was the only way in which their predecessors were able to look for gas before the invention of the safety-lamp. In the old mining days, when men took their lives in their hands, they were apt to be a great deal more careful than they were to-day, when they were so much better looked after. The fact was that in those days they had to take a candle to look for the fire-damp which might destroy them, and in so doing they

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had to be very particular indeed not to get their candle too far into the gas mixture. They were able to detect this spiring as they approached gas in exactly the same way in those days as Mr. Cochrane did with his lamp, so that as a matter of fact the principle could hardly be called a novel one. He (Mr. Blackett) had taken the lamp so recently as the previous day into the pit, and he had experienced the same difficulty as Mr. Merivale in discovering any gas. However, he had with him a Clowes lamp, and he was thus able to ascertain for certain whether gas was present or not. He had set Mr. Cochrane's lamp in the ordinary cooler air of the intakes, and it burned for quite 20 minutes or more before he attempted to make any test with it, his object being to get the lamp to its normal heat and normal working conditions. He had then taken it into a working-place, where the temperature was much warmer than in the intake—there was probably quite 20 degrees difference between the two—and when testing with the Clowes lamp had got only  $\frac{1}{4}$  per cent. When, however, he had put Mr. Cochrane's lamp into the mixture, he found that the flame spired up as if there was quite 1 per cent. of gas present. Fortunately, he knew that that was wrong, and that the lamp was misleading him. The truth was that the extra heat of the place had induced more volatile matter to come off from the lamp, and it was spiring from that cause alone. A jerk might lower the flame, so that he was very careful in handling the lamp, and when he got into the cooler air he let the lamp stand for some time, but found that it was still spiring, even in the fresher air. It was

quite obvious that anyone going round would be misled by such a lamp, because they must always standardize it in the fresh air before taking it in for testing purposes, and it was at once obvious to anyone that that was impossible in going round a pit. If the lamp had been a perfect success, it would have been perhaps better if the diaphragms used could have been made of more translucent material, as the present diaphragms had the effect of casting shadows "up over" when it was being carried.

Mr. Simon Tate (Trimdon Grange) said that he had also tried one of the lamps, with results somewhat similar to those obtained by Mr. Blackett. He would, however, look at the matter in this way: at present they had no means—at least,

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the ordinary workmen had no means—of ascertaining the presence of small proportions of gas without putting down the wick of the lamp, and the danger of putting it down probably prevented many a man from finding such small quantities of gas as he could with Mr. Cochrane's lamp. Although the lamp might not be scientifically correct in some points, yet he thought that it would err on the safe side by indicating small quantities of gas, and would be especially useful to shot-firers for showing whether it would be safe to fire a shot. In that respect it possessed an advantage, and he would like again to point out that with an ordinary safety-lamp, in testing for gas, the person examining had to so reduce the flame that there was a danger of the light being extinguished. The consequence was that examiners were inclined to neglect lowering the flame sufficiently, and were therefore unable to distinguish the small proportions of gas that could be detected with Mr. Cochrane's device.

Mr. W. C. Blackett said that he did not think that Mr. Tate was correct in that respect. If a stoneman or anyone else had Mr. Cochrane's lamp in the pit and it began to spire, he would not know whether it was spiring because the wick was too high or because he was in the presence of gas. He would probably come to the conclusion that the wick was too high, and so would pull it down and get back to the standard flame; and, as a matter of fact, with that particular lamp a man might lower his wick while he was in increasing quantities of gas, and at last, without knowing it, he might be in even over 2 per cent. A man would not be able to tell the difference between a spire in such an atmosphere and the one that he would get by having the wick too high. He (Mr. Blackett) did not think that it was so difficult for a man to use the ordinary safety-lamp in looking for gas. He need not lower the wick quite so far, if he was not content to see it as he had always been content to see it, because he had now a contrivance in the Cadman and Cunynghame plan of putting a little sodium in the flame above the wick, so that even when the wick was not lowered it would show a cap which the eye could not ordinarily perceive because of the luminous flame. He could not see how that difficulty could be got over with Mr. Cochrane's lamp.

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Mr Simon Tate replied that he would like to point out to Mr. Blackett that, before testing for gas prior to firing a shot, the flame of the lamp could be "set " where there was a current of fresh air, and if, afterwards, when the lamp was taken into a place where a shot was to be fired, the flame of the lamp indicated the presence of an unusual and dangerous quantity of gas, clearly the person in charge would have sufficient information to prevent him from firing a shot.

Mr. R. D. Cochrane (Hetton Colliery), in reply, said that he was very pleased to have had the opportunity of bringing his lamp before the notice of the members. He had it in his mind that a lamp with that simple attachment might be of use, not only for testing by colliery officials, but to the ordinary miner, who would have the satisfaction of knowing whether at any time he was working in a mixture of gas or not, which he (Mr. Cochrane) thought was a very desirable thing. He referred to hewers especially. It was quite evident that under the present system of drawing down the wick, it was utterly impossible for the ordinary man to know whether or not he was in the presence of gas, and he held that his contrivance would show 1 per cent. of gas very clearly—a result not obtainable by any other lamp known to him at the present time; with regard to 2 and 3 per cent. the evidence was most unmistakable.

The President (Mr. M. W. Parrington) said that the thanks of the members of the Institute, and the members of the profession generally, were due to Mr. Cochrane for the trouble that he had taken in bringing his lamp before them. It was certainly always helping in the direction of safety in mines. He would like to say one thing which was not prejudicial to Mr. Cochrane's invention, but more as a correction, and that was that in a seam that gave off gas at all there must be always gas in the working-places—it might be  $\frac{1}{4}$  per cent., or it might be less—but there must always be gas, and it was only a question of degree, so that Mr. Cochrane's remarks as to men being in the presence of gas or not would not apply—at any rate, in a gassy mine. He would like Mr. Cochrane to say whether it was absolutely necessary for the oil to be a mineral oil, because Mr. Blackett remarked on the alteration of the flame between the absolutely fresh air and the air of the working-place, and this

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seemed to him to be due to the light oil used, while possibly with an ordinary colza or a mixture of colza and mineral oil, which was the commonest oil now used, that would not have occurred.

Mr. Cochrane replied that it was not necessary to use pure paraffin; the indications as shown on the plate were from the use of colza as well as paraffin.

A unanimous vote of thanks was accorded to the writer of the paper.

The Secretary read the following paper, by Mr. George J. Ralph, on "The Holmes-Alderson Automatic Fire-damp Cutout":—

[39]

#### THE HOLMES-ALDERSON AUTOMATIC FIRE-DAMP CUT-OUT.

-----  
By GEORGE J. RALPH.  
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In view of the large and ever-increasing use of electricity for power purposes in mines, it is important that advantage should be taken of all satisfactory safety-appliances which human ingenuity can devise, to minimize danger from shock, fire, and explosion.

The following is a short description of an automatic cut-out, brought into action by the presence of fire-damp, for use on electric circuits in mines. The use of such an apparatus will

render the employment of electric motors safe in situations where gas is liable to accumulate, without its being necessary to totally enclose them in a flame-and-explosion-proof manner. Such enclosure involves the use of very much larger, heavier, and more expensive motors for a given horsepower than would otherwise be the case; in fact, the output of a motor is reduced to about one-half when totally enclosed. Again, totally-enclosed motors frequently suffer heavily in depreciation and breakdown, due to neglect of proper cleaning and adjustment, owing to the vital parts being difficult of access. Moreover, there is always the risk of a careless attendant neglecting to replace the covers or to secure them properly after examination and cleaning, which might lead to disastrous consequences.

The Holmes-Alderson automatic fire-damp cut-out has been designed to detect the presence of fire-damp, and, in conjunction with suitable relay cut-outs, to interrupt the supply of electrical energy to motors or other apparatus in the neighbourhood as soon as, or before, fire-damp is present in sufficient quantity to render the use of such energy a source of danger. It is, at the same time, adapted to give warning of the fact by a visible or audible signal. It is sufficiently sensitive to operate in a 2-per cent. mixture of gas and air, but, of course, may be set for any larger percentage as desired. It is equally applicable to direct-current

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and alternating-current circuits, and consumes but a very small amount of current—between one-half and three-quarters of an ampere.

Let it be assumed that gas accumulates to such an extent in the neighbourhood of an in-by electrically-driven pump or compressor, that an accidental spark or flash at the motor or its controlling gear might cause a disastrous explosion. If a firedamp cut-out be installed near the motor, the detector will operate before the atmosphere surrounding it reaches an explosive condition, cutting off the current from the circuit, and lighting up a red lamp as a danger-signal.

By employing a main switch, magnetically controlled by a solenoid, it is impossible for the ordinary attendant to restart the motor, since the cut-out is in a locked box and the key in the possession of some responsible person, who must be summoned to unlock the box in order to re-set the cut-out gear, and who would, of course, take steps to have the accumulation of gas removed before allowing current to be switched on again.

The detector is connected to the "live" or supply side of the double-pole switch, so that it is in circuit continuously. This is important, as it might so happen, for instance, that gas accumulated during a week-end, when probably the double-pole motor switch would be "off." The cut-out would, however, act, and thus prevent the motor from being started when work was resumed, until the place had been examined and cleared of gas.

Having briefly stated its applications, a description of the cut-out will now be given. The apparatus is the invention of Mr. Alderson, and depends for its operation on the catalytic action of platinum, or, in other words, on the fact that platinum increases in temperature in the presence of hydrogen or marsh-gas.

The apparatus is contained in two separate cast-iron boxes (Figs. 2 and 3), the detector itself consisting of two strips of metal, A and B (Fig. 1, Plate VI.), each composed of two pieces of dissimilar metals, such as steel and brass, having different coefficients of expansion. Each strip is rigidly fixed at one end, while the free ends overlap each other slightly, but under normal conditions do not make contact with each other. Any heating of

these strips causes bending or curving to take place, on account of one metal expanding more than the other, and

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below the strips are disposed coils of thin wire one coil being of platinum, and the other of some metal which has no catalytic properties. Under ordinary conditions, on passing a current through the coils, which are in series with each other and with a lamp or resistance contained in the cut-out box, the coils heat up, and the heat so developed is transmitted to the compound metal strips above them. Both strips then curve upwards equally, and therefore do not make contact.

[Photograph: Fig. 2.—Holmes-Alderson Automatic Fire-damp Cut-out Switch Box (open and closed).]

Variations of atmospheric temperature, or variations in the supply voltage, affect both coils equally; but should the atmosphere contain a sufficient percentage of fire-damp, the platinum coil will increase in temperature, and thus cause the compound strip, B, above it, to curve to a greater extent than before, sufficiently so to make it come into contact with the other strip, A.

When this happens, a circuit is completed through the small magnetic solenoid switch, C; and the core of this switch, carrying a

[Photograph: Fig. 3.—Holmes-Alderson Automatic Fire-damp Detector Box (open and closed).]

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connecting plate, being lifted, separates two spring contacts, D and E. The separation of these contacts causes the lamp, F, to be connected in series with the lamp, G, and with the heating coils, when the lamp, F, being lighted up brilliantly and coloured red, acts as a danger-signal. The current is so much reduced by this additional lamp being thrown in series with the circuit, that the heating coils cool down and the lamp, G, is very much dimmed.

The cut-out box (Fig. 2) can be placed at any distance from the detector box (Fig. 3), which, being only about 12 inches long by 3 inches wide and 3 inches deep, takes up very little space. It is either locked or sealed with a lead seal, and the surrounding air can enter through openings covered with fine wire-gauze as in a safety-lamp.

The cut-out box should preferably be mounted on the panel containing the motor switch-gear, and contains another magnetic solenoid switch, H, the core of which also carries a plate which connects or disconnects two spring contacts, I and J. These contacts are connected to the motor-starting switch-gear in such a manner that a circuit from one to the other through the connecting plate will cause the current to be cut off from the motor.

In the simpler form, this is effected by connecting the leads from the two spring contacts to the two ends of the "no-voltage" release-coil of the starting-switch. When the springs are connected, this forms a short circuit across the "no-volt" coil, which loses its magnetism and

allows the switch-arm to fly to the "off" position, thus cutting off the supply of current from the motor.

As it is possible, however, for the attendant to switch the current on again, and tie or forcibly fix the handle of the starting-switch so that it will not fly off, it is very strongly recommended that a solenoid-controlled main switch should be employed; and if this be enclosed in a locked-up case, the attendant cannot possibly switch on current again until the cutout magnetic solenoid switch, C, has been re-set by the person having the key of the box.

The actual sequence of operations is as follows :—A lead from the positive main goes to the magnetic solenoid switch, H, thence to the platinum coil in the detector, from there to the lamp, F, and then back to the negative main. The core of the

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magnetic solenoid switch, H, will lift, and will remain lifted so long as there is any supply to the mains, thus connecting the two contact-springs, I and J, and allowing the motor switch-gear to be operated.

Should gas be present in sufficient quantity, the compound strips in the detector will come into contact, and these strips being connected to the circuit through the magnetic solenoid switch, C, the core of this will be lifted and the contact-springs, D and E, separated, so lighting up the red lamp, F, and thereby reducing the current so much in the magnetic solenoid switch, H, that its core will fall and disconnect the contact-springs, I and J.

As the current in the magnetic solenoid switch, H, is reduced, the current is likewise reduced in the platinum coil of the detector, and as this cools the compound strips will separate again.

The main switch cannot operate, however, since its solenoid coil is open by the springs, I and J, being disconnected. The core of the magnetic solenoid switch, C, is so constructed that when it has lifted it will remain in that position until it is released by hand, to do which it is necessary to unlock the cut-out box. .

It will be seen that, owing to the magnetic solenoid switch, H, being in series with the lamp, G, and the detector coils, if the lamp should burn out, or the detector coils break, or any disconnection occur in the cut-out circuit, the core of the magnetic solenoid switch will drop to the safety position, and prevent the motor switch-gear from operating. The apparatus is thus safeguarding the circuit in case it should be accidentally put out of action, and it must be put right before the motor can be operated.

The replacement of the heating coils in the detector is as simple an operation as replacing a lamp in a holder, if this should become necessary at any time.

The lamp, G, is burning at considerably less than its rated voltage, and consequently should last for many thousands of hours. Should it require to be renewed, care must be taken that a lamp of the same voltage and candle-power is inserted, in order that the correct amount of current should flow through the coils to maintain them at the requisite temperature.

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A switch is provided in the detector to short-circuit the heating coil under the compound strip, A, so that the apparatus may be tested periodically to see that everything is in working order.

The closing of this switch will cause the strip, A, to cool, and come into contact with the strip, B, and thus operate the cut-out gear.

A two-pole switch is provided in the cut-out box to render everything "dead" inside it and the detector box, if this becomes necessary at any time for purposes of cleaning, etc.

If required, the apparatus can be supplied in a simpler form, which will merely give at any desired place a visible or audible indication, or both combined, that gas is present.

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Mr. George J. Ralph (Newcastle-upon-Tyne), upon the conclusion of the reading of the paper, experimentally illustrated it with an example of the apparatus.

Mr. J. B. Atkinson (H.M. Inspector of Mines, Newcastle-upon-Tyne) said that he had great pleasure in congratulating the writer of the paper upon the device. The members of the Institute had had the privilege of visiting the works of Messrs. J. H. Holmes & Company about a year previously, and the firm were then working upon the apparatus. It was, however, in a somewhat rudimentary condition, but they had evidently brought it up to a considerable state of perfection, and he thought that it would play a very useful part in the installation of electrical machinery underground. He would like to ask Mr. Ralph where he would place the apparatus underground, as very often electrical machinery was in an archway, with perhaps a small current of air coming in at one end and going through the arch. Probably it would be best to have it in some high position, so that it would be likely to encounter the gas when it first came in. He would also like to ask whether the device could be applied to small electric hand-lamps, in order that it might be possible to have a lamp so fitted up that if one was in the presence of 2 or 3 per cent. of gas, the lamp would give some indication of the gas. He was rather afraid, however, that the amount of current in an electric hand-lamp would be too small for that to be done. Could Mr. Ralph tell them the length of time which elapsed

[Plate VI.: Circuit Diagram of the Holmes Alderson Cut-out.]

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before the apparatus came into action—apparently it was only a few seconds.

Mr. W. C. Mountain (Newcastle-upon-Tyne) thought that the apparatus was very simple and extremely practical; there was very little in it that could possibly go wrong, and it would no doubt be of great value in the application of electricity in mines. He would like to ask whether the construction of the apparatus would allow of its working equally well with alternating current, the apparatus exhibited having been designed for continuous current.

Mr. W. C. Blakett (Sacriston) remarked that there were one or two points upon which he would like to be satisfied. First, he desired to know whether the metals—the one with the catalytic action and the other without that action—would continue indefinitely without change, or whether they would change so as to produce a different effect through lapse of time ; secondly, whether, if placed in the damp or sometimes warm moist atmosphere of a mine, this would not in the long run interfere with the delicate parts, so that while relying on it they would be deceived,-and the appliance would not operate. For instance, it was mentioned in the paper that the differential plates, as they might be called, were made of different metals, such as steel and brass; would not the steel in course of time be destroyed by the action of the atmosphere, and would any of the other moving parts be likely to stick ? Was there any change in the catalytic action of platinum through being used from time to time? Why did

Liveing's apparatus for the detection of gas fail more than once, and, whatever the failing was in that detector, was there any possibility of the same principle that was used in the present case failing also?

Mr. J. H. Merivale (Acklington) asked whether the platinum itself could reach such a temperature as to fire gas.

Mr. Blackett remarked that it was in a safety-box. There was, however, another question: in this particular form of detector box, would it be possible in the air of a mine for the dust to get between the platinum contacts so that when they did come together the current would be prevented from passing?

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Prof. P. Phillips Bedson (Armstrong College, Newcastle-upon-Tyne) said that with regard to platinum, it was well known that it lost its activity in course of time. It was very largely surface-action, and the surface of the metal would become altered, but there was, as explained in the paper, a provision to meet this by testing the apparatus from day to day. With regard to the Liveing detector and other devices in which platinum had been used, they were all liable to lose their power in course of time, and this fact required to be borne in mind.

Prof. Henry Louis (Armstrong College, Newcastle-upon-Tyne) said that, with regard to applying the principle to hand-lamps, he wished to ask Mr. Ralph whether he had any knowledge of a device which was brought out a good many years ago by the Sussmann Electric Lamp Company. That company had made a small accumulator-lamp, and attached to it a device by which a small red lamp was lit up when it was brought into the presence of gas. He remembered quite distinctly that the device in question did work, and he would like to know whether the present idea would not also be applicable to a lamp on a small scale.

Mr. Ralph, in replying, said that the detector need not necessarily be fixed alongside the motor; it could be fixed at any distance away, as this only involved the running of three small wires. It could be fixed up near the roof at either end of such an archway, as Mr. Atkinson had mentioned. The nearer the roof was the better it would be, as gas was more likely to accumulate there.

As regarded a hand-lamp for indicating the presence of gas, Mr. Alderson had, before he left the country, given him (Mr. Ralph) drawings of a small lamp embodying the same principle, but he had come to the conclusion that there was nothing very novel in it, because, as Prof. Louis had told them, such a lamp had already been put on the market by the Sussmann Electric Lamp Company. Whether there were any objections to this lamp he was not prepared to say, as he was not familiar with its details.

Respecting the time which the apparatus would take to come into operation of course the more gas there was present, the more quickly it would act. In the demonstration with 3 per cent. of

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gas that they had witnessed, it had acted in a few seconds; but, as a rule, one would not get a 3-per cent. accumulation all at once; there would be  $\frac{1}{2}$  per cent., increasing to 1,  $1\frac{1}{2}$ , and 2, and all the while the platinum would be increasing in temperature, so that with a given percentage of gas it would act more quickly when the accumulation was gradual.

Mr. Mountain had asked as to alterations necessary for its use on alternating-current circuits. The only alteration necessary to the cut-out was to use laminated cores in the solenoids, and, in place of the main solenoid switch, to use an ordinary hand-operated oil-switch fitted with a no-voltage trip-coil. The cut-out would open the circuit through the trip-coil, and allow the switch to fly off. An interlocking bolt should be fitted on the trip-gear, to prevent the lever of the oil-switch from being operated until current was again restored to the trip-coil.

Mr. Blackett had raised the question of the Liveing gas-detector, and the possible failure of the Holmes-Alderson detector from the same causes. In the Liveing apparatus, although the same principle was used, namely, the catalytic property of platinum, its results were based on a comparison of the luminosity of two platinum wires, one sealed in a tube of pure air and the other open to the atmosphere of the mine. The reason for its failure was that the resistance of the platinum wire exposed to the mine atmosphere increased in course of time. Such increase in resistance would alter the readings very considerably, since the luminosity of platinum increased at an enormously greater rate than the temperature. It was stated, for instance, that platinum at 2,600° Fahr. emitted forty times as much light as at 1,900° Fahr., so that for a matter of about 37 per cent. increase in temperature, there was 4,000 per cent. increase in light.

Consequently, the variation in the temperature of the platinum wire caused by an alteration in its resistance would affect the Liveing indicator very adversely, whereas it would make practically no difference in the apparatus under discussion. In fact, if one calculated it out, assuming that the resistance of the platinum wire increased in time by 20 per cent., it had the effect of making the detector more sensitive to gas, because, owing to the resistance of the heating coils being only a very small percentage of the total resistance of the circuit (the lamp in series offering at least ten times as much resistance), although the current would

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thereby be slightly reduced, the voltage across the heating coils would be increased considerably, and the temperature of the platinum wire would be increased. In practice, however, it might be assumed that the platinum-alloy wire in the non-catalytic heater would also increase in resistance gradually, and thereby maintain the balance of heating effect on the compound springs for a long time.

Mr. Blackett had also mentioned the corrosive effect of the moist warm atmosphere in mines. This had been guarded against as far as possible. For instance, the compound springs in the detector were stove-enamelled, and the thin spring contacts originally fitted in the cut-out had been replaced by carbon plates and contacts, which were not only non-corrosive, but eliminated all risk of fusing or sticking together due to sparking.

With regard to the accumulation of dust on the detector contacts, this point had been considered, and it was believed that with the form of contact now adopted (two knife-edges at right-angles) it was impossible for sufficient dust to lodge to prevent contact being established. One could not reproduce the exact conditions in experimenting, but the detector had been placed in a box, and fine coal-dust sifted over it with a very fine gauze sieve, and the apparatus had never failed to act from this cause.

With further reference to the damp atmosphere, it should be remembered that the heat developed in the detector box by the platinum coils, and in the cut-out box by the glow-lamps, tended to evaporate any moisture, and keep the parts warm and dry.

Mr. Merivale remarked that there might be a case where there was a sudden inrush of gas; had the apparatus been experimented with under those conditions?

Mr. Atkinson spoke of the case of a coal-cutter working at the face.

Mr. Blackett said that any inrush of gas might come to the coal-cutter first.

Mr. Mountain asked, if the apparatus was put into an explosive mixture with the cover on, how long it would take before it would operate.

Mr. Ralph, replying, said that the apparatus was not suitable

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for use on coal-cutters, and, in any case, he considered that the use of open motors on coal-cutters should not be tolerated : they should be totally enclosed for mechanical reasons; and in a very gassy pit, it seemed open to question whether it was policy to use electrically-driven coal-cutters at all. It would seem to be better to use portable electrically-driven compressors, taken up within a reasonable distance of the face, and use compressed air for drills, coal-cutters, etc.

In reply to Mr. Merivale's and Mr. Mountain's questions, tests had been made with the cover on the detector box, both with a gradual accumulation and a sudden inrush of gas. In the case of a gradual accumulation, the detector would operate within 5 seconds of reaching 2 per cent., while with a sudden inrush of 6 per cent., it would operate in from 7 to 10 seconds. The cover of the box was on in both cases.

Prof. Louis said that it must take far longer than the time which a spark required to ignite fire-damp.

Mr. Tate said that the apparatus might be some distance away, possibly a distance on the safe side. Mr. Ralph said that anyone would, he supposed, place it on the side from which danger might be expected. As Prof. Bedson had remarked, all apparatus needed a certain amount of attention, and he thought that the deterioration of the platinum was a point that could only be settled by practical experience. Everything had been arranged with a view to easy replacement, and one could quite readily restore the platinum by bringing it to white heat electrically and thus burn off any deposit that had taken place.

The President (Mr. M. W. Parrington) proposed a vote of thanks to the writer of the paper, which was carried unanimously.

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Mr. Henry Moore Hudspeth's paper upon "Electric Winding, with Special Reference to its Development in Upper Silesia," was taken as read, as follows: —

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ELECTRIC WINDING, WITH SPECIAL REFERENCE TO ITS DEVELOPMENT IN UPPER SILESIA.

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By HENRY MOORE HUDSPETH.

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Introduction.—Electric winding for main shafts is being largely adopted in Upper Silesia, and the Ilgner [ILGNER] system appears to be mostly favoured. Owing to the low price of boiler-

coal, steam is comparatively cheap, and this is, of course, to the disadvantage of electric winding when in competition with steam winding.

Electric winding is best adapted when, for example, working inclined seams, where, owing to the continually increasing depths, it is often a considerable time before the output from a fixed level reaches its maximum. If a steam winder were adopted, it should be built for the maximum output expected to be reached from the greatest depth; wherefore, until the machine is doing its full duty, it is working under uneconomical conditions. The electric winder, on the other hand, easily lends itself to enlargement, for the Koepe pulley, or drum, can be coupled to one motor, and provision made for the subsequent addition of a second motor; the Ilgner system especially lends itself to development in this direction, as the flywheel-converter plant can be arranged to suit varying demands. Thus, the electrical system of winding provides a plant which can work economically with the gradually increasing output and depth, and also limits the capital expenditure to the immediate requirements.

Again, circumstances exist under which electric winding offers the only solution to the existing difficulties. In certain instances it has been found necessary to erect the winding-machine on the headgear, as at the Deutschland Colliery, where there was no room for the winding-engine house on the ground-level. At that mine the Ilgner system was adopted, the following being the main particulars of the plant:—

The motor-generator takes three-phase alternating current at 3,000 volts, and, when running at 470 revolutions per minute, gives

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444 horsepower, the weight of the flywheel being about  $16 \frac{3}{4}$  tons. The winding-motor, which takes direct current at 600 volts, and runs at the maximum number of revolutions per minute (63), has a maximum capacity of about 620 horsepower. The Koepe pulley is  $14 \frac{3}{4}$  feet in diameter; the depth of wind, 787 feet; and the maximum winding velocity, 35 feet per second. The weight of coal per wind is  $2 \frac{1}{2}$  tons, and the amount drawn per 10-hour day, 690 tons.

Electric winding has also been adopted at the Ulrich shaft of the Cleophas Mine, where, owing to about 40 feet of mud, there were immense difficulties in getting good foundations, and also the danger that the winder in time would get out of alignment with the shaft. In this case the headgear itself is built on the shaft-walling, which is massive and is carried down to a solid foundation at a depth of about 40 feet. The winding-motor has a maximum capacity of about 200 horsepower, and takes direct current at 400 volts from a three-phase alternating-current motor-generator, at 3,000 volts. This plant is not utilized for winding coal, but for letting down materials and for conveying the men. It presents another case in which electric winding can be economically adopted.

To prevent interruption of coal-drawing by conveying men, etc., and to provide for the further important advantage of letting the hewers down near to their working-places, and for ventilation purposes, many colliery companies are sinking special shafts. These shafts lie necessarily at a greater or less distance from the main shafts and plant, and in these circumstances electric winding is nearly always the most economical system to adopt; for it would certainly be out of the question to put down a steam-plant for such intermittent work, especially if, as is often the case, there is a cheap supply of electric power at hand.

Economies or ought about by the introduction of Electric Winders. —The introduction of electric winding-engines has, owing to competition, brought about considerable reductions in the steam-consumption of steam winding-plants. A modern high-class steam winder, however, still fails to show as low a steam-consumption as an electric winder; and, at the present time, it is debatable whether the saving in steam and the better manipulation of the electric winder is not too dearly bought through the

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high capital cost. It must also be borne in mind that with non-condensing steam winders the exhaust-steam is often utilized in exhaust-steam turbines.

The greatest economical advantage of the electric winder is its low steam-consumption per shaft-horsepower-hour, which, moreover, is the only basis of comparison that can be made between electric and steam winders. The cost per ton wound is certainly a most important item, but it forms no basis of comparison, unless two plants happen to be identical, which is rarely the case.

Again, the steam-consumption of an electric winder is a predetermined and practically unalterable quantity. In the case of steam winders, the steam-consumption depends to some extent upon the driver himself.

The cost of the steam is an important item, and here it is necessary to point out that the statement—that the greater the cost of boiler-coal, the greater is the cost of steam—may or may not be true. It sometimes pays to use a dearer coal with a high evaporative power than to use a cheaper coal with a low evaporative power. The writer knows of an instance in which the cost per kilowatt-hour generated by a large colliery power-station was less when burning coal at 11s. 4d. per ton than when burning coal at 8s. per ton. This is a case in favour of basing the value of a coal upon its calorific or evaporative power. Generally speaking, however, the higher the cost of boiler-coal is, the dearer is the steam; and, consequently, the advantage of an electric over a steam winder is greater. Westphalia presents under these circumstances a greater advantage for electric winding than Upper Silesia, as the cost of steam in the latter district averages 1s. per ton, whereas in Westphalia it costs from 1s. 6d. to 2s. In Upper Silesia the introduction of better firing arrangements for boilers has led to a greater demand for the poorer qualities of coal by the zinc- and iron-works, and this tends to raise the value of such commodities, thereby making circumstances more favourable for electric winders.

With electric winders the velocity of winding usually depends absolutely upon the position of the steering lever; in fact, the acceleration, maximum velocity, and retardation periods are governed automatically, such regulation enabling almost complete safety to be ensured. That electric winding-engines are

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considered safer than steam winders is evidenced by the fact that in this district a speed of 33 feet per second is allowed for winding men with an electric machine as against 20 feet with a steam winder. This is an important consideration, especially in the case of deep mines.

In relation to the question of the generating plant, the writer insiders that the most reasonable method is to charge the power consumed to the winding-plant, at a rate to cover all costs of generation, etc.

[Photograph: Fig. 1.—Electric Winder at the Castellengo Colliery, Upper Silesia.]

Electric Winding at the Castellengo Colliery.—The two winding-engines are constructed on the Siemens-Ilgner system. No. 1, however, is the only one in operation at the present time, and is used for coal-drawing. The main particulars are as follows: —

Depth of shaft, in feet	853
Useful load, in tons	2.26
Cage: number of decks	2
„ tubs per deck	2
„ weight, in tons	3.25
Velocity of wind, in feet per second	41
Diameter of winding-rope, in inches	1.49

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The winding-machine (Fig. 1) consists of a Koepe pulley directly coupled to an electric motor, which is connected up to the starting dynamo of the flywheel-converter by the Ward-Leonard control. The steering lever of the winding-machine operates the regulating resistance in series with the field of the starting dynamo, and, as the latter feeds the winding-motor, its speed depends upon the position of the steering lever.

The flywheel-converter (Fig. 2), which is situated in the colliery power-station about 300 feet from the winder, consists

[Photograph: Fig. 2.— Flywheel-converter for the Electric Winder at the Castellengo Colliery, Upper Silesia.]

of two starting dynamos (one for each of the winding-motors), and the three-phase motor and flywheel, with the necessary regulating resistances. The three-phase motor takes current at 1,000 volts, and has a capacity of 367 horsepower when running at 475 revolutions per minute. This capacity corresponds to the mean load or power-consumption of the No. 1 winding-motor when the winder is making 80 trips per hour. Under test the winder made nearly 82 trips in an hour. This corresponds to 44 seconds per journey, made up as follows: —

	Seconds
Approximate period of acceleration	12
“ “ maximum velocity	10
“ “ retardation	14
“ “ banking out	8

Fig 3 shows the speed-curves of the winding-motor for part of an ordinary day's work. The load on the winder changes from -- 74 to + 790 horsepower; for balancing the same, the flywheel is  $13 \frac{3}{4}$  tons in weight, and when running without load it has a peripheral velocity of nearly 325 feet per second. The flywheel is built of special steel, and carefully balanced; originally it ran in ball-bearings, but, as the balls soon became defective the ordinary bearings with oil-rings have since been adopted. The balancing of the load by the flywheel is brought

[Graphs: Fig 3.---Speed curves of the Electric Winding Motor at the Castellengo Colliery, Upper Silesia. Maximum Velocity,  $V = 41$  Feet per Second.]

about as follows :—If the load on the winder exceed the normal, the excess must be taken from the flywheel. This is accomplished by inserting a resistance in the rotor circuit of the three-phase motor, the revolutions thereby being decreased and energy taken out of the flywheel. On the other hand, should the load be less than the normal, the resistance is cut out, and the motor runs the flywheel up to its full speed. The actuation of the resistances follows automatically. The over- or under-loading of the converter necessitates a stronger or weaker current from the three-phase mains, which increase or decrease of the current sets into operation a small motor in a direction corresponding to over- or under-load. If the energy of the flywheel is drawn upon to such an extent that there is not enough resistance to balance—which may happen if both winding-engines commence together—the

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steering lever is automatically prevented from being set out as far as usual, and thus only allows the winding-motor to be run at a decreased velocity. The flywheel may thus be again run up to full speed, when the interruption of the steering lever is cut out.

The winding-motor can run on the starting-dynamo without the flywheel, although at a less velocity, so that after the main shift is completed the flywheel is uncoupled from the starting-dynamo, thereby saving the not inconsiderable useless running of the converter-plant after coal-winding has ceased. The starting-up of the converter-plant and flywheel takes about half-an-hour, whereas without the flywheel the plant can be started up and ready for use in a few seconds. The uncoupling of the flywheel from the starting-dynamo puts into operation the interruption of the steering gear, and consequently the winder must run at a reduced velocity.

The three-phase motor and flywheel are only calculated to serve one winding-motor, and thus a reduction in capital cost is effected. It is expected that the one converter-plant will serve the two winders; the overloading of the converter is, however, prevented by the reduction in the winding velocities.

As both winders are of nearly equal proportions, the two starting-dynamos are identical, and either can be connected up to either of the winding-motors, so that a certain reserve is existent. Either of the winders can be run without the aid of the flywheel. The winding-machine is fitted with an apparatus for the prevention of overwinding, and the position of the steering lever is governed at every point of the wind, so that the driver cannot increase, but may decrease, the speed of the motor. The brakes are operated by compressed air from a

small electrically-driven compressor, the starting or stopping of which is governed by the air-pressure.

A test of the plant was made for an hour, during which time the guaranteed output of 80 trips was comfortably reached, each trip representing a useful load of 2.26 tons. The effective shaft output during the test amounted to—

$$(2.26 \times 2,240 \times 80 \times 853) / (60 \times 60 \times 550) = 174 \frac{1}{2} \text{ horsepower-hours.}$$

The total current-consumption was 267.6 units, or 358 horse-

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power-hours. Taking the efficiency of the generating plant and transmission efficiency as 0.9 and 0.95 respectively, these 358 horsepower-hours amount to  $358 \div 0.9 \times 0.95 = 418$  generated by the steam-turbine. The result of a steam test on the turbine showed a steam-consumption of 145 pounds per horsepower-hour; the total steam-consumption for 174 ½ shaft-horsepower-hours therefore being  $418 \times 14.5 = 6,061$  pounds, or 34.73 pounds per shaft-horsepower-hour. The output was 181 tons; the cost per unit, 0.3288d.; the units consumed per ton, 147; the power cost per ton, 0.483d.; and the current-consumption per wind, 3.345 units.

The following are the costs taken out for the month of March, 1909, during which coal was wound for about 9 hours per day, the total number of winds being 16,449 and the tons of coal wound, 29,000. The total number of metre-tons (German) of useful work done by the winder amounted to 8,856,425, which is equivalent to a load of 33,525 tons (English) having been, lifted:—

Current, 62,320 units at 0.3288d., equals	£85 7 6
Wages, winding men	20 3 4
Oil and material	0 11 0
Wages for cleaning and repairs	1 0 0
8 per cent. interest and depreciation on machine and building	65 0 0
Total	£172 1 10

Current-consumption per wind	3.78 units.
„ „ „ ton of coal	2.14 „
„ „ „ „ useful work	1.85 „
Power cost per wind	1.24d.
„ „ „ ton of coal	1*70d.
„ „ „ „ useful work	0.60d.
Total cost per wind	2.51d.
„ „ ton of coal	1.42d.
„ „ „ „ useful work	1.23d.

These costs appear somewhat formidable when compared with the figures put forward for steam winders by Mr. W. C. Mountain. They, however, represent the actual cost over a

period of one month, all stops and useless running of the converter, etc., being included; and the cost per unit covers all

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[Photograph: Fig. 4.---- Turbine with alternating- and direct-current generator at the Heinitz mine, Upper Silesia.]

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cost of development in the power-station, including interest and depreciation.

Electric Winding at the Heinitz Mine.-This plant, which is of the Brown-Boveri type, is of interest, inasmuch as it is the only one in existence, so far as the writer is aware, in which the winding-motor is directly connected up to a turbo-generator. A brief description of the plant is as follows:—

A Brown-Boveri-Parsons high-pressure turbine is directly coupled to a direct-current generator and an alternating-current generator (Fig 4). The three-phase alternating-current machine supplies electricity for the general working of the colliery, and, at the same time, forms a ground load for the turbine, thereby not only improving its steam-consumption, but also converting the retarding loads, due to braking on the winding-motor, into useful electric energy: The direct-current generator is connected up to the winding-motor by means of the Ward-Leonard control.

The advantages of this system over the Ilgner system of winding are at once evident. The electric energy is transmitted directly to the winding-motor, and hence there are not so many machines and apparatus, as the flywheel-converter is abolished. The omission of the expensive power-consuming flywheel and motor-generator ensures greater efficiency, less attention, reduced cost of upkeep, and less capital cost. The winder is always ready for use, as the turbine can be run up to speed in a few minutes. There is not so much engine-room required, and therefore buildings and foundations are cheaper.

The system, however, possesses certain disadvantages when compared with the Ilgner system. As will be gathered from the description below, the heavy starting torque of the winder itself is transmitted to the boilers, which, therefore, must be of sufficient capacity to meet the heavy demands on starting. So far as the boiler question is concerned, the system evidently differs but slightly from the ordinary steam-winding system, except that the steam is used in a highly efficient machine. On the other hand, with the Ilgner system the steam demand is constant, and the boilers supply steam corresponding approximately to the mean load on the winder.

The following are the main particulars of the winding-plant when finally completed : —

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Depth of shaft, in feet	2,526
Useful load, in tons	7
Velocity of wind, in feet per second	32.8

Tons per hour	226.4
Diameter of Koepe pulley, in feet	26.25
Cage: number of decks	4
“ tubs per deck	3
Diameter of winding-rope, in inches	2 9/16

The turbine, which has a maximum output of 1,740 kilowatts, takes steam at 140 pounds per square inch (superheated to 527° Fahr.), and is connected up to the central condensing-plant existent at the colliery, which shows on the average a vacuum of 92 per cent. The patent automatic overload-valve fitted to the turbine is of special interest, inasmuch as it is the means by which the turbine is enabled to take the heavy starting-load of the winder. The valve operates in the following way:— Under normal load the steam is throttled at the turbine inlet, so that the pressure behind the admission-valve is somewhat less than that before it. When the turbine is fully loaded—for example, on the starting of the winding-motor—the throttling of the steam ceases, the pressure behind the admission-valve is the same as that before it, the automatic overload-valve steps into operation, and live steam is admitted on to the second expansion step of the turbine, thereby increasing the capacity of the turbine considerably. The percentage of vacuum in the condensing-plant affects to a certain extent the working of the overload-valve. If the condensing-plant is heavily loaded, the starting of the winder brings the overload-valve into operation sooner than usual; on the other hand, when the vacuum is good the overload-valve is at times not opened. A further advantage of the automatic valve lies in the fact that, if the boiler-pressure sinks, the valve comes sooner into operation, and so keeps the turbine up to its required capacity.

As would be expected, the speed of the turbine is altered by starting the winder, but not to a dangerous extent. The revolutions per minute undergo an alteration of less than 2 per cent. (from 1,490 to 1,505) when the load due to the winding-motor changes over from the greatest positive to the greatest negative. This alteration is so small that it is not sufficient to bring the three-phase generator out of step.

The direct-current generator has a momentary maximum output

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[Photograph: Fig.5.—Electric Winder in the Heinitz Mine, Upper Silesia.]

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of 1,250 kilowatts and a continuous output of 475 kilowatts at 500 volts, and is provided with a Deri winding, which gives a spark-free commutation at all loads and requires only a small excitation current. The field-regulation apparatus can, therefore, be made very small.

The three-phase generator has an effective output of 1,000 kilowatts ( $\cos\phi = 0.8$ ) at 3,150 volts 50 periods per second, when running at a speed of 1,500 revolutions per minute. The excitation for both the alternating- and direct-current generator and the winding-motor is taken from an exciter mounted on the turbine shaft. As at present built, the winder (Fig. 5) is capable of drawing 140 tons of coal per hour from a depth of 1,771 feet (540 metres). For its ultimate drawing capacity, another winding-motor and direct-current generator will be required.

Below are particulars of a test made on the plant on September 17th, 1909, with a view to determining the steam consumption : —

[Table omitted]

These steam-consumptions are based upon the test, but calculated so as to show what would be consumed had steam been

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used of the guaranteed pressure and temperature, namely, 140 pounds per square inch and 527° Fahr. (275° Cent.) respectively.

The winder itself consists of a direct-current motor coupled direct to a Koepe pulley, provision having been made for the addition of a second similar motor. The machine has the usual retarding and safety devices, the safety-brake being put into operation and the main switch opened when (1) the exciting current for the motor fails, (2) the exciting current increases to 15 per cent. above the normal—that is, by the inadmissible increasing of the turbine revolutions, or (3) by the rotor current increasing above a fixed maximum, through an excessive load on the motor.

The motor is built for a continuous output of 557 horsepower, at a speed of 24 revolutions per minute; its maximum output, however, is 1,340 horsepower. The field excitation is at 110 volts, and the armature receives current at 490 volts.

For purposes of repairs, etc., to the motor, the latter can be entirely disconnected and run free of the Koepe pulley. The connexion between the motor and pulley is by means of a flange-coupling. The half of the coupling which is connected to the motor is arranged to run on two rollers, which latter can be easily moved into position when required.

Fig. 6\* shows the speed-curves for the winder when on test. The periods of acceleration and retardation are each about 10 seconds and the period of maximum velocity, 45 seconds.

[Graph: Fig. 6. ---Speed-curves of the Electric Winding Motor at the Heinitz Mine, Upper Silesia. Maximum Velocity,  $V = 32.8$  Feet per Second.]

\* Extracted from the *Elektrotechnische Zeitschrift*, 1910, vol. xxxi., page 592.

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Mr. W. C. Mountain (Newcastle-upon-Tyne) said that Mr. Hudspeth's paper was of service, as it was a useful attempt to show the commercial, as well as the practical, side of the problem. He would like, before offering any criticism, to clear up, if he possibly could, an impression that appeared to exist in the minds of a number of people to the effect that he was an opponent of electric winding. He was sure that nothing which he had said in any of the papers that he had read on the subject could possibly have created such an impression if his remarks had been carefully read. He had, since his visit to Germany about 5 years ago, had a great doubt in his own mind as to whether electric winding for heavy duties possessed sufficient commercial possibilities to enable it to be generally adopted. He was aware that at

the present time there were many applications of electric winding to pits of moderate output and for staple winding, but he was still very sceptical as to whether it would be possible to use economically electric winders for very large outputs, such as they had at some of the Yorkshire pits, in the modern pits in the North of England, and in South Wales. Assuming that a supply of electric energy could be obtained at a sufficiently low price to warrant its use, there was no doubt that electric winding was possible, and might be economical. In addition to this, there were many collieries, or groups of collieries, where power could be obtained from coke-oven gas passed under boilers, and steam thereby generated at a very low cost for use in steam-engines or steam-turbines. In the same way, waste-heat from coke-ovens could also be used under boilers, and there was the other alternative of utilizing gases from coke-ovens, or possibly from blast-furnaces, assuming that the latter were within reasonable distance of the collieries where the power was required. But, before one could state definitely whether or not electric winding was economical under such circumstances, it was necessary to consider every scheme upon its own merits, and to consider carefully the capital cost of the electric winding scheme compared with steam winding. The introduction of the exhaust-steam turbine, or, what was now more generally used, the mixed-pressure turbine, had entirely altered the phase of the economical production of electric power at collieries; and it was now a well-known and admitted fact that with a reasonably economical winding-engine it was possible to obtain as much power from the

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exhaust-steam passing into the turbine as was produced in the original engine, because an exhaust-steam turbine when taking steam at atmospheric pressure would produce 1 kilowatt for every 40 pounds of steam with a vacuum of about 28 inches. It must also be remembered that at most collieries the fan was driven by a steam-engine, and that there were possibly haulage-engines on the surface, from all of which the exhaust-steam could be taken to a turbine. Assuming that these conditions existed, it followed without doubt that electricity could be produced very much more cheaply from the exhaust-steam—which was really waste—than it could possibly be purchased from any supply company; and he knew of several instances where electric energy produced in that way, after providing 10 per cent. for depreciation and 5 per cent. for interest, did not cost the colliery company more than 0.15d. per unit. Mr. Hudspeth had touched upon what appeared to be a favourite claim made by makers of electric winding machinery, namely, the suggested simplicity of the plant, and the fact that owing to the steadier winding moment men could be wound at a higher speed with electric winders than with steam winders; but he (Mr. Mountain) regretted to say that he could not accept that as a just and proper claim. He quite admitted that in many old-fashioned winding-engines there was an absence of safety-devices, and of overwinding and automatic gear; but it was not fair to compare a modern electric winder with an antiquated steam-engine; and, in those circumstances, it was hardly necessary for him to point out that the modern steam winding-engine, fitted with automatic overwinding gear, automatic trip-gear, and compressed-air brakes, was as perfect as it could be, and the method of handling was at least as simple as any electric winder could be. In his opinion it was, therefore, unwise to put forward claims of that description, as they only tended to discredit the statements made on behalf of the advocates of electric winders. Regarding the speed of winding, he failed to see how any claim could be made on that score in favour of electric winding, as it was impossible to imagine anything simpler than to run a pair of steam winders at a reduced speed. There was no doubt that electric

winders had been greatly improved in regard to details of control, and also greatly reduced in cost during the last few years, that was, since he read his

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paper before The Institution of Mining Engineers,\* and that reduction in first cost made it more possible for electricity to compete with steam; but he did not think that the figures which Mr. Hudspeth had given in his paper had proved his (Mr. Hudspeth's) case, and he proposed to deal very generally with each of the problems that Mr. Hudspeth had brought forward.

The paper described three electric, winding installations. The first two, namely, the Deutschland and Castellengo plants, were fitted with balancers of the Ilgner type, consisting of a very heavy flywheel, which was utilized to store up energy and transmit it to the winding-motor during the periods of acceleration, being driven at one side by a motor. This motor drove by the assistance of the flywheel, during the period of heavy load, a generator on the opposite side, which delivered electrical energy into the motor on the winding-gear. The installation for the Heinitz Mine consisted of a steam-turbine with a three-phase generator at one end supplying current to the colliery motors, and with a continuous-current dynamo at the other end to deliver current to the winder-motor on what was known as the Ward-Leonard system. For those unacquainted with that system, it might perhaps make the description clear to them if he stated that it consisted of a continuous-current dynamo, the armature of which was directly coupled to the armature of the winder-motor, the magnetic field of the winder being constantly excited from an independent exciter, and the excitation of the generator varied by means of a regulating resistance, which, of course, varied the electromotive force of the generator and, consequently, the speed of the winder-motor. In considering such a system, one must bear in mind that it was a series of apparatus, consisting of the main generator which produced the current passing into the balancer-motor, the heavy flywheel running in two bearings., the generator operated by the motor, and the motor on the winder, together with a certain amount of switch-gear, including, in a three-phase system, a slip-regulator and the switch-gear in connexion with the various motors. The loss in this chain of machinery would certainly be not less than about 40 per cent.,

\* "Commercial Possibilities of Electric Winding for Main Shafts and Auxiliary Work," by W. C. Mountain, Trans. Inst. M.E., 1906, vol. xxxi., page 329.

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and unless the winder was designed to run with the main supply for night duty, it was necessary to keep the balancer constantly running, which constituted a very heavy loss when the pit was only winding men or stone and timber during the night and the winding was very intermittent. There was also the risk of breakdown to any portion of a chain of machinery of that kind, and it was well known that such breakdowns had occurred. There was no doubt that where the source of supply was such that the simple three-phase motor or continuous-current motor could be used with rheostatic control, the whole plant was very much more simple and reliable; but he was strongly inclined to recommend that in all winding installations where the source of supply was high-tension, the motor on

the motor-generator, if such were used, or the motor on the main winder, should be wound for a voltage which would enable the winding to be extremely simple and to consist of merely copper bars in mica tubes, with end-connexions so arranged that if a breakdown did occur (which with that system of winding would be very unlikely) any repair could be executed in the least possible time. This could be done with three-phase machinery by having static transformers, and the reduced cost of the motor for the lower voltage would go a long way towards paying for the cost of the transformers. He (Mr. Mountain) had endeavoured to analyse Mr. Hudspeth's figures as far as possible from the data supplied. These were, however, very scant, as only the comparative costs both as regards plant and running had been given; and, for comparison, he (Mr. Mountain) now gave the costs of a steam winding-plant for the same duty. He had also added the estimated cost of winding by electric winders and, steam winders per 100 tons wound, after providing 10 per cent. for depreciation and 5 per cent. for interest in each case. He considered that, in making such a provision, it was unduly heavy on the steam winders, but he did not think that it was more than enough to cover depreciation on the electric winders. With regard to the figures given for steam-consumption at the Heinitz Mine, Mr. Hudspeth had stated that the average output of the three-phase generator was 1,006 kilowatts, that the average output of the direct-current generator was 200 kilowatts, and, then, that the steam-consumption for the alternating-current generator was 1650 pounds of steam per kilowatt-hour, and for the direct-current generator 21.89

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pounds of steam per kilowatt-hour. It would be interesting to know how these figures were obtained, because it was rather difficult at first sight to separate the various outputs, as they were both working on the same turbine. Further, from those figures the total steam per hour would be, for the alternating current, 16,600 pounds per hour, and, for the direct current, 4,390 pounds per hour, making a total of 20,990 pounds per hour; but it was stated that the total steam-consumption was 22,725 pounds per hour, and these figures did not agree. He noted that the cost given for the Castellengo Colliery current had been put down at 0.3288d. per unit, and Mr. Hudspeth had added 8 per cent. for interest and depreciation on the machine and building, the sum of £65 being given as interest for one month. This gave a total capital outlay of £9,750, and from this figure one could not help drawing the conclusion that the author had included in that amount the total cost of the winding-plant, boilers, turbines, etc. If this were the case, then the price given per unit for the current generated was somewhat high. The summary which he had compiled was as under:—

#### COSTS OF ELECTRIC WINDING.

	Siemens-Ilgner System.		Ward-Leonard System.
	Deutschland Colliery.	Castellengo Colliery.	Heinitz Mine.
Maximum brake-horsepower of winding-motor	620	790	1,346
Motor-generator set (voltage supply)	3,000	1,000	500
Motor-generator brake-horsepower	444	367	
Weight of flywheel, in tons	17.75	13.75	

Revolutions of the set, per minute	470	475	
Revolutions of winding-motor, per minute	63	---	24
Type of drum	Koepe	Koepe	Koepe
Depth of shaft, in feet	780	853	1,771
Useful load, in tons	2.5	2.26	3.57
Weight of coal per hour, in tons	69	185	112
Shaft-horsepower output	60.8	174.5	224
Capital outlay for plant, including turbo-generator, Ilgner set, winding-motor and gear, and power-station	£9,750	£9,750	£9,050
Steam-consumption of turbine per 100 tons wound, in pounds	8,760	3,270	5,100
Current consumption per 100 tons wound, in Board-of-Trade units	336	215	230
Cost of current used per 100 tons wound	9s. 2d.	5s. 11d.	6s.3d.
Wages of men per 100 tons wound	2s. 8d..	1s. 9d.	1s. 10d.
Cost of oil, stores, etc., per 100 tons wound	3d.	3d.	3d.
Interest and depreciation (at 15 per cent. per annum) per 100 tons wound	12s. 11d.	8s.3d.	8s. 6d.
Total cost per 100 tons wound, including interest and depreciation	25s. 0d.	16s. 2d.	16s. 10d.

The price of the current was in all cases taken as 0.3288d. per Board-of-Trade unit, as given by Mr. Hudspeth; also the high cost at the Deutschland Colliery was due to the fact that the plant was evidently working at only about 40 per cent. of its full output.

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#### ESTIMATED COSTS OF STEAM WINDING.

	Deutschland Colliery.	Castellengo Colliery.	Heinitz Mine.
Engine cylinders: diameter, in inches	22	22	30
" stroke, in inches	40	40	60
Steam-pressure at stop-valve, in pounds per square inch	120	120	120
Drum: type	Parallel	Parallel	Parallel
" diameter, in feet	10	10	16
" width, in feet	6	6	8
Depth of shaft, in feet	780	853	1,771
Useful load, in tons	2.5	2.26	3.57
Weight of coal per hour, in tons	69	185	112
Shaft-horsepower output	60.8	174.5	224
Total steam-consumption per hour, in pounds	2,750	8,200	10,500
Coal burnt per hour, in hundredweights	3.5	10.5	14.4
Value of coal burnt per ton	5s.	5s.	5s.
Cost of engine and gear	£2,100	£2,100	£4,250
Cost of boiler, feed-pumps, and piping	£1,400	£1,900	£2,080
Boilers: diameter, in feet	7 ½	8 ½	8 ½
" length, in feet	30	30	30

" number	2	2	2
Interest and depreciation on the whole plant, at 15 per cent. per annum ...	£525	£600	£950
Wages of men per 100 tons wound	2s. 8d.	1s. 9d.	1s. 10d.
Cost of oil, stores, etc., per 100 tons wound	3d.	3d.	3 ½ d.
Cost of coal burnt per 100 tons wound	1s. 7d.	2s. 1d.	3s. 10d.
Interest and depreciation (at 15 per cent. per annum) per 100 tons wound	4s. 9d.	3s. 6d.	5s. 10d.
Total cost per 100 tons wound, including interest and depreciation	9s. 3d.	7s. 7d.	11s. 9 ½ d.

The engines in each case were of the non-compound double-cylinder type.

With regard to the cost of the electrical winding-plant, he (Mr. Mountain) had, where he was unable to gather the data from the paper, given his own estimate of the cost of the machinery, and with regard to the cost of the steam-plant, he was indebted to one of the leading firms of winding-engine makers for the costs, and for the estimate of steam-consumption upon which he had based his figures. It would be noted that he had also provided for a spare boiler, which should really not be actually debited to the cost of the electric winding-plant, as one spare boiler would probably be considered sufficient in the complete range. Coal had been taken for the steam winding at 5s. per ton; but there were, of course, many collieries where the coal used under the boilers was of much less value than that amount: at the same time, there were other collieries where coal was probably of greater value. This figure could, however, be readily adjusted, and, if the value of the coal were very greatly in excess of the amount that he had taken, it was very probable that electric winding might be advantageous. Very briefly the results were as follows:—

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	Deutschland Colliery.	Castellengo Colliery.	Heinitz Mine.
Approximate cost of electric winding-plant, including generating plant.	£9,750	£9,750	£9,050*
Cost of steam-plant for same duty.	3,500	4,000	6,330
Cost of winding per 100 tons, allowing for interest, depreciation, etc.-			
Electric plant	25s.	16s. 2d.	16s. 10d.
Steam	9s. 3d.	7s. 7d.	11s. 9 ½ d.

\*This figure includes only a portion of the generating plant.

In proof of his statements respecting the cost of steam winding, he (Mr. Mountain) was aware of a colliery near Sheffield where 4,200 tons were being- wound per day of 15 hours with one pair of winding-engines, having cylinders which measure 40 by 78 inches, from a depth of 1,626 feet, the cost (including interest and depreciation, men's time, and stores) being 5s. 2d. per 100 tons.

The conclusions which he drew from the examples given by Mr. Hudspeth were that, whilst the circumstances might be such as to render electric winding desirable at the particular collieries in question, he failed to see that any improved economical results over

steam winding had been obtained. He hoped that his remarks would not be taken as an indication that he was not in favour of electric winding where it could be usefully and economically applied; but he felt that advocates of electric winding would assist their ends very much more if they would be perfectly candid, and state what the actual first cost of the winding-plant was, and what the running charges were, instead of bringing forward figures which were very difficult to check. He also thought that Mr. Hudspeth had not made sufficient provision for interest and depreciation in the one example which he had given, and the only way in which he (Mr. Mountain) had been able to arrive at the cost of that plant was on the sum which Mr. Hudspeth had provided.

Mr. T. C. Futers (Whitley Bay) said that, like Mr. Mountain, he had to congratulate Mr. Hudspeth upon his paper, which was undoubtedly a useful contribution to this very controversial subject. It was a pity, however, that Mr. Hudspeth had not supplied more particulars of the capital cost of the plant that he had described; and the value of the paper would have been very much increased had the costs of the large Heinitz winder been included. On the question of electric winding, unfortunately

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many of its advocates seemed to think that because electric winders were being installed pretty generally in Germany, it must follow that it was the proper thing to do, and that they must therefore be a commercial success. He (Mr. Futers) hoped, however, that the time was yet a long way off when English engineers would follow blindly the lead of the German engineer in anything that might relate to mining engineering. The thing that struck a British engineer on visiting some of the German collieries was the enormous capital expenditure, and his constant wonder was "wherever do they get the money from?" Personally, he (Mr. Futers) was quite convinced that engineers in Great Britain had nothing to learn from Germany, unless it was how not to do these things. At the outset, Mr. Hudspeth himself seemed to wonder why electric winding should be adopted in Upper Silesia, seeing that boiler-fuel was so cheap and in favour of steam winding, and had then tried to excuse its existence by quoting a case which was abnormal rather than normal; but, even under those conditions, a properly-designed steam-engine would give results quite as good as any electric winder. It was quite true that an electric winder was very easily so arranged that a second motor could be added as the load increased, but it was a very doubtful advantage if this could only be gained by a much greater capital outlay and greater running cost afterwards. Again, there was absolutely no reason why in the case of the Deutschland Colliery a steam winder could not have been fitted to the top of the headgear, in exactly the same way as the electric one; and, further, in the case of the Ulrich shaft, he could not see that there would have been any difficulty in securing a good foundation for the engine, even in 40 feet of mud, as had evidently been done for the headgear. In any case, the winder might just as easily have been steam as electric, even if erected on top of the headgear. He quite agreed with Mr. Hudspeth in recommending the installation of electric winders in the case of outlying or auxiliary shafts situated some distance away from the main steam-plant; but, even in that case, it depended very much upon the initial cost of the plant, and the cost of the power-supply. Mr. Hudspeth stated that "a modern high-class steam winder still fails to show as low a steam-consumption as an electric winder." This he (Mr. Futers) did not for a moment admit: a steam winder could be built with a guaranteed steam-consumption of 25 pounds of steam per useful horse-

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power, and it was a more or less easy matter to guarantee 30 pounds. If, as Mr. Hudspeth had pointed out, the exhaust-steam in such a winder were afterwards used in an exhaust-steam turbine, then practically every unit of heat originally in the steam was turned into useful work, and no electric winder, even when supplied with current at a cheap rate, could compete with such a plant from a commercial point of view. Of course, if circumstances were such that an electric winder must be put in, or a colliery company preferred it, and could easily afford the cost, the conditions were altered; but it should not, on that account, be brought forward as an argument in favour of electric winding. It was, of course, claimed that the economy of electric winding lay in the lessened steam-consumption, but it would be admitted that it was absurd to try to save steam worth, say, £1, if, in order to do that, the interest on the capital cost of the plant would amount to 25s. The only satisfactory way to deal with the question of cost was that of "cost per ton of coal raised;" and, although it might be difficult to get actual results from electric and steam winders working under identical conditions, there were, he thought, enough data to be obtained to enable careful estimates of the cost to be computed. Further, the general adoption of the Koepe pulley, with all its disadvantages, on electrical winders in Germany, had always seemed to him to be a weak point, as it had been recognized that, in order to obtain anything like satisfactory results, the inertia of a large drum must be got rid of; and he was quite certain that if this type of pulley were to be applied to a well-designed engine, very much better results would be obtained. Moreover, as a rule, with such winders the speed, and consequently the output of the pit, was always limited; there was no chance of putting on an extra spurt when the steam was good and there were plenty of coals in the pit-bottom, so as to get a "good day," as might be done with a steam winder. Once a few minutes were lost, they could not be made up.

Dealing with the cost of the Castellengo Colliery winder, if £65 represented one month's interest and depreciation at 8 per cent., that would represent a capital outlay of £9,750, which was surely a heavy price to pay for a plant to deal with 1,800 tons per day of 10 hours, from a depth of 853 feet; and, again, the cost of raising a ton of coal, given as 1.42d., or nearly 12s. per 100 tons, was, he thought, just about double what would be looked

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upon as reasonable in this country. He had no doubt whatever that a steam winder could be put down to wind that quantity for 6s. per 100 tons from the same depth. Further, he thought that 8 per cent. was just about half of what ought to be allowed as reasonable for interest on capital and depreciation on the plant. With respect to the Heinitz Mine winder, he could not help thinking that the Germans had, in their enthusiasm for electricity, neglected an excellent opportunity of showing what really could be done in winding coal cheaply. They had recognized the necessity of raising as heavy a net load as the strength of the rope would admit, namely, 7 tons of coal, and at as slow a speed as possible, hence the velocity was only 32.8 feet per second; if it had been possible to have increased the net load, and kept the speed still slower, it would have still further increased the efficiency. He could not possibly understand why they should first put the steam through a turbine, transform it into electricity, and then apply it to an electric winder, which again was evidently obliged to have a Koepe pulley; as it was, it took 19.8 pounds of steam per shaft-horsepower, but, unfortunately, no particulars as to cost were given, and it would be of immense value if Mr. Hudspeth could supply these. If a reasonably economical steam winder had been installed, using, say, 30 pounds of steam per shaft-horsepower instead of 19.8 pounds, and then exhausting this at atmospheric pressure into a low-pressure turbine, a simple calculation

would show that 224 horsepower, as given by Mr. Hudspeth, at 30 pounds of steam, yielded 6,720 pounds. Assuming that 6,000 pounds was returned to the exhaust-turbine, and assuming further that 40 pounds of steam would yield 1 kilowatt, this was equal to 150 kilowatts, or, say, another 200 horsepower, which made an aggregate of 424 horsepower for a total consumption of 6,720 pounds of steam, or, roughly, 16 pounds of steam per horsepower. He questioned very much whether the cost of the plant required to attain these results would have been as high as that of the electrical equipment so well described by Mr. Hudspeth.

In conclusion, Mr Filters mentioned that Mr. G. H. J. Hooghwinkel had recently given the cost of two electric winding-plants as follows : —

	Cost of Complete Installation	Cost per Ton of Coal Wound
Ilgner equalizer, with current at ½ d. per unit	£19,000	2.7d.
Direct turbine drive	£32,000	1.7 d

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Any maker of steam winders would, he thought, be only too glad to have orders to build plants to deal with the same output at half these costs.

Mr. Mountain remarked that Mr. Futers had referred to the question of consumption and shaft-horsepower, but in regard to the Deutschland Colliery they had only 60.8 shaft-horsepower, and it would appear from this that the consumption of steam per shaft-horsepower-hour—that is, the actual horsepower in the shaft lifting coal only, assuming continuous working—was 98.5 pounds. In the Castellengo Colliery they had 174.5 shaft-horsepower, and the consumption per shaft-horsepower-hour on the same basis apparently worked out at 34.73 pounds of steam. In the Heinitz Mine, they had 224 shaft-horsepower, and this worked out at 25.5 pounds of steam.

Dr. Behr, in South Africa, had made some very exhaustive experiments on a tandem compound winding-engine, and, after a prolonged test, the consumption of steam per shaft-horsepower-hour worked out at only about 25 pounds. These figures were fairly well confirmed by the tests which Mr. Fryar had made on the Fraser-and-Chalmers steam winder.\*

It would be very interesting to see some really reliable figures of the consumption of steam in various classes of winding-engines per shaft-horsepower-hour. A number of figures were given in his (Mr. Mountain's) earlier paper; but, although the consumption of steam actually used might be probably a little less with electric winding-machinery, the high cost of the plant had eaten up the commercial advantages.

Mr. Futers pointed out that he took the figures given in the paper as 19.8 pounds per shaft-horsepower, which he assumed meant the actual power in the winder. He had taken the steam-consumption at 30 pounds for purposes of comparison.

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The President (Mr. M. W. Parrington) proposed a vote of thanks to Mr. Hudspeth for his paper, which was heartily accorded.

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A patent automatic oiling apparatus for colliery-tub and other axles was exhibited and described by Messrs. Dunford Brothers.

\* Trans. Inst, M. E., 1903, vol. xxvi., page 478.

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THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

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GENERAL MEETING,

Held in the Wood Memorial Hall, Newcastle-upon-Tyne,  
February 11th, 1911.

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Mr. M. W. PARRINGTON, President, in the Chair.

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DEATH OF MR. WILLIAM HENRY WOOD.

The President (Mr. M. W. Parrington) said that, before proceeding with the ordinary business of the meeting, he would like to refer to the great loss which the Institute had sustained by the death of Mr. William Henry Wood. Mr. Wood was one of its oldest members, his connexion dating back to the year 1857. Some time ago he had for a number of years served on the Council, and had devoted a good deal of attention to the affairs of the Institute. He proposed that the members should express to Mrs. Wood and her family their deepest sympathy and condolence with them in their bereavement.

The resolution was unanimously passed in silence, the members rising in their seats.

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The Secretary read the minutes of the last General Meeting, and reported the proceedings of the Council at their meetings on January 28th and that day.

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

Members—

Mr. Robert Richmond Blair, Mining Engineer, 5, Hamilton Terrace, Whitehaven.

Mr. John Brown, Colliery Manager, Pench Valley Coal Company, Limited, Pench Valley P.O., Central Provinces, India.

Mr. Robert Brown, Mechanical Engineer, 8, Lesbury Road, Newcastle-upon-Tyne.

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Mr. Samuel Jackson Hopper, Constructional Engineer, 53, Victoria Road, Hebburn, County Durham.

Mr. Ernest du Bois Lukis, Mining and Civil Engineer, Peruvian Corporation, Limited, Lima, Peru, South America.

Mr. John Rogers, Colliery Manager, Widdrington Colliery, Acklington, Northumberland.  
Mr. John George Stokoe, Colliery Manager, Alston House, Crigglestone, Wakefield.

Associate Members—

Mr. John Thomas Carr, Sixhills Street, Grimsby.

Mr. James Watts, Morro Velho Mines, Minas Geraes, Brazil, South America.

Associate—

Mr. Henry Edward English, Overman, Manor House, Lumley Park, Fence Houses.

Student—

Mr. William St. John Inman, Mining Student, Thornfield, Ryhope Road, Sunderland.

#### DISCUSSION OF MR. RALPH D. COCHRANE'S PAPER ON "A NEW METHOD OF TESTING FOR GAS IN MINES WITH SAFETY-LAMPS."\*

Mr. James Ashworth (Fernie, British Columbia) wrote that for some years he had not taken any active part in experiments designed to increase the efficiency of safety-lamps for gas-testing. At the point where he left off he had adapted (1) a hydrogen-gas flame to his Ashworth-Hepplewhite-Gray safety-lamp, and patented it as the Ashworth-Clowes lamp; (2) he had succeeded in making an Ashworth-Gray type of safety-lamp which would, when burning alcohol or methylated spirit, give a 3-inch cap with a tri-wick flame (this lamp was safe to take into the mine, that is to say, safer than the Pieler lamp); (3) he had constructed an Ashworth-Gray safety-lamp, using either benzolene or colzalene spirit (called naphtha in some parts of the world) or petroleum or paraffin oil, which would readily show 1 per cent. of fire-damp without adding any complicated parts; (4) by the addition of a platinum filament, heated by the flame, he had been able to indicate the presence of low percentages of gas; and (5) by a platinum filament placed inside a wire gauze, heated by a dry battery through a resistance to control its heat, he had been able to test for the presence of fire-damp (as in the Liveing apparatus) without the aid of a safety-lamp, otherwise than to give light to the operator when travelling from place to place.

\* Trans. Inst. M. E., 1910, vol. xl., page 272.

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During his active interest in the subject, the various additions to the Coal-Mines Regulation Act of 1872 had never dealt with "percentages" of gas, but only with the "blue cap," and hence the introduction of a safety-lamp to discover, say, 1 per cent. of gas was not required by the market, and was, in fact, more inconvenient than convenient.

The first objection that he raised to Mr. Cochrane's idea was that the diaphragm entirely obstructed the upward rays of light from the wick-flame, and this necessitated the canting of the lamp before the operator could see the roof. It was as important—in fact, more important—to be able to examine the roof carefully as to test solely for fire-damp. His next objection was that if the lamp were canted, the impingement of the flame on the diaphragm

would make it smoke; and, further, that the height at which Mr. Cochrane fixed his diaphragm would not admit of the wick-flame being used at its full height and lighting power.

To get the best results from a safety-lamp used for gas-testing purposes, the air which was being tested must approach the flame from a point below it. Some years ago, Messrs. James Laidler & Sons, of Durham, constructed for him a similar arrangement to the one now suggested by Mr. Cochrane, but with this difference—that his (Mr. Ashworth's) design was movable, and when testing for gas the shield was so set that the flame was hidden; consequently, any increase in the height of the flame was at once apparent, and this was all that Mr. Cochrane's arrangement effected.

In Mr. Cochrane's design for gas-testing, one principal feature of a safety-lamp for the purpose had been entirely omitted, in that no provision had been made for increasing the heat of the flame or decreasing its luminosity. The first principles to be observed when designing a gas-testing lamp were (1) to increase the heat of the flame, and (2) to decrease its luminosity; and if these two points had attention, then there was no need to add complicated parts, or such additions as the Cunynghame-Cadman arrangement.

So far as he (Mr. Ashworth) was aware, there was no necessity to discover a lower percentage of gas than 1 per cent., and in all mines where blasting was not practised any less than 2 per cent. He took it that no percentage under 3 would be considered dangerous.

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A safety-lamp, patented by Mr. J. Naylor, of Wigan, had duplex wicks, and comparing it with his (Mr. Ashworth's) three, he was practically certain that this lamp, burning paraffin, or even mineral colza oil, would indicate 1 per cent. of fire-damp if it were present in the air. Either of these lamps supplied hotter non-luminous testing-flames than ordinary lamps, and hence, without any complication or chemical addition, they were capable of giving the man with ordinarily good eyes every indication that safe mining required.

Prof. P. Phillips Bedson (Armstrong College, Newcastle-upon-Tyne) said that, with regard to the novelty of the idea, he would like to draw attention to the fact that a number of years ago he had communicated to the members a translation of a paper dealing with experiments made in an investigation of the behaviour of the Wolf safety-lamp.\* Not only was the appearance of the flame described, but there were some exceptionally good illustrations which showed exactly the phenomenon to which Mr. Cochrane had referred, and which he had used, or proposed to use, as a means of detecting fire-damp. He (Prof. Bedson) had always taken a great interest in the question of flame-production, and felt constrained to draw attention to the paper, because it contained much useful information on the subject, an explanation why the flame was used as an indicator, and the conditions under which it would give the best indications. Mr. Cochrane was not by any means the only person who was apparently not aware of the paper. Books, dealing with this subject, had been written, the authors of which appeared to be unaware of the work done by Profs. Kreisler and Winkler, and many investigations had been published recently, which were but repetitions of these researches. Whilst these investigations served to confirm the conclusions of Messrs. Kreisler and Winkler, their publication and their form forced upon one the conclusion that the best way of hiding knowledge was to publish it.

Mr. A. D. Nicholson (H.M. Inspector of Mines, Durham) said that he had had an opportunity of testing the device, and he was afraid that the result was rather disappointing. After breaking the air-tubes and testing by means of an ordinary safety-

\* "The Testing of Safety-lamps: An Account of Experiments made by Profs. Kreisler and Winkler," by Prof. P. Phillips Bedson, Trans. N. E. Inst., 1885, vol. xxxv., page 3.

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lamp with a reduced flame, he gradually got a cap of from 1/8 to 3/8 inch, but up to that point he was unable to find any indication whatever in the safety-lamp fitted with Mr. Cochrane's device. In addition, with the fixed diaphragm, with which the safety-lamp he had used was provided, the light was very small indeed for ordinary purposes, and he thought that there was a danger of the under side of the diaphragm becoming coated with soot, which would make the light worse still.

Mr. E. S. Wood (Murton Colliery) said that he had tested the lamp where there was gas present, and he must say that on every occasion he had found the results as shown by the spiring flame to correspond practically with a cap obtained with a Routledge-and-Johnson lamp. The device was not one of the handiest, as it did not throw any light up on to the roof, etc., as in an ordinary safety-lamp; but, as compared with the ordinary lamp, it gave a fairly good indication, the two practically coinciding.

Mr. William Severs (Beamish) said that, when using a safety-lamp fitted with Mr. Cochrane's device, he had found the flame to spire, in accordance with what Mr. Cochrane had said, where the atmosphere was practically still; but when he came back into the return airway, he found that he was apparently getting something like 4 per cent. of gas. That, he thought, could not be correct, so he had tested with an ordinary safety-lamp, and it did not show any cap at all. He had taken the safety-lamp fitted with the device to a regulator close to the shaft, and had found the flame still spiring, notwithstanding that there was no gas, and that was the only fault that he had to find with the idea. It seemed to him that, if there was any current of air at all, the flame would spire right up in the lamp in the same way as if a large quantity of gas were present.

Mr. Ralph D. Cochrane (Hetton Colliery), replying, said that, with regard to the spiring of the flame, that phenomenon took place more or less in every safety-lamp, but it was undoubtedly accentuated by the fixed position of the diaphragm. He would like to draw the attention of the members to the two first lamps that he had had fitted with the device, one with and the other without a shield (Figs. 1 and 2). In both lamps the diaphragm was adjustable from the outside and could be raised beyond

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the light, and this would entirely overcome the spiring of the flame. In testing for gas, the diaphragm should be 5/8 inch above the top of the flame, and when the flame spired up to the diaphragm, approximately 1 per cent. of gas was present, and 2 and 3 per cent. when the flame spired through the opening in the diaphragm. He had been informed of a case in which an ordinary deputy's lamp had been used where gas was present,

[Photographs: Fig. 1.—Safety-lamp fitted with Diaphragm and Gas-indicator, without Shield. Fig. 2.—Safety-lamp fitted with Diaphragm, Gas-indicator, and Shield.]

without the slightest indication of any being given: but, when a safety-lamp fitted with his device was tried, exactly 1 per cent. of gas was immediately indicated. This showed that with an ordinary safety-lamp every user could not see 1 per cent., but that with a lamp fitted with his device the indication was quite distinct. With regard to the light itself, the diaphragm possibly

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interfered with the same, as he had been told that the light became slightly diminished when taken into gas. That was simply owing to the diaphragm, which required to be slightly reduced when this disadvantage would be easily overcome.

He was very pleased indeed to have had an opportunity of bringing his device forward, and to have had the comments, adverse and otherwise, made by practical men, and he was glad if he had been in any way successful in producing a lamp that might possibly be of use. The lamp was complete in itself, and he thought that it was an attempt in the right direction, inasmuch as any examination for gas could be done with a full flame, instead of with a very diminutive flame as at present; and moreover, the present method of estimating the percentage of gas was at the best only a guess.

Mr. W. C. Blackett (Sacrison) said that he had not intended to say anything further on the subject, but after Mr. Cochrane's remarks he would like to add that his objection had nothing whatever to do with the arrangement of the diaphragm or anything of that kind. His objection was to the principle, and he could not possibly agree that the lamp was a step in the right direction. It was a step in the wrong direction from the very first, because the principle upon which it depended was not a sound one. Anyone who merely employed spiring to guide them in the pit as to the presence of small quantities of fire-damp would inevitably, in the end, be misled. For that reason he (Mr. Blackett) was bound to say that, in blunt language, he would condemn the lamp, in its general principle, as a means for discovering small percentages of gas.

Mr. W. Patterson (Newcastle-upon-Tyne) said that many years ago he was told, and he had since found, as many present had also possibly done, that there were three atmospheres at the coal-face. One objection that had been made to the lamp was that there was not an atmosphere at the coal-face in which the diaphragm could be adjusted. In a working-place, taking it for granted that it was fairly well ventilated, if a lamp were placed on the floor, it would very likely go out, but if it did not, the flame would elongate, the presence of marsh gas or some other reason being the cause. If, however, the lamp were raised to, say, the middle of the working-face, a fairly

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good flame would result, and the lamp would burn. Why not adjust the lamp in that particular atmosphere? If gas was present, it would make its way up to the roof, and it would be found there. Nothing had been devised to supersede the flame as an indicator of the presence of gas, and that being so, he was of opinion that a lamp fitted with Mr. Cochrane's device was the best that they had at the present time for gas-testing: it might not come up to all the scientific attainments that they required, but it was a good practical safety-lamp which would give a fair indication of gas.

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DISCUSSION OF MR. HENRY MOORE HUDSPETH'S PAPER ON "ELECTRIC WINDING,  
WITH SPECIAL REFERENCE TO ITS DEVELOPMENT IN UPPER SILESIA."\*

Mr. H. M. Hudspeth (Willington, County Durham) wrote that the paper had fully answered his intentions if any advance had been recorded towards a definite conclusion on the question of electric versus steam winding. Practically, only the plants at Castellengo Colliery and the Heinitz Mine were described. The plant at Deutschland Colliery, as would be seen from a cursory glance, was not working at anything near its maximum capacity, the average winding speed, for instance, after allowing 20 seconds for changing, being only about 8 feet per second. To take out costs on such a plant would, therefore, not only produce erroneous but actually harmful results.

The disagreement of the figures showing the total steam-consumption of the plant at the Heinitz Mine was merely apparent, not real. The steam-consumption of the alternating-and direct-current generators was, as stated, based upon the test, and corrected for the difference between the actual steam-pressure and temperature and those guaranteed by the makers. The total consumption, with steam at a temperature of 442° Fahr. and a pressure of 127 ½ pounds per square inch, was 22,725 pounds per hour, the guaranteed temperature and pressure being 527° Fahr. and 140 pounds per square inch respectively. An increase in pressure from 127 ½ to 140 pounds per square inch would admit

\* Trans. Inst. M. E., 1910, vol. xl., page 293.

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of a gain of about 5 per cent. in steam-consumption; and, with the temperature increased from 442° to 527° Fahr., the total heat in each case was respectively 1,231 and 1,272 units, which would represent a further gain of about 3 per cent. in steam-consumption. After applying these corrections, the figures approximately agreed.

With regard to the costs given by Mr. Mountain, he (Mr. Hudspeth) respectfully submitted that they were not correct. The estimated cost of steam winding was possibly correct, but it should be borne in mind that estimated costs, as drawn up by a firm of steam winding-engine builders, would in all probability be somewhat conservative—certainly not liberal. Again, estimated costs were not actual costs under working conditions, as was the case with the Castellengo Colliery costs.

In considering Mr. Mountain's costs of electric winding, it would be noticed that the wages of the men had been taken at the same rate as in the steam costs. This could not be correct, as the wages that ought to be charged to electric winding were only those of the winding-men themselves, other wages being included in the current cost charged to plant. On the other hand, wages charged for steam winding must include, in addition to the winding-men, charges for boilermen and firemen. A similar argument applied in the case of oil and stores. Again, interest and depreciation on the generating plant had been charged twice, as the cost of current charged to the winding-plant included these two items. The cost of the current generated at Castellengo Colliery was rather high, owing to the somewhat large steam-consumption of the turbo-generating plant.

With regard to the costs of the plant at the Heinitz Mine, at which the Brown-Boveri system of winding, with the Ward-Leonard control, was installed, he (Mr. Hudspeth) submitted a corrected table of costs per 100 tons wound, as follows:—

Steam consumption of direct. current generator, with steam at a pressure of 140 pounds per square inch and a temperature of 527° Fahr., in pounds	3,920
Current-consumption, in Board-of- Trade units	180
Cost of current, at 0·15d. per unit	2s. 3d.
Wages of men	1s. 3d.
Cost of oil, stores, etc.	1d.
Interest and depreciation, at 15 per cent. per annum	7s. 6d.
Total cost, including interest and depreciation	11s. 1d.
Steam consumption of direct. current generator, with steam at a pressure of 140 pounds per square inch and a temperature of 527° Fahr., in pounds	3,920

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The charge of 0.15d. per unit for current was not too low, when it was considered that interest and depreciation were not included, these being given under a separate heading. Moreover, under the circumstances, the working-cost of generating would be small, as attendance charges, etc., were divided over the whole turbine-plant. Interest and depreciation were calculated on a capital expenditure of £8,000, which made ample provision for the winding-motor, generator, and part of the turbine; in this case, there was no expensive Ilgner set.

Mr. Futers suggested that, at the Heinitz Mine, a steam winder in conjunction with an exhaust-steam turbine-plant would have been more satisfactory than the present installation. In the first place, it was rather difficult to accept Mr. Futers' figure of 30 pounds of steam per shaft-horsepower, when 46 pounds had been given by Mr. Mountain in his estimate, which, as had already been pointed out, was probably on the low side. Again, he (Mr. Hudspeth) questioned very much whether it would be economical to instal a low-pressure plant for so small an output as 150 kilowatts. The total capital-cost of such a plant would be something like £2,250, which, added to the estimated cost of the steam winder, would bring the total cost up to £8,580—that was, only £470 less than Mr. Mountain's estimated capital-cost for electric winding. Mr. Futers had also pointed out that by so doing the average steam-consumption over an aggregate of 424 horsepower was only 16 pounds per horsepower. This was possibly true, but it was also true that the average steam-consumption per horsepower at the Heinitz Mine, over an aggregate of 1,616 ½ horsepower, was less than 13. Moreover, steam winders, as designed by Mr. Mountain and Mr. Futers, would in both cases have to be taken out, and replaced by other plant when the maximum shaft output, from a depth of 2,526 feet, was reached.

He (Mr. Hudspeth) suggested that taking the cost of winding per 100 tons as the basis of comparison was not correct practice. For instance, let them consider two plants, each identical in drawing capacity, the one drawing 10 and the other 15 hours per day: in the former case, the cost per 100 tons wound, so far as interest and depreciation were concerned, would be 50 per cent. in excess of the latter. The improvement in the load-factor by working 15 hours instead of 10 hours must also not be overlooked.

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In conclusion, there were in Germany, as in England, although to a less extent, what might be termed "show " collieries where more capital had been expended than was warranted. He had visited some fifty collieries in Germany, and was decidedly of opinion that Mr. Futers, and others holding similar views, were under a serious misapprehension when they stated "that engineers in Great Britain had nothing to learn from Germany, unless it was how not to do these things," the supreme perfection of the English mining engineer being thereby practically inferred.

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The Secretary read the following paper, by Mr. Simon Tate, on "The Electrification of the Underground Machinery at Trimdon Grange Colliery " :—

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THE ELECTRIFICATION OF THE UNDERGROUND MACHINERY AT TRIMDON GRANGE COLLIERY.

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By SIMON TATE.

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Introduction.—As the equipment of collieries with electric power has become a question for the careful and serious consideration of many mining engineers, the writer feels that the following particulars relating to a plant which has been installed recently at Trimdon Grange Colliery, together with some of the results of its working, might be of interest to the members of the Institute. Fig. 1 shows the surface-arrangements at the colliery.

The immediate reason for this important and costly undertaking was due to its having been decided to unwater Garmondsway Colliery, which had been standing idle since the year 1844. It was known that a considerable feeder of water was pumped from this colliery when it was working, and a tradition existed that shortly after the colliery had stopped, but while pumping was still going on, an overman going one morning to carry out his usual inspection of the workings, found that the cage descended into water some distance above the hanging-on level. As nearly all the workings were to the dip of the shaft, the inference was that they were full of water, and as the ordinary feeder had previously been kept easily in hand with the pumping-engines, it was very evident that either the pumpmen had grossly neglected their duty, or that some additional water had found its way into the workings from the Magnesian Limestone (the principal water-bearing stratum in the district), which at this colliery is only about 90 feet above the Harvey Seam, the seam that had been worked. As the workings for a considerable distance abutted on the "Butterknowle Fault," it was obvious that the management were afraid of tapping the water in working this seam, as they had not taken any pillars out, but had reduced them to as small a size as was safe; in fact, it is reported that at one time they had made them too small, and thus brought on a

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[Fig.1.---Plan showing Surface Arrangements at Trimdon Grange Colliery. Scale, 160 Feet to 1 Inch.]

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"creep." It was therefore within the bounds of possibility that the 90 feet of strata had become broken, and that the limestone feeders had burst through, as suggested.

Since the year 1844, the Five-Quarter, Main Coal, and Low Main Seams at Trimdon Grange Colliery have all been worked up to, over, and above the position of Garmondsway Colliery Harvey Seam workings (Fig. 2); and each time, as the workings of these seams have approached the point where they abutted on the

[Diagram: Fig. 2.—Section of Strata showing Seams Outcropping against Limestone at Garmondsway Moor. Horizontal Scale, 132 Feet to 1 Inch ; Vertical Scale, 240 Feet to 1 Inch.]

limestone, large feeders of water have been given off. Consequently, it was expected that the feeders now to be pumped would have been much less than in 1844, an expectation, however, which has not been realized.

Before coming to any decision as to a new and larger pumping-plant, it was determined to test and prove the volume of the feeders of water which would be got from Garmondsway Colliery. A set of boring places were therefore driven in the Harvey Seam,

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and bore-holes 190 feet in length were put through into Garmondsway Colliery old workings, the water being tapped at a pressure of 250 pounds per square inch, the exact pressure which the levels showed should be due to the head of water present. In the year 1907, advantage was taken of a 12-weeks' strike to run off as much water as the pumps and the winding-engine (winding with two 500-gallon water tubs) could raise, and during this period the level of the standing water was lowered considerably; but when the strike ended, and it was only possible to draw at nights and at week-ends, it was found that the water rose rapidly. It was, therefore, decided to instal a new pumping-plant in the Harvey Seam at Trimdon Grange Colliery, as that seam lies to the dip of Garmondsway Colliery, and at this point to pump all the feeders of water coming from the old workings, as well as the feeders from Trimdon Grange Colliery Harvey Seam.

For some time past, the steam haulage- and pumping-plants had become gradually overtaxed, and the question therefore presented itself as to whether this should be met by additional steam-appliances, or by a complete remodelling of the entire power-supply by the application of electricity. These alternative schemes were the subject of a joint report by Mr. William Armstrong and the writer, and their decision being in favour of an electrical installation, it was decided to remodel both pumping and haulage systems on the lines recommended.

It is interesting to note that it is stated by the old men about the place, that this colliery was the first to have steam conveyed from the surface to supply haulage-engines placed in the seams underground.

For the supply of electricity, it was arranged to instal two generators, to be driven by two mixed-pressure condensing turbines, using the waste-steam from the surface-engines for their supply during coal-drawing hours, and partly live steam from the coke-oven boilers at other times. It was also arranged that the generating plant should be of sufficient capacity to

drive all the underground pumping and haulage machinery, and thus to dispense with the use of steam-driven machinery altogether for the underground work.

For the main pump, it was considered advisable to put in a Sulzer turbo-pump, capable of pumping 600 gallons per minute

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against a head of 1,000 feet. This pump has now been at work for about 16 months; it has worked well, and has never given the least trouble. It has a suction varying from 10 to 14 feet below the level of the pump.

Generating Plant (Figs. 3, 4, and 5).—This plant consists of two Parsons mixed-pressure condensing steam-turbines, each driving a 350-kilowatt three-phase Parsons alternator, with a periodicity of 40 cycles per second, and yielding an output of 95 amperes at a voltage of 2,750, when running at 2,400 revolutions per minute. In practice it has been found that these alternators

[Photograph: Fig. 3.—Steam-turbine, Dynamo, and Switchboard.]

have a large margin of output, and can be run continuously up to 25 per cent. over their guaranteed output. They are fitted with the Parsons compounding arrangement, which has the effect of keeping the voltage remarkably steady, in spite of considerable fluctuation in the load due to the haulages. The action of the apparatus is practically instantaneous, so that the voltage is quite steady enough to be used for lighting as well as for the supply of power.

The exhaust-steam from the two winding-, one fan-, and a small surface haulage-engine is conveyed to the turbines through

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a range of cast-iron pipes, 21 inches in diameter, which were formerly the pump-trees of a discarded lifting set (Fig. 1).

Condenser.—The class of condenser to be used was the subject of much consideration, owing to its being necessary occasionally to use the pit-water, which is strongly impregnated with lime. The experience gained at an adjoining colliery, where there is a surface-condenser using the same kind of water, was that the water was most deleterious to the tubes, as they rapidly became seriously encrusted, which occasioned interruptions and considerable expense for cleaning and renewal. It was therefore decided

[Photograph: Fig. 4.—Steam-turbines, Dynamo, and Switchboard.]

to adopt a multiple-jet condenser of the Westinghouse-Le Blanc type (Fig. 6), guaranteed when both turbos are running at full load to maintain a vacuum of 93 per cent. of the atmospheric pressure as recorded by the barometer; in practice, 90 per cent. is obtained. The condensing water is circulated by a motor-driven centrifugal pump, a centrifugal air-pump (which is the chief feature of this condensing arrangement) being threaded on to the

same spindle as the circulating pump; both are driven direct from a Dick-Kerr squirrel-cage motor, which, running at a synchronous speed of 480 revolutions per minute, requires a current of 14 amperes.

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Water-cooling Plant—This plant consists of a Harrison spray-cooler (Fig. 7), capable of dealing with 130,000 gallons of water per hour, the temperature of which it reduces 12° to 15° Fahr. before running it back to the circulating-pump suction.

[Photograph: Fig. 5.—Steam-turbines, showing Valve-gear.]

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Switchboard.—The switchboard (Figs. 3 and 4) is of the cellular type, having all the necessary recording instruments on front of the board, the live parts being securely locked up in separate cells behind the board, and fitted with remote control

[Photograph: Fig. 6. —Condensing Plant.]

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throughout. Each generator- and each feeder-panel is fitted with overload trips, no fuses being used, and each circuit has its own integrating wattmeter, so that the exact amount of power going to each feeder-circuit can be ascertained. The board is also fitted with a leakage-indicator, and is considered very safe, as every element on the front is perfectly dead.

Cables.—The main cables are all of the Callendar paper-bitumen insulated double-wire armoured type, the main cable from the switchboard being of 0.15 square inch area. This cable is suspended in the shaft every 60 feet by wooden cleats, which

[Photograph: Fig. 7.—Water-cooling Plant.]

are so weathered as to shed off all water. The cable is led into a junction-box at each seam, and out again into the shaft to the next seam, until the bottom seam is reached, where the last junction-box is placed. From each of these junction-boxes, feeders are taken for the pump- and haulage-motors, each branch being of paper-bitumen, insulated and single-wire armoured, and of 0.062 square inch area.

Pumping-plant.—The Sulzer pump (Figs. 8 and 9) is of the high-lift centrifugal type, having eight stages, and is capable of delivering 600 gallons of water per minute against a manometric

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head of 1,000 feet. It is driven direct by a Dick-Kerr motor of 250 horsepower, of the slip-ring type with wound rotor, the starting resistance being suitable for starting against a full load. The motor, when at full load, takes 42 amperes, with a synchronous speed of 1,200 revolutions per minute.

For dealing with the feeders of water met with in the workings of the Harvey Seam, there are a number of hydraulic pumps, all of which are driven from the rising-main of the Sulzer pump. One of these hydraulic pumps is situated as much as 180 feet below the level of the shaft-bottom, and is over a mile distant from the shaft.

[Photograph: Fig. 8.—Sulzer Electrically-driven Pump in the Harvey Seam.]

There is also what the writer considers a novel method of raising the water from the shaft-sump by means of a water ejector. To work this, advantage is taken of a feeder of water coming from the Low Main shaft, having a head above the Harvey sump of about 220 feet, which, passing through the ejector, raises the Harvey sump-water to a height of about 36 feet to the flat-sheet level, whence it runs to the main standage. If this feed fails at any time, there is a duplicate arrangement whereby another ejector can be driven from the Sulzer pump rising-main, so that the whole of the pumping in

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the Harvey Seam—that is, both the in-bye pumping and the shaft pumping—may be said to be done by the one Sulzer pump. This may not be quite as economical for the in-bye pumping as taking the electric current in-bye and driving an electric power-pump, but for special reasons it is desirable to confine the electric-motors to positions as near the bottom of the downcast shaft as possible.

Haulage-plant.—The old underground haulages having proved inadequate, owing to the necessity of overcoming greater distances and heavier gradients, it was imperative that the electric haulers should be more powerful than the replaced steam

[Photograph: Fig. 9.—Sulzer Electrically-driven Pump in the Harvey Seam.]

haulers. All four main-and-tail-rope haulages have been converted from steam to electricity. For uniformity, and also in order to lessen the necessary number of spare motors, a standard motor of 150 horsepower was adopted (Figs. 10, 11, 12, and 13) in three cases; in the fourth, which required more power, two 150-horsepower motors (Fig. 14) were coupled in tandem on the same spindle, both of them being interchangeable with all the other haulage-motors, so that one spare motor is a spare for all the four haulages, as well as for the condenser-motor. These haulage-motors are of the slip-ring type, having wound rotors

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and a synchronous speed of 480 revolutions per minute, and are controlled by liquid controllers of the Westinghouse pattern. The range of control is all that can be desired for the steady starting-up of the sets from rest to their maximum speed, and for slowing down when stopping, or for slow running when men are in the sets. The speed of the haulage is from 6 to 10 miles per hour.

Shaft-siding Creeper.—The small creeper for operating the tubs in the shaft-siding has a 10 to 20-horsepower motor of the slip-ring type, with wound rotor and liquid control, driving

[Photograph; Fig. 10.—Electric Haulage-gear and Motor in the Main Coal Seam.]

through a worm-gear a fleeting wheel for the endless rope. For this motor the voltage is reduced from 2,750 to 500 volts by an oil-cooled transformer.

Lighting.—The whole of the colliery premises, both surface and underground, are lighted by electricity, which was previously generated by two compound steam-engines, driving two direct-current dynamos, with an output of 23 kilowatts each at a voltage of 220. For this plant a 75-kilowatt transformer, taking current from the turbogenerators and reducing it from 2,750 to 220

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volts, was substituted. This arrangement is sufficiently large to meet the lighting requirements of the village.

Electrical Plant.—The following comprises the electrical plant, the whole of which is driven by one electric generator : —

	No. of Motors.	Horse-power.
One Sulzer pump, pumping all the feeders	1	250
No. 1 Harvey Seam haulage	2	300
No. 2 Harvey Seam haulage	1	150
Low Main Seam haulage	1	150
Main Coal Seam haulage	1	150
A small endless-rope hauler	1	12
A static transformer up to 75 kilowatts, equal to	1	100

[Photograph: Fig. 11.—Electric Haulage-gear in the Low Main Seam, showing Rope-drive.]

It will be seen that the total horsepower of the various motors and the transformer exceeds the output of the generator; but, as all of them do not at any one time require their maximum current, the single generator has been found sufficient to keep them all going.

On ordinary working days, the whole of the current required for driving the Sulzer pump and the haulage is generated from the exhaust-steam of the two winding-engines, one fan, and a small haulage-engine, supplemented by live steam whenever necessary. After coal-drawing hours and at week-ends, the

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steam required for driving the generators for the pumps, and for lighting, is obtained by high-pressure steam from the four boilers fired by the waste-heat from 73 beehive coke-ovens, the hand-fired boilers being damped down.

Previously the boiler-plant consisted of ten Lancashire boilers, six hand-fired, and four heated by coke-oven gases, all of which required to be driven both day and night. Had a steam-pump been installed, at least two additional Lancashire boilers of a large type, and hand-fired, would have been needed. By the installation of the electric plant, seven boilers have been able

[Photograph: Fig. 12. —Electric Haulage-gear in the Low Main Seam, showing Drums and Rope-drive.]

to do all the work required, the four coke-oven boilers working continuously, and two of the hand-fired boilers during coal-drawing hours in the day-shift only; whilst the third hand-fired boiler is used only on Mondays and Tuesdays, when the coke-oven boilers are slack.

Boiler Feed-water.—Previous to the installation of the turbine-plant, the feed-water for the boilers was heated by passing it into water-heaters, into which the various surface-engines exhausted, and by this means the feed-water was heated up to about 180° Fahr. It was anticipated that considerable loss would be sustained

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if cold water was used for the boiler-feed, and it was therefore arranged to pass the feed-water through a special heater placed immediately over two exhaust-steam receivers, which are fixed near to the turbine-plant. The feed-water is taken from the condenser discharge-pipe, and passes through two sets (five each) of nozzle-sprays, which are placed inside this special heater. All the exhaust-steam that is not taken by the turbines is sent by means of a bye-pass through this heater, and assists in heating the feed-water. Moreover, it has been arranged that all the condensed water which collects in the heaters at the various engines

[Photograph: Fig. 13. - No. 2 Electric Haulage-gear and Motor in the Harvey Seam.]

shall also pass into the feed-water, whereby the temperature of the feed is brought up to 170° Fahr., or slightly less than under the conditions existing before the exhaust-steam was used for driving the turbines.

Exhaust-steam Receivers.—The exhaust-steam from the winding- and fan-engines is conveyed into the old feed-water heaters at each engine, thence to two additional receivers, which are placed adjacent to the turbos, and from these receivers into the turbine cylinders.

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Conclusions.—The immediate benefits derived from the working of the whole installation may be summarized as under:

- (a) Dealing easily with the feeders of water, which vary between wet and dry weather from 350 to 500 gallons per minute, pumping the Trimdon Grange Colliery feeders, and unwatering the whole of the workings of the Garmondsway Colliery.
- (b) Pumping all the water, about 90 gallons per minute, in the Trimdon Grange Colliery Harvey Seam dip-workings by hydraulic pumps driven from the Sulzer pump rising-main.
- (c) Increasing the horsepower of all the underground haulages, most of which were considerably below the requirements.

[Photograph: Fig. 14. — No. 1 Electric Haulage-gear and Motors (Twin) in the Harvey Seam.]

- (d) Doing all the extra pumping, and hauling an increased quantity of coal with four less hand-fired boilers than previously, and six less than would have been required if a steam pumping-plant had been adopted.
- (e) Lighting all the colliery premises from the turbine generator through a transformer, thus saving two high-pressure steam electric generators. ,
- (f) A reduction in the working-costs of the colliery, by the reduction of the number of hand-fired boilers and firemen, and the saving of fuel consumption.

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- (g) The generation of electric current at a cheaper rate than that at which it can be purchased.

The saving in boiler-fuel and labour is considerable, and is as follows :—

[Tables of Accounts for Coal and Labour, omitted.]

Total amount saved per Annum:

	£	s.	d.
Coals	2,246	8	0
Labour	344	14	4

Add, Cost of working two additional boilers, which would have been required if the old system had been continued, £500 per annum	1,000 0 0
	£3, 591 2 4

The problem of reducing the steam-consumption of the ordinary non-condensing reciprocating engines commonly used at collieries has received a large amount of consideration, and

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in many cases a central condensing-plant has been put down. The results have not, however, proved satisfactory, for the reason that the condensers are necessarily some distance from the reciprocating engines, and the reciprocating engines being constructed, for non-condensing, the steam-ports are too small to obtain a high effective vacuum in the cylinders. There is also considerable loss of vacuum due to friction and air-leaks in a long line of piping. In exceptional cases, as much as 20 per cent. has been saved with such an arrangement, but in most cases a saving of 10 or 12 per cent. is about all that is realized by a central "family" condenser.

If the steam from the reciprocating engines is passed through a low-pressure turbine before coming to the condenser, it is possible to make use of every inch of vacuum obtainable, and where a sufficient supply of cold water is available, cent. per cent. of the power of the reciprocating engines can be recovered; but with ordinary vacuum from 26 inches upwards, the power that can be recovered from the exhaust-steam will vary from 40 to 80 per cent.

From the indicator-cards taken on the reciprocating engines from which the supply of exhaust-steam is drawn, there is, in round figures, about 800 horsepower per hour. The total brake-horsepower of the motors installed is approximately 1,200.

During January, 1911, the plant ran for 722 hours, and generated 182,000 units, the maximum observed load being 620 kilowatts, which gives a load-factor of about 41 per cent.

The average hourly load during the day-time is between 275 and 350 kilowatts, with occasional peaks up to 500 kilowatts; but when all the reciprocating engines are running, it is easy to maintain this load with exhaust-steam.

Since the completion of the electric installation, it is found that the running cost at the switchboard is about 0.045d. per unit, and the total cost does not exceed 0.15d. per unit, after allowing for interest on capital and depreciation.

From the experience gained in the present instance, the writer is of opinion that at collieries where a considerable quantity of electric current is required, and where there is a large amount of exhaust-steam from high-pressure winding, haulage, or ventilating engines situated within reasonable distance of each other, electric current can be generated by exhaust and

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mixed-flow turbines at a cheaper rate per unit than is possible in cases where fuel has to be purchased for this specific purpose; and the adoption of this system of utilizing the waste-steam for the production of electricity is worthy of general consideration. Even at collieries where there is sufficient heat from coke-ovens to generate all the steam required for colliery

purposes, the exhaust-steam from the engines, and the surplus steam from the boilers, could be utilized to generate electricity which could be sold, and thus turn a waste product into profitable merchandise. The total units generated during the year 1910 were 1,860,000, and taking the rate at which the plant is at present working, this would work out at just 2,000,000 per annum.

Mr. W. C. Mountain (Newcastle-upon-Tyne) wrote that Mr. Tate was to be congratulated upon putting before the Institute an extremely practical and interesting paper. He had had an opportunity of seeing the installation at Trimdon Grange Colliery, and considered that the general way in which it had been carried out reflected great credit upon the management. It appeared to him to be a typical case where exhaust-steam could be utilized economically. There were undoubtedly many collieries in the United Kingdom, and also abroad, where the management could avail themselves of the advantages offered by exhaust-steam or mixed-pressure turbines; and the paper would help very considerably those interested in coming to a definite conclusion as to the installation of such plant. He thought, however, that the author had omitted several rather necessary points in his paper.

Information was given as to the source from which the exhaust-steam was obtained, but it would add very much to the value of the paper if Mr. Tate would also give full particulars of the size of each of the winding-engines and their speed at maximum velocity of winding; the weight of coal per wind, and that of the tubs, cages, slings, and winding-rope, so that one could calculate from such data the actual horsepower in the shaft. By shaft-horsepower he (Mr. Mountain) meant the actual horsepower in winding the coal, assuming that the winding was continuous, and omitting any horsepower required for the weight of the rope, acceleration, windage, etc. It would also add to the interest of the paper if particulars of the ventilating fan were

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given together with the size of the engine, the number of revolutions per minute, the quantity of air, and the air-pressure. In the case, too, of the haulage-engine, particulars as to the size of the cylinders, the load hauled, and the standing and running time would be of service. The steam-pressure in the boiler was also omitted. With these data it would be possible to estimate pretty closely the actual amount of exhaust-steam available, and a valuable guide to those proposing to instal such a system would be available.

The conclusions were, he thought, very clearly stated, and their value would, without doubt, be increased if the total cost of the turbine-plant—that is, the steam-turbines with their generators, switchboard, condensing plant, cooling-pond, and reservoirs---was given. This would enable anyone contemplating the adoption of such a plant to form an idea as to the time that would be required to pay off its cost, after allowing for interest and depreciation.

The statement that the running-cost at the switchboard was about 0.045d. per unit, and that the total cost did not exceed 0.15d., was particularly interesting, but, in justice to himself, the author should have stated the percentage allowed on capital and for depreciation. Personally, he (Mr. Mountain) would be disposed to charge such a scheme with 5 per cent. interest on capital, and from 7 ½ to 10 per cent. was, he thought, a fair amount to include for depreciation. The total cost of 0.15d. per unit was, of course, arrived at after charging interest and depreciation on the stand-by plant. If it were on the running plant only, the cost per unit would be approximately 1.1d., and this bore out the statement which he had repeatedly made—that with an exhaust-steam plant current could be produced, including interest and depreciation, at from 0.125d. to 0.15d. per unit. It therefore seemed that if one

could obtain electricity at so low a cost in that way, where steam was required at a colliery it was undoubtedly desirable to put in steam winding-engines, if they were of large size, and utilize the exhaust-steam from such engines, and from engines on the surface, for the production of electrical energy in the way described.

He (Mr. Mountain) understood that the Newcastle-upon-Tyne Electric Supply Company, Limited, who thoroughly appreciated the competition which was likely to arise from the use of

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exhaust-steam turbines at collieries in their district, were prepared to arrange for a supply of current from their system, so that it was only necessary for colliery owners to put in one exhaust-steam turbine, and the stand-by supply could be called upon when required, a nominal charge being made for the laying-in of the current. This would probably be of importance to colliery owners who might not feel disposed to spend the money necessary for a complete stand-by or duplicate.

He noted with interest the arrangement adopted for boiler feed-water heating and exhaust-steam receivers, and he thought that the author was very wise not to instal expensive special exhaust-steam receivers. He (Mr. Mountain) was strongly of opinion that the most satisfactory type of receiver was one or more old boilers, and, if possible, this arrangement could be made more effective by passing the boiler-flue gases round the receivers. In this way it was possible to obtain considerable economy in feed-water heating, and such an arrangement produced very effective receivers. It always seemed to him that, as no receiver which had yet been made was capable of bridging stops of more than half a minute or, at the very outside, one minute duration, the expense incurred in installing this apparatus was altogether out of proportion to the benefits obtained.

Mr. F. R. Simpson (Blaydon-upon-Tyne) congratulated the author upon his paper. At a colliery with which he (Mr. Simpson) was connected, a Worthington single-stage pump of about 350 horsepower was installed some time ago, and he would very much like to know what sort of combined efficiency Mr. Tate was getting out of his Sulzer pump. With regard to the cost of generating power, this seemed to him to be very low, but perhaps the author had not charged any high rate for interest and depreciation. If his (Mr. Simpson's) calculations were correct, something like £10,000 had been charged for the cost of the whole installation, but he was of opinion that it must have cost more than that. He thought that, after the plant had been running some time, it would be found that the total cost per unit had been rather more than 0.15d.

The President (Mr. M. W. Parrington) asked whether Mr. Tate had found, on the application of the turbine, that he got any back-pressure in his winding-engine cylinder.

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Mr. W. C. Blackett (Sacrison) asked whether it was really an important matter that there was back-pressure, within a pound or two. Referring to Mr. Simpson's remarks, he thought that a comparison of the two pumps would not be easy, inasmuch as there was an extraordinary difference in efficiency, depending on the quantity of water and the head; a small quantity with a heavy head could not possibly have the same efficiency as a large quantity with a low head.

Mr. Simpson remarked that his quantity was 3,000 gallons, with a head of 300 feet.

Mr. H. W. Clothier (Wallsend) said that it appeared to him that the safe application of electricity for power purposes in mines should be considered under two very distinct heads, namely, (1) when used at or about the coal-face, and (2) when used for pumping, haulages, etc. The former condition certainly introduced many difficulties which were uncommon to surface work, but he thought that the conditions classified under (2) did not differ very materially from any well-constructed installation above ground, so that there could be no question as to the correctness of the author's policy in adopting electricity on the score of safety; moreover, the results also proved beyond doubt the wisdom of the change as a sound commercial venture.

It was satisfactory to note the results obtained by the Parsons compounding arrangement, which he understood to be an arrangement of winding on the alternator. On installations where there was not a large amount of power-supply available, a good system of automatic regulation was essential, and it had been a common practice on alternating-current systems to obtain this by the use of automatic shunt regulators, which included an apparatus with intricate parts and connexions designed to regulate the field-circuit of the alternator so as to correspond with the variations in the load. He thought that the author had done well to avoid such apparatus.

With regard to the switchboard, he preferred to have all live parts completely enclosed in a strong metal armouring. The author stated that the board is "considered very safe, as every element on the front is perfectly dead." It did not necessarily follow, however, that the board was safe because every element on the front was dead; and, although in this case every reasonable

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precaution appeared to have been taken towards locking off the live parts in separate cells at the back of the board, he thought that safety was best obtained by constructing the gear in such a way that all live parts were completely enclosed, and that none but metal which was at earth-potential should be accessible either at the front or the back.

He would like further particulars as to the kind of overload trips on the generators and feeders, and suggested that it would be of interest if a diagram were given, showing the connexions of

[Diagram: Fig. 1.—Combined Cable Joint Box and Transformer for Pit Lighting.]

the switchboard and details as to the various settings of the automatic protective gear. Was the neutral point insulated or earthed? He admitted that there was much to be said for both systems of connexion, but he preferred the latter. Incidentally he thought that it would avoid the necessity for the use of the leakage-indicator mentioned by the author.

With regard to lighting, he understood that the reason for the adoption of 220 volts was to allow of the use of the existing

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lighting connexions, but possibly for a new installation it would be better to use a lower voltage. Fig. 1 showed a transformer specially designed for lighting in mines, the object

being to combine a lighting transformer with a joint box, so that a low voltage-supply—say, 25 or 50 volts—could be tapped off at intervals from the cable along the main roads. In this instance, an earthed system had distinct advantages, as it saved the necessity of leakage-indicating devices and earth-shields, or other provision for protection against the possibility of the secondary becoming accidentally raised to the potential of the primary conductors. A diagram showing the proposed connexions was illustrated in Fig. 2.

The saving that the author effected by the adoption of electricity for power purposes was remarkable, and it would seem that all collieries working under similar conditions could with advantage adopt similar measures. It should, however, be considered whether even a greater saving might not be effected by the adoption of electricity for power throughout the colliery.

The cost of 0.15d. per unit would be of great interest to the electrical industry, and it would be quite impossible for a power-company at present to supply at a price which would compete with that figure. He questioned, however, whether the author had taken his figures on a fair basis. They certainly would not apply to the laying-out of a new installation, and it seemed very much like a case of "robbing Peter to pay Paul." The existing surface engines were retained, and it was apparently by virtue of the inefficient system of running these non-condensing that a large amount of exhaust-steam was available for use in driving

[Diagram: Fig. 2.—Diagram of Connexions of Combined Cable Joint Box and Transformer for Pit Lighting.]

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the electrical equipment. This exhaust-steam having previously been considered waste, it was counted as costing nothing, to the advantage of the cost per unit of the electricity generated. Probably, when considering the capital outlay, it was the best economy to retain the existing surface engines; but, it would be very interesting to know what would be the cost per unit for new work if the whole plant, including the surface engines, were electrically driven, and what would be the total steam-consumption. It was well known that collieries in the district could instal their own generating plant, utilizing the waste-heat from coke-ovens, and by connecting up to the power-supply companies they could send their surplus power into a common pool. He suggested that, if they could generate electricity at 0.15d. per unit, it would be a profitable undertaking, and that it ought to be worth while to put down more coke-ovens and increase their revenue by the sale of electricity.

Mr. Blackett said that the last speaker's remark, that they might be "robbing Peter to pay Paul," required consideration. He (Mr. Blackett) thought that there might be a good deal in it, but at the same time, it must be remembered that collieries were not existing under the conditions in which a power-company found itself when it went to virgin ground for the purpose of putting down a station and erecting all its machinery for a definite purpose. A colliery company existed under quite different circumstances, among which was the matter of winding-engines, which involved a totally different requirement from that of the finest engines that could be put in to generate power, and some consideration should be given to that particular point—the use to which, in many cases, collieries put steam. A winding-engine, or haulage-engines winding their loads, could not be impeded by refinements such as were put on the engines for power-generation. To some extent Mr. Clothier's remark was deserved, but at the same time he did not think that Mr. Clothier was giving quite fair play in his account of the other side of the question.

Mr. R. W. Glass (Axwell Park Colliery) asked whether the author could give them a diagram showing what the fluctuations of the voltage were. Mr. Tate had a generator of 350 kilowatts, and it was sometimes running up to a maximum observed load of

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670 kilowatts. He would also like to know whether the voltage was controlled by hand-regulation, shunt-winding, or how.

Mr. Simon Tate (Trimdon Grange Colliery) said that he had, at other times, benefited from papers presented to the members, and in communicating his paper he had been amply repaid for anything of interest which he had been able to bring before them. He would prefer not to reply to the various criticisms and remarks at present; they would, however, receive his careful consideration, and he hoped to be able to give all the information asked for at the next meeting.

The President (Mr. M. W. Parrington) said that the members were very much indebted to the author for his paper. He thought that it was one of the most interesting communications that had been before them for a long time. It would certainly raise a good deal of discussion, and a good deal of thought in the minds of those who were considering the application of electricity and mixed-pressure turbines. He proposed a vote of thanks to Mr. Tate.

The vote of thanks was cordially adopted.

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Mr. G. Percy Ashmore's paper on " The Occurrence of Diamonds in German South-West Africa " was taken as read, as follows :—

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#### THE OCCURRENCE OF DIAMONDS IN GERMAN SOUTH-WEST AFRICA.

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By G. PERCY ASHMORE.

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Introduction.—Diamonds were first found at Kolmanskop, in Luderitz Bay, by a Kaffir boy named Mrokan, who, not knowing- what the bright stones were, handed them to his "boss," August Stauch, who promptly took out eight claims, which were registered in Swakopmund by the Kolonial-Gesellschaft on May 14th, 1908. Since that date more than 400 claims have been taken up by various private companies and individuals, and the German government have been granted thirty. The area covered by a claim is at the present time the land enclosed in a circle with a radius of 1 kilometre, while the "Abbaufelder," or mining claims, are rectangular pieces of land, measuring 50 by 50 metres. The diamonds are found in sand-dunes, and not at a greater depth than 3 inches from the surface.

Output, etc.—August Stauch, together with — Lenz (the contractor for the Luderitz Bay Railway) and two others, formed a company consisting of only themselves, and have up to date produced 10,000 carats\* monthly: the rest of the companies and individuals bring up the total monthly output to 14,000 carats.\* The diamonds are very small, averaging about 3 stones to the carat, and are selling at Cape Town at about 26s. per carat.

Geology (Fig. 1, Plate III).—The country consists principally of gneiss, granite, hornblende-dolerite, and sandstone conglomerate of Cretaceous age. The surface is covered with sand-dunes, and the sandstone conglomerate furnishes the diamond-fields with a brackish water, the brackishness of which is accounted for by the decomposition of the felspar contained in

\* A diamond carat is 3.1683 grains troy or 205.3 milligrammes.

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the granite and gneiss. The lime is changed into a carbonate, and the other salts, being more soluble, are leached out, and collect in the water below the surface, making it brackish.

Occurrence of Diamonds.—The following theories as to the occurrence of the stones have been brought forward by various geologists who have visited the fields : —

(1) That the diamonds have come from the Orange River.— The writer's objection to this theory is that a large number of the diamonds have flaws, which they would not have if they were river-stones. It is an accepted fact that the reason why river-stones are flawless is because such flaws form the lines of least resistance, and when stones and boulders are rolled about by river-action, the flaws become broken up and disappear; consequently, river-stones are generally more valuable than pipe-stones.

(2) That they have been directly derived from the sea.—The writer's objection to this theory is that the action of the sea on the beach would be precisely the same as that which takes place in river-beds, but more violent.

(3) That they are locally formed, and the hornblende-dolerite is the matrix.—With this idea the writer does not agree, because the local dolerite, gneiss, and granite do not contain the minerals that are found with the local diamonds, namely, bort, serpentine, olivine, jasper, corundum, garnets, agate, and ilmenite.

(4) — Merensky and — Frames consider that the diamonds were deposited contemporaneously with Cretaceous sediments occurring there, and that these beds on disintegration were concentrated by the wind in the valleys.

(5) — Lotz assumes that the diamonds originated from the area of the Vaal River, and were carried into the sea by the Orange River, the distribution along the coast having been effected by ocean-currents, and finally by the wind in a northerly direction inland. It must be admitted that the occurrence of numerous waterworn pebbles of agate, etc., along the present coast, as well as some miles inland at an altitude of 150 feet above the present sea-level, made that view appear feasible. Being similar to the Vaal wash, the diamantiferous deposits would be probably derived from the same rocks; but the Vaal River is 500 miles away, and so far no diamonds have been

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found in the Orange River. — Kuntz says that it is possible that the agate pebbles, etc., do come from the Orange River, but that the diamonds are probably of local origin. Prof. Halm thinks that the real source lies in the desert.

(6) The writer's opinion is that all the diamonds are essentially pipe-stones, derived from kimberlite-pipes, dykes, or sheets, because he has found them with flaws and unwaterworn crystals (dodecahedra and octohedra), and also sharp splinters, all of which goes to suggest pipe-stones. Again, most of the accessory minerals which occur in pipes of blue ground in South Africa have been found here also, namely, bort, serpentine, olivine, jasper, corundum, garnets, agate, ilmenite, quartz, magnetite, and chromium diopside. The following, so far as the writer's examination went, were missing, namely, vivianite, topaz, spinel, and bronzite; but it is not every pipe in South Africa that exhibits this complete series.\* Since his visit in November, 1908, the writer has been informed that both yellow and blue ground (or kimberlite) have been found.

The noticeable feature of the diamonds is that they are not much worn, and so cannot have travelled far. All are small stones, averaging about 3 to the carat, but stones of 9 carats and more have been found in rare instances.

Wind.—The prevailing wind is a strong one; during the daytime it blows from south-south-west, and in the night from almost due south. Luderitz Bay is about the centre of the area affected by the Trade winds, and consequently subjected to violent winds, and the diamonds have been blown northwards. The writer therefore concludes that the stones were blown with the wind from a pipe or pipes in a direction north of Elizabeth Point towards Kolmanskop.

\* The "bantam" is also conspicuous by its absence.

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The President (Mr. M. W. Parrington) proposed a vote of thanks to Mr. Ashmore for his paper, which was heartily accorded.

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The following paper upon "The Pench Valley Coal-field," by Mr. F. I. Leslie Ditmas, was communicated to the members at the General Meeting held on December 10th, 1910 : —

[Plate III. —Diagrams of Sections to illustrate Mr. G. Percy Ashmore's paper on "The occurrence of Diamonds in German South-West Africa".]

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## THE PENCH VALLEY COAL-FIELD.

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By F. I. LESLIE DITMAS.

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Introduction.—The following is a brief account of that part of the Satpura coal-basin which the author has been engaged in opening up. To make the paper of more general interest, however, figures and particulars of coal-mining in India are given.

The Satpura coal-field has been known since the year 1827, when it was mentioned by Captain S. Coulthard.\* The total lack of communication with the railways and industrial centres of India, however, prevented the coal from being exploited for commercial purposes. As far back as 1855, Mr. S. Hislop,† the well-known geologist of Kampti, mentioned the discovery of coal close to the Pench river to the south of Bhajipani village, and Major

Ashburner, Deputy Commissioner of Chhindwara, in the year 1866 was in various ways very active in promoting the discovery of coal-outcrops.

Geographical Position.—The Chhindwara district, which became British territory in 1853, and in which the Pench Valley lies, is situated on the Satpura plateau between 21° 28' and 22° 49' north latitude, and 78° 10' and 79° 24' east longitude. It is one of the districts of the Central Provinces, and has an area of 4,631 square miles, and a population of 407,927. Chhindwara, the capital, is the largest and most important town, and is situated 80 miles distant by road and 243 by rail from Nagpur, the capital of the Central Provinces. The distance by rail from Bombay is 763 miles and from Calcutta, 782 miles.

Physical Aspects.—The Chhindwara tahsil, where the collieries are situated, lies at an elevation of over 2,200 feet. The surrounding country is wild and mountainous, often rising to a

\* "The Trap Formation of the Sagar District, and of those Districts Westward of it, as far as Bhopalpur, on the Banks of the River Newas, in Omatwara," by Captain S. Coulthard, Asiatic Researches, 1833, vol. xviii., page 72.

† "On the Connexion of the Umret Coal-beds with the Plant-beds of Nagpur ; and of both with those of Burdwan," by the Rev. S. Hislop, Quarterly Journal of the Geological Society of London, 1855, vol. xi., page 555.

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height of 3,000 feet; it is covered with forests, and divided into jagirs, or hereditary estates of the old hill-chieftains.

Valleys, and patches here and there, are under cultivation. The villages, usually about 3 miles distant from each other, consist of small mud-built houses, with thatched or burnt-tiled roofs, Seethia village (Fig. 5) being a typical example. In this district the strata are masked by an overflow of lava known as the "Deccan Trap."

[Photograph: Fig. 5.—View of Seethia Village.]

Hills.—The marked features of the hill system are the range which forms the southern edge of the Satpura plateau, and that which rises from the central level of the plateau to the highest elevation (3,000 feet), falling again on the north to the Nerbudda valley. The hill-tops are for the most part massive flat-topped trap rock. The metalled roads, although very few, are good.

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Rivers.—The Tawa river rises and flows for a few miles of its course at the western end of the Chhindwara district, some miles from the Pench Valley. With the exception of this and the Pench and Kanhan rivers, the streams are small, and there are no waterfalls of any size that could be made use of for industrial purposes. The Pench and Kanhan rivers are

tributaries of the Godaveri, and flow into the Bay of Bengal; whilst the Tawa river flows into the sacred Nerbudda, which empties itself into the Indian Ocean.

Rainfall.—This is registered at Chhindwara, the average fall for the 39 years ending 1905-1906 being 41 inches. The average fall for June is 7, for July, 11, and for August, 7 ½ inches. The greatest rainfall was in 1878-1879, when 55 inches were recorded, and the smallest in 1899-1900, when only 16 inches fell. The rainy season is usually an anxious time for the Indian colliery manager, owing to the water percolating rapidly into the workings, which are frequently near the surface.

Climate.—The climate is on the whole a good one for Europeans, but the extremes of temperature are very great, varying as much as 40° in 24 hours, and necessitating great care in the choice of dress. The last four months of the year are the most unhealthy, and natives coming from other districts of the Central Provinces also find the additional touch of cold in this district unhealthy. All the colliery bungalows have fire-places, as fires are necessary in the evenings during the cold weather, although the sun is very warm during the middle of the day. The hottest months are May and June, just before the rainy season, which commences about June 15th; after the first fall of rain, the temperature drops very suddenly. The hot winds before the rains are most trying, especially when accompanied by dust-storms, as they often are.

Languages.—The chief languages spoken are Hindi, Gondni, and Marathi, but at the collieries English and Hindi only are spoken by the officials. The Gonds, who form 34 per cent. of the entire population in nearly all of the villages, know how to speak Hindi, and the Pathan hewers (of which there were as many as 300 at times) speak Hindustani and Pushtoo, the latter language, of course, being their native tongue.

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Agriculture.—If the colliery company owns surface-rights and engages in agricultural pursuits, these are in the charge of a special staff, supervised by a European who has expert knowledge in such matters. The chief crops are wheat, juar (millet), kodon (small millet), cotton, jagni (oil-seed), gram, til (sesamum), and tur (*Cajanus indicus*). Only a little rice is grown, and small quantities of linseed, san-hemp (*Grotalaria juncea*), sugar-cane, and tobacco. It is very necessary when importing labour to make sure that all necessaries can be easily obtained at reasonable prices in the local market.

Forests.—Timber plays so important a part in coal and other branches of mining that it is necessary to remark briefly on the local forests. Of the Chhindwara district, excluding the estates of the native chieftains, 24 per cent., or 729 square miles, is occupied by Government forests, which lie on the main southern range of the Satpuras. The felling of the trees is only permitted in certain of the forests, and the number and species limited. The whole of the forest areas are worked on a system to give the largest output of big logs, so that the felling of small trees is not allowed. It is therefore necessary at times to go a long distance for suitable pit-wood, but the Forest Department is always very obliging in trying to meet the needs of the mines. The forests are situated on two principal classes of soil, one derived from the disintegration of trap-rock, and the other from sandstone; it is interesting to

note that the soil derived from trap is richer than that derived from sandstone, and, as a rule, gives a better natural reproduction of forest growth. Teak is found in most of the forests, but unfortunately for mining purposes the trees are small in girth, and difficult to get in long straight lengths. Sal (*Shorea robusta*) is felled near the mines, and is much used for making tub-frames, and for a variety of purposes. Tinsa (*Ougeinia dalbergioides*) is a good timber tree; the bija sal (*Pterocarpus marsupium*) grows to a fine height, but yields very little long straight timber; and the salai (*Boswellia serrata*) is found in abundance, and grows with a straight stem to a height of 30 to 50 feet. There are a number of other species, but these, from a mining point of view, are less important. Propwood costs at the colliery 50s. per hundred pieces.

Railways—The Satpura branch of the Bengal-Nagpur Railway

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enters the district from the east. Khirsadoh Station, which is on the edge of the coal-measures, is 17 miles by rail from Chhindwara, and 15 ½ miles by a good second-class road, suitable for motor traffic. The next station is Barkui, 5 miles farther east and 804 miles from Howrah-Calcutta, and is the present terminus of this branch. There are coal-sidings at Khirsadoh for empty and full wagons, a siding into Chandametta Colliery half-way between Khirsadoh and Barkui, and further sidings at Barkui for the colliery there of that name. The gauge is 2 feet 6 inches, and the permanent way is laid

[Photograph: Fig. 6.—Open Hopper-wagon of the Gondola Type.]

with 41-pound flat-footed steel rails, on sal-wood sleepers. The line is ballasted with stone, except for some 60 miles, where good black basalt has been used. The sharpest curve has a radius of 409 feet, and the ruling gradient is 1 in 80. The collieries are supplied with three kinds of empties— covered vans, with a tare of 6 tons 14 hundredweight, which carry 17 tons of coal; high-sided open trucks, with a tare of 6 tons, which carry 13 ½ tons; and open hopper-wagons of the gondola type, with a tare of 8 tons 15 hundredweight, carrying 15 ¼ tons (Fig. 6). These latter have chilled-steel wheels, and are

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fitted with four doors (which open in the wagon bottom), actuated in pairs by two hand-wheels on either side : they are used for transshipping the coal, by means of a gantry and shoots at Gondia Junction, into the broad-gauge wagons. When one considers the weight carried in the wagon in general use in England, where the gauge is 4 feet 8 ½ inches, one can more fully realize the excellence of the rolling-stock supplied to the Pench Collieries. The entire stock is fitted with the vacuum brake. The Bengal-Nagpur Railway is busily engaged in constructing a lino direct from Nagpur to Chhindwara, a distance of 95 miles, but this is not likely to be in working order much before the end of 1911. It will shorten the coal-haul to Nagpur by no less than 131 miles, and to all places beyond that town towards the west. The gauge of this line will also be 2 feet 6 inches. The Great Indian Peninsular Railway is also busy with a new 5 ½ -foot standard-gauge line into the Pench Valley. It starts from Itarsi Station on the Bombay-Jabalpur main line, runs south for some 60 miles, and then

enters the district from the west, the distance from the Pench Valley coal-field to Itarsi being about 130 miles. This line should be carrying coal towards the end of 1912, and will be of immense service to this field, bringing it into direct communication with the important markets of Central and Northern India, as well as the great manufacturing centre of Bombay. It should also greatly stimulate the coal-trade, and, at the same time, make Pench coal a very formidable competitor with that of Bengal, owing to the lowness of the freight.

General Remarks on Indian Geology in Relation to the Coal-measures.—The rocks which in India probably correspond, as regards the time of their formation, with the true Carboniferous rocks of Europe, are not coal-bearing, and the oldest coal-measures belong to a period which is well included within the limits of the Upper Palaeozoic or Permian, or the Lower Jurassic formations. All the useful coal-measures may conveniently be described as being of Permo-Triassic age, and, with two exceptions, it may be added, these measures do not occur beyond the limits of the Peninsula. In the extra-peninsular areas, however, we find coal in various later deposits. The following is the succession of the more important fossiliferous rocks, the marine beds being omitted from the sequence, but classed as equivalent

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to their supposed representatives amongst the formations without marine fossils : —

[Table, of equivalent strata, omitted.]

From the foregoing table it will be seen that the base of the Gondwana system corresponds approximately to the Upper Carboniferous formation of Europe, while the highest of the Gondwanas is about Upper Jurassic in age. The Gondwana system, so named by H. B. Medicott in 1872,\* is "chiefly composed of sandstones and shales, which, except for some exposures along the east coast, appear to have been entirely deposited in fresh water, and probably by rivers."† According to Sir T. H. Holland—

"The Gondwana beds were laid down in great river valleys on a continent, which, at the time, probably stretched from India to Central and South Africa, where similar coal-bearing beds, of corresponding age, occur. Soon after the formation of the Lower Gondwanas, which include the best and thickest coal-seams, great outflows of lava occurred on Gondwanaland, forming the rocks that now constitute the Rajmahal Hills in Bengal and the Stormberg of South Africa. But these outbursts were small compared to the enormous outflows that afterwards spread out over the continent in Upper Cretaceous times forming a thick mantle of trap rocks that still covers some 200,000 square miles of Peninsular India. Large areas of Gondwana strata, and, with them, valuable coal-seams, are covered by the Deccan trap, which has also concealed probably other rich mineral deposits in the older rocks below . . . There is another feature disadvantageous to the prospector as the outcome of this circumstance: the present surface of the peninsula is one of the oldest peneplains in the world, and its rivers, having nearly reached the base-level of erosion, expose very little of the rocks for the inspection of the mineralogist; large areas are covered by an envelope of decomposition-products and cultivated soil, which

\* "Notes on the Age of some Fossil Floras of India," by Ottokar Feistmantel, Records of the Geological Survey of India, 1876, vol. ix., page 28 ; and "Annual Report of the Geological Survey of India, and of the Geological Museum, Calcutta, for the Year 1880," by H. B. Medicott, *ibid.*, 1881, vol. xiv., page ii.

† A Manual of the Geology of India, second edition, by R. D. Oldham, 1893, Page 149.

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effectively masks a large proportion of the underlying rocks with whatever is included in them in the way of valuable minerals."\*

The lowest division of this system is known as the Talchir Series, from its original discovery in the small state of that name in Orissa.†" The beds of this series are of small thickness; but they are known and, from their peculiar features, easily recognized in most of the coal-fields. They include boulder-beds supposed to be due to glacial action, and are thus regarded as similar in origin, probably also corresponding in geological age, to the Dwyka formation which lies at the base of the similar coal-bearing Karoo system in South Africa.‡ The only section of the Gondwana system which is important from the coal-producing point of view is that distinguished as the Damuda Series, from its development in the valley of the Damuda river in Bengal.§

Geological Table of the Pench Valley.—The following is a geological synopsis of the Pench Valley : —

Alluvial deposits.  
Deccan trap.  
Inter- and infratrappean.  
Upper Gondwana-  
    Jabalpur group.  
    Mahadeva series-  
        Upper: Bagra group.  
        Middle: Denwa group.  
        Lower: Pachmarhi group.  
Lower Gondwana-  
    Damuda series-  
        Upper: {Bijori group } Kamthis of Deccan.  
            {Motur group}  
        Lower: Barakar group (coal-bearing).  
    Talchir group.

Satpura Basin.-The limits of this basin, in which the Pench Valley lies, are computed to be some 30 to 40 miles from north to south, by 80 to 90 miles from east to west.

Geology.-E. A. Jones divides the Pench Valley coal-area into

\* Sketch of the Mineral Resources of India, by T. H. Holland, 1908, page 2.

† "On the Geological Structure and Relations of the Talcheer Coal-field, in the District of Cuttack," by W. T. and H. F. Blanford and William Theobald, Jun., Memoirs of the Geological Survey of India, 1859, vol. i., page 46.

‡ "Quinquennial Review of the Mineral Production of India during the Years 1904 to 1908," by Sir Thomas H. Holland and L. Leigh Fermor, Records of the Geological Survey of India, 1910, vol. xxxix., page 42.

§ Ibid., page 43 ; and "Account of Results arrived at from Investigations conducted by the Geological Survey of India in Central India during the Season," by T. Oldham, Journal of the Asiatic Society of Bengal, 1856, vol. xxv., page 253.

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seven separate fields,\* caused partly by the overlying trap, and partly by faulting, but it would appear at the present time to be more satisfactory to speak of two fields only.

Gujandoh Coal-field.—The coal-field designated by this name lies quite detached from the Pench coal-field. The very small area of coal-bearing strata which is exposed here is evidently brought in by the general rise of the ground to the south of Gujandoh village (E. Long. 73° 46'), and evidently forms the southern edge of the coal-basin. The coal should extend, under the Motur clay and the trap, to the stream running to the south of Dongar Parassia village boundary, where several coal-seams were cut by the steam-drill, but this remains to be proved. The small coal-seam, 5 feet thick, found at Gujandoh, was discovered to be dipping very steeply to the north, and lying close against a fault. The native firm who attempted to work this seam gave it up in despair about 2 years ago, but fresh preparations were being made in December, 1909, to commence exploring again.

Pench Valley Coal-field (Fig. 1, Plate IV.).†—There are three unconformable formations of the Lower Coal-measures, each of which has recognizable and distinctive features : —The Moturs, a formation peculiar to the Pench Valley; the Barakars, the great coal-bearing strata of India; and the Talchirs, the barren beds occurring between the coal-bearing strata and the meta-morphic or Vindhyan rocks.

The Moturs.—This group derives its name from the village of Motur, lying some 12 miles to the south-east of Pachmarhi (the hot-weather hill-station for the Government of the Central Provinces), 3,500 feet above sea-level, and 28 miles from the Pench Valley. The writer believes this Motur formation to be peculiar to that valley, and not sufficiently well known. E. A. Jones describes it as—

"A group of rocks consisting for the most part of mottled red, yellow, green, and white calcareous clays . . . The clays . . . are usually of a dark-red claret colour, sometimes greenish or yellow, and white, . . . Where the clay has been removed . . . the ground is thickly strewn with the nodules . . . They are also somewhat saline, and . . . cattle and other animals . . . lick up the city with avidity."‡

\*The Southern Coal-fields of the Satpura Gondwana Basin," by E A Jones, Memoirs of the Geological Survey of India, 1887, vol. xxiv., part i., page 1.

†The writer's thanks are due to Mr. H. H. Hayden, Officiating Director of the Geological Survey of India, for permission to reproduce the map of the coal-field.

‡"The Southern Coal-fields of the Satpura Gondwana Basin," by E. A. Jones, Memoirs of the Geological Survey of India, 1887, vol. xxiv., part i , pages 46 and 47.

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The Motur strata contain coal-seams, but the coal appears to be softer than that from, the Barakar measures, and of less commercial value. For local consumption this coal could be easily won from small inclines. The rocks also in this group do not appear to be so hard as those in the Barakars, among which occurs a rock extremely difficult to drill or sink through, and not unlike very hard white post.

The Barakars.—The Barakar group furnishes the coal found in the Mohpani, Tawa, and Wardha areas, and at PENCH immediately underlies the Motur formation, which covers them over a large area to a depth of anything up to 200 feet; but, of course, there are places where the Barakars come to the surface and are clearly exposed, as in the bed of the river at the south-western corner of the land of Dongar Parassia village, and again near Bhandaria village, about 2 miles to the west, and at many other places.

Bijori Group.—To quote E. A. Jones, "the rocks of the Bijori horizon are characteristically Damudas, and comprise shales (occasionally carbonaceous), micaceous flags, and sandstones."

The Talchirs.—These consist very largely of boulder-beds; the shales usually contain a few boulders, and are often crowded with them. The sandstones and shales have the greenish tinge peculiar to the Talchirs. The dip in this coal-field is, as a rule, northerly to north-westerly, not usually exceeding 10 degrees, although in some places it is very much steeper, and may locally, over a small area, incline eastwards or southwards. H. B. Medlicott has estimated the possible thickness of the Talchirs in a portion of the western end of this coal-field as over 2,000 feet of accumulated thickness. These thicknesses, of course, represent "time thickness"—that is, accumulated successive thicknesses of gradually overlapping strata, such as would have to be taken into account in applying any rate of deposition to ascertain the time represented by the formation. Up to the present date no deep borings have been made in this area.

Condition of the Coal-measures.—The coal-measures of the PENCH Valley coal-field have been much distorted by a series of east-and-west faults, parallel to the line of trap intrusion, and by a further series of diagonal cross-faults. The stratal disturbances developed generally are a system of step-faults, more or

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less parallel and regular. There are at least two indications of great upheaval and elevation of the coal-seams formed in Barakar times which cause an exposure of the coal-outcrops for many miles along the strike of the field. But, unless care is exercised in exploration-work, the more recent rocks which have in so many cases almost entirely obscured the older beds may mislead the prospector.

[Photograph: Fig. 7.—View of Chandametta Colliery.]

Trap.—This rock is of the usual basaltic character, and occupies an immense area. It is found capping the whole of the Motur hills, and also many of the hills to the south.

Dykes.—The dykes, running east and west, are numerous, but are not traceable for long distances at the surface. In many cases, they are due to intrusion along the bedding-planes of the rocks.

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Faults older than Trap Outflow.—The trap is found covering the fault in places, as that one east of the Pench river. The faulting must therefore have been subsequent to the deposition of the Moturs, but prior to the outpouring of the trap. These faults have an immense throw in some cases, which must be fully 1,000 to 1,500 feet.

Alluvial Deposits.—Such deposits are being formed along the river-banks, from material washed down from higher ground, and these hide a large portion of the older rocks, making the field-work of the prospector so much the more difficult.

Petrology.—The metamorphic rocks consist of the usual gneisses and schists, numerous garnets being found in some parts of the latter.

Coal-seams.—It is considered that there are three workable seams in the Pench Valley, lying at a depth of less than 300 feet, although at the present time one only has been worked to any extent. Again, it is difficult to say at what depth these seams will be found, owing to the hilly character of the country and the numerous faults that occur. At Chandametta Colliery (Fig. 7), on one side of a hill, is the main incline, where the seam is struck at a vertical depth of a little over 50 feet, while on the other side of the same hill the 15-foot diameter shaft, which will be used for winding coal as soon as the new standard-gauge line is built, shows the following section of strata: —

[Table of Strata omitted.]

In another part of the coal-field the 9 ½-foot seam is met with at 161 feet 9 inches, the first 5-foot seam at 210 feet 10 inches, and the second 5-foot seam at 281 feet 6 inches. The thinner seam, at present considered unworkable, is omitted. The 5-foot seams are considered of better quality than the thinner and thicker one, and will be opened up from pits

which are now in course of sinking. With deeper borings, there is every reason to suppose that more seams will be proved, possibly of

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much better quality. In the year 1908, the output from Barkui Colliery (Fig. 8) was about 16 per cent. less than that of Chandametta. The selling-prices per ton into wagons in November, 1910, were—Barkui steam, 6s. 8d.; Chandametta steam, 3s. 8d.; and Chandametta slack, 1s. 10d.

Quartz Veins.—Quartz veins are scattered throughout this area, and are especially noticeable on the west, but so far they have not yielded any minerals of commercial value.

[Photograph: Fig. 8. —View of Barkui Colliery (looking South).

Other Minerals.—The Pench Valley yields good building-sandstone and fire-clay, but as yet these are of very little use commercially, although used locally by the villagers.

Iron-ores.—Iron-ores of good quality are entirely absent.

Limestone.—The surface-soil overlying the Barakar measures contains in many places large quantities of kunkar limestone, in the form of nodules. These are collected and burnt (in kilns made of stone and mud) for the lime, which is then used in the construction of local buildings, road-bridges, etc. The price varies from 16s. to 22s. 8d. per hundred cubic feet.

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Gondwana Plants.—The writer and Mr. S. D. Ware forwarded to the Geological Survey of India Museum at Calcutta some fossil-plants collected from beds above the coal-measures in the Pench Valley, between the village of Dongar Parassia and the boundary of the Deccan trap, north of the village of Harraye. The specimens were obtained in an area marked as "Barakar" on the map accompanying the late E. A. Jones' memoir on the Satpura coal-field.\* The collection identified by the museum, included *Phyllothea indica*, Bunb.; *Glossopteris indica*, Schimp.; *Gangamopteris cyclopteroides*, Fstm; and several other apparently new forms. The material identified is hardly sufficient to settle the age of the beds, and it is hoped that further discoveries of fossil-plants in this area will be made, in order that the Pench Valley beds may be compared with the Mophani coal-field, which, on the other side of the Satpura basin, has yielded Karharbari plants.

System of Working.—When it was decided to work this virgin field, the question as to what system in the long run would prove itself to be the best had to be considered. The first seam to be worked lay at a depth of a little over 50 feet below the surface, and was 9 feet 6 inches thick. After considerable thought, it was decided to commence opening out on the bord-and-pillar system, owing to the noted tendency of similar measures in the Central Provinces to spontaneous combustion if the smallest amount of slack coal were inadvertently left in the

goaf. Further, having so very moderate a cover, it was felt certain that, after heavy falls, cracks would spread to the surface, and cause a large inflow of rainwater during the monsoons. It was decided to make the pillars small, with 30-foot centres, the roads being driven not less than 8 or more than 10 feet wide, with an average height of 7 feet. The roof, being in some cases of soft fire-clay, or shale, did not naturally form a hard top, and the top coal was therefore left in. The system of winning the coal differs in some striking particulars from the usual Bengal practice. Large contractors are not encouraged—a road or place is given to a man on contract, and he is paid on the footage driven, not on the quantity of coal cut. This man employs two or more men to help him, the gang working under one name in the measurement book. They are employed only in hewing the coal, and in

\* "The Southern Coal-fields of the Satpura Gondwana Basin," by E. A. Jones, *Memoirs of the Geological Survey of India*, 1887, vol. xxiv., part i., page 1.

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squaring up before full measurement is given. They kirve a judd in the bottom of the coal-face to a depth of not less than 3 feet, and make a small nick in one side to a depth of 2 feet, the full height of the place. It is curious to notice that the hewer usually stands in order to kirve his judd, and it has always been most difficult to make him understand the advantage of kirving this judd as small as possible. On completion, they drill a couple of shot-holes at a suitable distance from the roof, being supplied for this purpose with a Hardy "Conqueror" hand boring-machine, and a set of drills. One machine is served out for five to seven places, and all drill and pick-sharpening is done free by the company. The head of the gang, having brought in suitable stemming from the surface, calls for the shot-firer, who is paid, 16s. (12 rupees) monthly by the company. The shot-firer, who is accompanied by a lad, is provided with a locked leather bag, and he alone inserts the compressed blasting-powder, which is imported direct from England in 10-ton lots. After giving proper warning, he lights the fuse and retires to a safe distance. Both shots are lit up at one time, but it is the rule to make one fuse longer than the other, so as to facilitate the counting of shots from the detonation. After a short interval he returns, examines the place with the hewer, and, if safe, moves off to fire shots elsewhere, blasting being continuous both night and day. The powder is given out twice daily under European supervision, in the morning and evening, an account being kept of all powder and fuse issued. The shot-firers work from 6 a.m. to 6 p.m., with an interval for rest and food of 2 hours from noon till 2 p.m. The fallen coal is lifted by the fillers, who are women and young lads, who usually work in small parties of two or more persons and are paid by the tub-load. When the faces are near the landings, the women "put" their own tubs in and out; in other cases, they bring the coal in baskets to the empty set standing in the landing. All coal-carriers supply their own baskets, which are made locally. A well-made cane basket will hold 80 pounds of coal, and a woman can carry this easily on her head for a considerable distance. A certain number of English-made shovels and light picks are supplied free. Where the distance is great, male hand-putters are employed to run the tubs from the flats to the landings. Hand-putters are paid a daily wage. Where the conditions will allow, underground self-acting jigs

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are employed. A good woman filler, working really hard, can earn as much as 6 annas a day, but this is exceptional. The tubs, on arriving at the landing, are booked in the filler's name by the pit-writer, who is a servant of the company and is paid by the month, this method proving to be more satisfactory than using metal tokens. At the end of each half-shift he brings his book to the colliery clerk, who checks the number of tubs with the banksman's record. As all coal is tippler-loaded, the manager is able to calculate very exactly at the end of the day how much tonnage has been raised. The tubs are made up in sets of ten.

Quality of Coal.—The coal has no distinct line of cleavage, nor a great number of backs ; when split it shows a leafy impression on its flat face, and it yields a finer dust in working than average Bengal coal. No fewer than five seams are found at a moderate depth, and vary considerably in quality, and, when the coal is placed at bank, show a striking difference in their weathering properties. Although coke has been made in small quantities for experimental purposes, so far it has not been produced on a commercial scale; nor, from all accounts, does it seem to have given satisfactory results when coked in ovens in England. It is quite possible, however, that some other seam in the Pench Valley will prove itself suitable for coking purposes. The coal is understood to give good results when working producer-gas plants.

There is little moisture in the coal worked at the Chandametta Colliery, owing to its position, as the surface-water quickly runs off into the valley. When exposed on the surface, this coal is extremely friable, weathers rapidly, and splits up into smallish pieces. It contains a good deal of iron pyrites, and has a great affinity for oxygen, this at times causing even small heaps to heat rapidly and burst out into flame. No small coal was ever left in the workings. This same seam, which was sunk to about 2 miles away, at the bottom of the valley, and half a mile from the Pench river, contained a great deal of moisture. The coal is absorbent, and, given the conditions, it can hold a lot of water. It has a peculiar laminated appearance, due to its being composed of alternating layers of bright and dull coal, the former being purer and more bituminous than the latter, which in some cases is shale rather than coal. The best coals are naturally those in which the bright layers predominate. There is a

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general tendency to variation in the thickness and quality of each seam within short distances, and so far no fire-damp has been discovered in the workings. The dip of the seam is chiefly northwards 1 in 10. Minor faults are fairly frequent, the downthrow varying from 3 to 8 feet (which is most general) to 10 feet or more. No fossils have been discovered in the coal itself. The ash resulting from combustion is whitish, and there is a good deal of it. It clinkers very little in the fire-box, but gives trouble from the accumulation of ash there, and in the tubes and smokebox, so that in hauling heavy loads the firebox has to be cleaned fairly often. It is difficult to form an exact estimate of the quantity of marketable coal in so new a field that has been so little worked; but it is safe to say that there is in sight a sufficient quantity to yield not less than 100 million tons, and a great deal more should be discovered as the work is extended. Some idea of the quality of the coal may be gathered from the following analyses: —

[Table of analyses, omitted.]

Production of Coal.—The following table compares the production of coal of the PENCH VALLEY COAL COMPANY with that of the whole of India : —

Year.	India, Tons.	PENCH VALLEY, Tons.	PENCH VALLEY, Percentage of Total for India.
1905	8,417,739	1,104	0.02
1906	9,783,250	32,102	0.33
1907	11,147,339	74,663	0.67
1908	12,769,635	120,249	0.94

Consumers.—One of the chief consumers of PENCH coal is the BENGAL-NAGPUR RAILWAY; then come the cotton-mills and ginning factories at Nagpur, Jabalpur, and Ahmedabad, and the other industries in various localities in the Central Provinces, Berar, Central India, United Provinces, and the Punjab. Potteries and the Public Works Department also buy a fair quantity. The manganese-mines, which are nearly all worked opencast, consume very little, and then only during the rainy season, when pumping. Owing to the great distance from the sea-board (about some 800 miles), no PENCH coal is exported.

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Labour Employed at PENCH VALLEY.—The following table gives particulars of the number of persons employed above and below ground at PENCH VALLEY : —

[Table, of Labour Employed at PENCH VALLEY, \* omitted]

Screening.—Two kinds of screens are in use, one a simple bar-screen with ordinary kick-up, which makes large steam, rubble, and dust coal; and the other a mechanical screen for an output of 1,000 tons daily, with a short steel picking-belt and revolving tippler, which is most satisfactory. Fig. 9 shows screening-plant in course of erection.

Lighting.—On the engine-planes the ordinary evil-smelling and dirty-burning lights are used, fed with the cheapest kind of Burma oil. As far as possible, candles are used at the faces, a hewer receiving free two candles per foot of coal cut, and a filler one candle per four tubs. Extra candles are supplied, but are charged for at cost price. In narrow places, or in roads that have to go a long way before holing, candles are far preferable to lamps, as they are so much cooler, and this is much appreciated by the workpeople. Coal-carriers and putters use oil-lamps, containing from 4 to 6 chittacks,† when working in a rapid air-current, as it was found that the candles blew out or burnt away too rapidly. In these cases, the free allowance is 1 chittack for two tubs, extra oil being paid for.

Ventilation.—This is almost entirely natural, but is assisted by small furnaces placed at the bottom of the air-shafts. The air is split in the usual manner. It is curious to notice that in the return-airway there is little change in the temperature

\* Labour employed in the brickfields, construction of buildings, felling timber, sinking water-wells, surface-railways, and other work away from the mines, is not included in these figures.

† 1 chittack is equal to 1 oz. 17 ½ dwts. troy, or 2 2/35 ozs. avoird.

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during summer or winter. Of course, during the hot-weather months it is far pleasanter below ground in the main-intake airways than on the surface.

Fitting Shops.—The shops, with brick walls and corrugated galvanized-iron roofs, are erected in a central position, so that all the repairs from the pits can easily be sent to them. All the

[Photograph: Fig. 9.—Erecting Screening-plant.]

shops are connected up with a 2-foot tram-line running to the different machines, and there is a special beam with blocks for lifting heavy weights, so that coolie labour is reduced to a minimum, and great time-saving effected. The shops are well fitted up with belt-driven lathes and machines.

Machinery.—This consists of the usual colliery type of winding- and hauling-engines, possessing no special features, but

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of good sound make. The Worthington and Tangye pumps are steam-driven, and the boilers are of the Lancashire, Cochrane, and ordinary vertical kinds.

Compressed-air Plant.—This is only an experimental plant, consisting of a Robey vertical single-cylinder engine, 10 inches in diameter, direct-coupled to a Reavell rotary air-compressor. This supplies the air to the Hardy and Siskol punching-machines, both of which are in use at the face. Air-receivers are placed at suitable positions in-by. A Siskol percussive boring-machine is used for making the shot-holes, the size of the compressed-powder pellets being 1 1/8 inches. Powder only is used for coal-work, and gelignite for stone-drifts or sinking-pits.

Various.—Sylvester prop-withdrawers are in daily use. All shots in sinking pits are fired by means of a rack-bar magneto-exploder, actuated from the surface. The tramway gauge is 2 feet, laid with 14-pound flat-bottomed steel rails, spiked to hardwood sleepers. The tub-frames are of teak or other hard wood brought in from the local forests. As far as possible everything is made in the shops, including tubs, screens, sinking and other small headgear, etc., etc. The colliery tubs are 3 feet 1 inch high from the rail, 4 ½ feet long, by 3 feet in width and 2 feet in depth, and have a carrying capacity of 12 to 14 hundredweight. The bodies are made of steel plates and angle-irons, and are fixed on wooden frames, the wheels being imported from Sheffield.

Although there are no Trades Unions, strikes are not uncommon at Indian collieries; but at times the people do combine and give trouble, especially in the cotton- and jute-mills.

The coolie-houses, of brick with red-tile roofs, are mostly built by the colliery company, each family having a room not less than 10 feet by 10 in area, usually with a small partition. When cooking is done inside, the smoke passes out of the roof through the tiles. The occupier generally adds on a walled courtyard for an extra room, which may be partly roofed. The hewers are encouraged to keep cattle and cultivate a patch of ground, as this makes them more settled. Burnt bricks cost 4 rupees per thousand, with cartage extra; bamboos cost 5 rupees a hundred. A bullock-cart with two bulls can be hired for 12 annas to

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1 rupee a day, the cost in Bombay or Karachi being double this, and the cart will carry about 1,200 pounds weight of goods.

A Government postal and telegraph office was started for the use of the collieries, and it is interesting to notice the large amount of money remitted weekly in money orders, showing clearly what confidence the native is acquiring now in these matters.

Pay.—In some respects the method is very different from that generally in vogue in Bengal. The European staff is paid on the first of the month, the other monthly paid hands, consisting almost entirely of babu (native) colliery clerks and orderlies, being paid on the fifteenth of the month following that on which the pay is due. All colliery hands, above and below ground, and in the engineering department, are paid every Saturday afternoon, the pay commencing at 3 p.m. The colliery pay and measurement books are closed on Wednesday night, so that there is always 3 days' pay kept in hand. Upon every day except Saturday the pits are idle from noon until 2 p.m., but on Saturday work goes on steadily until 2 p.m., and then ceases for the rest of the day. By this means the European staff have Sunday quite free, except for the necessary repairs and washing-out of boilers. In Bengal the Sunday-morning payment of wages, is fairly common. There is no night-shift on Saturday, the pits being closed on Sunday, and no coal-cutting is allowed until the men go to work on Sunday night at 10 p.m.

Signatures.—As the majority of natives in India are illiterate and unable to sign their names, they are made to attach their thumb-impression to paper. This system is in general use all over India in Government and private business transactions.

Fines.—Fines have to be inflicted from time to time for disregard or disobedience of orders. The money thus collected is used as a fund from which payments are made to deserving cases in illness, or for railway-fares granted to dependents of men who have succumbed to illness whilst at work at the collieries, to take them back to their homes. Any one incapacitated by an accident whilst at work, draws a sick allowance as long as he is certified by the doctor to be unfit for duty. Fining is not encouraged, and as little used as a punishment as possible.

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Shifts.—At bank the shifts consist of a day of 12 hours, with an interval of 2 hours in the middle. Double shifts are not encouraged, and only in exceptional circumstances are engine-men, foremen, or others allowed to work a continuous double shift. The long 24-hour shift of Bengal has always been strictly tabooed, and Sunday work also kept down as much as possible. Except for watchmen, it has never been the wish of the general manager to work men more than 6 days a week. Only the daily-paid hands have their time checked, and these are compelled to attend punctually, the "buzzers" sounding 60 minutes, 30 minutes, and 5 minutes before work starts, at the midday interval, and again at "loose." The workmen have to attend fairly promptly, otherwise they lose the daily issue of oil and candles, which only lasts for a certain time in the morning and evening. With the exception of the daily-paid hands, they are allowed to come to bank when they like, and are fond of going backwards and forwards by the travelling road, which is an incline used only for the purpose. The night-shift is worked in the same manner. Work starts an hour later in the winter months— that is, at 7 a.m.—for both the pits and fitting shops, as the natives object strongly to starting early in the cold mornings.

Bazaar.—The ground has been bought from the Government by the colliery company, who have built a number of shops, which are let out monthly to shopkeepers. Sunday is the chief bazaar day, and it has been found that fully 4,000 persons enter its gates on that day alone. The company police and keep the place clean, and have sunk a drinking-water well for general use. Almost anything required by the native can be bought, and some of the larger shops have commenced to sell European tinned goods imported for the staff. About 23 pounds of salt, which is sea-salt from Bombay, can be bought for a rupee. The local "gur" or unrefined sugar is generally preferred to that imported from Northern India, and sells at 9 pounds to the rupee, against 11 to 13 pounds for the imported article. Ghi or clarified butter costs one rupee for 2 pounds, and in the hot weather 1 ½ pounds only is received for the same sum. Two gallons (approximately) of milk cost a rupee. Firewood bought in the bazaar for sale in the towns costs 2 rupees 4 annas for a load of 800 pounds. Grass for thatching houses costs 1 rupee 8 annas a cart-load, and manure 1 to 2

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rupees a cart-load. The hide of a bullock fetches 5 rupees, and that of a buffalo double that amount. Wheat is 30 pounds to the rupee, and rice 23 pounds for a rupee, the price for the latter being naturally higher than for the grains grown in the district, as it has to be imported and is a luxury. The rate for gram was 36 pounds. Juar (a native grain) is regarded as the staple food-grain of the district, and averages 44 pounds per rupee. The daily food for adult labourers does not cost more than 2 annas for males, that for women and children costing less. At the collieries where men earn higher wages one can safely estimate this as costing more like 4 annas. An ordinary labourer spends the noble sum of 13s. 4d. yearly on his clothes, the men in higher positions naturally spending more. The cost of a house to one of the labouring classes is about £2, and the furniture another £1, this amount depending on the number of brass cooking-pots used. The bazaar supplies lamps, matches, and kerosene oil, which are very generally used, and tobacco and cigarettes. The former is locally grown, but the latter are imported and much smoked. Imported cloth is also sold (both European and Indian), and the local weaving industry has almost ceased. It is curious to note that the higher native officials drink soda-water, but, as it is considered expensive, the common people do not drink it. Meat, which costs twopence a pound, is usually goat's flesh, and excellent fish, caught in the PENCH river, costs the same. Eggs are very small, and are sold

at four a penny; and one can also buy mangoes, bananas, cucumbers, potatoes, chilis, etc. The butchers have a small building slightly removed from the main part of the bazaar. Besides grain-sellers, there are metal-merchants, sellers of brass cooking-pots and earthen water-pots, shoemakers, basket-makers, and a variety of others.

Medical.—The colliery hospital, which has been placed in a central position, has a resident native hospital attendant, who has a qualified compounder as his assistant. The brick building with a tiled roof has a ward with four beds, a small operating theatre, a room for out-patients, and a small office. There is also a well with excellent drinking-water, and the usual conveniences. The hospital assistant receives his orders direct from the European medical superintendent, who is in medical charge of all the collieries. There is a dispensary at the general office, which

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is 2 ½ miles from the hospital. Besides visiting the collieries, the hospital assistant is responsible for seeing that the surface sweepers do their work properly, and for the general cleanliness of the surface sanitation. The pit sweepers are under the colliery managers. In cases of serious accident the managers telephone for the doctor. The collieries are well supplied with drinking-water from numerous wells, which are medically inspected from time to time, and there are also washing-places for the labourers, supplied with fresh water from the underground pumps. The wages of a compounder are about £1 a month, of the hospital assistants from £5 to £15, and of European doctors from £30 to £60 monthly.

Disease.—Owing to the great care exercised in looking after the water-supply and general sanitation, there has been no serious outbreak of disease, but there have, of course been a number of patients suffering from fever and malaria from time to time. Plague and cholera have both been bad in the district, but not a single case was reported at the collieries. There have been cases of small-pox, but these were promptly isolated and the disease prevented from spreading.

Bungalows.—In designing these, healthiness, simplicity, immunity from fire, and minimum cost of annual repairs, combined with suitability and homeliness, were aimed at. The bungalow (Figs. 2, 3, and 4, Plate IV.) contains three rooms, the middle one measuring 20 feet by 16 and the other two each 16 feet square. The two last-named have dressing-rooms 8 feet square, which lead off them through archways, and bathrooms measuring 8 feet by 7. There is a fire-place in one bedroom, and also in the central room. At the western verandah there is a store-room, 9 feet by 10, with a full-sized door and a small window. The verandah is 10 feet wide, and has a length in front of 79 feet. The gable and end walls are 2 feet in thickness, all other walls being only 18 inches, and hard-burnt bricks and Katni lime were used throughout. The roof is tiled with hexagonal tiles costing 10 rupees per hundred, and covering 100 square feet. They are placed on as a single tiling, and make an absolutely waterproof roof, as they lock into each other, cannot be disturbed by wind or monkeys, and make a very neat and workmanlike job when finished. Great care must be taken

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in keeping absolutely the correct distances in nailing on the battens, and once this is completed the tile-laying can proceed at a great rate. The verandah posts are of teak, fitting into a neat block of white stone. On the top of the posts carrying the verandah roof are placed light girders. Owing to the expense, it was impossible to have wooden ceilings, so the ordinary cloth ones were fitted up, and whitewashed. The centres of the rooms are 19 feet high, and the sides 13 feet, and all the verandah and room floors are of concrete. The inside walls are plastered and colour-washed, and the outside ones cement-washed. This type of house is very comfortable for two single men or one married man. In India the kitchen is always a separate building, and not less than 30 feet away from the bungalow, whilst the servants' quarters are still farther away. The cost of such a bungalow is approximately £300.

Apprentices.—Mention might be made of what has been done to train natives in mining engineering at the Pench Collieries. When starting these pits a few years ago, there was found to be a total lack of trained men to fill the subordinate posts, and the general manager sought a remedy. He therefore addressed a letter to the Chief Commissioner of the Central Provinces, offering to take lads of good family (not necessarily English speakers) and train them as colliery engineers, the only conditions laid down being that they should be of respectable parentage, and willing to learn and work hard. Any failure in willingness to work would result in instant dismissal. The lads would be paid a small daily wage from the date of joining, and this would be increased from the day their work in the shops deserved it. After a year the movement was most popular, and far more boys applied for posts than could be taken on. The European engineers took great interest in the boys, and it was interesting to note how eager all the apprentices were to make drawings or do book-work, but how very adverse they were at first to manual labour. Moreover, at the start they could not understand that it was necessary for them to be as punctual as the rest of the workers. The general manager's idea was to inculcate exactness in work and the spirit of command in these boys, as they were training to be foremen. The boys mostly came from better-class homes, and had not been accustomed to manual labour of any description.

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Wages.—The figures here given do not necessarily apply to Pench, but will serve as a guide as to the wages paid to Europeans and natives in India under ordinary circumstances. A man going to India holding a second-class certificate usually signs an agreement for 3 or 4 years, and is given a second-class ticket out to his destination, and the same home again, if his work has been satisfactory. The starting pay is between 200 and 225 rupees per month, with free quarters and medical attendance; and there may be other allowances, such as free passes on the railway if employed at a railway-owned colliery, although railway collieries charge house-rent. The yearly rises of pay are from 25 to 30 rupees a month, so that a man starting on 225 rupees per month would draw 275 rupees (£18 6s. 8d.) a month in his third year. With the holder of a first-class certificate the agreement is for the same period, and the travelling may either be by first or second class, and the starting pay between £20 and £30 a month. He will, in addition to this, have free quarters and some allowances, and will probably be given a commission on the profit of the colliery which he manages. Some firms also give a bonus on his passing the language examination. The pay of agents and general managers is as varied as it is in England. Country-born Europeans or ex-soldiers who have had some mining experience are often employed as assistant managers. These hold no certificate, and are paid from 100 to 200 rupees per month, the amount depending on length of service or ability. Labour all over India has very rapidly gone up in price during the last 5 years; this

can be accounted for by the industrial expansion, and the decimation of the working population by outbreaks of plague and malaria. Coolies in Bombay or Calcutta think nothing of demanding and receiving 12 annas a day, and in the Punjab canal colonies at harvest time as much as a rupee is paid a day for field labour. Railway contractors, who are usually obliged to import coolies for their works, have in many cases to pay not less than 8 annas a day for ordinary workmen; women earning a little less. At the collieries deputies draw 15 to 17 rupees per month; shot-firers, 12 rupees per month; shot-firers' lads, 2 ½ annas a day; pit-sweepers, 3 ½ to 4 annas per day; banksmen, 4 ½ to 5 annas per day; onsetters, 4 annas per day. The surface men have half an anna a day more than those below ground, which is the reverse of the English

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custom; pit writers, 6 annas per day; masons, 6 annas per day; watchmen, 4 annas per day; hand-putters, 4 annas per day; timber men, 5 to 7 annas per day; pumpers, 4 ½ annas per day; picking-belt women, 2 ½ to 3 annas per day; tub-greasing lads, 1 ½ annas per day; brakemen on self-acting inclines, 6 annas per day; coal-fillers, 2 annas per 12-hundredweight tub; taking down top-coal, one-quarter anna per cubic foot; pillar-cutting, 1 rupee per 70 cubic feet; driving headways, 1 rupee per foot; stonework, double the coal rates; platelayers, 15 rupees to 17 rupees 8 annas per month; storekeeper at colliery, 15 rupees per month; traffic clerk, 20 to 35 rupees per month; and timekeepers and pay-clerks, 35 to 45 rupees per month. In the engineering department the wages are: head native mechanic, 1 rupee 8 annas to 3 rupees per day; fitters, 1 rupee per day; lampman or tinsmith, 5 annas per day; fitter's coolies, 4 annas per day; carpenters, 10 annas to 1 rupee 8 annas per day. A Chinaman will not work under 3 rupees per day, but then he is generally an excellent carpenter. The blacksmith is paid 1 rupee 8 annas per day; ordinary smiths, 8 to 12 annas per day; engine-drivers, from 8 annas per day; and firemen, from 5 annas per day.

Inspection of Workings at Pench.—The deputies before each shift inspect all roads, working-places, etc., and make their report. After this the men are allowed to proceed to work, the deputies spending the rest of their shift in the workings. The European under-manager, who has a cabin below ground, after reading and initialling the reports, goes below, and proceeds on much the same lines as in the County of Durham. The machinery is in charge of the European engineer, who has the usual report-books to sign; and accidents are reported, when serious, through the Deputy Commissioner at Chhindwara to the Chief Inspector of Mines.

Signals.—All signals are posted up in English and in the vernacular. As so few of the men can read the native characters, written rules are not of very great use to the ordinary labourer; the more educated natives can, however, read and speak English. It is well to have as few signals and rules as possible.

Inspectors of Mines in India.—There, are three inspection circles for British India, each in charge of an Inspector of Mines,

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with a Chief Inspector at their head, stationed at Dhanbad, in the Bengal coal-field.

Other Government Inspectors.—The Inspector of Explosives usually visits the colliery magazines once a year, and the Inspector of Steam-boilers the colliery boilers, all of which have to be registered.

Manager's Certificates.—It is now necessary to be the possessor of a first- or second-class certificate before a person is allowed to take charge of an Indian mine working under the Coal Mines Regulation Act of 1901. There are usually two examinations held yearly for candidates, who may be Europeans or Indians. A holder of an English first- or second-class certificate is granted an Indian first- or second-class certificate without re-examination.

Mining Education.—The Government Sibpur College, Calcutta, has special mining classes under the direction of a Professor of Mining from England, and gives scholarships; whilst mining classes are held in the Bengal coal-fields at various centres, and are largely attended. The Government of India gives special scholarships to students, with a grant of £150 a year, tenable at the Birmingham University.

Central Provinces Mining Rules.—Before a concession to engage in mining operations in these Provinces is granted, it is necessary to obtain from the Government a certificate, showing that one is a fit and proper person, such a certificate being granted to an individual or a firm. Then an exploring licence is granted, after which a prospecting licence may be applied for, although it is not always necessary to obtain an exploring licence first. Prospecting licences are granted for 1 year, and may be extended a further year, but in no case will they be allowed to exceed a period of 3 years.

Mining leases are granted for a term of 30 years, with a fixed dead rent, and on coal the royalty is from 1 to 4 annas per ton; but it is understood that for the future the lowest coal royalty will be 4 annas. The Government Mining Manual contains all the rules, and as this is under revision, it is hardly necessary to give further details. Minerals in the Central Provinces belong to the Government, except in a very few villages, where

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these have been settled on the surface-holder by an old Act. The surface may belong to a private individual, in which case the compensation to be paid by the mining company is fixed by mutual agreement, or, should this fail, the Government appoints an official arbitrator, taking as a basis for negotiation the rent paid to the Government for that particular land, its position, etc., etc. On taking up an area in a Government forest, another set of simple rules holds good, and application has to pass through the Forest Department. The Central Provinces Government are at present very anxious to develop their minerals to the full, and render every help to new companies. In Bengal the rules regarding minerals are very different; there the Government does not claim the mineral, and every local Rajah or petty holder of surface-rights claims the minerals lying under his estate.

Appendices.

Appendix I.—Statistics relating to the State Collieries worked by Railway Companies or by the State.

[Table omitted.]

There is also Dandot Colliery, belonging to the North-Western State Railway, with an output of 24,629 tons in 1909, which was worked at a small loss. The pressed-fuel factories at Haranpur and Khost are worked by the same railway. Haranpur, in 1909, sent out 6,274 tons of fuel at a loss of £52, whilst in the same year the Khost factory despatched 18,140 tons of pressed fuel at a profit of £533.

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The consumption of coal and wood on Indian railways was as under :—

[Table omitted.]

Compared with the year 1908, the quantity of Indian coal consumed by the railways increased by 85,000 tons, whilst the foreign coal consumed decreased by 3,412 tons.

One ton of coal is assumed to be the equivalent of 2 ½ tons of wood. Wood is still used in considerable quantities on the North-Western State Railway, the Burma Railways, and the Madras and Southern Mahratta Railways.

The consumption of coal on Indian railways as a whole, compared with that of certain foreign countries, is as follows :—

[Table omitted]

Appendix II.—Earnings from the Transport of Coal.

The transport of coal forms an important item in the earnings of the railway companies, especially the East Indian and the Bengal-Nagpur systems, which serve the Raniganj, Jherria, Giridih, and Daltonganj fields. The traffic in coal for all Indian railways is shown in the following table, which excludes coal carried by railways for their own consumption :—

[Table omitted.]

Appendix III.—Tests with Railway Coal.

A railway test was made during 1909-1910 with shipments of first-class Bengal coal, of Natal coal, and of Australian coal, with the following results:— Bengal coal ran 26 pounds per train-mile ; Natal coal, 27 pounds per train-mile; and Australian coal, 30 pounds per train-mile.

The fact that Bengal coal travels badly perhaps explains why the Ceylon and Mauritius Governments have both declared a preference for Natal coal.

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Appendix IV.—Average Assays of Tertiary and Gondwana (Bengal) Coals.

[Table omitted.]

Appendix V.—Assays of Coal, from the Raniganj Coal-field (Dr. W. Saise).

[Table omitted.]

Appendix VI.—Coal Freights from the Raniganj Coal-field (Bengal) for full wagon-loads of Coal at Owner's Risk (Owners to load and unload).

[Table omitted.]

The freight from Pench Valley to Bombay is 12s. 4d. (9 rupees 4 annas).

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The freight per mile of coal carried by the Indian Railways to the above places is 2 pies, or one-sixth of an anna per ton-mile, except in the case of Howrah, a suburb of Calcutta on the west bank of the Hoogly, where the rate is 3 ½ pies per mile. The freight for coal on Japanese railways is 4 pies per ton-mile, with an additional charge of 5 annas for the use of the coal-wagon.

The freights by sea from Calcutta for full loads of coal during 1907 and 1908 were as under:-

[Table omitted.]

The carriage by sea is very variable, and what maybe correct for one time of the year will not be so for another.

Appendix VII.—Quantity of Coal produced in the Countries of the East during the year 1908.

	Metric Tons.		Metric Tons.
Japan	14,825,363	Dutch East Indies	432,923
India	12,974,558	Indo-China	347,000
China	8,890,000	Formosa	92,042
Australia	10,357,218	British Borneo	98,712
New Zealand	1,890,839	Korea	5,895

The returns for China and Korea are for the year 1906, and are only estimates ; those for Formosa are for the Kelung District only, and not for the whole island.

A comparison of some Indian and Japanese coal figures is given in the following table : —

[Table omitted.]

Amongst other things in the above table, it is interesting to notice that the outputs of both countries were as nearly as possible equal in the year 1885.

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A vote of thanks to Mr. Ditmas for his paper was proposed by the President (Mr. M. W. Parrington), and unanimously accorded.

[Plate IV.--- Map and Section of Coalfields of the Satpura Gondwana Basin, and Plan for a Manager's Bungalow.]

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THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

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GENERAL MEETING,

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

April 8th, 1911.

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Mr. M. W. PARRINGTON, President, in the Chair.

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The Secretary read the minutes of the last General Meeting, and reported the proceedings of the Council at their meetings on March 25th and that day.

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

Members—

Mr. Ernest Robson Bawden, Mining Engineer, Dedza Boma, Angoniland, Nyassaland, British Central Africa.

Mr. Robert Seymour Benson, Engineer, Teesdale Iron Works, Stockton-upon-Tees.

Mr. Frederic Lancelot Booth, Colliery Manager, Ashington Colliery, Morpeth.

Mr. Edward Herbert Clifford, Mining Engineer, Rand Club, Johannesburg, Transvaal.

Mr. Edward Stokoe Clough, Colliery Manager, Bomarsund House, Bomarsund, Bedlington, Northumberland.

Mr. John William Evans, Colliery Manager, Glynderw House, Penllergaer, near Swansea.

Mr. George Harold Greenwell, Mining Engineer, c/o Messrs. Kilburn & Company, 4, Fairlie Place, Calcutta, India.

Mr. Alfred Edward Hale, Colliery Manager, Mountjoy Lodge, Cinderford, Gloucestershire.

Mr. George Patrick Heron, Mechanical Engineer, Pont Head House, Leadgate, County Durham.

Mr. Charles Phelps, Mining Engineer, c/o Messrs. Wragg & Company, Gatooma, Southern Rhodesia, South Africa.

Mr. Henry William Taylor, Mining Engineer, 16, Quadrant, Richmond, Surrey.

Mr. Siddell Watson, Mining Engineer, Settlingstones, Fourstones, Northumberland.

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Associate Members—

Mr. Thomas Grantham James Giddy, High Street, Newcastle, New South Wales, Australia.

Mr. Henry Alfred Lawson, Fenham View, Wingrove Road, Newcastle-upon-Tyne.

Mr. John Watts, Blythwood North, Osborne Road, Newcastle-upon-Tyne.

Associates—

Mr. Alexander French, Mine Surveyor, Institute, Peases West, Crook, County Durham.

Mr. Percy Hunter, Assistant Master Shifter, Ravenscar, Gosforth, Newcastle-upon-Tyne.

Student—

Mr. James Robson Brass, Mining Student, Charlaw and Sacriston Collieries, County Durham.

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#### APPLIANCE FOR COLLECTING COAL-DUST IN MINES.

Mr. Charles Rollin exhibited a model of his appliance, which is in the form of a small train of trucks, upon one of which is fixed a dust-collecting fan. A movable or dust-collecting arm, connected to the fan, can be placed at any desired angle by levers operated by an attendant on the train.

The fan receives its motive power from the motion of the trucks as they are pulled along the way, and the dust collected is delivered through suitable connexions into covered trucks, the dust being deposited therein, and the air (freed from dust) liberated at the far end of the train. At the commencement of each journey along the way which it is intended to cleanse, the movable arm is set at a different angle, and a separate portion of the road is thus freed from dust each time.

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Mr. W. C. Blackett read the following paper on "The Fire- and Rescue-station of the Durham and Northumberland Collieries Fire- and Rescue-brigade": —

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#### THE FIRE- AND RESCUE-STATION OF THE DURHAM AND NORTHUMBERLAND COLLIERIES FIRE- AND RESCUE-BRIGADE.

By W. C. BLACKETT.

Introduction.—The opening of the first of the fire- and rescue-stations for service in the Counties of Durham and Northumberland suggests a short review of some of the causes which have resulted in the scheme.

Coal-mining has been carried on in the northern coal-field for many hundred years, and accidents from explosions of gas have occurred from time to time from the very earliest periods of its history.

When, about the year 1676, the Hon. Roger North wrote his famous Life of the Right Honourable Francis North, Baron of Guilford, he spoke of the "damps, or foul air," of the coalmines, and somehow or other got hold of the curious notion that "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." He also adds that "the blast is mighty violent; but men have been saved by lying flat on their bellies."\*

Another interesting treatise, The Compleat Collier, speaks of an "Ignorant Man" being "burnt to Death by the Surfet, which is another dangerous sort of bad Air, but of a fiery Nature like Lightning, which blasts and tears all before it," and expresses fear of the "Invention of drawing Water by Fire, . . . because Nature doth generally afford us too much Sulpherous 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 our Concern."†

As far back certainly as the year 1239, when Henry III. granted a charter to the freemen of Newcastle-upon-Tyne for

\* Life of the Right Honourable Francis North, Baron of Guilford, by the Hon. Roger North, third edition, 1819, vol. i., pages 261 and 262.

† The Compleat Collier, by J. C., 1846 edition, pages 17 and 23,

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liberty to dig coals, and throughout the fourteenth century, when it is known that mines were worked at Elswick, as well as in many other parts of the coal-field, the hardy northern miners not only learnt their art, but acquired by practice and inherited by instinct a capacity for dealing with accidental emergencies, which in its practical application to rescue and recovery-work after explosion has hitherto been splendidly efficient.

Dr. J. S. Haldane's idea of the use of mice and birds in testing for carbon monoxide (and this most valuable expedient is likely to save more lives than any of the so-called "rescue" appliances) may be said to have been to some extent forestalled by the Hon. Roger North, who stated that "damps, or foul air, kill insensibly," and that "an infallible trial is by a dog."\* Again, Mr. T. Y. Hall suggested the use of "some living animal" for the purpose,† although it must be confessed that he had no such bases, arising from skilful research or scientific investigation, as led Dr. Haldane to his admirable conclusions.

The rapidity with which a mine can be recovered after explosion by the use of birds in the hands of practical miners is remarkable, and can never be exceeded by men relying upon the assistance of cumbrous and distressing breathing-appliances.

The occurrence of serious fires at Courrieres, Hamstead, and other places, resulting in such calamitous death-rolls from suffocation, brought a more familiar conception of circumstances into the minds of the general public; and when the people learnt that there had been for many years appliances made, and since improved upon, which enabled the wearer to live in an unbreathable atmosphere, and when, also, these received the as yet totally undeserved

designation of "life-saving" or "rescue" appliances, then the demand arose, as was natural, that they should be provided at stations within reasonable reach of collieries where such risks from fire and explosions existed.

Prominent mining engineers advocated zealously their use, and pictured hypothetical difficulties as being easily and safely overcome, with lives saved as the certain reward of the effort. Trial galleries were erected, and demonstrations given with men working in suffocating atmospheres, training in the breathing-

\* Op. cit., pages 261 and 262.

† "On Penetrating Dangerous Gases," by T. Y. Hall, Trans. N. E. Inst., 1854, vol. ii., second edition, page 85.

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dress being the principal feature of the whole movement, until more recently there has been added the teaching of some of the first principles of mining, such as the properties of gases, the reading of mine plans, etc.

Realizing that these dresses are far from being perfectly reliable, and that the use of most of them is very distressing by reason of their weight and generated heat, and appreciating the helplessness of the wearer from the impossibility to see in thick smoke, the writer holds to his often-repeated opinion that their possible uses are being very greatly exaggerated and prematurely enforced.

Recognizing early that fire would probably require more serious attention than would the results of explosion, the colliery owners of Durham and Northumberland determined not merely to have men trained to wear breathing-dresses, but to have them also especially skilled to fight fires; and co-operation with the highly efficient brigade under Mr. Guy Simonds at Elswick was made possible owing to the broad-minded reception by Sir W. G. Armstrong, Whitworth, & Company, Limited, of the proposals made by the coal-owners. A committee of management was formed, consisting of Messrs. W. C. Blackett (Chairman), R. O. Brown, C. S. Carnes, W. Cochran Carr, T. E. Forster, T. Y. Greener, Samuel Hare, Austin Kirkup, F. O. Kirkup, John Morison, C. B. Palmer, M. W. Parrington, J. J. Prest, Simon Tate, and R. L. Weeks. Mr. Guy Simonds was appointed Chief of the Brigade, and his services have proved most valuable, bringing, as he does, in addition to his trained skill as an engineer and fire-fighter, a capacity for organization and enforcement of discipline, without which any brigade for the purpose in view would be useless, and infusing also an enthusiasm for the work which has already greatly helped to establish the station upon a sound and practical basis.

A building (Figs. 1, 2, and 3, Plate VII.) has therefore been erected at Elswick, which not only provides such accommodation as is necessary for the plant subsequently described, but also living rooms for two senior men with their families and for six unmarried men, together with special quarters for three colliery apprentices, who may have a course of training in the complete plant and discipline of the station. There is also a large lecture-room, and an office for secretarial work.

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Types of Breathing-apparatus.—There were two types of breathing-apparatus from which to choose, namely, (a) that which maintains its supply of oxygen from steel cylinders containing the gas compressed to, say, 120 atmospheres, and which has the expired carbonic-acid gas absorbed by such a substance as caustic potash; and (b) that which depends upon liquid air boiling off and being discharged into the surrounding atmosphere instead of being, as it were, regenerated.

The former appliance, as well as being very heavy, generates (owing to the chemical combination going on in the caustic potash) considerable heat, which becomes most enervating; and, in addition, the apparatus is complicated with delicate valves. Hard useful work is difficult to perform in such a dress, especially in warm and moisture-laden mines, and the inevitable distress which ensues explains the anxiety of its advocates that only men who are considered medically sound should wear it, while its complications explain why it is deemed so necessary to train men to its use.

In liquid air, however, the committee found ideal possibilities; and, despite the many imperfections of the original Aerolith, it was eventually chosen, with the determination that its drawbacks should be overcome.

The refreshing cold of the lighter-weighted Aerolith (only about half the weight of other appliances) makes the use of liquid air most desirable, while, owing to there being no valves or adjustments of any kind, practically any man can wear the apparatus without much training; moreover, if he be already exercised in the use of the bellows-helmet, with its telephone and its 60 yards of tubing, he has little or practically nothing more to learn.

If anyone is inclined to doubt the wisdom of choosing apparatus employing liquid air instead of those relying upon compressed oxygen and the consequent absorption of carbonic-acid gas by caustic potash, he has only to try a very short pit-shift in each dress to be convinced.

The original apparatus supplied was impracticable, and this may be said without disparagement, as Messrs. Henry Simonis and Company, the makers, were not then so familiar with the work to be done, nor had they then had opportunities of putting their appliance to work. The face-mask was so

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Photograph: Fig.7.—Experimental Drift at Scotswood, with three men wearing the Durham Improved Aerolith Breathing-apparatus, one man charging an Apparatus with Liquid Air, and Two men using a portable telephone.]

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uncomfortable as to produce positive exhaustion; accordingly, a light leather head-piece, known as the "Durham" helmet, was constructed, only to be discarded and followed by experiments with other shapes. Mouth-breathing has also been tried, but the attachment at present most favoured is one covering the nose and mouth, and held to the face by being attached to an ordinary pit-cap by light straps. In smoke the helmet or close-fitting goggles may have to be used.

Experiment also revealed the fact that liquid air with only an ordinary amount of oxygen was undesirable, owing to the fact that nitrogen is given off more freely than oxygen. It was found advisable to have air with 60 per cent. of oxygen, and this is easily produced.

The Durham Improved Aerolith Breathing-apparatus.—Figs. 4 and 5 (Plate VII.) are diagrams showing The Durham Improved Aerolith Breathing-apparatus, the pack, A, being made of nickel, and filled with asbestos-wool, into which about 10 pounds of liquid air are poured at B. The pack is surrounded by a non-conducting material to prevent access of heat. The vapour flows through a tube, C, which is carried once round the pack, in order to increase the temperature of the air a little before breathing. From the tube, C, it is carried to the breathing-bag, and so to the helmet; it then returns with exhaled air through the tube, D, into the gilled pipe, E, wherein it serves to boil off by its temperature a further supply of air. Excess of air-pressure passes out of a small relief-valve on the head-piece, or leaks past the face-joint. Trouble arose through the moist exhaled air freezing, instead of helping to boil off more air, owing to the conductivity of the gilled tube, E, and so producing a contrary effect, with increased difficulty of breathing; indeed, the writer could not bear the distress occasioned, although men seem to vary in this respect, a great deal depending upon their moisture and lung capacity. This difficulty has now been overcome by placing inside the tube, E, a small cartridge of caustic potash, which serves the double purpose of drying and warming the exhaled air and reducing the carbonic acid. The breathing-bag, or receiver, has also been made less obtrusive, and the fittings on the pack have been protected by wicker-work.

The result, so far, of all these improvements is a dress weighing

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[Photograph: Fig.8.—Man in Bellows-helmet using Jet from Small Hand-pump.]

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when empty, 12 pounds, and, when full, 22 pounds, which allows of over 3 hours' use (Fig. 7).

Liquid air expands to about 700 or 800 times its volume in returning to its gaseous state of atmospheric pressure. Ten pounds of liquid air, as used, contain 6 pounds of oxygen, or, say, one-tenth of a cubic foot; and this amount expands to nearly 80 cubic feet, giving a very ample supply for 3 hours. This indicates how much of the air is wasted, as, at the outside, less than 1 cubic foot of oxygen can be absorbed by a man in an hour, which produces practically the same volume of carbonic acid; and expired air, according to Dr. J. S. Haldane, contains about 4 per cent. of the latter gas, an amount which he states makes air uncomfortable to breathe.

Reference has already been made to the bellows-helmet, an appliance (Fig. 8) which is highly recommended for local use at collieries, and examples of which are already in the possession of several collieries.

It is considered that, in nine cases out of ten, the purpose of a breathing-appliance would be effected within a distance of 60 yards from respirable air, and the head-dress designed by Mr. Simonds fulfills this requirement. It is supplied with air by a common bellows through strongly armoured tubing, and is fitted with telephones from end to end; and, being quite fool-proof, it requires no special training in its use, while men who have used it can practically at once wear the Aerolith apparatus, and be effective for work.

It is also intended to keep on hand a small number of oxygen appliances for special emergency purposes at the advance base of the liquid-air supply and telephone-station.

It has been recognized that telephoning would form a very important branch of any recovery-work, and Mr. Simonds has been able to devise a special installation, whereby a telephone-line can be laid down the deepest shaft and in-by as quickly as a man can walk, whilst maintaining all the time communication between the layer, the shaft-bottom, and the surface. The contrivance is novel, and is not excelled by anything of the kind elsewhere (Fig. 7).

All this apparatus, together with the dresses, oxygen-reviving pulmotor, canaries, liquid air, and hand-pumps, is in constant readiness upon the tender-car (Fig. 9), which can be dispatched within a minute or two of any call,

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[Photograph: Fig. 9.—Motor-tender, Motor-car, Sleeping-van and-Motor Pump.]

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For practice purposes it is hoped to acquire very soon an old drift (Figs. 7 and 8) within a short distance of the station, when selected men from collieries will receive lessons which they can transmit to their local brigades, while quarters for three mining apprentices at a time are provided in the station for special training in fire and rescue discipline.

Liquid-air Plant.—The committee not being satisfied with any of the liquid-air making appliances in this country, Mr. Simonds was authorized to visit Austria and Germany, and he there found the Heylandt plant, which may be said to be the best that the world produces at the present time. It is capable of yielding 30 pounds of liquid air per hour, and, unlike most other plants, begins producing within a quarter of an hour of starting the compressor. To keep enough air for the use of ten dresses during 2 days, a stock of 1,600 pounds will have to be maintained; and, as the evaporation is at the rate of 6 per cent. per day, the plant will have to run about 4 hours a day. Originally, the only storage-bottles made were of glass, but at last nickel bottles holding 50 pounds have been obtained, and the constant risk of breakage and loss is thus avoided.

Fig. 6 (Plate VII.) is a diagram of the plant, air being taken from the atmosphere into the purifier, A, where it is freed from carbonic acid by quicklime, and from dust by coke. From the purifier it passes to a Whitehead three-stage air-compressor, B, where it is compressed to about 180 or 200 atmospheres, and then passed through two cylindrical steel absorption cylinders, C, filled with chloride of calcium, which removes the moisture before it enters the liquefier, D. Through this liquefier two-thirds of the compressed air circulates inside a spiral coil of tubing, on the outside of which the other one-third, mostly nitrogen, is allowed to expand itself. During compression the great heat generated is largely abstracted by water-jackets, and therefore on expansion the one-third so rapidly absorbs heat from the liquefier-coil, with its contents of already very dense air, that the temperature of the latter is brought down so much nearer to absolute zero point as to pass the critical dividing-line between the state of vapour and liquid, exactly as, on a higher plane, steam-vapour becomes water.

Thereafter the liquid of air behaves exactly as the liquid of water, having regard to the difference in their boiling-points,

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[Photograph: Fig. 10.—1 ½ -inch Jet from Motor-pump.]

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over 500° Fahr., the former requiring just as much care to store in the high relative heat of our surroundings as would water in a heat of nearly 400° Fahr. In the same way, as water could not be confined in a surrounding heat of 400° Fahr., so liquid air cannot thus be confined; and, despite all care, a daily loss of some 6 per cent. must be expected.

In order that the expansive power in this one-third shall not be lost, an adjustable quantity of the compressed air is first carried to a small engine, E, and helps to drive the electric motor which originally compressed it; and it is the exhaust therefrom which serves to cool the liquefier-coils, and throw down liquid rich in oxygen.

As the critical dew-point of oxygen is some 25 degrees Fahr. higher than that of nitrogen, advantage is taken of this fact to obtain the necessary high percentage of oxygen in liquid form, while much of the nitrogen is left uncondensed for use in the air-engine and for cooling purposes around the coil. It must be remembered, also, that when a mixture of liquid oxygen and nitrogen evaporates, it behaves exactly like other mixed liquids : the more volatile nitrogen distills off first, leaving the residue richer and richer in oxygen, and so the air for breathing becomes better as the charge in the pack becomes less.

Motor-pump.—The motor-pump (Figs. 9, 10, and 12), by Messrs. Merryweather and Sons, is of the very latest description. The motor is of 60 horsepower (R.A.C.), or about 80 brake-horsepower, and drives at will either the road wheels, by means of sprockets and chains, or the Hatfield pump, the three cylinders of which thrust at each angle of an equilateral triangle. The pump can deliver a maximum of 500 gallons per minute at a pressure which, through 100 feet of 3-inch hose and a 1-inch nozzle, gives 150 pounds on the square inch; while, with its most powerful jet, 1 ½ inches in diameter, on a short length of 4-inch hose, into which, by a breeching-pipe, two 3-inch hoses are delivering, it can project its water for 200 feet (Fig 10). The speed of such a jet is so great as to make it almost as hard as metal, while in addition to the generating power the equally important shock effect is enormous. .

The car, which can carry from six to ten men, is provided with 1,600 feet of 3-inch hose, fitted with "either-end" Stortz couplings, by which any one end can be instantly

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[Photograph: Fig.11.—Wireless-telegraphy Apparatus: Receiving a Message from the Beaumont seam (800 feet down) at Benwell colliery.]

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joined to any other. It is capable of a speed of 30 miles an hour; but it should be remembered that speed will be of little avail unless the owners of collieries have clearly

arranged beforehand for access to a supply of water, and where and how it can be furnished—whether the pump may serve itself from a pond, or have its own portable dam served by other pipe-supplies great or small.

Tender, etc.—The tender (Fig. 9), which has already been mentioned, is the result of much careful consideration, and was built at Elswick Works and furnished with a 25-30-horse-power motor. It is always standing ready for instant use, and has every necessary appliance on board for use in underground accident. Particular attention is drawn to the small hand-pump (Fig. 8) standing upon its rear platform, which has been designed and built for use at underground fires. Entirely of brass and aluminium, it weighs only 35 pounds, and can be carried by one man, while it is provided with a 10-foot length of 2-inch suction-hose, two 50-foot lengths of 1-inch delivery-hose, and a portable canvas water-dam, from which, or from large buckets or water-tubs, the suction can be taken. For its size, it can throw a surprisingly powerful jet of water, and has been brought into existence by the experience of the brigade in connexion with the fire at the Eden Pit. Such a pump, if kept in readiness at any colliery, might some day become worth its weight in gold.

Experience also demonstrated the necessity of providing a living-van (Fig. 9) for the brigade when called to any colliery, so that for food, sleep, and change of clothes, the men can be independent of outside help. The van provides six men with bunks, sleeping-bags, mattresses, underclothes, trousers, biscuits, meat, tea, milk, tobacco, soap, towels, and bath.

In addition, the station possesses a small two-seated motorcar (Fig. 9) for purposes of inspection and general go-between work.

The most recent experiments which have been made were with wireless telegraphy between the surface and men in workings close upon 800 feet deep and a great measure of success has been achieved (Fig. 11). Through the enterprise of the Helsby Wireless Telegraph Company, their representatives, Messrs. Sharman and Webb, achieved this wonderful result. There was

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[Photograph: Fig.12.—View inside the Rescue-station, showing the Motor-pump, Sliding poles from Upper Floors, and Hand-rope for opening the Doors.]

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not the slightest difficulty in hearing the Morse code at either end, and the brigade men sent and received Morse messages with the greatest ease. The apparatus is to be further experimented with, as the possible advantages of such a means of communication are at once apparent, and open out a very interesting field. It is a question whether experiments with aerial wireless work should not also be made, as the post office telephone system by wires is so repeatedly a failure.

Home Office Report.—Doubtless the members are conversant with the Report of the Mines (Rescue and Aid) Committee, appointed by the Home Secretary to consider the organization of rescue and aid in cases of accidents in mines\*; and although at the time of writing no

Order has yet been formally put forward by the Home Secretary under the Act of 1910, there is but little doubt that it will soon appear in that form. The writer need not enter into the details of the report, but it is evident that the original full intention of the station is already defeated, and that the committee will not be allowed, as was hoped, to gain experience before having to contemplate other stations. No other central stations will be, of course, necessary, if each colliery provides two sets of portable breathing-apparatus to each statutory brigade which the Order may necessitate; but, as all collieries will have to organize from one to four brigades, depending on the number of underground employees, the number of dresses to be obtained in this country will be impossible for a long time, and it will probably be advisable in any case to provide them in supplementary stations at convenient centres.

It will be a matter for the further consideration of the Durham and Northumberland Coal-owners' Associations whether they will not also supply some of these stations with fire-engines, and then, as the writer advocates, whether the whole of the fire insurance of the two counties should not be effected mutually in the same way as the insurance against compensation for personal injuries is already effected.

Fig. 12 is a view inside the station, showing the motor-pump, sliding poles from upper floors, and hand-rope for opening the doors.

\* Report of the Departmental Committee on the Organization of Rescue and Aid in the Case of Accidents in Mines, 1911 [Cd. 5,550].

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The writer includes, as an appendix, a copy of the instructions for the use of The Durham Improved Aerolith Breathing-apparatus, as compiled for the Durham and Northumberland Collieries Fire- and Rescue-brigade by Mr. Simonds.

#### APPENDIX.—Instructions for the Use of The Durham Improved Aerolith Breathing-apparatus.

##### I.—General Notes on Care of Apparatus.

When not in use, the closing plugs should be tightly inserted in the ends of both the supply and exhaust-pipes, as otherwise the cartridge deteriorates. The cartridges remain serviceable for about 4 hours' continuous work, and for about 6 hours' intermittent work.

Examination will at once show whether the cartridges are expended, or not. If more than one-third of the contents of the wire-gauze cylinder is found to be sticking together, the cartridge should be replaced.

The cartridges should not be removed from their air-tight cylinders until required for use, as they deteriorate on exposure to the air.

##### II.—Instructions for Adjusting Helmets and Packs.

While the packs are being filled, each man of the party must fit on his cap attachment.

The pneumatic head-lining need not be pumped up to any great extent, as, if the rubber is bearing lightly all round the face, it will make a sufficiently air-tight joint, and excessive pressure on the face causes headache.

When the pack is in place, and the waist-belt tightened, the rings of the lower corners of the apron must be hooked on to the spring-hooks on the belt. It is advisable, if possible, for the men to screw up each other's breathing-pipes to the helmet.

### III.—Instructions for Using Charging Stand.

The charging stand consists of a tripod, with a pencil and indiarubber attached, and a detail box containing one spring-balance, one hooded lamp, one hook, one glove, a bottle of water, and some cotton-wool.

The senior man will charge the pack, unless he details this duty to one of the other men of the party. The charging should be carried out as follows: — The tripod should be first set up, and the lamp screwed on to the top (to do this, it is not necessary to unscrew the nut from the bolt on the bottom of the lamp, as the nut and washer are of such a shape as to allow them to pass through the slot on the top of the tripod). The spring-balance should then be hooked on the top of the tripod, the lower hook hooked on to the spring-balance, and the pack hooked on to the lower hook, the basket guard having first been turned back. The back edge of the pack must be inside the steadying arms on the after leg of the tripod. Before starting to fill the pack, the pencil attached to the tripod should be drawn along the pointer of the spring-balance, leaving a pencil-line on the dial. The pack may now be filled with liquid air, and the difference between the position of the pencil-mark and the point at which the pointer stops will give the total weight of liquid air in the apparatus. When this weight has been taken, the particulars of the weight, time of filling, time of duration, and time of setting of the alarm-watch, must be entered on the back of the watch belonging to this pack. The pack should then be removed, the filling plug, and air-escape plug closed, and the pack given to the man who is to wear it.

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Before starting to fill another pack, the pencil-mark must be removed with the indiarubber from the dial of the spring-balance. After the filling plug has been screwed down tight, should any escape of air be noticed, some cotton-wool should be packed in on top of the plunger of the filling plug, and damped with water from the water-bottle.

The glove carried in the detail box should always be worn on the left hand when pouring liquid air from the liquid-air bottles.

### IV.—Instructions for Men using Breathing-apparatus.

Duty of the Senior Man.—(1) To fill or to superintend personally the filling of all packs.

(2) To note the weight of all packs before and after filling.

(3) To have all watches set by his own (this may be done beforehand).

(4) To enter on the back of each watch the time of weighing, and estimated time of duration of efficiency of air-supply, taking 1 pound as equal to 15 minutes.

(5) To set each man's watch to sound the alarm at half the estimated time of the air-supply.

(6) If any person other than one of his own party is wearing the apparatus, to get a promise from that person that, on the sounding of the alarm, he will at once return as speedily as possible to breathable air, and that he will generally obey the senior fireman's orders in so far as his safety in the apparatus is concerned. Should this promise not be given, the senior man would be justified in refusing to allow the person concerned to wear the apparatus.

(7) The senior man must arrange for the position of the advance base, and also decide what gear and apparatus shall be taken there.

(8) When in charge of the working-party, he should do no work; he must remember that on his watchfulness depends the lives of his whole party; the working-party must be left free to devote all their attentions to the work in hand, and this they cannot do with any confidence unless they know that the senior man's first consideration is for the safety of his party.

(9) When a man reports that his alarm has sounded, to see that the man returns to fresh air, or is given a fresh charge of air. In the latter case orders No. 2, 4, 5, and 6 must be again adhered to.

Note.—Under exceptional circumstances the senior man may allow any of his party to continue working beyond the half-time limit; but he must never do this unless he knows that the return to breathable air will not take more than a few minutes, and that the road is clear and easily travelled. The grave responsibility incurred by allowing this extension of time must not be lost sight of.

(10) He must send back such reports as are desirable. For this purpose the man at the advance base may be used as a messenger, being called up to the party by the pre-arranged signal. He should endeavour to have the helmet telephone-line brought in as soon as possible.

(11) Should any breakdown occur while wearing the apparatus, the man concerned must be sent back to safety at once, accompanied by one or more men, as circumstances may direct.

Distinguishing Marks of Senior Men.—The man in charge of the party will wear a black and white armband on each arm.

Composition of the Party.—The helmet party should not consist of less than five men, namely, the senior man, two working hands, one in charge of the

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[Plate VII. : Plans of Rescue Station, and diagrams of Breathing-Apparatus and Liquid Air Plant.

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advance base, and one connecting man; any additional men would be added to the number of working-hands.

Bases.—The base will be the place defined in the Route and Order Book.

An advance base must be formed as close up to the party as possible, without leaving breathable air. Liquid air must be pushed forward to the advance base as speedily as possible. Other apparatus, such as canaries, reviving-apparatus, fire-engines, etc., can be taken on there if circumstances demand it. The following must, however, be always kept at the advance base:—Charging stand complete; two bottles of oatmeal and water; one canary in cage; one oxygen-breathing apparatus (2 hours), the pack to be worn and the helmet ready to put on at once; and one electric hand-lamp in use and two spare lamps.

Duties of Man at Advance Base.—(1) To listen for sound signal from man in charge, calling him up.

(2) To keep in touch with base, and to get liquid air and appliances to his base as speedily as possible.

(3) To watch the condition of his canary, so that should any poisonous gas drive back to him, he may put on his oxygen apparatus. Should the gas come back on him, he must

inform the man in charge of the party, who will probably make arrangements to retire to the advance base. A sound signal will be arranged for this eventuality.

(4) To see that his apparatus is ready for use, and when his gauge shows not more than half an hour, to get in reserve supplies for his own apparatus from the base.

Duties of Connecting Man.—This man will see that connexion is kept between the advance base and the base. Any supplies of liquid air brought to the pit must be reported to him, and he must see that this information is sent to the man at the advance base.

Information will be found in the Route and Order Book as to telephone communication at the pit. Should there be such communication between the pit-head and any convenient place below ground, it will render communication very simple. If not, or if damaged by explosion, the advisability of laying the temporary line must be considered (see special orders for laying the portable telephone).

Duties of Working-party.—To work under the senior man and report to him when their alarm has sounded.

To report to him any signs of defect in his apparatus.

Each man, in addition to his apparatus, must have in his possession an alarm-watch, set and entered up by the senior man; an electric hand-lamp; and a piece of chalk.

When advancing or retiring, the party must keep within a few yards of one another.

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The President (Mr. M. W. Parrington) proposed a vote of thanks to Mr. Blackett for his paper, which was heartily-accorded.

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Mr. Berent Conrad Gullachsen's paper on "The Rescue-station at the Kleophas Mine, Zalenze, Upper Silesia, Germany," was taken as read, as follows: —

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THE RESCUE-STATION AT THE KLEOPHAS MINE, ZALENZE, UPPER SILESIA,  
GERMANY.

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By BERENT CONRAD GULLACHSEN.

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Introduction.—About 15 years ago, the Kleophas Mine was the scene of a terrible disaster. During the night of March 3rd, 1896, a fire, supposed to have been caused by careless workmen, broke out in a brick-lined staple, which, however, contained wooden guides, ladders, and platforms, all of which were very dry, on account of the presence of a steam-pipe. Large volumes of smoke quickly found their way into the main intake, filled the workings, and finally passed to the upcast shaft; and in the resulting unbreathable atmosphere 104 miners perished.

As the rescue- and fire-extinguishing apparatus at the mine, at that time, proved to be of no practical use, much interest was taken in the provision of the newest and most up-to-date appliances. At first some of the workmen and officials were only exercised occasionally in the oxygen-breathing apparatus, but in the year 1897 regular drills were enforced. Any new apparatus invented was immediately purchased and given a trial, and the mine now

possesses a large collection, illustrating the development of rescue-apparatus from the simple pneumatophore.

Up to the year 1903 the Schlauch, the Walcher-Uysdal, and the Shamrock types of apparatus were used, as also those in which a solid alkaline absorbing material was employed, such as the New Shamrock, the Mayer-Pilar, and the Griersberg.

At this date fortnightly drills took place, first in the interior of an old brick-oven, and later in a drift driven into the mine-dump ; and the now old-fashioned plan of making as high a percentage as possible of the miners acquainted with the use of the various appliances was carried out. The duration of the drill was at first very short, each man, on an average, only using an apparatus for about 15 to 20 minutes; but, in the

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following year, the time was increased by the adoption of the improved Giersberg apparatus, which was provided with changeable regenerators, an oxygen regulating-valve, and an injector for the respired air. With this apparatus each man was able to continue work for from 20 to 30 minutes, without a stoppage. In the year 1905, examples of the direct mouth-breathing and smoke-helmet Draeger apparatus were obtained, and from this time the period for which apparatus could be used increased steadily, until the long and now normal period of 2 hours' continuous drill was reached. Towards the end of the year 1908, the drills were carried on by a party of five men, who set up timber, erected dams, and performed other work in the smoke-filled gallery, which was driven 65 ½ feet (20 metres) into the mine-dump, but proved a very unsatisfactory and exhausting place for a 2-hour drill.

There was at this date no provision outside the offices for the storage of the various valuable appliances, a condition existing at most of the mines in Upper Silesia, until the erection of the central rescue-station at Beuthen, which quickly exercised a good influence. The occurrence of the great disasters at Courrieres and Reden gave further impetus to the formation of rescue-stations, and so a plan was drawn up for the construction of a station and experimental gallery at the Kleophas Mine, the work being carried out and completed in February, 1909.

Description of the Rescue-station: Store-room (Fig. 1, Plate VIII.).—The store-room is directly connected with the shaft by a tramway, in order that, when necessary, all tools and apparatus may be immediately available. On this tramway three special wagons stand ready for immediate use, being loaded with a Westphalian air-pump apparatus, a Draeger apparatus, and all the necessary accessories, including a flying telephone. This last-named appliance consists of three telephones in iron boxes and 7,874 feet (2,400 metres) of cable, wound on four rollers carried in wooden boxes. A line can be laid rapidly by running out the cable as the wagon proceeds to the point required.

Upon the wall of the store-room are hung eighteen Draeger appliances in boxes, which also contain an electric accumulator-lamp, oxygen-cylinders, and alkali cartridges, together with a broad leather belt, containing an axe, a strong rope about 20

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feet (6 metres) long, and a nail-bag. The articles forming each outfit are clearly numbered, in order to prevent any mixing, and the appliances for the officials are provided with white

carrying-straps, while those for the workmen have black. It is the rule that each member of the rescue-corps must always use the outfit bearing the number allotted to him, and to the leader's outfit is attached a small horn for the purpose of signalling, which is arranged as follows:—One blast, stop; two blasts, continue; three blasts, all in order; and four blasts, return quickly.

On the walls are also displayed notices such as: "Do not forget the electric lamps," "Only proceed in the mine in parties of four men and one guide," etc.; and a diagrammatic sketch of the rescue-apparatus, which is used for instruction classes.

A complete Konig apparatus, including a large air-pump, 394 feet (120 metres) of air-piping on a windlass, and two helmets, etc., is also provided; and for treating the unconscious there are two Westphalian-Wieder as well as a Brat oxygen reviving-apparatus. Bandages, splints, etc., are packed ready for immediate transport in a Hartmann ambulance-case. In a cupboard are kept all the reserve portions of the different appliances, while upon a number of shelves are stored all necessary materials that might be required; and, to avoid confusion, each shelf contains only one kind of article. Other appliances comprise a Broockmann apparatus for gas analysis, an oxygen-pump, with several oxygen-cylinders, a number of Minimax and Pluvius appliances, and an apparatus for registering the work performed on the machine in the experimental gallery.

For the quick erection of airways, iron props are provided, each prop consisting of two iron pipes, about  $2\frac{3}{4}$  and  $2\frac{1}{2}$  inches (70 and 64 millimetres) in diameter respectively, and of a minimum length of  $5\frac{1}{4}$  feet (1.6 metres), inside of which is a wooden prop. Props can be clamped at any desired length, and, being light, can be used without trouble in the mine, and the brattice-cloth nailed to them.

There is a small workshop, in which all the appliances are repaired and kept in good order, and where all the electric storage-battery lamps, etc., are charged.

A table completes the furnishing of the room, the drawers containing the mine-ventilation plans on a scale of 1: 2,000,

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the plans of the different seams, and drawing and writing material, note-books, etc.

Both the store-room and the observation gallery are heated by steam, and ventilated by movable roof-ventilators.

Experimental Gallery (Figs. 1, 2, and 3, Plate VIII.).—The experimental gallery, of horse-shoe shape and one storey in height, is entered from the store-room by two doors, the central portion being the observation gallery, also entered from the store-room by a third door. As a result of the number of drills that have been carried out, the gallery has been fully timbered. Entering from the store-room on the ground floor, the work-registering machine is first met with, the remainder of what might be called the first side of the gallery consisting of a narrow broken-in way. The short length at the end of the gallery is left clear, and is used for the construction of brick and timber dams, etc., during the drills, whilst the other side is made to represent an inclined plane and travelling-way. In the upper storey is a length of low passage-way for the purpose of accustoming the men to travel with the apparatus in similar places in the mine, the remainder of the storey being left open for such work as erecting air-regulators, putting in timber, making airways, etc.

The smoke with which the gallery is filled is produced by burning wood-shavings, greasy cotton-waste, small coal, etc., in fireplaces provided for the purpose. All the doors and windows are rendered smoke-tight by means of rubber. The gallery is cleared of smoke by opening the windows and doors, and, in case of necessity, can be more rapidly cleared by the breaking of a large glass window in the roof. The building of an electric ventilating fan is under consideration.

Observation Gallery (Fig. 1, Plate VIII.).—The interior of the whole of the experimental gallery can be kept under close observation by means of a number of windows in the walls of the observation gallery. Signals can be given by electric bells, and in this way the movements of the men in the gallery controlled, the sounding of a horn four times being the signal for all to retire.

The observation gallery contains the collection of different types of oxygen-breathing apparatus, arranged so as to show

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their progress and improvement; and hanging on the walls is a plan of the building, diagrams of the appliances (with instructions how to use them), the rules and regulations of the rescue-corps, and the names of the members and their places of abode, etc.

Telephonic Communication.—The station is connected with the mine telephone-exchange, which is open day and night and in telephonic communication with all parts of the mine, both above and underground, and with the public telephone-exchange .

Cost of the Store-room and Experimental and Observation Galleries.—The building of the rescue-station and its entire equipment resulted in the following expenditure:—

	£ s. d.
Building	2,766 10 0
Heating apparatus	125 0 0
Furnishing, including all materials	817 10 0
Total cost	£3,709 0 0

Fire-station.—The store-room is in direct communication with the fire-station, which leads out on to the street through two large doors, and contains all the necessary equipment for a mine fire-station. The fire-engine is a modern machine; the firemen are selected from the mine workers, and carry out weekly drills under the direction of an experienced man.

Organization and Drilling of the Rescue-corps.—In organizing the corps only industrious, temperate, and healthy men are selected, the object aimed at being to have a small and, above all else, well-trained troop of men. The management of everything in connexion with the rescue-station is under the direct care of the under-manager, who sees to the drilling of the men, the forming of the rescue-corps, and to all payments of the men. The men, mostly working miners, first undergo a course of instruction in the working of the apparatus, and are

made intimate with the use of the different materials, after which drills commence in a clear atmosphere. Later on drills are undertaken in smoke, under the direction of an official; and to accustom new members gradually to hard work in such an atmosphere, the machine for registering the amount of work

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done is first employed, until the men become used to the apparatus. When a man has performed two drills, each of 2 hours' duration, in a smoky atmosphere, he is considered to be a qualified member of the rescue-corps. The permanent rescue-corps consists of eight men, with the same number as a reserve, and each rescue-party consists of a leader (overman) and four men. The members of the corps also undergo a 10-days' course of instruction at the central rescue-station at Beuthen, and an 8-days' course in ambulance at the hospital at Kattowitz.

Before each drill the leader asks his men questions dealing with their work, and in the drill proper (which lasts fully 2 hours) brattice airways are erected, wooden and brick dams built, timber put in, etc. Shortly before each drill difficulties such as fallen timber, overturned tubs, etc., are, unknown to the members of the rescue-party, placed in the gallery, and have to be overcome and put in order. During each drill the transport of an injured man is also performed, with the use of a lay figure, and practice carried out in reviving the unconscious by natural and artificial means.

The leader of each party has special and important duties to perform : he is responsible for the well-being of his party; he must not allow any member thereof to pass out of sight; and he must control the working of their apparatus. He must also know where each member lives, the numbers of the outfits belonging to each, in which shift and in what sort of work they are engaged, etc., and he must be able to get the men together at the shortest possible notice. For this purpose the members of the rescue-corps must live as near the mine as possible; and, if this is not the case, then the leader must have reserves upon which to depend, in order to complete his party immediately. A bicycle stands in the store-room ready for use in summoning members. After each drill, all appliances that have been used have to be overhauled and put in order, which work is performed by a mechanic and an assistant, who have strict instructions that one of them must always remain as watchman in the rescue-station.

The aim of the management is so to arrange that at all times, both day and night, six fully-qualified men are always at the surface, and ready for immediate action. By this means instant action is assured, and on this in nearly every case the successful result of the work depends. The ordinary work of the corps

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is arranged as follows:—Of the three parties of six men each, the first will be employed in the day-shift on the surface, the second in the day-shift underground, and the third in the night-shift on the surface (12-hour shifts). The parties regularly change shifts, and work both at the surface and underground, and in this way do not lose their knowledge of underground work; and, further, in order that they may become acquainted with all forms of underground work, they have to do work in connexion with sand-filling, attending haulage-engines, etc. When on the surface, their places of work are connected by telephone with the rescue-station.

Besides these regular rescue-parties, there will, of course, also be a number of other trained men who can be called upon in case of necessity.

Cost of the Drills.—Each man is paid 2s. for every 2-hours' drill, and money prizes are offered for each accident that is attended. The total cost of the drills, material, and wages, including that of the mechanic, amounts to about £300 per annum.

Conclusion.—The writer is indebted to Mr. V. Tomaszewski for showing him everything in connexion with the rescue-station and giving him all the information necessary for this paper.

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The President (Mr. M. W. Parrington) proposed a vote of thanks to Mr. Gullachsen for his paper, which was cordially adopted.

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Upon the conclusion of the meeting, the members visited the Fire- and Rescue-station of the Durham and Northumberland Collieries Fire- and Rescue-brigade at Elswick, where the station and appliances were inspected, and a turn-out, etc, by the brigade was witnessed.

[Plate VI. Plan of the Rescue-station at the Kleophas Mine, Zalenze.]

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THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

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GENERAL MEETING,

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

June 10th, 1911. i

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Mr. M. W. PARRINGTON, President, in the Chair.

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The Secretary read the minutes of the last General Meeting, and reported the proceedings of the Council at their meetings on May 27th and that day.

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The Secretary read the balloting list for the election of officers for the year 1911-1912.

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

Honorary Members—

Mr. Richard Donald Bain, Mining Engineer, Durham.

Sir Henry Hall, I.S.O., Mining Engineer, Brookside, Chester.

Mr. Joseph Samuel Martin, I.S.O., Mining Engineer, The Vikings, 16, Durdham Park, Bristol.

Mr. Thomas Harry Mottram, H.M. Inspector of Mines, 1, Marmion Road, Sefton Park, Liverpool.

Mr. Arthur Darling Nicholson, H.M. Inspector of Mines, Red Hill, Durham.

Members—

Mr. Valerian Danchich, Mining Engineer, 5, Alexandra Villas, Finsbury Park, London, N.

Mr. James Walter Henry Dew, Engineer, 8, Laurence Pountney Hill, Cannon Street, London, E.C.

Mr. Thomas Emmerson, Colliery Manager, The British India Coal Company, Limited, Nowpara Colliery, Asansol P.O., E.I. Railway, India.

Mr. Christopher Liddell, Colliery Manager, Houghton Main Colliery, near Barnsley.

Mr. Charles Benjamin Saner, Mining Engineer, Village Deep, Limited, P.O. Box 1064, Johannesburg, Transvaal.

Mr. William Angus Scott, Electrical and Mechanical Engineer, 102, St. Mary Street, Cardiff,

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Mr. Francis Robert Archibald Shiel, Mining Engineer, Rosebank, Burnopfield, County Durham.

Mr. Edward Turnley Willis, Mining Engineer, 3, The Drive, Gosforth, Newcastle-upon-Tyne.

Mr. Joseph William Wilson, Engineer, 118, Abington Avenue, Northampton.

Associates—

Mr. Moses Elder, Master Shifter, Allerdene Colliery, Lamesley, Gateshead-upon-Tyne.

Mr. George Roberts Emery, Assistant Deputy, 17, Brick Row, Newsham, Northumberland.

Mr. Edward Nutley, Under-manager, 3, Victoria Terrace, Hamsterley Colliery, Ebchester, County Durham.

Student—

Mr. Arthur Cecil Alexander, Mining Student, Third Pit, Fence Houses.

DISCUSSION OF MR. F. I. LESLIE DITMAS' PAPER ON "THE PENCH VALLEY COAL-FIELD."\*

Mr. W. R. Lascelles (Rajputana, India) wrote that he had read the paper with much interest, but in his opinion the dangers and difficulties in working; longwall were very much over-estimated by the author. By means of a careful method of panelling, and with the various areas of suitable size, longwall or broken workings could be very profitably and cheaply worked ; and, after an area had been worked out, strong stoppings and sand-dams could be built. The danger from gob-fires was not great—any coal left in would not fire for many weeks. The roof generally was excellent.

Mr. F.I. Leslie Ditmas (Resolven) wrote that he was interested in Mr. W. R. Lascelles' opinion as to the advantages of working longwall at Pench. He (Mr. Ditmas) had always avoided that system at the colliery there, and it was only started at Barkui Colliery after he had given up his position as general manager of the Pench Collieries. His fears and surmises were, however, justified, as the following results would show :—Very shortly after the first falls had taken place behind the longwall, the goaf fired, and despite various attempts to subdue the fire, it could not be overcome. The result had been very disastrous: not only had

\* Trans. Inst. M. E., 1911, vol. xli., page 133,

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it cost the unfortunate shareholders much unnecessary loss of money, but that part of the mine had had to be abandoned. In their report of May 16th, 1911, the directors stated that: "The fire mentioned in our last report continues to burn . . . but we anticipate being forced at an early date to abandon these old workings . . . The incline of the New South Mine has reached a total distance of 600 feet." During the 5 years he (Mr. Ditmas) was in charge of the various collieries, there was never a single case of fire below ground, and the workings were laid out entirely on the bord-and-pillar system, with pillars of sufficient area to carry the superincumbent weight. Small heaps of slack taken from the screens had more than once fired at the surface, which was a clear indication of what might be expected if any coal were left in the goaf. Further, the roof at Barkui was shale, with a thin seam of coal above, so that, when the goaf caved in, this would come down, and add further risk of spontaneous combustion. Despite the objections to long-wall working at Barkui, it did not, however, follow that there were not many collieries in India where the system could be employed to considerable advantage and profit.

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#### DISCUSSION OF MR. SIMON TATE'S PAPER ON "THE ELECTRIFICATION OF THE UNDERGROUND MACHINERY AT TRIMDON GRANGE COLLIERY."\*

Mr. Simon Tate said that he now had the pleasure of presenting such particulars as were asked for when his paper was discussed in February last. He had had further communication with Mr. W. C. Mountain, with whose assistance he had compiled the following data.

The boiler-pressure at Trimdon Grange Colliery was 80 pounds per square inch, and in forming an estimate of the amount of exhaust-steam available, it had been assumed that under normal working conditions this would be equivalent to about 24,000 pounds per hour. The dimensions and capacity of the machinery from which the exhaust-steam was obtained were as follows:—

\* Trans. Inst. M. E., 1911, vol. xli., page 104.

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[Tables, of details of two main engines and loads, omitted.]

Small Single-cylinder Hauling-engine. [Dimensions omitted.]

This engine hauled stones to the stone-heap for a distance of about 510 feet, up an average gradient of about 1 in 6, and ran about 13 hours a day. It was somewhat difficult to estimate its work, as it ran three heavy inclines, namely, it took stones to a very high stone-heap, it took washed debris to the same tip, and it ran coals from the ground-level to the coke-oven tops. It was practically running continuously, the trains being made up as follows:—

[Table of train-loads, omitted.]

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[Table, of details of Ventilating-fan engine, omitted.]

From the foregoing figures it would appear that the actual horsepower in use, apart from mechanical losses in the engines and gearing, etc., was as follows:—

	Horsepower
Harvey winding-engine	102
Low Main winding engine	53
Hauling-engine	20
Ventilating-fan engine	33
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The writer has been informed by Mr. Mountain that in previous matters of this kind he has found that an allowance of 100 pounds of steam per horsepower in the shaft or in the work has been found about what might be expected, which applied to the figures now given showed a probable available supply of exhaust-steam equal to 21,000 pounds. This approximated fairly closely with the estimated quantity of steam upon which the foregoing figures were based when considering the problem originally.

With regard to the total cost of the plant, this was as follows:—

[Table of capital cost, totalling £10,000, omitted.]

In giving the cost per unit generated at 0.15d., 5 per cent. interest on the capital was provided for, but no provision was made for depreciation. The figures included all cost for upkeep, maintenance, and repairs, but possibly in future it would be necessary to provide for depreciation, and if the machinery was

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well kept, 5 per cent. per annum on the original capital sum should be sufficient, particularly as in the capital expenditure such items as buildings, which were not likely to depreciate to any great extent, were included.

With regard to Mr. Simpson's enquiry as to the combined efficiency of the Sulzer pump and motor, in order to reply satisfactorily thereto, Mr. Mountain had kindly made experiments to ascertain independently the information asked for, with the following results:—

The quantity of water discharged per minute was  $1,125/2$ , or, say, 563 gallons per minute.

The head on the delivery side of the pump was measured by means of a pressure-gauge, and the suction-head was 12 feet net, plus the friction due to 210 feet of 10-inch piping, which was about 3 feet, making the total suction-head about 15 feet. The following readings were based on these figures:—

[Table, of electrical readings and work done at different times, omitted.]

Taking the average of these four readings, the following figures were obtained :—

Volts	2,925
Amperes	47
Delivery-head, $987 \frac{1}{2}$ feet plus 15 feet suction, equals	$1,002 \frac{1}{2}$ feet
Gallons per minute	563

From the test-curves of the motor supplied by the makers, it appeared that the power-factor of the motor at full load was 90 per cent., and the efficiency at full load 94 per cent. The actual electric horsepower supplied therefore was:—

$2,925 \times 47 \times 1.73 \times 0.9 \div 746$ , equal to 286.9 electric horsepower.

The water-horsepower was :—

$563 \times 10 \times 1,002 \div 33,000$ , equal to 1709 water-horsepower.

The overall efficiency between the power put into the motor and the power taken out of the pump was :—

$170.9 \times 100 \div 286.9$ , equal to 59.5 per cent.

The efficiency of the motor from the maker's figures was 94

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per cent., the brake-horsepower delivered to the pump-shaft being therefore: —

$286.9 \times 94 \div 100$ , equal to 269.7 brake-horsepower.

The efficiency of the pump is consequently: —

$170.9 \times 100 \div 269.7$ , or 63.4 per cent.

With regard to the remarks as to the increase of backpressure due to the installation, no difficulty or increase in the back-pressure upon the winding- and fan-engines, due to the exhaust-steam turbines, had been encountered.

Previously the exhaust-steam from these engines was passed through water-heaters, which resulted in a small back-pressure of from 3 to 4 pounds, and since the turbines were installed, the back-pressure was exactly the same, so that the engines were not affected by the working of the new plant.

With regard to Mr. Clothier's remarks as to the basis upon which the costs were calculated, a careful account of all the stores used, wages paid, and coal consumed had been taken. Mr. Clothier in his criticism had probably not taken into account the low cost of raising the steam in the first instance, which, of course, is peculiar to collieries where cheap fuel and waste-heat from coke-ovens is available. He (Mr. Tate), however, did not think that any supply company could possibly produce current and deliver it to the collieries at so low a price as it could be produced by the utilization of their exhaust-steam; and he thought that the figures which he had produced—and for which he was prepared to vouch—clearly demonstrated that as an investment the capital expenditure of nearly £10,000 had been money well spent, as the whole of the capital was likely to be returned from savings alone in certainly from 3 to 4 years' working. If the results which had been obtained at Trimdon Grange Colliery, which was no better situated than many other collieries, could be obtained elsewhere (as they no doubt would be where a similar system of power production was adopted), the utilization of exhaust-steam in mixed-pressure turboines must have a considerable future before it.

Replying to Mr. Glass as to the regulation, he (Mr. Tate) was sorry that he could not furnish a chart, but he might state that the fluctuations between maximum and no load was automatically corrected by a Parsons compounding alternator, and the variations did not exceed 10 per cent.

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Mr. F. R. Simpson (Blaydon-upon-Tyne) wrote that he was sorry not to have been present when his (the writer's) question as to the combined efficiency of the Sulzer centrifugal pump and motor had been answered by Mr. Tate. As a comparison, he (Mr. Simpson) had pleasure in giving the duty of his own plant, as ascertained by Dr. W. M. Thornton, of Armstrong College. The plant was designed and guaranteed to perform the following duty:

[Table omitted]

To carry out this work, the plant installed consisted of a single-stage centrifugal pump and a three-phase motor of 350 horsepower. The current was obtained from a public supply company, the voltage being 650 and the periodicity 40. The test was carefully made, and a large tank was specially constructed to obtain accurate measurements of the water pumped.

The result of the trial was as under: —

[Table omitted.]

In comparing these results with those obtained by Mr. Tate, consideration should be given to the respective relations of head to quantity. In the writer's case, the quantity was large and the head small, whereas the opposite was the fact in Mr. Tate's plant.

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DISCUSSION OF MR. W. C. BLACKETT'S PAPER ON "THE FIRE- AND RESCUE-STATION OF THE DURHAM AND NORTHUMBERLAND COLLIERIES FIRE-AND RESCUE BRIGADE."\*

Mr. Frank Coulson (Durham) said that the members should feel very much indebted to Mr. Blackett for his valuable and instructive paper.

\* Trans. Inst. M. E., 1911, vol. xli., page 253.

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Forty years ago, the question of a rescue-station for the Counties of Durham and Northumberland was raised, but at that time it was found that it would be necessary to employ a train, consisting of a number of trucks, in order to convey to the site of the explosion the material which it was suggested would be necessary. No doubt science had since lent itself considerably to an improvement in methods. He (Mr. Coulson) would like to ask Mr. Blackett whether it would not be possible to have a store of liquid air at an underground station, so that men could be supplied with it by means of flexible tubes, and thus be able to advance a certain distance in front of it, without being compelled to carry a knapsack on the back. The scheme did not, in his opinion, go quite far enough. In the case of an explosion, it was sometimes impossible to get down either the downcast or the upcast shaft; such cases had occurred, and considerable time had been lost, as in many collieries there was no means provided for getting down either shaft except by the help of the winding-engines. A light winch and rope might be included in the outfit, and carried on the motor to the site of the accident; a small air-compressor with canvas tubing would also be very useful, so that air could be forced into the workings, or into the neighbourhood where the rescue-party were working. He thought that a searchlight, which could be worked by accumulators, would also be a useful addition, not only for the surface but underground, as it was very necessary to have a good light.

With respect to the fire-engine, he supposed that every colliery would establish its own; but it was a great source of satisfaction to know that a fire-engine was at the disposal of any colliery, because in a case of fire so many collieries would be shut off from their water-supply, as collieries mostly relied on their pumps for water. A fire-station at a colliery should be out of reach altogether of any chance of fire, and to accomplish that it would be necessary to work it by oil-engines, as means of power from the colliery might be destroyed by the fire. It was, he thought, possible, within certain limits, to extend the scheme of the rescue-station.

Mr. H. M. Parrington (Hylton) referred, firstly, to the pressure of 200 atmospheres attained during the process of making

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liquid air, and asked Mr. Blackett whether the question of combustion at such a high pressure was not of great importance; and, secondly, to the handling of liquid air and the dangers, if any, that might arise by carelessness in doing so.

Mr. W. C. Blackett (Sacriston), replying, said that the extension of the scheme was having serious consideration, and the members would not, he thought, be disappointed in that respect. With regard to the delivery of air through a pipe, instead of from the knapsack on the back, that no doubt could be done, although it would not possess any advantage over the present method, as the pack was not a very heavy weight, and it would be substituted by the weight and limits of a length of hose-pipe.

The suggestion as to the addition of a portable winch to the existing outfit seemed to have an element of use, and something might possibly be made of it. As regarded putting compressed air through a hose-pipe into the workings, if it were possible to get a hose-pipe into the workings, it was possible for the rescuers themselves to get in; and the station already possessed the bellows-helmet.

The portable electric lights provided were being improved almost every day, and although not of the description of a searchlight, they gave quite an excellent light.

With regard to the handling of liquid air, this involved a question of considerable interest; without doubt it required careful handling, like any other substance the powers of which one had not fully experienced. A drop of water thrown on a red-hot plate created a protective film of steam around it, and the water would not readily evaporate, as it did not get quickly into contact with the plate. Surfaces commonly looked upon as cool were to liquid air red-hot, and so liquid air might be allowed to trickle over one's hand and no injury would result, because to the liquid air the hand was red-hot. If it were allowed to remain on the hand, or to soak through a glove, it would get into actual contact with the flesh, and cause severe burns, destroying the tissue and taking many months to heal. Great care also had to be taken with liquid air as regarded its mixture with other substances—ordinary substances consisting of carbonaceous matter—as it became very explosive.

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He had heard it expressed as a matter of surprise that what was used was not liquid air, but mostly liquid oxygen. This was because the latter was better for the purpose, and liquid "air" was more easily produced rich in oxygen, as explained in the paper.

There was one particular point that did not seem to have been fully investigated, and that was the physiological effect that might possibly result from the repeated and continuous breathing of oxygen. They could not shut their minds to the possibility, or be absolutely certain, that the breathing, many times over, of large quantities of oxygen, might not have some as yet undiscovered ill effects on men. That might not be so, but the possibility should be borne in mind that oxygen might not be so harmless to men as was imagined.

Mr. Simon Tate (Trimdon Grange Colliery) remarked that, after a serious explosion, the only way to save the lives of any survivors was to restore the ventilation in those parts of the mine where the men were incarcerated by falls, noxious gases, fires, etc., and, whilst so doing, to prevent the deadly afterdamp or other noxious gases from being driven in upon them. The Home Office and others were apparently not quite alive to the dangers and difficulties consequent on an explosion. His fear was that with so much paraphernalia and restrictions such a waste of valuable time would ensue that many lives would be lost that otherwise might be saved, for, as a rule, rescues were not accomplished by the people who hesitated and calculated what the cost of their attempts would be. Moreover, through dilatoriness there was always the danger of incipient fires that had originated from the heat of an explosion breaking out into serious activity, if too long a period was allowed to elapse before the work of exploration and discovery was undertaken.

Mr. E. Seymour Wood (Murton Colliery) said that, with regard to the dresses, there also existed a great danger during the preliminary training of the men in their use. Men were being trained at Murton Colliery, and great care had to be taken to select those physically fit.

When training, they were able to do a certain amount of work, but, if they overtaxed their powers, they felt that they must get out of the gallery at once.

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The men must get to know the use of the dress thoroughly, until they were absolutely confident in its use, otherwise deaths might occur even during training.

The President said that perhaps the members would be interested to know what the Rescue Committee were doing. They had had an opportunity of seeing the work at the Elswick rescue-station, and the committee were considering whether there should not be another central station in the coal-field—a station similar to that at Elswick, with means of producing liquid air. Then came the questions of sub-stations, on which there was a difference of opinion, even amongst the members of the committee. It was a question whether there should be a sub-station at every colliery, depending upon the colliery officials only for its efficiency, or whether a number of sub-stations, each in charge of a small permanent staff, should be established at convenient distances from the collieries. He was in favour of the latter plan, because the rescue-apparatus at each station would always be kept in perfect condition by the trained staff, and ready to send out at a moment's notice to any colliery in need of it. Then the members of the colliery rescue-brigades could be trained in the use of the apparatus at these stations by the expert staff, and be taught the strict discipline which was so essential in such brigades.

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DISCUSSION OF ME. BERENT CONRAD GULLACHSEN'S PAPER ON "THE RESCUE-STATION AT THE KLEOPHAS MINE, ZALENZE, UPPER SILESIA, GERMANY."\*

Mr. Berent Conrad Gullachsen (Cleveland, Transvaal) wrote that in his paper the experimental gallery was stated to be one storey in height; this was an error, as it was two stories in height. A mistake had also occurred in the spelling of Mr. Y. Tomaszewski's name. The scale of Figs. 1, 2, and 3 (Plate VIII.) was 18 feet to 1 inch.

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Mr. W. B. Wilson read the following paper on "The Advantages of Freezing as a Method of Sinking Through Heavily-watered or Difficult Ground " : —

\* Trans. Inst. M. E., 1911, vol. xli., page 272.

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THE ADVANTAGES OF FREEZING AS A METHOD OF SINKING THROUGH HEAVILY-WATERED OR DIFFICULT GROUND.

By WILLIAM BRUMWELL WILSON.

In recent years the sinking of shafts in this country has become a more difficult and varied engineering problem, due to the exhaustion of the shallower seams, and to the discovery and subsequent development of new coal-areas. Deeper shafts have become necessary, and frequently the conditions as regards strata and water are very different from what they formerly were.

In East Durham deep shafts have recently been sunk at Dawdon, Easington, and Horden, under conditions of unusual difficulty; also at several places to the east of the old Barnsley coal-field, and in Staffordshire and South Wales. Other shafts, are now being sunk in these districts, and many more are in contemplation in Yorkshire and in other parts of England.

The best method therefore of sinking such deep shafts, and of overcoming the attendant difficulties, becomes a matter of increasing importance. In several recent winnings very great difficulties, both from heavy feeders of water and from loose difficult ground, have been met with and successfully overcome by various methods. At Horden Colliery enormous feeders of water were encountered, these being successfully dealt with by the aid of a powerful combination of lifting sets of steam-driven pumps,\* and at Bentley Colliery a most difficult stratum of soft ground was sunk through by an ingenious method of steel piling.† In both of these cases the results were eminently successful.

The Kind-Chaudron method of sinking has recently been successful in a shaft at Dover, but is not being utilized in the one now sinking. The system had previously been adopted, as

\* See "Shaft-sinking at the Horden Colliery, South-East Durham," by John Joseph Prest, Minutes of Proceedings of The Institution of Civil Engineers, 1908, vol. clxxiii., page 42.

† See "The Sinking of Bentley Colliery," by J. W. Fryar and Robert Clive. Trans. Inst. M.E., 1907, vol. xxxiv., page 389.

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long ago as 1876, when Whitburn Colliery, in Durham, and Cannock and Huntingdon Colliery, in South Staffordshire, were being sunk. At Whitburn, where the sinking was very heavily watered, the method was successful, but at Cannock and Huntingdon it was not. The application of the system is, however, limited, owing to its unsuitability for shafts of large diameter: it has been employed in some eighty cases, but in no instance was the shaft of a greater diameter than 15 feet, the recently-sunk Dover shaft being only 14 ½ feet in diameter. Doubtless, larger shafts could be sunk by the Kind-Chaudron Company, but it would apparently entail a reconstruction of their heavy plant, and would therefore increase the cost, which will be found already higher in England than the cost of other methods. To increase the diameter would also increase the drawback now felt in procuring the cumbersome shaft-lining necessary to the system.

Another and more recent process which is worthy of notice is the Portier method of cementation, which has during the last few years met with some measure of success on the Continent, notably at the sinking of Victoria Colliery, in Westphalia, where cement was forced through bore-holes into each crack or fissure as it was found. It is stated that one of the fissures, which was successfully dealt with, gave off a feeder of water of over 4,000 gallons per minute (19 cubic metres). This plan has been named "methodic cementation," and another application of the method is termed "systematic cementation," when a sufficient number of bore-holes are put down into the impermeable measures, and cement forced down them all with the object of closing up all the fissures or water-cavities before the shafts are sunk. Although the idea has not been adopted by English engineers, and would scarcely be suitable for sinking through the often heavily-watered limestone, it is nevertheless receiving some attention on the Continent, and has been utilized by and received the approval of the eminent French engineer, Mr. Saclier.

The freezing method has recently been adopted with great success in England, and appears to be in growing favour. Two excellent papers\* dealing with the method have already been

\* See "Sinking by the Freezing Method at Washington, County. Durham," by Mark Ford, Trans. Inst. M.E., 1902, vol. xxiv., page 293; and "Sinking through Magnesian Limestone and Yellow Sand by the Freezing-process at Dawdon Colliery, near Seaham Harbour, County Durham," by E. Seymour Wood, *ibid.*, 1906, vol. xxxii., page 551.

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communicated to the members, in which, however, the subject was treated almost exclusively from an engineer's point of view; and it is the object in the present case to deal, not so much with the process of freezing, which is fairly well understood, as with its comparative advantages and results. A better appreciation of these advantages in England would doubtless result in a more frequent adoption of the process.

On the Continent it is in very general use, especially in the North of France, where refrigeration was first used in sinking some 27 years ago by Mr. Poetsch, the originator of the system. It is also in use in Westphalia, in Belgium, and in other parts of Europe.

In the North of France, when freezing is adopted, it is not usually by reason of the ground being so heavily watered, but because there is generally a considerable depth of loose difficult ground, very similar to that successfully passed through at Bentley Colliery, in Yorkshire.

In Belgium the water-bearing measures often run to a considerable depth, and deep freezings have been successfully carried out; but the deepest, so far as the writer has been able to ascertain, was in Westphalia, where a depth of 1,364 feet (416 metres) was successfully frozen and sunk through at the Deutscher Kaiser Colliery.

In England the system has only been adopted in six cases; five have been successful, and in the sixth instance, that at Bullcroft, near Doncaster, although the operations are not yet complete, they are now, after some temporary embarrassment, sufficiently far advanced to be assured of success.

The primary advantage of the adoption of the process of refrigeration in shaft-sinking is that the cost of putting through the dangerous ground can be ascertained beforehand, and the total cost prepared for. Under other systems the cost is very frequently most difficult to estimate, and anyone who has had to deal with heavy pumping operations will no doubt remember the many interruptions and unavoidable delays, and the ever accumulating cost generally attending such work.

Where the coal-measures come to the surface, the quantity of water to be met with is usually not great, and can be estimated with tolerable accuracy, but when these measures are concealed by overlying formations, the water to be dealt with

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in a sinking may be any quantity, and it is therefore impossible to estimate the cost of such an undertaking. The advantage of knowing beforehand what is to be the cost of putting through the dangerous ground is a very substantial recommendation for the system.

When pumping is resorted to, and has been carried on for some time, and a shaft or shafts sunk through the water-bearing strata, there is always the danger of some movement of the surrounding surface. Such a movement has frequently affected the foundations of boiler-chimneys and engine-pillars, with very troublesome results, and neighbouring wells and water-supplies are also not infrequently affected, a circumstance which occasionally results in litigation. If the ground be frozen before the shafts are sunk, the surrounding measures and the surrounding waters are not interfered with in any way, and remain in their normal condition. In the Monkwearmouth sinking, recently carried out, refrigeration was adopted, not because heavy feeders of water were anticipated, but because it was deemed undesirable to interfere by pumping with surrounding conditions.

Apart from and in addition to the cost of actual pumping operations, the speed at which sinking can proceed is much reduced while the sinkers have water to contend with. This is true in proportion to the quantity of water, and the cost of sinking is increased in like proportion. Where the ground is frozen, the work can go on continuously in dry ground, without the many unavoidable interruptions attending sinking sets of pumps.

In the lining and securing of the shaft sides, the advantages are still more in favour of the freezing process, as tubbing can be fixed and wedged, or walling laid through frozen ground with as much expedition and accuracy as if the work were done on the surface; whereas when water is being contended with, such work is generally slow, and the difficulties of maintaining satisfactory accuracy are considerable.

The cost of freezing increases as a matter of course with the depth of the ground to be frozen, but it should be remembered that this is equally true if the water is dealt with by means of pumps. There appears to be some misconception as to the depth which can be successfully frozen : Mr. J. Riemer, one of

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the greatest authorities on shaft-sinking, has stated that ice at a depth of 656 feet (200 metres) becomes plastic and unable to withstand pressure;\* experience, however, does not substantiate this statement. At Easington, the deepest freezing in England as yet, the ice when seen at a depth of 615 feet was hard and brittle; and the writer is also informed that at the Deutscher Kaiser Colliery, where the measures were frozen to a depth of 1,365 feet, being more than twice the depth at Easington, the ice was hard and quite able to stand the pressure, and there does not appear to be any reason to accept this as the limit of depth for successful freezing. It may therefore be assumed that, so far as the usual water-bearing measures in England are concerned, no difficulty need be anticipated in this respect.

The maximum advantage of the freezing process can be best obtained when the decision to adopt the system is made at the very outset, when the ground is clear, and before any erections are set up. The boring sheds can then be constructed in such a manner as eventually to form part of the sinking headgears, and the whole of the sheds can be made suitable to cover the pit-heap during sinking operations. The refrigerating plant can also be placed in the most convenient position, as near the shafts as possible. This practice is usually adopted in the North of France.

The cost of freezing two shafts, 20 feet in diameter, under ordinary circumstances and conditions, should be approximately as follows:—

To a depth of 300 feet

£17,500

“	“	600	“	£28,000
“	“	1,200	“	£50,000

These figures include the providing of all boring and refrigerating plant, of all labour and stores in connexion with the boring and the running of the refrigerating plant, and the maintenance of the ice-walls while the shafts are being sunk and secured. They do not, however, include steam or water, and the amounts should, in the opinion of the writer, leave a reasonable margin for contractor's profit.

Many sinkings, even when water is encountered, can, of course, be carried out more economically in the ordinary manner

\* See Shaft-sinking in Difficult Cases, by J. Riemer, translated from the German by J. W. Brough, 1907, page 64.

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than by the adoption of refrigeration; but it cannot be doubted that a large number of shafts have been sunk in England where it would have been greatly to the advantage of the owners if the method under consideration had been adopted at the outset.

The choice of method depends upon the nature of the ground and the quantity of water likely to be met with; this, however, is so frequently an unknown one, that it is better to be on the side of safety. If it were possible to be sure that the feeders to be encountered would not exceed 1,000 gallons per minute, doubtless the old method of pumping would be the better; while, if it were certain that 3,000 gallons per minute would be exceeded, then there is little doubt that refrigeration could be adopted with advantage. Local conditions and circumstances would affect the question if the quantity lay between these two figures.

At Easington, as is well known, two attempts were made to freeze the shafts, the first being unsuccessful, or rather only successful in part, whilst the second was successfully carried out. During the first attempt the bottom of the North Shaft, which was the leading shaft so far as these operations were concerned, was standing in limestone 54 feet above the top of the sand. After the usual indications that the strata were satisfactorily frozen, the water was drawn from the shaft, and beneath the water-level ice was found on the shaft side 4 or 5 feet thick, although of irregular thickness. When sinking was commenced, the limestone was apparently hard frozen, and, though more or less water-bearing, was passed through in safety. Beneath the limestone and overlying the sand were the Marl-slates, 2 feet 6 inches thick, which were also passed through in safety; but when some 3 feet of sand had been excavated, a terrible inrush of water took place from the south-south-eastern side of the shaft, overwhelming the nineteen sinkers. The kibble which was standing in the bottom brought sixteen of these men safely to bank, and on returning found two more on the surface of the water, who were also brought safely to bank. The nineteenth man could not, however, be found; he had probably been engulfed in the sand, which, as soon as the water settled, was found to have risen 53 feet up the shaft.

As it proved impossible to make any useful impression upon the water with the sinking engines, the freezing process

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was abandoned, and operations of another nature were commenced.

What was the cause of the failure? is a question that is frequently asked. It was not the fault of the system, nor was it the fault in any way of the contractor's plant. The output of cold, which was 450,000 frigories per hour, was much greater than the work should have needed, and more than the output during the second and successful freezing, when it was only 280,000 frigories per hour. There are three possible explanations by which to account for the failure. The rupture took place either in the Marl-slates or immediately on top of the sand, and it has been suggested that the Marl-slates, being dry and of rather a soft nature, and of a somewhat greasy feel, might be impermeable to moisture, and therefore never frozen. Another possible explanation is that a current of water was running past the North Shaft in the neighbourhood of the holes on the south-south-eastern side; and as the ground rises very rapidly to the west of the shafts, this seems to be a not unlikely underground condition. This being so, heat was extracted from the water as it flowed towards the sea, fresh or warmer water flowing continuously from the west. This theory is supported by the fact that No. 11 hole, which was on the south-south-eastern side of the shaft, and in the immediate neighbourhood of the inrush of water, stubbornly absorbed 7.2° Fahr. (4° Cent.), while the other holes around the shaft absorbed only from 3.15° to 3.6° Fahr. (1.75° to 2° Cent.). It may be added that this condition was maintained more or less during the second freezing. A third possible explanation of the failure might be that the holes in the neighbourhood of No. 11 hole deviated from the vertical to such an extent that the frost was unable to extend from one to the other, thus leaving an unfrozen or imperfectly frozen space between. It is also quite possible that the actual cause might be a combination of these circumstances, but whatever it was, it can scarcely be laid to the charge of the system. It should be remembered that this was only the second application of the process in England, the first being on a much less extensive scale; that all the other instances have been successful; and that at Easington the second attempt was in every way satisfactory.

In the second freezing the general mode of procedure was

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very similar to that of the first, with the exception that eight additional holes were bored at the North Pit (Fig. 1), and three at the South Pit, the original number being twenty-six round each shaft. Four of the additional holes at the North Pit were put down in the neighbourhood of No. 11 hole, one on either side of and slightly behind No. 10 hole, and one on either side of and slightly behind No. 12 hole, with the object of strengthening the neighbourhood of suspected weakness. The other

[Diagram: Fig. 1.—Plan showing the Position of the Bore-holes at the North Pit Shaft, Easington Colliery. The small hatched Holes are the additional holes put down. scale, 10 feet to 1 inch.]

four additional holes were bored at other points around the shaft where deviation from verticality threw the holes first bored too far apart, and this was undoubtedly a proper precaution to take. The danger arising from departure from verticality has now practically been removed by the greatly improved methods of

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surveying. The other point of difference between the two operations was that, in the second and successful case, the outer freezing tubes in each hole were isolated from the surrounding measures, upwards from the point at which it was desired that the frost should take effect, and evidences on the shaft side showed that this isolation was very effective. This arrangement was fully explained by Mr. E. S. Wood in his paper.\*

A review of the circumstances would lead one to the conclusion that the system of refrigeration has gradually become the safest, and in many cases the cheapest, method of sinking shafts through heavily-watered or difficult measures.

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On the motion of the President (Mr M. W. Parrington), a hearty vote of thanks was unanimously accorded to Mr. Wilson for his paper.

\* "Sinking through Magnesian Limestone and Yellow Sand by the Freezing-process at Dawdon Colliery, near Seaham Harbour, County Durham," by E. Seymour Wood, Trans. Inst. M. E., 1906, vol. xxxii., page 551.

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#### THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

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#### EXCURSION MEETING,

Held at Blackhill, July 21st, 1911.

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The members assembled at St. Aidan's Hall, Blackhill, where they were received by Mr. George Ainsworth (General Manager), Mr. Edward James George (Secretary), and other officials of the Consett Iron Company, Limited, and entertained to luncheon.

On the motion of Mr. Simon Tate, a hearty vote of thanks was given to the firm for their kindness in opening their works to the inspection of the members, and for their hospitality.

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#### CONSETT IRON-WORKS.

Coal and Coke.

The Consett Iron Company, Limited, owns several collieries, which extend over an area of many thousand acres, and produce annually over 2 ¼ million tons of coal; while the coke-ovens of the company produce over half-a-million tons of coke during the same period. The greater proportion of the coke is consumed at the company's own blast-furnaces, and the remainder is sold for use in blast-furnaces, etc., in Cumberland, Cleveland, and foreign pig-iron-producing districts.

Pig-iron.

There are eight blast-furnaces, seven of which are each 55 feet in height, with a hearth 9 feet in diameter, the height to the top of the bosh being 20 feet, the diameter of the bosh 20 feet, and the diameter of the throat 14 ½ feet; the bell has an opening of 10 ½ feet. There are from seven to nine tuyeres to each furnace.

All the eight furnaces are fed with material by means of a bell and hopper, with a standard beam and hydraulic brake.

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The ore and other material is conveyed on a high-level approach, considerably above the tops of the furnaces, in bottom-door trucks, and is tipped from these into depots, from which the charging barrows are filled.

Each of the seven furnaces is equipped with three Cowper stoves, which vary from 65 to 70 feet in height, and from 21 to 24 feet in diameter, the capacity of each furnace being about 900 tons per week. The pressure of blast now maintained is  $4\frac{1}{2}$  pounds per square inch, with a temperature of about 1,200° Fahr. at the bags.

At the present time four of these older furnaces are in blast, two are relined and ready for work, and one is being relined. The five furnaces at work are making Bessemer pig-iron from imported Spanish and other ores. The limestone comes from the company's quarries at Stanhope-in-Weardale.

The eighth furnace is a new one, and was blown in on September 9th, 1909. It is 75 feet in height, with a hearth 11 feet in diameter, the height to the top of the bosh being 21 feet, the diameter of the bosh 18 feet, and the diameter of the throat 15 feet; the bell has an opening of  $10\frac{1}{2}$  feet. The furnace is provided with ten tuyeres. There are four Cowper stoves to this furnace, each 85 feet high and 24 feet in diameter. The gases on leaving the downcomer pass through two large circular dust-chambers, and thence to the stoves through brick-lined tubes, all above ground, of ample diameter, and provided with dust-catchers and valves, thus avoiding the necessity of stopping the furnace for flue-cleaning purposes.

At this furnace the company aims to maintain a volume of 20,000 cubic feet of free air per minute, the pressure varying from 8 to 12 pounds per square inch, at a temperature of about 1,200° Fahr. at the bags, and the make of Bessemer iron averages 1,500 tons per week.

The seven older furnaces (not connected with the new one) are blown with two engines of the beam type and five engines of the vertical tandem type. The beam-engines have steam-cylinders 50 inches and blowing-cylinders 100 inches in diameter, by 9 feet stroke, and are designed for a blast-pressure of 5 pounds per square inch. The vertical tandem engines have steam-cylinders 50 inches and blowing-cylinders 100 inches in diameter, by 5 feet stroke, and are designed for a blast-pressure of 10 pounds

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per square inch, but in case of emergency will deliver at 15 pounds per square inch. Steam for these engines is raised in nine Babcock-and-Wilcox water-tube boilers, working at a pressure of 60 pounds per square inch.

The blast for the new furnace is supplied by two turbo-blowers working alternately; each has a capacity of 21,000 cubic feet of free air per minute, at 10 pounds pressure, is designed to blow at 15 pounds per square inch, and is fitted complete with surface-condensers. Steam for the turbo-blowers is supplied by eight Stirling and two Babcock-and-Wilcox water-tube boilers, working at a pressure of 135 pounds per square inch, the excess of steam passing over from these boilers through a surplus valve to the low-pressure boilers.

In close proximity to the new furnace is a power-station provided with two 350-kilowatt 500-volt high-speed generating sets, and one 400-kilowatt 500-volt turbo-generator. The current is used for pumping the waste-water for the blast-furnaces, mills, etc., as well as for the lighting of the offices and works generally. The steam for this plant is raised in three Babcock-and-Wilcox water-tube boilers, working at a pressure of 135 pounds per square inch, usually in parallel with those to the new furnace.

All the boilers mentioned above are fired with blast-furnace waste-gas.

The gases from certain stoves and boilers pass through a large underground flue to a firebrick chimney, 250 feet high and 16 ½ feet in internal diameter at the top. The new furnace has its own chimney, made from brick-lined steel plates, and is 200 feet high and 8 ½ feet in internal diameter. The gases from a number of stoves are discharged through two fans into the atmosphere at a height a few feet above the top of the stoves.

The slag from the furnaces is removed in a fluid state in side-and end-tipping ladles having a capacity of 10 tons.

#### Steel Plates.

There are two melting-shops supplying ingots for the manufacture of steel plates. In the East Shop there is a range of nine Siemens open-hearth furnaces, with a capacity of 35 tons each. In the West Shop there are eleven similar furnaces, eight with a capacity of 20 tons each, and three with a capacity of 35 tons each. These furnaces are supplied with gas from a range of

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thirty-three steam-blown Siemens gas-producers. The two melting-shops have a capacity of over 5,000 tons of ingots per week.

The No. 2 cogging-mill is a 28-inch mill, driven from the No. 2 plate-mill engine, through bevel gearing, and is reversed by means of a hydraulic clutch. The mill consists of one stand each of pinions and rolls, fitted with the usual live-roller frames, and screwing and edging gear. Cutting is done by means of a steam-hammer placed at right-angles to the mill, and served by a steam jib-crane. This mill is capable of dealing with over 1,650 tons of ingots per week.

The No. 1 plate-mill has one stand of pinions; one stand of roughing rolls, 25 inches in diameter; and one stand of finishing rolls, 26 inches in diameter: each stand being 6 ¼ feet in length. The mill is driven by a high-pressure non-condensing engine, with cylinders 50 inches in diameter by 5 feet stroke, the flywheel weighing 70 tons. The steam-lift is capable of handling slabs weighing from 20 to 25 hundredweight. The capacity of the mill is equal to 400 tons of plates per week.

The No. 2 plate-mill is a clutch-reversing mill, and comprises one stand of pinions; one stand of roughing rolls, 25 inches in diameter; and one stand of finishing rolls, 27 inches in diameter : each stand being 7 feet long. The mill is driven by a high-pressure non-condensing flywheel engine, with cylinders 45 inches in diameter by 5 feet stroke. The reverse action is obtained by the five-wheel method and clutch-motion. All the wheels, shafts, and clutches are made from Siemens steel. The delivery side of the mill is provided with a traversing steam platform, constructed so as to work the plates to and fro through the rolls, and also to take them bodily from the roughing to the finishing rolls; the receiving side is simply fitted with stationary live-roller frames. The output of No. 2 mill is about 800 tons of finished plates per week.

Both Nos. 1 and 2 plate-mills have plate- and scrap-shearing machines conveniently placed for their use. There are six Lancashire, two Babcock-and-Wilcox, fifteen furnace-stack, and two Lancashire furnace-boilers, making a total of twenty-five boilers driving the two mills.

The No. 4 cogging-mill is a 45-inch mill, having one stand each of pinions and rolls, and is driven by a pair of reversing

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high-pressure non-condensing engines, with cylinders 42 inches in diameter by 5 feet stroke, geared to the mill in the ratio of  $2 \frac{1}{2}$  to 1. The wheels, shafts, and couplings are all of Siemens steel. The mill is provided with live-roller gear on each side, and hydraulic edging gear on the delivery side. The top roll is balanced by hydraulic pressure, and the screwing is effected by steam-power. In a line with the mill, a large bloom-shearing machine is placed, driven by a high-pressure reversing engine, and provided with live rollers mounted in falling tables on the receiving and delivery sides of the shear. The ingots are heated in six vertical heating-furnaces, served by a steam-derrick locomotive-crane. This mill is capable of dealing with 2,600 tons of ingots per week.

The No. 3 plate-mill has one stand of pinions; one stand of roughing rolls, 25 inches in diameter; one stand of finishing rolls, 26 inches in diameter; and one stand of chequering rolls, 26 inches in diameter: the roughing and finishing rolls being  $6 \frac{1}{4}$  feet long and the chequering rolls  $5 \frac{1}{2}$  feet long. The mill is driven by a high-pressure non-condensing flywheel engine geared inversely as  $1 \frac{1}{2}$  to 1. It is furnished with a steam-lift similar to that at No. 1 plate-mill, and is also equipped with the necessary plate- and scrap-cutting shears. The output is about 400 tons of finished plates per week.

The No. 4 plate-mill is a 28-inch clutch-reverse mill, driven by a high-pressure non-condensing flywheel engine, the reverse action being obtained by the five-wheel method and clutch-motion. All the gearing and shafts are made of Siemens mild steel. The mill has one stand of pinions; one stand of roughing rolls, 28 inches in diameter; and one stand of finishing rolls, 30 inches in diameter: each stand being 8 feet long. The mill is also provided with traversing and live-roller tables, similar to No. 2 plate-mill. A 15-ton steam overhead travelling crane on box-girders is used for changing the rolls. There are two strong plate-shearing machines, one for plates  $1\frac{1}{2}$  inches thick and the other for those  $1\frac{1}{4}$  inches thick. The capacity of this mill is about 1,500 tons of finished plates per week.

A battery of fourteen hand-fired Lancashire boilers is installed outside of the roof area; and, in addition, there are, in the cogging- and plate-mills, sixteen boilers, eight being vertical, four Lancashire and four Cornish, making a total of thirty boilers.

The ingots for the angle-mills are supplied from the North Melting-shop, containing eight Siemens open-hearth furnaces, one of 40 tons, two of 28 tons, and five of 35 tons capacity. These furnaces are of similar construction to those in the East and West Melting-shops, but are laid out somewhat more conveniently, with ample space, and have unusually large and well ventilated valve-chambers. Gas is supplied from fifteen Siemens gas-producers, and these also are conveniently laid out for dealing with both coal and ashes. The ingot-producing capacity of these furnaces is 2,000 tons per week.

The 45-inch cogging-mill is driven by a high-pressure non-condensing engine, with two cylinders, 45 inches in diameter by 5 feet stroke, fitted with piston-valves and Allan link-motion, and geared at 2 to 1. The mill comprises one stand of roll-housings, and one stand of pinions, seated upon cast-iron bedplates. The mill, with live roller-gear on each side, is designed for dealing with slabs or billets, and its capacity is about 2,500 tons per week.

The 32-inch angle-mill is driven by a reversing high-pressure non-condensing engine, with two cylinders, 54 inches in-diameter by 4 ½ feet stroke, fitted with piston-valves and Allan link-motion, and coupled direct to the mill by an inside crankshaft and steel couplings. The mill, which is provided with live rollers on each side, and skidding gear on the receiving side, is about 125 feet distant from the bloom shear, and has one stand of pinions, one stand of roughing rolls, and one stand of finishing rolls, all coupled through Siemens steel boxes and spindles. Two hot saws are provided, the far one being about 275 feet distant from the mill. The capacity of this mill is about 2,000 tons per week.

The 22-inch angle-mill is driven by a reversing high-pressure non-condensing engine, with two cylinders, 40 inches in diameter by 4 feet stroke, coupled through steel boxes and spindles in the same manner as the 32-inch mill. It comprises one stand of pinions, one stand of roughing rolls, and one stand of finishing rolls, with live-roller gear on the receiving and delivery sides, and an inclined shoot on the receiving side. The live-roller gear leads from the mill to the billet-shear and steam circular sawing-machine; and on a line with these is a relief live-

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roller frame for distributing the rolled bars, as in the 32-inch mill. The capacity of this mill is about 1,600 tons per week.

The 12-inch guide mill is driven by a high-pressure non-condensing flywheel engine, with one cylinder, 30 inches in diameter by 2 ½ feet stroke, fitted with piston-valve and governor-gear. It consists of one stand of pinions, one stand of roughing rolls, one stand of finishing rolls, and two stands of guide-rolls, all coupled through steel boxes and spindles. A steam circular sawing-machine and billet-shear are likewise provided. This is a reheating mill, and two furnaces are conveniently placed, with stack-boilers attached. The capacity of this mill is about 350 tons per week.

The cogging-mill is served by a 25-ton overhead square-shaft steam-crane, and two overhead cranes, each of 15 tons capacity, with attached boilers. The cranes traverse the three angle-mills and roll-turning shop, these being placed in one line and under one roof.

The roll-turning shop is placed at the end of the 32-inch mill, and contains three powerful lathes, each driven by its own engine.

The hydraulic plant comprises two sets of Worthington high-pressure pumps, and one accumulator and tank, with automatic governor-gear attached, working to a pressure of 700 pounds per square inch.

#### Boilers, Shops, Foundry, Brick-works, etc.

There is a battery of eighteen Lancashire boilers, fired by automatic stoking-gear. They are arranged in pairs, and work through nine iron chimneys lined with brick. The mill-furnace boilers are of vertical type, with one internal flue fitted with cross tubes, and stand upon cast-iron columns. All the boilers are designed to carry a pressure of 100 pounds, and in daily working are pressed to 80 pounds per square inch. The steam-pipes, from 9 inches in diameter upwards, are made from Siemens mild wrought-steel in lengths up to 16 feet, welded from end to end, with solid flanges contracted and riveted on.

The bar-bank is arranged at the southern end of the mills. Bar-skidding gear is provided, worked from the driving-engine through shafting, the friction-cones being set in motion by hydraulic-rams. The loading on the bank is done by two 3-ton steam locomotive travelling cranes, having 30 feet nibs.

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There are the usual fitting, blacksmiths', boilersmiths', pattern-makers', joiners', and other shops, where renewals and repairs to machinery and other plant are executed.

The foundry is situated at Crookhall, 1  $\frac{3}{4}$  miles from the main works, and has a capacity of 250 tons of castings per week. The plant consists of three cupolas, an air-furnace, drying-stoves, a loam-mill, and a blowing-plant, with two 25-ton overhead steam-cranes, and one hand-power jib-crane. The ingot-moulds, and the whole of the castings necessary for mill and general ironwork repairs, are made here. There are pattern and blacksmith shops, and a brass-foundry.

The brick-works, situated about half a mile from the iron-and steel-works, have a capacity of about 120,000 bricks per week. There are ten brick-burning kilns, each equal to 18,000 bricks per load, fired by the waste-heat from five rows of coke-ovens immediately adjoining, the waste-gases from which are collected in one large flue, and., after passing through the kilns, are conveyed in small flues under the floor of the drying-shed. There are also a small mill and a press for mixing and making ganister-bricks, which are burnt in two suitable hand-fired kilns.

The locomotives and locomotive cranes are of various classes, and sixty-four are in general use. The locomotive repairing-shop is situated at Templetown, about a mile from the works, on the main line between the works and the collieries, and is furnished with all necessary tools and appliances.

#### Otto Coke-ovens.

At Templetown the company has a battery of fifty-five bye-product coke-ovens of the Otto-Hilgenstock type, with the necessary plant for producing sulphate of ammonia and recovering tar. There is in course of erection a second battery of fifty ovens, and the company will shortly erect a plant for the production of crude benzol.

[1]

#### APPENDICES.

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#### I.—NOTES OF PAPERS ON THE WORKING OF MINES, METALLURGY, ETC., FROM THE TRANSACTIONS OF COLONIAL AND FOREIGN SOCIETIES AND COLONIAL AND FOREIGN PUBLICATIONS.

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The following contractions are used in the titles of the publications abstracted:—

Ann. Mines Belgique. Annales des Mines de Belgique, Brussels.

Ann. Mines, Paris. Annales des Mines, Paris.

Journ. Canad. Min. Inst. Journal of the Canadian Mining Institute, Montreal.

Journ. Chem., Met., & Min. Soc. S. Africa. Journal of the Chemical, Metallurgical, and Mining Society of South Africa, Johannesburg.

Journ. Min. Soc. Nova Scotia. Journal of the Mining Society of Nova Scotia, Halifax.

Oesterr. Zeitschr. f. Berg- u. Hutt. Oesterreichische Zeitschrift für Berg- und Huttenwesen, Vienna.

Proc. Am. Acad. Arts & Sci. Proceedings of the American Academy of Arts and Sciences.

Records Geol. Surv. India. Records of the Geological Survey of India, Calcutta.

Rev. Sci., Paris. Revue Scientifique, Paris.

Mem. & Trav. Soc. Ing. Civ. France. Memoires et Travaux de la Societe des Ingenieurs Civils de France, Paris.

Zeitschr. f. Berg-, Hutt.- u. Salinenw. Zeitschrift für das Berg-, Hutten- und Salinenwesen im preussischen Staate, Berlin.

Zeitschr. f. prakt. Geol. Zeitschrift für praktische Geologie, Berlin.

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#### GEOLOGY, MINERAL DEPOSITS, Etc.

What is an Ore?—By J. F. Kemp. Journ. Canad. Min. Inst., 1909, vol. xii., pages 356-370.

The author gives definitions of the word as contained in standard dictionaries, and as used by various authorities, and points out that a distinction should be drawn between the purely scientific and the technical use of the word. He suggests that in the scientific sense an ore is a metalliferous mineral belonging to the group of those which have profitably yielded the metals to the miner or metallurgist; and that in its technical sense an ore is a metalliferous mineral or an aggregate of metalliferous minerals, more or less mixed with gangue, and capable of being, from the standpoint of the miner, won at a profit, or, from the standpoint of the metallurgist, treated at a profit. The test of yielding the metal or metals at a profit seems to him in the last analysis to be the only feasible one to employ. A. P. A. S.

[2]

Bismuth and Tin-ore in Guanajuato, Mexico.—By E. Wittich. Zeitschr. f. prakt. Geol., 1910, vol. xviii., pages 119-123.

The andesites, rhyolites, and derivative tuffs which form the Sierra de Santa Rosa (the northernmost portion of the Sierra de Guanajuato, in the State of that name) are split by two or more lines of crush and dislocation practically parallel with the main trend of the mountain-range, and demonstrably rich in bismuth minerals. The selenite of bismuth ( $\text{Bi}_2\text{Se}_3$ ), known as "guanajuatite," is the most important of these, and occurs in a gangue of quartz: in reality, part of the selenium is replaced in this ore by sulphur. Another bismuth mineral, described by some authors as silaonite, is merely our old friend guanajuatite, with which an additional quantity of bismuth is intermixed. These and other minerals were formerly got in La Industrial mine, which was worked on a very modest scale, and has been shut down for many a long year. A brief description is given of the associated minerals, such as quartz (in crystals attaining 4 inches in length), fluor spar, and baryte. Pyrite is of very common occurrence, and, in conjunction with fluor spar, infills the fissures and encrusts the divisional planes (joint-planes) of the country rock. Nests and smears or patches of molybdenite also are found, and so, too, small crystalline groups of mispickel. The "Industrial" mining concession covers an area approaching 60 acres, and is the only bismuth-mine that has ever been worked in Mexico; but the impoverishment of the ore and also the absence of a suitable market ultimately compelled its abandonment. Latterly several hitherto unknown bismuth-bearing lodes have been struck in the neighbourhood of this mine.

While the eastern and northern portions of the Sierra de Guanajuato are mainly built up of the above-mentioned andesitic and rhyolitic sills and their derivative tuffs, by far the larger part of the Sierra consists of presumably Triassic slates, and Tertiary red conglomerates: among these the sulphidic silver-ores are of widespread occurrence, while the oxidic stanniferous deposits are practically confined to the rhyolites and their tuffs. Tin-ore occurs here in lodes, in bedded deposits (mantos), and as stream-tin in placers. The lodes probably represent the infilling of the later series of dislocation-fissures: their general strike is N. 10°-20° W., the dip is usually steep, but their course and thickness are extremely irregular. The ores in the lodes are predominantly specular iron-ore and tin-stone; massive haematite is of frequent occurrence. The gangue is siliceous, consisting of quartz, chalcedony, or opal. A tungstate of lead (PbWO<sub>4</sub>) is an associate of the tinstone here, and recalls the association of wolfram with the cassiterite of the Cornish granites. The mantos (bedded deposits) are really rhyolitic tuffs impregnated with tinstone and haematite, or containing these ores in a pisolitic form: their thickness is inconsiderable, but their horizontal extent is great. From such ore-bearing tuffs placers are easily formed, and the alluvial deposits in the eastern portion of the Sierra are extraordinarily thick: terraces ranging from 65 to 100 feet in height (especially at the embouchure of lateral streams into the main valleys) and cones of dejection are of frequent occurrence. The stream-tin is won in the most primitive fashion, and the methods of smelting are equally rudimentary. Nevertheless, 75 per cent. of the metal contained in the ore is got out of it. The entire industry remains at present in the hands of the native Indians. The irregularity of the lodes, the uncertainty of the placers, and the comparatively small interest taken in tin-ore in a Sierra which is so rich in other metals, have hitherto prevented the start of any tin-mining enterprise on a large scale.

L. L. B.

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Origin of Boghead Coals.—By E. C. Jeffrey. Proc. Am. Acad. Arts & Sci., 1910, vol. xlvi., pages 273-290.

The author has made a microscopical investigation of Kentucky "cannel coal," Scottish and Autun boghead coals, and New South Wales oil-shale, and claims to have proved, in contradistinction to the views advanced by the late B. Renault, Dr. C. E. Bertrand, Prof. H. Potonie, and similar well-known authorities, that these natural fuels are not made up of the remains of gelatinous algae. He says that previous researches have been based on the examination of insufficiently thin sections of such coals, and that their constituent organisms are really the spores of vascular cryptogams. He further remarks that petroleum products have been largely derived from such "waxy and resinous spores . . . laid down on the bottoms of the shallow lakes of the Coal period." These lacustrine layers, either as cannels, bogheads, or bituminous shales, according to the sporal composition and the proportionate admixture of earthy substances, are the original source of petroleum, which has been distilled from such deposits in the presence of permeable strata under appropriate conditions of pressure and temperature.

L. L. B.

Coal-seams proved by a Deep Boring near Anderlues, Belgium.—Anon. Report from La Louviere to the Chronique des Travaux Publics, 1910, vol. xxxiv., page 4762.

A coal concession of 2,372 acres (960 hectares), on the territories of Anderlues (of sinister fame) and neighbouring communes has been applied for by the prospecting exploration company "La Bruxelloise," in consequence of results obtained by a bore-hole that has attained the depth of 3,280 feet (1,000 metres). The hole, 6,561 yards (6,000 metres) south

of the Bois-de-la-Haye Colliery, began with the large diameter of 26 inches (66 centimetres), passed through 1,380 feet (366 metres) of reversed Lower Coal-Measures, and, at the depth of 2,664 feet (812 metres) entered the Upper Coal-Measures. The first seam, 4 ¼ feet (1.31 metres) thick, and nearly all coal, was encountered at 2,805 feet (854 metres). On May 15th, 1910, at the depth of 3,230 feet (984 metres), the hole had still a diameter of 10 ½ inches (26 centimetres), which permitted its continuance; and six thin seams were passed through, having a collective coal thickness of 13 feet (3.97 metres). At the depth of 2,664 feet (812 metres), where the boring left the conglomerate terminating the reversed Lower Coal-Measures, it is believed to have passed through a fault analogous to the Faille d'Ormont.

J. W. P.

The Fenillaz Auriferous Lodes, Piedmont.—By W. Hotz. *Zeitschr. f. prakt. Geol.*, 1910, vol. xviii., pages 94-104.

The gneiss area of Monte Rosa is remarkable for its wealth in auriferous quartz-lodes, and the Arceza-Brusson gneiss massif lies along the same line as the great mountains of Monte Rosa and Grand Paradis. The author here describes certain lodes on the east side of the valley at Brusson, but a monograph on the entire district is promised by Prof. Carl Schmidt, of Basel, who has collected a vast amount of material in the way of maps, sections, chemical analyses, etc., not to speak of his own detailed survey of the area. Gold-mining was started at Brusson about the year 1900, and in June, 1909, operations were finally abandoned.

A detailed description is given of the geology of the area: crystalline schists, Triassic limestones, and Jurassic green slates (serpentine) are all

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folded together, and are traversed by gold-bearing quartz-pyrite lodes: among the latter the author distinguishes as the three most considerable—the Fenillaz lode, the Speranza lode, and the Gae Bianche lode or lodes. They strike nearly due east and west, practically normal to the strike of the country-rock, and dip between 30 and 40 degrees northwards. The average thickness of the lodes ranges from 8 to 20 inches, and they are usually marked off sharply from the country-rock. The quartz gangue (milky white to yellowish) is either massive and compact or drusy and cavernous. The compact quartz is bespattered with tiny crystals of pyrite which in some cases mass together into nests and stringers; in the drusy quartz, good cubes of pyrite occasionally are found, but that mineral as a rule has been decomposed and leached out of the quartz. The gold occurs in the free state in thin flakelets or in plainly crystalline dendrites, chiefly in the drusy quartz, and more particularly is the precious metal accumulated in the brown-stained portions thereof to which some remnants of limonite still cling. The average proportion of gold in the vein-stuff hardly attains 5 parts per million, but now and then some immensely rich masses of quartz were struck.

The workings in the Fenillaz lode are described (it was the only lode worked in the eastern portion of the concession), and the details are brought home to the mind of the reader by means of plans and sections. There appears to be no doubt that the free gold is of secondary formation, and originates from the auriferous pyrite of portions of the lode which have been swept away by denudation. The Speranza and Gae Bianche lodes are also described in some detail. The latter (two lodes) are generally 20 and occasionally 40 inches thick, and in depth the two Gae Bianche lodes unite to form one exceeding 6 ½ feet in thickness: unfortunately, they are by no means richly auriferous, and the drusy structure

which hereabouts is a good indicator of gold is hardly to be seen in the quartz of the Gae Bianche lodes.

The auriferous quartz-lodes are certainly of more recent origin than the early Tertiary period of mountain-building, at which time the plication of the crystalline schists and the Triassic and Jurassic sedimentaries took place. The Fenillaz lode was first worked in 1903, and, as above stated, mining operations were abandoned in June, 1909. It was evident, from the beginning, that there was great variability in the yield from mere traces to several pounds of gold per ton. A table of output is given for the years 1905-1909, showing maxima in 1906 and 1908. It would seem that the Fenillaz lode even now has not been absolutely worked out. Where the lodes continue deep down into the gneiss further workable finds of gold cannot be looked for; but it is quite possible that other lodes may be discovered, which, like the Fenillaz lode, will yield a good amount of gold in a drusy quartz-gangue, in the upper part of the mica-schists in the neighbourhood of the limestones. L. L. B.

Petroleum Industry of Rumania.—By E. Tassilly. Rev. Sci., Paris, 1910, pages 225-237.

The author attended, as a Delegate of the French Ministry of Commerce, the International Petroleum Congress at Bucarest [Bucharest], and the present memoir embodies the results of his mission as well as a vast amount of information which he collected from competent quarters in Rumania. The petroliferous deposits of that country extend along a narrow belt parallel with the Carpathians, from the Suceava district into Oltenia; they occur as primary deposits in the Palaeogene and the saliferous Miocene formations, while the workable deposits in the other Tertiary formations are secondary, that is

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to say, have migrated from their original locus. A few isolated occurrences of petroleum have also been recorded in Western Rumania. The strata are, as a rule, highly plicated, and within the same district the depth at which petroleum occurs may vary from a few yards to 800. The occurrence of natural gas, mud-volcanoes, and brine-springs is characteristic of the entire oil-bearing belt. At Colibasi, near Draganesei, in a boring 1,000 feet deep, there was so violent an evolution of gas that the boring had to be abandoned. The peasants smothered the flames with cartloads of earth, but the gas found a way out and is still escaping, although the boring was put down as long ago as 1882. With regard to output, Rumania occupies at present the fourth place among the oil-producing nations, and will probably take the third place (next to Russia) within the near future.

Originally the oil was got by means of shafts sunk by manual labour; but nowadays borings, variously carried out by the American, the Canadian, and the hydraulic methods, are accountable for the lion's share of the output. The depth of the shafts ranges from 50 to 835 feet and that of the bore-holes from 380 to 3,000 feet. As motive power, crude oil is utilized, and occasionally natural gas—although it is not always easy to capture the gas for that purpose.

The oil-bearing belts are enumerated as follows: (1) The Bustenari-Campina-Poiana-Gura-Draganesei belt, with which is connected that of Recea, 12 ½ miles long, with an area exceeding 2,800 acres; (2) the Tintea-Bacoi-Moreni-Gura-Ocnitei belt, rather more than 17 miles long; and (3) the Colibasi-Glodei-Laculete belt, about 10 miles long, with two others each about 4 ½ miles long. Looking at the output from the stratigraphical standpoint, it is noted that the Eocene, the Miocene, and the Lower Pliocene contain no rich oil-deposits; where the Oligocene has a sandy facies, it may hold plenteous stores of oil, while the Upper

Pliocene is conspicuous for abundant natural reservoirs concentrated along narrow belts. In fact, the Oligocene accounts for half the total output, and the Maeotic formation for 30 per cent. (statistics of 1903 to 1907). However, the exhaustion of the Oligocene deposits is within sight; while the output of the Pliocene jumped from 7 per cent. in 1903 to 33 per cent. in 1907, owing mainly to the working of the Moreni oil-field. The Rumanian Government has built at Constantza, (Kustendje) on the Black Sea, a park of 25 oil-reservoirs approaching 4½ million cubic feet in total capacity, and private enterprise is accountable for 26 other reservoirs averaging together about 2 ½ million cubic feet. The system of pipe-lines in Rumania covers a total length of 474 miles; oil is carried by the railways in tank-wagons of a capacity of 10 to 15 tons, of which wagons there are about 2,000 available in the country. Water-transport, on account of the comparatively low freights from Campina to Constantza and to Giurgiu (or Giurgevo) on the Danube, is all to the advantage of the Rumanian oil-exporter. It is by the Danube that a great quantity is carried direct in tank steamers to Regensburg (Ratisbon) in Bavaria, where a wharf 440 yards long is specially assigned to the petroleum traffic. At present, rather more than a third of the output is exported, the remainder being consumed in Rumania itself (total output in 1908 = 1,147,727 tons).

A detailed account is given of the methods of distillation of the crude oil, as also of the elimination of the bye-products (paraffin, vaseline, etc.) and of the residues well known as Russia as massiut ( = pacura in Rumania). The Rumanian petroleum is, in many respects, analogous to the Russian; but it is further characterized by the presence in considerable proportion of the simple aromatic carbides (benzene, toluene, xylene, etc.), and of a series

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of ethylenic and acetylenic hydrocarbons, camphenes, terpenes, etc. In colour, the crude oil ranges from olive brown to blackish brown; when it is, by chance, pale, it is either red or yellow; and it invariably possesses a greenish fluorescence, analogous to that of American petroleum. Its specific gravity ranges on an average from 0.77 to over 0.86. Very exceptionally, the specific gravity reaches 0.935 or 0.944. The odour is not, as a rule, disagreeable. The great virtue of Rumanian petroleum, as the French railway companies that consume it have found, is its excellent illuminating quality: in good lamps it yields a steady intense light. Mixed with American petroleum of second-rate quality, it also gives very satisfactory results. The industry is largely financed by German, French, Rumanian, American, and Italian capitalists, British and Dutch capitalists taking in this instance a back seat. The chief foreign consumers are France, Great Britain, Germany, and Turkey, in the order named.

L. L. B.

Mineral Resources of the Argentine Republic.—By Richard Stappenbeck. *Zeitschr. f. prakt. Geol.*, 1910, vol. xviii., pages 67-81.

This paper is accompanied by a map of mineral-occurrences and a bibliographical list comprising 30 entries. The author remarks at the outset that the mineral industry has hitherto not shared in the great economic development which has taken place in Argentina of late years, the main reasons being the remoteness of the deposits from the industrial centre of the country (La Plata), the want of cheap fuel, the absence of trained miners, and the wasteful, not to say utterly reckless, methods of mining. It appears certain, moreover, that the known mineral deposits represent a mere fraction of the actually existing deposits: vast areas in the uninhabited solitudes of the Cordilleras, more especially in Patagonia, are still

unexplored, but the railways now under construction will greatly modify this condition of things.

Auriferous deposits occur in all the mountainous districts of Argentina, in the form both of quartz-reefs and of placers. The description of most of these is not given at first hand; and the same may be said of the silver-ore deposits. Copper-ores are of widespread occurrence, either infilling amygdaloids in melaphyres, or in the form of lodes and impregnations. Perhaps the richest deposits occur in the provinces of Mendoza, Salta, Catamarca, and La Rioja. Details and analyses are largely quoted from previous writers. Among deposits which deserve further investigation are the lodes of Leoncito in the Cordillera de Olivarez, of the Sierra de la Huerta (Morado), of Bellavista on the Rio Castano, of the Cerro Ansitta, etc. The Magellan territory is extremely rich in copper-ores, among them being highly auriferous and argentiferous bornite and chalcopyrite.

Iron-ores were not at one time regarded as a great asset of the Republic, but recently a huge haematite-deposit has been discovered in the Misiones territory; while considerable occurrences of magnetite are reported east of the Cerro Lacco on the Puna de Atacama, and from certain localities in San Juan province. Brief mention is made of ores of lead, antimony, tin, wolfram, selenium, vanadium, cobalt, nickel, and arsenic.

A great number of seams of lignite have been proved in the Miocene formations of Patagonia and Tierra del Fuego, the best being those of Rio de las Minas and Skyring Water. Day by day, fresh discoveries of petroleum are made in the Rhaetic and the Cretaceous strata of Argentina; with the petroliferous deposits are variously associated ozokerite, albertite, and asphalt. Recently, the petroleum deposit of Comodoro Rivadavia on the coast of Chubut

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was discovered by a mere chance. A series of extraordinarily extensive deposits of boronatro-calcite occurs in the Los Andes territory (Puna de Atacama), but working on a grand scale will hardly begin before the completion of the projected railway. The vast deposits of rock-salt described by Dr. Brackebusch have been recently supplemented by fresh discoveries. Gypsum, ornamental marbles, and native sulphur either have been and are being worked, or would repay working; but the numerous occurrences of graphite are disappointing, on account of the hardness and impurity of the mineral.

In the supplement to the *Zeitschr. f. prakt. Geol.*, entitled *Bergwirtschaftliche Mitteilungen u. Anzeigen*, 1910, pages 33-34, Dr. E. O. Rasser gives an account of the endeavours made since 1870 by the Argentine Government to discover workable coal-seams in the territory of the Republic. The occurrences so far proved cover all the geological periods that range from the Carboniferous to the Tertiary, and differ correspondingly in character. True coal, with impressions of fossil plants, has been struck at El Salto and Las Higueras; and it may be generally said that the coals at the eastern base of the Cordilleras in the provinces of Mendoza and San Juan, as well as those in the Famatina mountains in the province of Rioja, belong to the Carboniferous formation. The most important occurrence is probably that of Retamito in San Juan province, a locality situated in an easily accessible valley, not too far from the railway, where abundant timber, water-supply, and adequate labour are available. The strata, however, dip rather steeply at an average angle of 40 degrees. North of Retamito, near Carpinteria, Permo-Carboniferous coal-seams, practically horizontal, crop out. Good results are expected from the coal-fields belonging to the same formation (Jachal, Guaco, Trapiche, etc.) which extend farther northwards. The most numerous coal-

occurrences, however, have been observed in the Rhaetic or Upper Keuper along the eastern flank of the Cordilleras: they include the coal-fields of Marayes, Challao Cacheuta, and Las Higueras. The horizontal seams of Curileuvu (Neuquen territory) are conspicuous for their richness in gas (250 per cent. more than Cardiff coal) and for their heating power: some observers regard the mineral as carbonized asphalt, but it is perhaps comparable with the rafaelite of San Rafael, which has a heating power of 8,712 calories, and is, moreover, remarkable for containing 0.15 per cent. of vanadium. On the left bank of the Upper Rio Diamante, there occurs a horizontal seam of rafaelite, 20 to 24 inches thick. A German syndicate will probably work the Curileuvu coal, if further investigation confirms the impression that the deposits are of industrial importance. The Neuquen territory is also rich in gold, argentiferous galena, copper, petroleum, etc. L. L. B.

Petroleums and Coal compared in their Nature, Mode of Occurrence, and Origin.—By Eugene Coste. Journ. Canad. Min. Inst., 1909, vol. xii., pages 273-302.

Only that portion of the paper dealing with the origin of petroleums and coals has been abstracted, as being of more general interest.

The origin of the members of the coal series from the natural decomposition of vegetable matter, either in situ or when drifted, has been so abundantly proved, and is now so generally accepted by geologists, that it is not necessary to make further reference to this branch of the subject. With regard to the origin of petroleum, however, there is a diversity of opinion, and the author discusses in detail the various theories that have been put forward. With reference to the only two kinds of organic matter in nature to which the

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derivation of petroleum might be attributed, namely, (1) the soft tissues of animals, and (2) vegetation, he gives fourteen reasons antagonistic to the first theory, the principal being that (1) the soft tissues of animals always decompose, decay completely, and disappear entirely, before their entombment in the sedimentary strata can take place; and (2) that vegetation decomposes naturally into the coal series of carbon compounds, all the members of these coal series being found in the sedimentary strata. He also points out that the belief in the organic origin of petroleum leads to chaos in the understanding of other geological facts and physical laws brought out clearly in the study of many petroleum occurrences or deposits.

That the origin of petroleum is volcanic the author is quite convinced, and he gives a number of reasons in support of his opinion, amongst others being the following:—(1) The fact that volcanic emanations of hydrocarbons are the only natural geological process of petroleum production of to-day; (2) the presence of petroleum in volcanic and igneous rocks, metalliferous veins, and meteorites; (3) the rock-pressure of the natural gas in petroleum deposits, which pressure increases with depth in each field; (4) the products associated with petroleums in their reservoirs, principally salt, sulphur, hydrogen, sulphide, gypsum, calcite, dolomite, and silica, these also being the products associated with hydrocarbons in present-day volcanic emanations; (5) the fact that petroleum deposits are located along faulted and fissured zones of the earth's crust, parallel to the great tectonic, orogenic, and volcanic dislocations; (6) the fact that petroleums are never indigenous to the strata in which they are found, and are secondary products impregnating porous rocks of all ages; (7) the fact that petroleums are found in such abundance in certain small localities while neighbouring localities are found entirely barren, pointing to the conclusion that they have originated from the volcanic tank below; and (8) the fact that the sedimentary strata of the oil-fields are so

highly impervious that the volcanic fracturing and fissuring and the volcanic force of the natural gas alone can explain how so many small porous receptacles at different horizons between these impervious strata have been filled with petroleum, salt, and sulphur waters.

The author considers that the recognition of the solfataric volcanic origin of the petroleums not only removes every difficulty in the way of the full comprehension of all the chemical and geological facts, as at present established with regard to the nature and mode of occurrence of petroleums, but fully harmonizes also with the physical laws governing the circulation of gases and liquids through great thicknesses of impervious strata before being able to reach to and accumulate in a few small separated receptacles in their midst. The volcanic origin of the petroleums forms, therefore, a complete chain of evidence, with none of the links weak or missing.

A. P. A. S.

Tin-mining in Perak.—By L. Giraud. *Mem. & Trav. Soc. Ing. Civ. France*, 1909, vol. i., series 6, pages 47-117.

Perak, one of the Federated Malay States, now under British protection, furnishes 31 per cent. of the tin produced in the world. Communications are good, and the climate is healthy, especially in the mining districts. The ore must be smelted in the Malay States or in Great Britain in order to avoid the heavy export duty, which, however, affords most of the revenue (£1,675,620) per annum. In metal or the equivalent ore, 26,090 tons were exported in 1907.

Four main formations are met with—the granitic, calcareous, ancient sedimentary, and Quaternary; and the presence of tin is coeval with the

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granites, in which numerous veins are found, three well-defined being known in the Sengan Chain. The calcareous formation is rich in minerals of all kinds, including twenty stanniferous deposits, some of which are worked; and in the ancient sedimentary formation the shales are worked for the tin veins which they contain. The Quaternary comprises the alluvia formed by the decomposition of the various rocks; and cassiterite (the tin-ore worked in Perak), borne away from its deposits, is concentrated in these alluvia.

Cassiterite occurs (1) as inclusion beds, (2) as veins and lodes, (3) in the alluvial, and (4) in the eluvial formation. Nearly all the tin is obtained from the alluvia, which are formed of quartz, city, tourmaline, cassiterite, ilmenite, etc., the cassiterite being found in fragments of a few millimetres to the finest dust. The thickness of the tin-bearing alluvium may vary from a few inches to more than 100 feet (30 metres), while that of the cover may exceed 65 feet (20 metres). The tin-content of the alluvia varies from 0.86 pound per cubic yard (0.3 kilogramme per cubic metre) at the Bruseh mine to 72 pounds per cubic yard (25 kilogrammes per cubic metre) at that of Tambun.

Along the central mountain-chain, on the western slope, there are calcareous hills; and sometimes their summits have depressions filled with ferruginous sand containing cassiterite, several being worked.

The eluvial deposits are due to the decomposition of rocks containing tin in the state of inclusion or under the form of thin stanniferous and ferruginous veins. The deposit may attain a thickness of 16 feet (5 metres) or double that figure. The content is generally slight; but the deposits are easily worked, being on the surface. Explorations in the alluvia are made by boring, and those in the mineralized rocks by trial-pits, timbered or not, circular if

sunk by coolies, and square when put down by Malays. The working of beds and veins is effected in the ordinary manner.

The method of working the alluvia underground consists in sinking shafts to the rich seam, and then driving headings in it. The Chinese and Siamese formerly employed this method, but only in the richest parts of the seam, and only taking out the ore got by the drivings, thus leaving a great deal for subsequent working. When the height of the alluvium does not exceed 8 feet (2.5 metres), the land is staked out in squares of about 40 feet (10 to 15 metres) side; a shaft is sunk at each intersection of the lines; and then timbered drifts are put out to connect the shafts. The pillars thus formed are then worked out by headings having only the height of the seam, and only gobbled near a road or a river. When the height of the alluvium is greater, the same method is pursued, the workings are allowed to fall in, and a subsequent working is effected with fresh shafts, because the others are destroyed by thrust of the measures. Water-carriage stowing is strongly indicated with this method of working, because it would utilize the tailings and permit of the more economical working upwards from the bed-rock.

Open-cast working is, however, that most generally employed, either by one or other of two Chinese methods (described and illustrated) or by inclines. When there is sufficient head and volume of water, and the nature of the surface permits of the tailings being taken off easily, it is advisable to adopt hydraulic methods, either that of gravitation by "lampangs" (also described and illustrated) or again by disaggregating the ground by a strong jet of water from a "monitor"; but it is often necessary to raise the tailings by a sand-elevator working with water under pressure like a steam-injector.

The mechanical preparation of sandy alluvia is effected by the Chinese case or by sluices, and that of clayey alluvia (with at least 20 per cent.

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of clay) by dissolvers with vertical or horizontal axes. When the clayey alluvia contain stones, the latter are first picked out by hand or are separated by screening. The ore leaving the Chinese case or the sluice is not pure, but contains some "amangue" (as the heavy particles are called), which is got rid of by a hand re-washing with sieve. The amangue, thus separated and still containing cassiterite, has to be washed again, if necessary several times, and with a trough if the tin content be slight.

J. W. P.

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#### MINING TECHNOLOGY.

Instructions for Handling Explosives.—Anon. Journ. Chem., Met., & Min. Soc. S. Africa, 1910, vol. xi., pages 84-85.

The following is a summary of the instructions drawn up by a subcommittee of the Council of the Chemical, Metallurgical, and Mining Society of South Africa, and approved by the Transvaal Chamber of Mines for exhibition on all mining properties: —

Detonators.—Detonators must always be kept dry, as moisture or dampness, even when invisible, reduces their effectiveness, and may even cause mis-fires. Before insertion of the fuse, the sawdust must be thoroughly shaken out of the detonator-tube, by gentle tapping of the open end upon a piece of wood. On no account must any instrument be inserted into the detonator-tube to clean out the sawdust.

Preparing a Charge.—Safety-fuse must be cut square with a sharp knife, and inserted into the detonator-tube until it reaches the fulminate. The upper end of the detonator-tube must

then be squeezed round the fuse with special fuse-pliers. Care must be taken not to squeeze the lower end of the detonator tube containing the fulminate, otherwise an explosion is likely to occur. The wrapper at one end of a cartridge must next be opened, and a small hole made in the explosive by a piece of wood or the copper end of the fuse-nippers. Into this hole the detonator (with fuse attached) must be inserted to two-thirds of its length, and the cartridge paper must then be firmly tied with string. On no account must the detonator be buried in the explosive (unless it be an electric detonator).

Charging the Hole.—Cartridges must be inserted one at a time into the hole, and each one squeezed gently but firmly home. The primer (the cartridge with a detonator and fuse attached) must always be placed on the top of the charge with as little pressure as possible. In wet workings the junction of the fuse and detonator must be made watertight, either by means of Chatterton's compound, insulating tape, or firm grease. The tamping-bar must be of wood, but the end may be sheathed with either copper or brass. Iron or steel bars or scrapers must not be used.

Tamping.—The material used for tamping should be preferably of a clayey nature, made up in the form of cartridges of a slightly smaller diameter than the hole. In order to avoid any interference with the detonator, the first tamping cartridge must be put into the hole with the greatest care. The remaining tamping cartridges may then be firmly but carefully tamped. When tamping, care must be taken to avoid withdrawal of the primer, etc., from the charge.

Lighting the Fuse.—The fuse must be prepared for lighting by splitting the end about an inch down with a sharp knife. As soon as an efficient fuse-lighter is available, the cheesa stick made of blasting gelatine should be prohibited, as poisonous gases are formed by this burning explosive.

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Mis-fires.—In the event of a mis-fire, only sufficient tamping must be withdrawn, by means of a wooden swab-stick, to allow of the mis-fired shot being fired.

Plugging of Sockets.—After a blast, all the rock thrown down, and also all the remaining holes or sockets, must be carefully examined for unexploded cartridges or detonators.

General.—All nitro-glycerine explosives are, when the temperature is below 45° Fahr., liable to congeal or become hard from the effect of cold. On no account must they be used when in this condition, and not until they have been carefully softened or thawed in a warming-pan specially constructed for the purpose. All open lights must be removed to a safe distance, and no iron or steel tools must be used when opening cases containing explosives or during the preparation of the charges.

A. P. A. S.

Tests of Ammonium-nitrate Safety-explosives.—By H. Dautriche. Ann. Mines, Paris, 1910, series 10, vol. xvii., pages 5-17.

These tests were made in order to determine whether the coal-dust resulting from holing in a coal-seam would be ignited by the products of detonation of safety-explosives and thereby heighten both their effect and their temperature. Incidentally the part played by the paper and the paraffin of the cartridge-coverings was studied, and it was noted that it varied according to the diameter of the cartridges, being practically negligible in the case of an inch and a fifth (30 millimetres) or so, but of some importance in the case of cartridges measuring an inch and three-fifths (40 millimetres) in diameter, whether the shots were fired in coal or in stone.

The explosive generally used in the experiments contained 93 per cent. of ammonium nitrate and 7 per cent. of trinitro-toluene, but, in two cases, the cartridges were charged with picric acid. Elaborate tables of the results are supplied, and the following conclusions are deduced. Finely divided carbon, whether wood, charcoal or coal, burns at the expense of the oxygen evolved by the 93/7 explosive. The coverings of the cartridges of smaller diameter hardly burn at all, but those of larger diameter burn very readily. The oxygen evolved by the explosive is entirely used up, and carbon monoxide is formed. When picric acid was substituted for the 93/7 explosive, the varied effects due to the evolution of oxygen were no longer observed, and this was quite in accord with expectation. L. L. B.

Outbursts of Gas in Coal-mining.—By —. Schaustein. Zeitschr. f. Berg-, Hutt.- u. Salinenw., 1910, vol. lviii., pages 1-47.

The author discusses a series of reports on the above subject from Belgium, France, England, Austria, Canada, Australia, etc. The outbursts are those occurring in coal-mines in which amounts of dust coal varying from a few tons to a few hundred tons are suddenly driven out of the face or out of the sides of passages. In the Morissey Pit, in British Columbia, dust coal estimated at 3,500 tons was blown out at one outburst. The quantity of gas accompanying the dust coal differs very much, and is still more difficult to estimate than that of the latter. The gas also continues to stream out after the first outburst. In Besseges, on November 10th, 1890, at an outburst involving the loss of 131 lives, about 28,000 cubic feet of mine gas issued in the first 150 seconds and about 180,000 cubic feet in the first 12 hours. In the Agrappe Pit, in 1879, at an accident which cost 121 lives, it was estimated that 85,000 cubic

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feet of gas per minute issued from the coal-seam in the short period immediately succeeding the outburst. The air-current is in many cases reversed for about 100 yards, and sometimes even right back to the pit-head. Lamps are generally extinguished by the current of air set in motion by the gas before the latter reaches them. The outburst is in some cases accompanied by decrease and in others by increase of temperature, the latter in deeper pits. In Belgian pits the number of outbursts occurring increases with the depth till 2,150 feet is reached. They then decrease again, but only because, in 1891, the date of the statistics taken, few pits of more than that depth were at work in that country. At depths of less than 840 feet no outbursts have occurred in Belgium. In the other countries referred to, the experiences were of a similar kind. It would appear also that fewer outbursts occurred in the workings proper than in drifts and galleries. The inclination of the strata apparently exercises no influence on the frequency. The nature of the coal was often altered by an outburst. In most cases soft coal became harder, while in some others the seam was impregnated with a special kind of soot-coal. In the South of France the coal often became soft and earthy. In an English pit cracks and compression of the seam occurred at the same time, and the coal was discoloured. In an Australian pit the outbursts always occurred near cracks or compressions, and the coal became harder than before. The author concludes that some connexion exists between outbursts on the one hand and faults in compressions of the strata on the other, and that the occurrences in question are commonly accompanied by an alteration of the nature of the coal.

Measures taken for the protection of the miners against the effects of such outbursts are the avoidance of the use of naked lights, even on the heapstead, up to which the gas has been

known to penetrate in the face of the air-current. To enable the gas to pass off safely, the Belgian mine police ordain: —

(1) That the pulley-frames shall not be roofed over. The framing must be of incombustible material, and steam-heating must be resorted to in place of braziers near the pit's mouth.

(2) That the use of explosives shall be restricted as much as possible. In driving a heading into a gassy seam it is forbidden; while in galleries and such like stone-workings it is permitted only in presence of an air-current that has not been led through coal-workings.

(3) That measures be taken to remove the fire-damp from the mine as quickly as possible after an outburst, and prevent the back current against the ventilation. With this view it is recommended that the passages be made as large as possible, even at places where a throttling becomes necessary. Another recommendation is that the gobbing be delayed as much as possible, and that all choking of the passages, whether by heaps of material, empty tubs, or other obstacles be avoided. In drifts towards gassy seams the regulations require that there be a flowing current of air coming direct from the shaft without traversing other workings. The current is to prevent the damming-back of the fire-damp. In sinking down to a lower level it is recommended that both shafts be carried right down before fore-winning work is begun, and that careful ventilation and an extensive use of air-doors be resorted to. The air-tubes in the boards and headways should be kept as high as possible to prevent them from being smothered up by the dust-coal. Among other proposals is one that access to the lower level be obtained by a staple at a distance from the shaft, so that large quantities of gas may not find their way into the latter.

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Means suggested for the prevention of accidents from outbursts of gas are:—(1) The employment of experienced men; and (2) the avoidance of obstacles to the escape of the men. In Belgium, in some instances, emergency passages have been provided. Where a compressed-air installation is fitted, it is proposed that the pipes be provided at intervals with cocks, so that the men can let out air for breathing. It has also been proposed that a special system of piping be installed for the same purpose, and in connexion with this a number of refuge-cabins. Wooden tunnels of large section led in to the winning face have been proposed, and in some cases successfully applied. The tunnels were to be supplied with air-currents. In the South of France, in driving towards a coal-seam, the method is employed of firing as many shots as possible simultaneously from bank after the withdrawal of the men, so as to discharge any gas that may threaten danger. Bell and siren signals warn the men at bank when foul air is to be expected. When the actual coal-winning begins, recourse is again taken to the ordinary system.

In the Besseges pit in the Gard coalfield, in which fire-damp is prevalent, the rules enforced are:—(1) That shots be fired only in the neighbouring strata—not in the coal; (2) that, where shots are fired in succession, only safety-explosives are to be used; and (3) that while the shots are being fired, the ventilation-current is to be interrupted.

Fire-damp in Belgium.—In a report on Belgian conditions presented to the German Minister of Trade and Commerce, Bergrat Bracht traverses nearly the same ground as Herr Schaustein, but, in addition, illustrates his remarks by five plates, which show the stratification to be extremely broken and undulating. The coal-seams take somewhat the form of tilted anticlines, the southern limbs of these lying approximately horizontal and the northern vertical. The liability of the district to outbursts of gas is in great part attributed to the broken nature of the stratification. The quantity of gas in the seams in which the outbursts

occur is given as 14 to 22 per cent. The most dangerous seams are said to provide an exceedingly good coking coal.

The Arnould theory advanced in 1880, and extensively accepted in Belgium, is outlined. The carbonic-acid gas developed in the formation of the coal is supposed to be stored in the latter under very high pressure. Passages and open workings being under a much lower pressure, the gas flows towards these, and as partitions, especially of stone, become thinner, they tend to give way. The most dangerous points are folds and faults in the stratification.

To prevent the damming back of the air-current by the gas, groups of strong doors opening in the one direction only are fitted in the line of the former. The doors of a group are so arranged that, when one of them is opened, another is always closed. The air-ducts are arranged near the roof, so that they cannot be smothered up by the dust-coal of an outburst, and are carried to within 17 feet of the face. In one case the ducts were kept low and were then of an oval form 2 feet high by 16 inches broad. Ordinary ducts are 14 inches in diameter. In the Produits Pit safety passages were made through the gobbing; and safety niches, lighted by electric lamps and supplied with compressed air by a system of piping, were instituted.

Outbursts of Gas in the Ruhr District.—These are shortly touched upon. A number of outbursts are enumerated similar to those of the Belgian and French mines. Regular observation of such outbursts began last year, previous ones consisting of gas, water, and dust coal not having been noted.

Outbursts of Gas in the Saar District.—Outbursts of a like nature occurred in 1909 in the Velsen Pit of the Furstenhausen Colliery and in the Luisenthal Pit of the Gerhard Colliery. In the former case about 150 tubfuls of duff and

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in the latter 40 tubfuls of coal, 12 tubfuls of other solid material and 16,000 cubic feet of gas were pressed out.

A. R. L.

Catalytic Action and Explosions of Fire-damp.—By H. Fliessner. (Oesterr. Zeitschr. f. Berg-u. Hutt., 1910, vol. lviii, pages 197-199.)

The speed of re-action in chemical processes depends on the temperature, or on the concentration of the re-acting substances. It is increased by raising the temperature; at ordinary temperatures, the combination of hydrogen and oxygen takes place slowly, while at 1,290° Fahr. (700° Cent.) re-action is almost instantaneous. The speed of re-action is doubled for every 18° Fahr. (10° Cent.) rise in temperature. Concentration, such as that of gases under pressure, produces the same effect. Pure oxygen stimulates combustion more rapidly than ordinary air, because it is concentrated, and not diluted with nitrogen. The speed with which a substance re-acts is in direct proportion to its concentration.

If, however, neither the temperature nor the concentration are varied, but a new substance is added, it has the same effect of hastening reaction, and is called a catalysator. If hydrogen and oxygen be led over platinum wire, they combine rapidly, the re-action spreads to the neighbouring particles of gas, and an explosion ensues, the platinum itself remaining intact. The speed of re-action which, at ordinary temperatures, and without a catalysator, proceeds almost imperceptibly, is raised by the platinum to explosion-point, and other chemical substances operate in the same way. Of these, one of the most effective is coal. The

oxidation of many substances by free oxygen is hastened if coal be present, but a large surface is required for its catalytic action. A characteristic of coal is to condense the gases at its surface—in other words, to produce their concentration. As this action takes place between a solid body and the gases in contact with it, it is directly proportional to the area of the former—that is, the coal; therefore the larger the surface is, the greater will be the reaction.

Large areas of finely-powdered coal-dust are constantly produced by mining operations, and the writer is of opinion that these act as a prompt catalyser when brought into contact with a mixture of methane (fire-damp) and air, and cause an explosion. Considered with regard to their catalytic action, there is this difference between coal-dust and platinum that, whereas platinum remains unchanged, coal-dust itself participates in the re-action, and burns. Without any change in temperature or greater concentration, all the conditions needed for explosion due to chemical re-action are present. The coal itself not only takes part in the explosion, but heats the liberated carburetted hydrogen, the impact of the air caused by the explosion whirls up more coal-dust, and the conflagration rapidly spreads. Most of the external conditions which conduce to such a catastrophe, such as blasting, naked lights, fusing of the electric spark, can be controlled by human means. Where none of these can be held accountable for an explosion, the writer considers that it may be due to the catalytic action of coal-dust, which is thus seen to be one of the miner's deadliest enemies.

E. M. D.

The Explosibility of Coal-dust.—By George S. Rice. United States Geological Survey, 1910, Bulletin No. 425, pages 1-186.

This bulletin traces the growth of the belief in the explosibility of coal-dust, summarizes the experiments and mine investigations that have established

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this belief, and gives the present status of preventive measures. It has been prepared in accordance with the provisions of the Acts of Congress authorizing investigations relating to the causes of mine explosions, and contains references to, and descriptions of, experiments made at the testing-station of the United States Geological Survey at Pittsburg (Pennsylvania). This station was established and equipped for the purpose of carrying on investigations relating to mine explosions, fuels, and structural materials.

The bulletin is a preliminary study of the coal-dust problem, and opportunity will be afforded in the future to take up systematic experimenting both at Pittsburg Station and in the field, on the lines suggested in the Report.

A. P. A. S.

Experiments with Coal-dust at the Lievin Testing-station.—By J. Taffanel. Mem. & Trav. Soc. Ing. Civ. France, 1910, vol. ii., series 6, pages 188-189.

At the Lievin testing-station, founded at a cost of £14,000 (350,000 francs) after the Courrieres catastrophe by the Comite Central des Houilleres de France in conjunction with the mine administration, three series of experimental tests have been undertaken. The first determined the principal elements of coal-dust inflammability, the second the manner in which coal-dust explosions are produced, while the object of the third, still in progress, is to study the extension of such explosions and means for arresting them. The following information has been already acquired.

The initial cause is almost invariably a fire-damp explosion or an untamped or defectively-tamped shot, in which latter case the use of safety-explosives diminishes the probability of ignition. For coal-dust to explode, its mere inflammability is not sufficient; the combustion must also be intense enough for the expansion-waves to maintain the cloud of dust, so as to fulfil the conditions of quantity, fineness, purity, dryness, and volatile-matter content which are rarely met with in the mine, and may be rendered still rarer by sprinkling and "schistification"—that is, the addition of incombustible dust

The coal-dust explosion is, however, progressive; and the intensity of the combustion is soon increased by the eddies and accelerations caused by the explosion as it extends, so that many dusty deposits are quite capable of propagating a fairly-started coal-dust explosion, which appears to have no limit. With a favourable fire-disposed deposit the explosion is very violent, the speed of the flame exceeding 3,280 feet (1,000 metres) per second, and exerting momentary pressures more than double any that can be obtained in a closed chamber. Actual experiments show that the violent phase of these phenomena is not easy to realize in a gallery having bends or obstacles that break the waves and oppose sufficient resistance to the rapid air-currents.

J. W. P.

Fire-damp Accidents (including Coal-dust Explosions) in the Coal-mines of Belgium during: the Years 1891-1909.—By Messes. V. Watteyne and A. Breyre. Ann. Mines Belgique, 1910, vol. xv., part 2.

Investigations into the explosions in Belgian mines during the periods 1891-1900 and 1901-1909 show that in both periods the greater number of fatal accidents were caused by sudden outbursts, and that the next in order of magnitude were caused by asphyxiations, use of explosives, and defective lamps. Also that, whereas in the period 1891-1900 no explosions were due to the use of electric lamps, in the period 1901-1909 no accidents

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were caused by defective lamps or by uncertain or various causes. The figures relating to the number of deaths show that during the period 1901-1909 they amounted to only 33 per cent. of those that took place during 1891-1900. This progress is attributed to the practical application of the experimental results obtained at Frameries.

The causes of the explosions are classified, and the precautions to be taken in each case are discussed as follows: —

(A) Explosions due to Ordinary Lamps.—(1) Lamps with Naked Light.—Even in mines classed as non-fiery, there may always be found an accumulation of fire-damp owing to local conditions. It is compulsory that in those mines where fire-damp is generally absent, there must be a sufficient number of safety-lamps kept at the mine to permit of the inspection of those roadways where the presence of fire-damp may be suspected.

(2) Opening of Safety-lamps.—To prevent accidents from the opening of lamps, magnetic locks are especially recommended. The introduction of re-lighters has produced good results, in doing away with the temptation to open lamps surreptitiously.

(3) Rupture of Glasses.—These are almost always produced by accidental blows from tools or pieces of stone, and not by the heating of the glass by fire-damp or benzene burning inside the lamp. In mines known to be fiery, the use of glasses that will successfully withstand certain tests carried out at the experimental station at Frameries is obligatory.

(4) Defective or Damaged Lamps.—These accidents will be avoided by careful inspection of the lamps handed to the workmen, and by the men taking every precaution against accident in the course of their work.

(5) Lamps without any Special Defect, other than that of Insufficient Degree of Safety.—Only those types of lamps will be authorized that have passed at Frameries the most rigid tests in currents of every kind, velocity, and direction. These tests have notably shown that the Mueseler unshielded lamp, such as was constructed before the 1904 regulation, and which behaves in a remarkable manner in horizontal currents, does not resist ascensional, descending, or eddy currents.

(B) Explosions due to Electric Lamps.—A single accident occurred on July 4th, 1905, at No. 4 Pit of the collieries of Bois-de-la-Haye at Anderlues. It appears to be proved that this accident was due to the explosion of a firedamp mixture by the exposure of the filament of an electric lamp. The remedy suggested consists in protecting the bulb of the electric lamp by a very resistant glass with hermetically-sealed joints. According to the results of the experiments made at Frameries, these electric lamps possess a degree of security at least equal to that of the best constructed ordinary lamps.

(C) Explosions due to Explosives.—Despite the fact that considerable progress has been made in their manufacture and their mode of usage, explosives remain the dominant cause of the explosions of fire-damp and coal-dust.

(1) Explosions due to Shot-holes charged with Black Powder.—Investigation confirms the danger arising from the use of black powder, which should be prohibited in every mine.

(2) Explosions caused by Detonating Explosives.—It is necessary, whenever possible, and always when it is known or greatly feared that an explosive mixture of fire-damp is present, to avoid the use of these explosives—whatever they may be. In every case it is important to use only those carefully-controlled explosives which have been submitted to repeated tests in special laboratories. The maximum charges should be confined to the previously-determined limiting charges, and with sufficient and careful tamping.

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(3) Explosions due to the use of Fuses.—This method of firing shot-holes is to be condemned.

(4) Setting fire to Explosives open to the Atmosphere.—The four accidents of this class are all coal-dust explosions. This practice must, then, be absolutely done away with, even in the absence of fire-damp.

(5) Explosions due to Various or Unknown Causes.—These accidents are less interesting, because of the uncertainty as to their causes, and of their special and exceptional character. Amongst these causes are ignition of explosive mixtures by sparks produced by the striking of tools against hard rocks. The experiments carried out at Frameries on this subject have shown that, whilst these sparks may be quite harmless in an explosive mixture of firedamp, they may produce the explosion of a mixture containing 7 per cent. of fire-damp and 3 per cent. of hydrogen.

(D) Production of the Explosive Mixture: the Danger of Coal-dust.—With regard to this question, the authors have nothing new to say. The necessity of adequate ventilation, of complete filling in of old workings, of watering of roadways in dusty mines, etc., is emphasized. In connexion with the accidents studied, falls in atmospheric pressure do not appear to have played any part.

In considering accidents due to asphyxiation by a normal escape of firedamp without explosion, the authors distinguish between the cause of the accumulation of gas and the accident itself—due to the presence of workmen in the dangerous accumulation.

The majority of the accumulations are due to an interruption in the work (temporary abandonment of workings, stoppage, etc.); some have taken place in traversing certain faults. Hence the necessity of good ventilation in all cases. The presence of the workmen in the dangerous accumulations is due to (1) entering working-places for the purpose of regaining some tools, or (2) to officials penetrating to the working-faces in order to re-establish ventilation, to get rid of the fire-damp, or simply to report on the state of the workings. Some of these accidents might have been avoided if rescue-apparatus had been available. It is necessary, therefore, to have the entrances to such places securely barred.

It is pointed out that the use of electric lamps in such suspected roadways is dangerous, since these lamps give no indication or warning as to the presence of gas.

D. B.

Explosion of a Powder-magazine at the Tucquegnieux Mines, France.—By G. Vaudeville. *Ann. Mines, Paris*, 1909, series 10, vol. xvi., pages 563-581.

On February 6th, 1909, at 9.30 a.m., a magazine containing 4 tons of compressed black powder blew up with fatal effect, but the actual cause of the disaster remains undetermined. Six persons lost their lives thereby, and a seventh was slightly injured. In addition to the powder, there were in the magazine at the time 10,000 "electric fuzes," which had been unloaded there on the previous afternoon: they detonated one after the other, when reached by the conflagration to which the explosion had given rise.

A detailed description is given of the material damage, which was really less than might have been expected. The effects were not "shattering"; there was simply a temporary "excess of pressure," to which comparatively flimsy partitions yielded: the magazine practically collapsed in situ, there was a shower of tiles from the roof, but there was no violent projection of considerable

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masses to any distance. It would seem that the vibration caused by the detonation of great masses of powder is of an oscillatory nature, the period of oscillation being fairly long (say, about a second). One of the lessons to be learnt from this explosion is that the walls of powder-magazines need not be specially strong, if the roof is so constructed as to afford an easy exit to the gases evolved. The roof, being projected vertically, will be projected with the less violence the lighter are the materials of which it is made. A further conclusion is set down, that it is advisable to increase the cubic capacity of powder-magazines in relation to the stock which they are destined to hold.

L. L. B.

Construction of Brakes on the Safety-apparatus of Cages.—By W. Macka. *Oesterr. Zeitschr. f. Berg- u. Hutt.*, 1910, vol. lviii., pages 179-181.

In any system of brakes for arresting the descent of a cage in the event of an accident, the men in the cage must not be injured by any sudden shock; while, at the same time, the permissible strain on the catches must not be exceeded. Even if the speed of winding be only moderate, the main difficulty in stopping a cage is while it is being lowered. If the winding-rope breaks, the kinetic energy of the cage must be immediately absorbed by a

resistance only slightly greater than its own weight. The brake should be so arranged that the work of the spring, or other mechanism actuating it, is merely to drive the catches closely against the guides, their further or braking action being produced by the liberated kinetic energy of the cage itself, as it falls.

An apparatus of this kind, suited to cages with side-guides, has been designed by Prof. Undeutsch, and modified by the writer. The spring-brake is above the cage, and is covered to prevent the broken head-rope from fouling it. The catches are keyed on to two small separate shafts, and the action is similar to that of an eccentric, except that the rods work from within instead of from without, and the catches act in opposite directions. The spring, when suddenly released, forces the catches against the guides, and so long as it is fully extended, the pressure of the catches sets up so much frictional resistance that they cannot be jerked off. All the parts of the apparatus are simple, and no undue weight is thrown upon the head of the cage. The weight of the spring, on which the whole action depends, should be about 90 per cent. of that of the cage when empty. E. M. D.

Mining Accidents and the Rendering of First Aid.—By Charles H. Hair. Journ. Canad. Min. Inst., 1909, vol. xii., pages 343-349.

The author deals with the various accidents arising in mining operations, and offers suggestions as to the prevention of those accidents that are due to causes over which no one has control. These accidents are much less frequent than accidents attributable to preventable causes. As regards the danger of gas containing carbon dioxide, carbon monoxide, nitrogen, fumes of nitroglycerine, etc., carbon-monoxide poisoning is probably the most fatal. Cases of gas-poisoning may be divided into two classes, namely, acute and chronic : the first class resulting where a limited quantity of the gas is inhaled, and the second where a considerable quantity of gas is inhaled in a very short time. The symptoms in the acute cases are (1) Beating in the head; (2) flushed condition of the skin, especially of the upper part of the body; (3) giddiness; (4) nausea, and usually vomiting; (5) difficulty of respiration;. (6) restlessness; and (7) fullness and compressibility of the pulse.

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When a large amount of the gas is inhaled, there ensues usually giddiness, passing into unconsciousness in a short time. After the unconscious period, if the patient recovers therefrom, follows a drowsiness or languor and an intermittent pulse, with considerable difficulty in respiration.

In the chronic cases of gas-poisoning where men are constantly inhaling small quantities of the gas, the four main symptoms are:—(1) Slight persistent headache, (2) cough, (3) indigestion, and (4) nerve disorders.

The gas may be absorbed by carrying dynamite in the boots, or by rubbing the face with the hands after handling dynamite. One instance is quoted of a man having eaten an apple after having cut a stick of dynamite with a knife, and the same effects were reproduced. The writer is of opinion, however, that the main symptoms are due to a volatilization of the fumes of nitroglycerine rather than to absorption through an unbroken skin.

Dealing- with the treatment of such cases, the author recommends the removal of the patient to fresh air as quickly as possible; but if, for any reason, such a course is impossible, to force air into the immediate vicinity. This should be followed by keeping the patient's body warm

with blankets, but the head cool, and by his removal to a room where there is an abundance of fresh air.

After dealing with the treatment of venous and arterial haemorrhage, head wounds, fractures, and eye-wounds, the author points out the importance of the prevention of shock to the patient, and makes the following recommendations in the case of an accident of a serious nature:—(1) Place the patient in as warm a room as possible; (2) keep the patient lying down; (3) allow the patient water, diluted whisky, or alcohol, if any is at hand; (4) do not allow too many other persons in the room in which the patient is placed; and (5) prevent, if possible, the patient from learning of the seriousness of his accident.

A. P. A. S.

Comparison of the Older Draeger Apparatus with the New 1910 Pattern.—By Fritz Jungst. Gluckauf, 1910, vol. xlvii., pages 1433-1440.

In order to minimize risk of failure, facilitate getting the apparatus, ready for use, and relieve the wearer, the new pattern has been modified in several respects. First, the two oxygen-bottles and absorbent cartridges have been replaced by one of each, the pressure in the gas-bottle being increased to 150 atmospheres; the cartridge is taller and of oval cross-section, and the charge is sufficient for a working period of 3 hours. The total weight is reduced by about 4 ounces (100 grammes). No screwing is needed in putting the cartridge into position for use, the sealed cap being torn off and the lower end of the cartridge slipped into place over the bottom valve, which it opens against the pressure of a spring. The connection with the upper valve is established by means of a locking lever, the arm of which is simply pulled down and locked. The spanner for screwing on the oxygen-bottle is attached to the apparatus, in an accessible position, so that it cannot get lost. The finimeter is mounted under a leather flap on the front of the carrying strap, so that it can be taken out by the wearer, for the purpose of ascertaining how much oxygen is still left for use. The breathing-bag has been separated from the helmet, and no longer obstructs the free movement of the head, the short intermediate pipe being made very flexible. In the helmet, the front alone is of metal, for the attachment of the fittings, the part fitting against the head being of leather, with a pneumatic ring of fabric rubbered on both sides. The field of vision is enlarged, and the device for wiping off condensed

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moisture improved. For those who cannot comfortably wear a helmet, an improved form of nose-clip and goggles has been devised, and both flexible pipes are led under the left arm, leaving the right arm free, except for the shoulder-strap. A smaller pattern of apparatus, with an oxygen supply for half an hour, is slung over the shoulder like a wallet.

C. S.

Safety of Winding-ropes.—By F. Baumann. Gluckauf, 1910, vol. xlvii., pages 1521-1525.

Calculations and tables are given in the paper showing the diameter of ropes made of wire of different breaking strengths, for winding various loads from depths ranging from about 820 feet (250 metres) to 4,920 feet (1,500 metres), with a nine-fold initial margin of safety, and giving the margin of safety in winding men when the margin has decreased to six-fold for winding coal. Recommendations are also given for preserving the rope while in use, greasing being advocated in preference to galvanizing—since the zinc coating is liable to

abrasion, and also to corrosion by acid pit-water, whilst hot galvanizing lessens the tensile strength and suppleness of the rope. The grease should be free from acid, and applied in a melted state at frequent intervals (1 to 4 weeks). Every 3 months the rope should be shortened by about 6 ½ feet (2 metres) at each end, for the purpose of removing the weakened portions and shifting the part most subjected to strain at the head pulley. Spare ropes should be preferably stored on the bobbins supplied by the makers, and not hung up, being thereby less exposed to rust.

C. S.

Flat Manila-fibre Winding-ropes for Great Depths.—Anon. Soc. Ing. Civ. France: Resume de Quinzaine, 1910, pages 425-426.

Besides round ropes of steel and iron wire, the Societe Anonyme des Filatures, Corderies et Tissages d'Angers makes, with mathematical precision, flat Manila-fibre ropes weighing up to 50 pounds per yard (25 kilogrammes per metre) and sometimes 3,937 feet (1,200 metres) long. The dynamometric resistance to tensile strain is shown by a 100-ton testing machine to exceed 9,955 pounds per square inch (700 kilogrammes per square centimetre).

J. W. P.

Experiments and Improvements in Mine Work in Prussia in 1909.—Anon. Zeitschr. f. Berg-, Hutt.- u. Salinenw., 1910, vol. lviii., pages 83-140.

As the title implies, this is a review of the new appliances and methods brought forth by the past year. Worthy of notice among these are: —

A Substitute for Blasting.—In the Scharnhorst and Preussen I. Pits in the Dortmund district, a system of moistening the coal to be worked has given good results. A hole 10 feet long is bored in four lengths of successively decreased diameter. A tube, with slightly conical rims soldered to each of its ends, is driven in, so that it fits tightly at each end. Water under pressure is then introduced and made to penetrate the coal for from half an hour to 2 hours, according to the nature of the latter. The coal is now wedged down. In one seam, at a depth of 40 feet, one such bore-hole enables from 40 to 50 tons to be won. The costs by this method here come to about one-quarter of those with ordinary blasting, the wages per ton being from 15 to 17 per cent. lower. No coal-dust is developed.

Concrete Lining for Pit-shafts.—In the Zweckel Shaft of the Gladbeck division of the West Recklinghausen district, a new method of lining pit-shafts

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with concrete is applied. In place of the old method of an iron or wooden casing with concrete rammed in behind it, concrete blocks with groove and feather joints, laid in a ring 19 feet 8 inches in diameter, are employed. These are 12 inches high by 3 1/8 inches thick, there being twenty-four of them in each ring. Two tiers of iron rods to each ring, laid parallel with the inner perimeter, are fitted with two ends projecting from each block into the concrete filling behind, and there connected with concentric iron rings, so that blocks and filling are thus held together. The filling, in a mixture of 1 to 4, is rammed in after each two successive rings are in place. The wall can be 30 per cent. thinner than one made of brickwork; it is less permeable by water, and, owing to its smoothness, offers less resistance to the passage of the air-current than a brick wall. It can also be more rapidly constructed than the masonry work.

Iron Pit-props.—An iron pit-prop which has been tried in the König Pit (Saarbrücken) is of a novel character, and may prove valuable where severe earth-pressure renders necessary a certain elasticity in the supports, although it is not yet a practical success. Two Mannesmann tubes are fitted one within the other in telescopic fashion, the inner one at the top of the extended prop being filled with a coarse-grained material which can run through a hole in its end plug into the outer one below. The plug is so shaped as to form a non-return valve, so that the material, after passing down through it, cannot be squeezed up again. The prop being adjusted to the required height and its filling-material allowed to run down, it can be further compressed only by means of a relieving appliance at its foot, a turn of the key of which allows material to run out through an opening. The prop was found to stand pressure exceedingly well; but, when the latter became severe, the relieving appliance has hitherto shown liability to jam. It remains to be seen whether the adoption of another kind of filling will remove this drawback.

A. R. L.

Concrete and Reinforced Concrete in Upper Silesian Mines.—By —. Staudinger. Zeitschr. f. Berg-, Hutt.- u. Salinenw., 1910, vol. lviii., pages 249-275^

In the Upper Silesian district, reinforced concrete was first used in 1898 for the lining of shafts, in which its strength and cheapness were clearly demonstrated. A year later it was used in the form of thick cement plasterings and general lining work. In walling of all kinds in the district it now holds its own with brickwork. The reinforced concrete is in general made by workmen belonging to the collieries. It has shown itself superior to ordinary masonry in resisting pressure, but inferior to it in keeping out water.

The concrete linings are made behind temporary boardings of 2-inch timber, with vertical supports consisting of props or old rails. The boardings can be removed about 48 hours after the completion of the lining. The linings vary from 12 to 20 inches in thickness, according to the quality of the concrete. They are made thicker than is thought necessary, on account of the limited experience as yet gathered with the material.

The author discusses the employment of concrete in mines in its different aspects, referring to methods of production, applications, influence in accelerating work, cost, etc., and shows where it may be used with advantage. A tabulated list is given of works actually carried out, illustrated by small sketches, with dimensions.

A. R. L.

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Use of Reinforced Concrete for Lining: Bore-holes.—By M. Foerster. Zeitschr. f. Berg-, Hutt.- u. Salinenw., 1910, vol. lviii., pages 381-385.

A number of experiments have been made by Dr. von Emperger, of Vienna, in the laboratory of the Technical College of that city. It was found that only irregular pressures of the earth tending to flatten the bore-hole tubes were to be feared; and that, in consequence, a lining was required which was well able to withstand compression at its outer surface and tension at its inner surface.

The objects experimented upon were as follows:—(I. and I.a) Single Mannesmann tubes; (II.) double tubes filled with cement-mortar (put in in a fluid condition); (III. 3 and 4) iron tubes covered with concrete and spiral iron armouring 1 ¼ (30 millimetres) and 1 ¾ inches (45 millimetres) thick respectively; and (IV. 5 to 8) inner strengthening with reinforced concrete and different thicknesses of armouring.

The results of experiments are given below: —

	Tons.	Kilogrammes.
(I.)	5 to 7.5	5,000 to 7,500
(.a)	6 to 7.5	6,000 to 8,300
(II.)	15.0	15,000
(III.) 3	30.5	30,500
„ 4	41.5	41,500
(IV.) 5	10.9	10,900
„ 6	20.0	20,000
„ 7	40.0	40,000
„ 8	42.6	42,600

Numbers 5 and 6 were lined by hand, and numbers 7 and 8 by centrifugal machinery, by which the concrete material was pressed against the iron and homogeneously and evenly distributed.

A. R. L.

Hydraulic-packing: Appliances at the Consolidation Colliery, No. I.-VI. Shaft.—By —. Schafer. Gluckauf, 1910, vol. xlvi., pages 1440-1444.

The chief feature of the system is the employment of wire-netting, in place of the usual brattice-cloth, for keeping the packing in place laterally, and allowing the water to drain through. The netting is of galvanized-iron wire, with 3/8-inch (9-millimetre) mesh. The lowermost portion of the goaf in each section is packed by hand, in order to ensure partial clarification of the water on the spot. The packing dries so quickly that the wire-netting, with its supporting timbers, can be removed on the following day. To protect the bends in the wrought-iron pipes from premature abrasion by the packing material, they are fitted with wrought-iron liners of suitable diameter, bent to the proper curvature, and cut into short pieces 4 to 8 inches (10 to 20 centimetres) long, each of which is wrapped in wire-netting and coated with cement-mortar before insertion. Worn places in the straight lengths are patched with sheet-iron, lapped with wire, the entire pipe being then wrapped with thin wire-netting and coated with concrete, about 2 ¼ to 2 ¾ inches (60 to 70 millimetres) thick. In point of economy, it is calculated that the actual cost of hydraulic packing is a fraction under 3d. (23 pfennigs) per ton of coal higher than that of hand-packing; but when the proportion of haulage expenses, etc., chargeable to the latter system is taken into consideration, together with the saving in manual labour and the increased protection against surface subsidence, the advantage is regarded as largely in favour of hydraulic packing.

C. S.

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Prevention of Irruptions of Quicksand and Water in the Margaretha Pit at Espenhain, Silesia.—By —. Niess. Zeitschr. f. Berg-, Hutt.- u. Salinenw., 1910, vol. lviii., pages 173-180.

In this pit a seam of lignite about 30 feet thick, covered in succession by slate, slaty quicksand, gravel, sandy slate, and various varieties of sand and slate, was liable at intervals to sudden outbursts of mud and water into the workings. It appeared that smaller roof-falls first lowered the level of the sand-layers at a height of about 70 feet above the workings. A space, here formed, then gradually filled with water. The slate seam above, which at first stood its ground, after a time fell in, and its weight, added to that of the water, gradually overcame the resistance of the intervening strata, till a crash on a large scale into

the workings resulted. The water then ran off, and the workings were safe until a similar development gradually brought about another irruption.

The method of encountering the evil finally adopted was that of regulating the subsidences by tapping off the mud and water from above into open spaces in the working-level by boring up from the latter. The spaces were walled or partitioned off, and after the irruption of roof-material into them had been artificially brought about, the water was allowed to run off. After the introduction of this system, violent unexpected irruptions into the workings ceased to occur.

A. R. L.

Mining Subsidence at Raibl, Bohemia.—[Official]. Oesterr. Zeitschr. f. Berg- u. Hutt., 1910, vol. lviii, page 31.

A mining accident of a singular kind, in which seven people were killed, occurred at Raibl (Bohemia). Without warning, the ground suddenly gave way under a small municipal hospital, and the building sank, into the cavity this formed, to a depth of about 40 feet. The depression was immediately filled with water from a stream a few yards distant.

The catastrophe was the result of operations at a lead-mine in the vicinity, and an inrush of water, slime, and pebbles took place. Two short galleries, 12 feet long, had been driven one above the other through the rock into the water-bearing strata. The intention was to tap the water for use above ground, to run it into a reservoir (the construction of which had already been begun), and pump it thence to the surface. The work was carried on by blasting and electric drills. About 80 feet below the surface, and the same distance from the new depression, the waste-heap of an old working was laid bare. To avoid the danger of a sudden inrush of water, the drill was worked 6 feet in advance of the excavations, and the water flowing in through these forward conduits had increased from 11 to 130 gallons per minute. Two dynamite blasting charges seem then to have caused the roof to fall in, carrying with it the ground above, and destroying the house.

E. M. D.

On the Sulphur contained in Fuels.—By Rudolf Schaefer. Zeitschr. f. Berg-, Hutt- u. Salinenw., 1910, vol. lviii., pages 281-296.

The author shows that sulphur is present in greater or less degree, and in forms that are in part detrimental and combustible and in part harmless and incombustible, in all fuels. He proposes that fuels should be classed and judged in relation to their percentages of combustible sulphur, and that where the presence of a large percentage of sulphur dioxide in the products of

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combustion can be shown to be of considerable detriment to the neighbourhood in general, the employment of fuels rich in combustible sulphur should be forbidden.

A. R. L.

Nitrogen extracted from Coal and from the Atmosphere.—By Ed. Lamy. Soc. Ing. Civ. France: Resume de Quinzaine, 1910, pages 395-398.

The world's consumption of nitrate last year was about 2,000,000 tons; and fortunately the large deposits of this substance may suffice for the requirements of industry and agriculture during a century or two. Coal contains from 1 to 2 per cent. of nitrogen, part of which is

recovered in the form of ammonia by distillation in coke-ovens or gas-retorts. This is a very valuable source of nitrogen, but it will become insufficient when natural nitrate fails.

Experts have therefore turned their attention to the atmosphere, and, thanks to electricity, have succeeded in extracting nitrogen in a form that can be utilized, the new compounds being cyanamide, or nitrated lime, nitric acid, and the nitrates. Cyanamide, which contains carbon, nitrogen and lime, is obtained by passing pure dry nitrogen over calcium carbide, raised to a high temperature in the electric furnace, the nitrogen content varying between 15 and 20.

Inasmuch as electric power plays a preponderating part in the production of nitrated compounds, it must be obtained in large quantity at low cost, so that recourse has been had to water power; and the Norwegian Nitrate Company have put up works at Nolodden, with the Birkeland electric furnace, which is remarkably stable and can work a whole year without great expense for maintenance and repairs.

J. W. P.

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#### MECHANICAL ENGINEERING, ELECTRICITY IN MINES, Etc.

Conditions for the Establishment of Large Generating-stations.—By G. Chevrier. Mem. & Trav. Soc. Ing. Civ. France, 1909, vol. i., series 6, pages 622-656.

The dominant factor in large central stations is the capacity to generate current so as to keep pace with requirements, for the electric accumulator is out of the question. Accordingly, the working must be kept as constant as possible, and every precaution must be taken to avoid accidental stoppage, with provision of means for minimizing the consequences of such an eventuality. The second condition is naturally economy of production, which is not incompatible with security (trustworthiness) of working; and the slightly increased cost of plant necessary to secure the latter is negligible in comparison with the expense entailed by breakdown and stoppage.

There is now increasing tendency towards uniformity of installations, at any rate in their main features, the chief characteristic of which is determined by a consideration of the large area occupied by steam-boilers as compared with the amount of motive power required. This leads to arranging the boilers at right-angles to the main centre-line of the engine-house, instead of parallel with it, as formerly, before the use of turbo-motors, which have now become general. This arrangement of "boiler streets" (rues de chauffe)—so called from the circumstance that boilers of the same set or boiler-house are placed opposite one another like houses in the same street— is now generally adopted, and permits of realizing, under the most rational conditions—(1) progressive extension of the station by the addition of similar groups; (2) the division into perfectly independent sections (a great

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advantage, especially in stations for lighting); (3) the "loop" (boucle) of steam and feed-water pipes, thus avoiding interruption of the circuit in the event of a breakdown; and (4) rational grouping of all the services for one and the same set of boilers.

The logical arrangement of the rest of the installation, as determined by this first disposition, consists in surrounding (as a frame) the boiler-house by (a) the engine-room and (b) the coal "silos," while the switchboard and its accessories will be placed by preference on the long side of the engine-room farthest from the boilers. In this manner the three chief services—steam-raising, power-production, and electricity-generation—will be localized in a manner

susceptible of but little variation. Between these main features and selection of the plant there intervene a few questions of general character that deserve the greatest attention, foremost among them being (1) arrangements for permanently ensuring the best possible utilization of the electric generators and (2) the auxiliary appliances.

On the first of these depends to a great extent the economical working of the plant; and in this connexion there is a radical difference between the two extreme types—the station for lighting and that for traction. Generally speaking, the differentiating factor will be the degree of interdependence between the elements that concur in producing the total current; and this dependence may be complete in the latter case, while for lighting there is the greatest advantage in subdividing the total power.

The auxiliaries, which are of vital importance, may be classed under four heads, according to the degree of influence that they may exert on continuous working or eventual stoppage, namely:—(1) Those the slightest failure or stoppage of which instantly compromises the working of a group or suppresses its participation in the general service; (2) those with somewhat less urgency as regards the immediate danger of accident; (3) those that can sustain a short stoppage; and (4) those the working of which may be suspended for a far longer period. Former errors led to the rule of having at the station no other steam-engine than the motors of the main generators; but this is too absolute, and has the defect of subjecting all the auxiliaries to maintenance of the voltage at the terminals. The solution now generally adopted, which may be regarded as satisfactory from the standpoint of both security and economy, is to transform the energy at the terminals into continuous current, either by commutators with transformers, or (more usually) by generator-motors, which permits of having, at the poles of the continuous-current circuit, a battery of accumulators, always ready to take the place of the generator automatically. In the author's opinion it is best to restrict this arrangement to cases where it may be absolutely necessary. He considers the best solution to consist in only applying the accumulator arrangement to the second of the above-mentioned classes of auxiliaries, and in only subjecting to each turbo-motor its own excitation and condensation.

J. W. P.

Direct Utilization of Coke-oven Gas.—By E. Cuvalette. *Mem. & Trav. Soc. Ing. Civ. France*, 1909, vol. i., series 6, pages 173-214 and 214-222.

(1) Numerous tests at the Lens Collieries, in the Pas-de-Calais, have shown 12 per cent. of surplus gas in coal containing 26 per cent. of volatile matter, 7 tons of which fuel yielded 1,148 cubic feet of purified gas having a density of 0.482. With richer coals, 20 and even 32 per cent. may be obtained; but, when the quantity of surplus gas is excessive, the quality of the coke is liable to suffer.

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After treatment for recovery of the bye-products, coke-oven gas still contains deleterious substances, and must be purified before being used in motors. Especially must there remain no more than traces of tar and sulphur. The greatest improvement in this respect made during the last few years is the addition of about 2 per cent. of air to the gas before it enters the purifiers, the active life of the purifying substance being greatly prolonged.

The features characterizing the use of coke-oven gas in explosion-motors are its composition, and especially its richness in hydrogen, which causes premature or tardy ignition. Accordingly, no gas must be used that is not thoroughly purified; the cylinders and

chambers must be kept perfectly clean, and care of the motors should be entrusted only to men capable of regulating the gaseous mixtures and their ignition.

In current working the kilowatt-hour is obtained with 35.3 cubic feet if the gas be utilized in a motor, or with 79 cubic feet if used for firing boilers supplying turbines. If the plant costs £14 per kilowatt in the former case and £8 in the latter, being liquidated in 8 or in 12 years, the respective charges for interest at 5 per cent. and amortization will amount to 28s. 4d. and 17s. 7d. respectively.

With a utilization of 3,600 hours yearly—a low estimate for a colliery having important night services—the interest and amortization charges for the kilowatt-hour will come out at 0.098d. with the engine and 0.062d. with the turbine, still leaving a difference of about 0.075d. in favour of the gas-motor, an amount more than sufficient to compensate for all increase of direct expense in producing power.

In fine, the cost of the kilowatt is approximately the same in both cases; but the reciprocating motor has the advantage of permitting, with the same volume of gas, the production of more than double the power—an advantage which is considerable when the utilization is high.

(2) At the workshops of Lens No. 8 Pit, a 20-horsepower Letombe gas-engine was set to drive by belts a set of pumps; but, working with gas taken directly from a bye-product recovery-plant—that is, with insufficient tar and sulphur-elimination—it failed to afford regularity of service. Re-erected to work with purified gas, and to drive a dynamo for lighting, the same engine gave satisfactory results.

For affording precise information as to what might be got out of direct utilization, a 500-horsepower engine of the Societe Francaise de Constructions Mecaniques (Cail), was coupled directly with a Westinghouse 5,000-volt three-phase alternator, working with the surplus gas of 140 ordinary Lens-type ovens, purified and stored in a holder. The guaranteed consumption of gas at 450 British thermal units per cubic foot (4,000 calories per cubic metre) is 22 cubic feet per effective horsepower-hour with the full load, 25 ½ with three-quarter, and 29 ½ with half load.

At the Rivage (quay) works the surplus gas of 140 Koppers regenerative ovens, with recovery and purifying plants, is utilized in six 1,200-horsepower Augsburg-Nurnberg double-acting motors, making 107 revolutions per minute, with compressed-air starting arrangement, electric ignition, and a water-pump for cooling the pistons and their rods. On the main shaft are keyed a 25-ton flywheel and the rotor of a 940 kilo-volt-ampere Westinghouse three-phase alternator. The mean calorific power of the gas is 420 British thermal units per cubic foot (from 3,500 to 4,000 calories per cubic metre).

The consumption is guaranteed not to exceed 7,936 British thermal units (2,000 calories), without taking into consideration the latent heat of the vaporization of the water formed by the combustion, per indicated horsepower-

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hour with the full load. The consumption with half load is 10,316 British thermal units (2,600 calories) and with quarter load 13,094 (3,300 calories). The efficiency of the motors is 83 per cent.

J. W. P.

Advantages of Balanced Draught for Boiler and other Firing.—By Serge Heryngfet. Mem. & Trav. Soc. Ing. Civ. France, 1910, vol. ii., series 6, pages 288-290.

The principle of "balanced draught" (*tirage equilibre*) is to regulate automatically the admission of air to the grate in accordance with the steam requirements at the dome, while at the same time regulating the opening of the damper that closes the off-take leading the gases to the chimney, so as to maintain a uniform pressure, about equal to that of the atmosphere, at the entrance to the combustion-chamber. With this arrangement the vaporizing power is increased, owing to the fact that the gases of combustion, circulating in the passages with less velocity, remain longer in contact with the heating surface and completely lave all its parts. The entrance of cold air by chinks in the setting is partly avoided, owing to the diminution of pressure in the passages being very slight. The entrance of air by the furnace-door, when opened, is avoided, because atmospheric pressure is maintained thereat. Smoke is greatly diminished, and air-excess is reduced to a minimum—whence follows reduction in the quantity of the combustion-gases, with increase of their temperature and carbon-dioxide content.

A fan, driven by a small steam-engine, forces air under the grate-bars, the speed being regulated, by means of a special valve in the steam-pipe, between the maximum, when the steam-pressure is slightly below the normal, and the minimum, when it exceeds the normal. At the same time, the damper is shifted by a small hydraulic piston, controlled by a bell dipping in water and in communication with the furnace gases, so as to rise and fall in accordance with their pressure. The regulation is such that the damper is always open to the extent necessary for maintaining atmospheric pressure in the furnace.

Coke-dust cannot be burnt with natural draught; but at the Hotchkiss works, Saint-Denis (Seine), four parts of coke-dust with one of Lievin unscreened coal, costing a little over 11s. per ton, are burnt with balanced draught under a Roser boiler of 861 square feet heating-surface, giving a ton of steam for 2s. (Fr. 2.273) against 2s. 10d. (Fr. 3.507) with the same coal alone and natural draught, thus effecting an economy of more than 35 per cent.

J. W. P.

Check on Boiler-furnace Working by the Gases of Combustion.—Anon. *Electro*, 1910, vol. ix., pages 84-86.

The surest method for keeping a check upon the working of boiler and other furnaces consists in verifying the combustion-gases as regards their carbonic-acid content, continuous analysis being necessary for making sure of an economical calorific power; and the stoker should have means for constantly ascertaining the useful effect of his fuel. If a greater quantity of air than that required for complete combustion be brought up to the fuel, a loss of heat will ensue, owing to air in excess having been needlessly raised to the temperature of the escaping gases; and, as carbon is a fuel's chief constituent, while its combination with the air's oxygen disengages carbonic acid, the latter's volumetric content in the chimney gases is so much greater as less air in excess is introduced into the furnace.

In practice, the bare quantity of air required for a fuel's combustion is,

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however, insufficient to ensure good working-; but the overplus should not, especially for steam-boilers, exceed 35 or 40 per cent. of the theoretical volume. There are no external distinctive marks to show whether sufficient air is admitted to a furnace or not; and the only means for being- constantly reassured on this point is to determine the carbonic-acid content of the gases. The Ados analysing and registering apparatus (described and illustrated)

determines automatically, at intervals of 5 to 10 minutes which may be regulated at will, the percentage of carbonic acid contained in the gases of combustion, and diagrammatically records the results on a paper band making one revolution in 24 hours, thus giving at a glance a general idea of the furnace-working and the useful effect of the fuel consumed. The apparatus, which may be placed at any distance from the furnace—in the manager's office, for instance—is actuated either by the chimney draught or by water power.

J. W. P.

Progress in Gas-motor Construction.—By R. E. Mathot. Mem. & Trav. Soc. Ing. Civ. France, 1909, vol. i., series 6, pages 1-46.

Gas-motors are chiefly reproached with want of elasticity and regularity, while having indispensable parts that are delicate. It is true that the ignition-apparatus is delicate; but the gas-motor, unlike the steam-engine, is supplied for the power ordered, with perhaps a margin of 5 to 10 per cent.; and any desired regularity may be obtained by adding a flywheel of sufficient weight.

For single-acting motors of less than 150 to 175 horsepower, the most rational form would appear to be that approaching the German type, with independent casing, constituting a water-jacket, which forms part of the bedplate carrying the cylinder, being prolonged backwards for receiving the brackets of the lateral shaft.

Of the three chief methods of regulation—(1) by constant volume and gas-content, (2) by constant volume and variable gas-content, and (3) by constant gas-content and variable volume—the first is simple and economical; but it is not suitable for motors working with poor gas, nor for those of more than 25 horsepower working with service gas. The second is incompatible with high compressions; and the third has the author's preference, provided that it be carried out by a mechanism acting on the travel of the admission-valve for motors of less than 200 horsepower.

For the regulation of large motors, even the highest authorities are not agreed as to the best method; and several makers have abandoned a system that they formerly advocated. One maker has devised a method with variable gas-content and compression, while some firms have realized in their valve-gear a combination of admission variable in volume with mixture variable in gas-content. For such work as lifting appliances and the driving of roll-trains, it must be possible to vary the speed; and especially large motors coupled directly with blowing engines for blast-furnaces must be capable of varying in speed as 1 to 2. In such a case distribution with constant mixture and variable volume appears the most suitable, owing to its simplicity and better yield.

The arrangement most commonly adopted for actuating valves is that with a single shaft (parallel with the bedplate and taking its motion by gear from the main shaft), carrying the cams or eccentrics that deflect the valve-levers and also the governor-gear. The valves should have such dimensions that the mean gas speed shall not exceed, say, 100 feet per second, their diameters being

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calculated in accordance with the nature of the substance supplying the motor. The valves must be easily accessible for cleaning and grinding-in; and their spindles, made in one piece with the valve should be provided with lubricating tubes.

For lifting the valves of single-acting motors, levers with rollers are generally used, a cam acting on one end, and a strong spring bringing back the valve. For admission-valves, the lever has only to overcome the force of the spring; but for exhaust-valves it must also overcome the gas-pressure, which in large motors may be considerable.

The author concludes, from his considerations and the many trials that he has carried out on all types in Europe and America, that the gas-motor may now be considered as capable of advantageously replacing the steam-engine in many instances; but this is far from being the case with all the types now on the market.

Several modern motors (illustrated) are distinguished by great simplicity of mechanism, such as the single cam for controlling the distribution, regulation by variable quantity, and automatic lubrication, the bedplates being designed for maximum strength with minimum weight. These motors give good results as regards silent working, sensitiveness of regulation, high efficiency, and margin as regards power.

J. W. P.

Treatment of Boiler-water.—By A. L. McCallum. Journ. Min. Soc. Nova Scotia, 1910, vol. xv., pages 79-81.

The author points out that the only successful way of utilizing water which corrodes the boiler is to discover some means of preventing the corrosion from starting. He advocates the use of potassium bichromate and other substances which have the power of putting iron into what is called the "passive" state, in which condition it is not readily acted upon by reagents which under ordinary conditions would readily dissolve the iron. The water experimented with was ordinary lake water, containing 2.8 grains of solids (of which over 60 per cent. was organic matter) per gallon. Water treated in this way, after having been used for a year, has given rise to no trouble in the boiler. The old tubes were first removed, and new tubes fitted in the boiler, and at the end of a year were as good as when first put in, no pitting having taken place. The bichromate is simply dissolved in water, and put into the boiler in any convenient way.

A. P. A. S.

Centrifugal Pumps, Air-compressors, and Steam-turbines.—By Jean Rey. Mem. & Trav. Soc. Ing. Civ. France, 1910, vol. ii., series 6, pages 221-223.

As regards the construction of multicellular centrifugal pumps, the increased efficiency and specific utilization permit of obtaining considerable heights of lift at the usual speeds of electric motors. Not only have the new types higher efficiency than those of a few years ago, but the curve of work on the shaft, in a function of the volume delivered, is far more favourable.

The latest types of multicellular air-compressors not only permit of obtaining higher efficiencies, but also suppress "pumpage" with slight volumes, thus greatly increasing the economic yield. The work on the shaft also shows a more favourable curve, suppressing the disadvantages revealed by former curves for electric driving. Flexible shafts should not be employed, for they do not ensure security of working. The improvement made in the design and

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construction of the wheels and diffusers now permits, with rigid shafts, of getting out compressors which have less bulk and weight, divided into a small number of bodies, and may be driven by a single shaft.

The multicellular system is being continually more and more employed for steam-turbines, good specimens of which may be made with a small number of wheels; and the expansion of steam from high pressure to that of the atmosphere may be effected with one or two wheels only, without detriment to the efficiency, while the use of superheated steam is greatly facilitated.

A mixed steam-turbine, driving an air-compressor at the Roche-la-Moliere and Firminy collieries, which is relatively simple and affords a complete solution of the problem, is supplied by a steam-accumulator on the low-pressure side, and may simultaneously or separately receive live steam on the high-pressure side, so as always to maintain a constant pressure.

J. W. P.

Motive-power Evolution in Belgium.—By B. Vincotte. Report to the Belgian Boiler Association, 1909, pages 22-37.

For several years past there has been a tendency to improve the arrangements for producing motive power by the adoption of higher pressures, and in many cases superheating, as also electric driving. In collieries and rolling-mills especially, central stations permit of substituting electric motors for a multiplicity of small engines consuming a great deal of steam.

Steam-turbines are becoming constantly more general. Of the thirty now owned by members of the Association, including eleven of 1,500 kilowatts or over, and twelve of 1,000 to 1,500 kilowatts, twenty-four have been running long enough to afford subject for comparison. The (tabulated) results of trials, show that, if for small powers the steam-engine is appreciably more economical than the turbine, for powers between 1,500 and 2,000 kilowatts this difference, which always remains in favour of the steam-engine, becomes sufficiently slight to be compensated by the other advantages of the turbine. For 146,500 hours of running, there was stoppage for repairs of 2,784 hours, or 1.9 per cent., due to the turbine alone, which is comparable with the figures given by reciprocating engines.

The following table gives the results of trials with modern steam winding-engines, the first two non-condensing and the third with central condensation:

Duration of trial	6 hours.	6 hours.	7 ¾ hours.
Depth of winding, in feet	1,570	902	2,772
Total number of lifts	129	180	147
Total load raised, in tons	281 ¼	433	626 ¾
Consumption of steam per horsepower for load raised, in pounds	49	52 ½	38 ½

On the first of these engines a 24-hour trial showed that the total consumption, including the steam condensed in the pipes and that expended for letting down men, timber, etc., was 74 pounds per horsepower in load raised, but only comprising the weight of coal and rock. It would be difficult to attain these figures with the electric winder, which, however, is gaining ground at collieries.

Trials made on steam-engines which have been running some years show an appreciably increased consumption, due to defects that are almost always easy to rectify; but engines properly kept up do not show a consumption increasing with age.

J. W. P.

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Comparison of Turbo-machines with Reciprocating Appliances.—By A. Barbezat. Mem. d-Trav. Soc. Ing. Civ. France, 1910, vol. ii., series 6, pages 217-221.

Pumps.—The distinguishing feature of the Barbezat centrifugal pump is that the diaphragms separating the different wheels are made individually and fixed to the common casing, so that the pump body becomes very simple, and may be cast in one piece, of steel or iron, according to the height of lift. This permits of cleaning the inside quickly and easily, and it also, as the surface is polished, reduces greatly friction of the flow. The axial thrust of each wheel is balanced, and the whole revolving portion is also provided with an automatic equilibrator, so that the pressure on the packing at the delivery side is appreciably diminished.

A pump at the Arbre Saint-Michel Collieries, making 1,480 revolutions per minute and raising 26,400 gallons per hour to a height of 722 feet, has an efficiency of 73 per cent. Trials of fifteen other pumps, having efficiencies varying with the volume and height of lift, show that, as regards cost of maintenance and sinking fund, they are quite indicated for considerable volumes and pressures, but that for slight volumes and pressures reciprocating pumps are to be preferred, the limits being recorded in a table.

Air-compressors.—The 400-horsepower Rateau compressor which served for the trials of the Barbezat petroleum-turbine, has twenty-five wheels, distributed among three bodies, which are water-jacketed, so that the temperature of the air is not raised more than 120° Fahr., the water-consumption being about 3 quarts (34 litres) per second. At the normal speed of 4,250 revolutions per minute 39 cubic feet (1.1 cubic metres) are compressed to 73½ pounds per square inch above atmospheric pressure. The characteristic curves warrant the deduction that the efficiency with respect to the actual compression is 70 per cent., and with respect to the ideal isothermic compression, 62 per cent., these figures being scarcely lowered when the volume delivered varies between two-thirds and three-fourths of the normal. The 65 and 68 per cent. efficiency of turbo-compressors, obtained by comparing the work theoretically necessary for an isothermic compression with that actually absorbed by the compressor, are not inferior to those of piston-compressors; and under some conditions their efficiency is superior.

Steam-turbines.—The Barbezat steam-turbine is characterized by the combination of a Laval action-wheel and a Parsons reaction-drum, the steam being received by the former between boiler-pressure and that of 44 pounds per square inch, and by the latter between the last-named pressure and the condenser-vacuum. The vanes are fixed to the discs by self-welding, the metal being brought up in a molten state—a method that is less expensive for a given strength; and the pitch of the vanes may be as slight as desired without greatly increasing the cost of the wheel.

A 650-horsepower engine, making 3,000 revolutions per minute and utilizing steam at 570° Fahr., with a vacuum of 92 per cent., consumed only 13 pounds of steam per brake-horsepower, corresponding with a thermo-dynamic yield of 58 per cent., although the construction of this, the first turbine of the type, is not perfect. Above 500 to 1,000 horsepower, steam-turbines are as economical of steam as are reciprocating engines; but below such power the latter have the advantage.

J. W. P.

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Electric Lifting Appliances.—By G. Dehenne. Mem. da Trav. Soc. Ing. Civ. France, 1910, vol. ii., series 6, pages 159-163.

This subject is a very big one, even if only two classes of electric appliances—lifts and winding-engines—be taken into consideration; and specially noteworthy is the electric winding-engine supplied to the Bethune Colliery by the Societe Alsacienne de Construction. In 1873, the late Hippolyte Fontaine showed that dynamo-electric machines might be reversed; and, in 1876, the first application of electricity was made to a lifting appliance.

The author divides the lifting appliances that may be actuated electrically into three classes—(1) those in which the load moves in a single direction (vertical or inclined), as is the case with lifts, winding-engines, haulage-inclines, and bucket-chains; (2) those in which it partakes of two motions (one vertical and the other radial), as with ordinary cranes; and (3) those in which there are three motions (vertical, longitudinal, and transverse), as with traversers and overhead travellers. There is a marked tendency to replace chains by wire ropes, owing to the improved manufacture of the latter and the progressive increase in the weight of loads raised.

The switching apparatus indispensable for every adaptation of electromotors to appliances to be driven, which is greatly tending to unification and simplification, may be divided into two main classes—"combinators" and "contactors," the latter having originated in the controllers of electric tram-cars. The combinations for the progressive starting, speed-regulation, and optional electric braking of the motors are obtained by means of metallic rubbing-contacts, arranged on a cylindrical surface with a spindle carrying a handle; and the connections of the apparatus with the line, the electromotor, and the regulating rheostat terminate in contact-pieces, fixed parallel with the cylinder axis. By passing the rubbing-contacts over flexible plates connected with the fixed contact-pieces, the most varied requirements may be obtained.

Contactors establish the continuity of the circuits by simple juxtaposition of movable against fixed contacts, either directly by a hand-lever, or by means of an electro-magnet excited from a distance, in which latter case they are termed "magnetic-relay contactors" (contacteurs a relais magnetiques).

J. W. P.

Quarrying: with the Aid of Electricity.—Anon. Bulletin des Ateliers de Constructions Electriques de Charleroi, 1909, pages 239-255.

The porphyries of Quenast and Lessines constitute the two principal outcrops of the eruptive rocks in Belgium. According to Alphonse Renard and Lavallee-Poussin, they were formed at a temperature of 585° Fahr. (307° Cent.) and under a pressure of 87 atmospheres. Their composition and mode of consolidation produces a hard, compact rock, remarkably tenacious, with practically flat fracture, highly esteemed for paving, road-metalling, ballasting, and concreting. The rock, which is covered only by a variable thickness of clay, is got by blasting. The shot-holes, of decreasing diameter, are drilled by hand, a hole 16 feet deep occupying two men for a 10-hour day if vertical, and half as much again if horizontal. The charge consists of about 16 pounds (5 to 10 kilogrammes) of fine-grained blasting-powder, over a dynamite cartridge with fulminate capsule partially inserted in the dynamite. If sunk completely, mis-fire or incomplete detonation might ensue. The only excuse for the dynamite, which alone would shatter the rock without bringing it down, is that it increases the action of the powder.

Getting and conveying the rock has until lately been effected in the most primitive manner, which has restricted the depth of working to about 280 feet; but the introduction of electricity into the working of two quarries at Lessines has given such favourable results (although the schemes have only as yet been partly carried out) as to show that economical working can be carried to great depth; that there is better utilization of power, especially for the extraction, and better yield of the stone-breakers, with less encumberment; that mechanical rock-drilling may be employed to advantage, with reduction of the labour for forming the setts; that electric locomotives may be employed to advantage; that by the use of electric excavators the rock may be worked economically under a cover of 90 feet (25 to 30 metres), with diminished cost of working and increased out-turn.

Carrieres Emile Notte.—A fully steam-jacketed compound Pierson-Corliss engine of 350 electric horsepower at 125 revolutions is coupled directly with a three-phase alternator with revolving inductor, which can give out 300 kilo-volt-amperes at 550 volts with a frequency of 50 periods per second, and the exciter, which also maintains 30 incandescent lamps. This plant is sufficiently strong and stable to stand the shocks of the hauling-engine and stone-breaker motors, which, however, are coupled so as to give the greatest amount of elasticity possible; and the spur-gear is encased. The metal head-gear is firmly bedded in the rock. Working is now effected at three different levels. At the 280 feet (85 metres) level the winder and its motor show an efficiency of 64.5 per cent.; and a ton is got out with the expenditure of 0.34 kilowatt-hour.

Nouvelles Carrieres de Lessines.—The generating plant comprises a Winterthur aspiration gas-producer of new type, specially designed for utilizing anthracitic coals and avoiding difficulties due to variation of sample, and a 250-horsepower Winterthur duplex gas-engine for uniform explosive mixture and admission variable by the governor, directly driving a three-phase alternator, with inductor revolving outside the armature, capable of giving out 200 kilo-volt-amperes at 550 volts. As working is not yet carried very deep, most of the power is at present absorbed by a stone-breaker capable of turning out 30 tons per hour, belt-driven, without intermediate shaft, by a 58-horse-power three-phase motor. A similar motor of 28 horsepower drives the sizing drum; and the power required to break and size a ton of stone does not amount to 1.1 kilowatt-hour. The electric hauling-engine for the incline that supplies the stone-breaker is fitted with an electro-magnetic strap-brake, that goes on of itself if the current should fail, and it can also be put on at any time while the wagon is running down empty without motor.

J. W. P.

New Ore-crushing Mill with Suspended Rollers.—By C. von Ernst. Oesterr. Zeitschr. f. Berg- u. Hutt., 1910, vol. lviii., pages 54-56.

The Sanna system of ore-crushing is suitable for fine and medium ores. The plant consists of two rollers mounted in stirrups, each having two arms, which are connected by set-screws to the driving shaft; the latter is movable between the arms. The rollers hang suspended from the shaft, and, according to the nature and size of the ore to be crushed, can be spaced apart, or brought close together, by means of springs and pins. They are driven by pulley-belts from the shaft, and can be turned freely at any angle. If set at an angle of 30 degrees from the perpendicular, half the weight of the machinery comes upon the ore to be crushed.

A saving in time of 20 per cent. is claimed for this mill. Two rolling-mills

were tested, each measuring  $25 \frac{1}{2}$  by  $13 \frac{3}{4}$  inches; speed, 72 revolutions per minute. Both were fed with the same quantities of mixed limestone and calamine ( $\frac{3}{16}$ -to- $\frac{11}{16}$  inch in size), and delivered  $2 \frac{1}{2}$  tons of crushed ore per hour. With an expenditure of 6 horsepower, the ordinary rollers yielded 29 per cent. of  $\frac{1}{16}$ -to- $\frac{1}{8}$ -inch ore, and the new type 41 per cent. of ore of the same fineness, with an expenditure of 4 to 5 horsepower. When fed with  $\frac{1}{8}$ -to- $\frac{3}{16}$ -inch ore, the new roller, developing 4 horsepower delivered  $2 \frac{1}{2}$  tons of ore per hour, 93 per cent. of which was less than  $\frac{1}{16}$  inch in grain. E. M. D.

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ADMINISTRATION AND STATISTICS.

Economical Advantage of Large Railway Wagons.—Mem. & Trav. Soc. Ing. Civ. France, 1910, vol. ii., series 6, pages 87-124.

No further reduction in railway-carriage rates can be hoped for, unless working expenses be reduced; and large wagons—of 20, 40, and even 60 tons capacity—afford means to this end, especially for substances of comparatively slight value in proportion to their weight. The saving which they effect is abundantly shown by the following example, which is quite a usual case.

A coal-train of 800 tons gross weight is hauled from the mine to its destination, a distance of 155 miles (250 kilometres), the wagons being returned empty. If the coal be loaded into fifteen 40-ton wagons taring 15 tons, instead of into fifty 10-ton wagons taring 6 tons, the net load will be 600 instead of 500 tons, and the train of returned empties will weigh 225 instead of 300 tons. With the fifty small wagons the journey out will give 200,000 and that homeward 75,000 ton-kilometres, against  $(206,250 + 56,250 = 262,500)$  ton-kilometres for the fifteen large wagons. The latter, therefore, after having carried 100 tons more (paying) coal, save 7,766 ton-miles  $(275,000 - 262,500 = 12,500)$  ton-kilometres) haulage.

Taking  $\frac{1}{4}$  d. ( $2 \frac{1}{2}$  centimes) as the mean carriage-rate per ton-kilometre for the distance in question, the large wagons will have earned £150 against £125. This shows a receipt of  $1.4 - 1.1 = 0.3$  centime per ton-kilometre, earned by the large as compared with the small wagons, due to diminution of the deadweight, corresponding with £2,000 (50,000 fr.) for the carriage of 100,000 tons.

There are also other advantages in favour of large wagons. A train made up of them will be 45 per cent. shorter than the other, with corresponding diminution in the length of sidings required at the mine and at destination. Again, with the shorter train, audible and visible signals are better perceived; there is less danger in shunting and coupling, besides saving of time in sorting wagons and making up a train, less encumbrance by the rolling-stock, more rapid loading and unloading, and fewer brakemen to pay.

The Fox system of pressed-out steel plates and parts, fitting into one another, produces a strong and light wagon which, mounted on two four-wheeled bogies, runs easily round curves, and permits of higher speeds than do ordinary wagons. J. W. P.

Growth of Coal-mining in Belgium.—Graphic Diagrams, showing the Increase and Fluctuations of Coal-output, etc., between 1830 and 1908, contributed by the Belgian Mine Administration to the Brussels International Exhibition of 1910.

The annual output increased with great regularity from 3,000,000 tons in 1831 to 25,000,000 in 1908, the greatest falling off having occurred between 1872 and 1878. The annual coal-consumption per inhabitant rose from half a

ton in 1831 to 3 tons in 1908. The cost of getting a ton—which was 6s. 4d. in 1845, when its value was near upon 8s.—became 12s. in 1873 and 11s. 9 ½ d. in 1908; and the sum paid for labour per ton increased from 4s. per ton in 1845 to 7s. 7d. in 1908. The greatest depth yet attained by working in Belgium is 1,066 feet (325 metres) at the Levant du Flenu Colliery, near Mons.

The total number of workmen rose from 30,000 in 1831 to 145,000 in 1908, and the total power of the engines employed at collieries increased from 21,000 horsepower (including 10,000 for winding) in 1845 to 245,000 horsepower (including 105,000 for winding) in 1908. The annual production per hewer has varied but little from its figure of about 900 tons in 1889; and that of the underground labourer increased only from 180 tons in 1845 to 220 in 1908, whereas the production per surface and underground hand together increased from 80 tons in 1830 to 180 in 1908.

Coal-imports advanced regularly between 1830 and 1865 from about zero to half a million tons per annum, attaining 6,000,000 in 1908. The excess of exports over imports rose with tolerable regularity from half a million tons in 1831 to 5,000,000 tons in 1872, and then remained at about 4,000,000 until 1893, when it fell off regularly until its amount in 1908 did not exceed the initial figure of half a million.

The value of the whole tonnage raised, which was only £800,000 in 1831, rose to £8,800,000 in 1872 and £14,000,000 the following year, but fell to £8,000,000 in 1884, rose again to £12,000,000 in 1890 and £15,200,000 in 1908, the value per ton passing from 6s. 9d. in 1831 to 16s. in 1873 and 12s. 9d. in 1908. J.W.P.

Mining Industry and Mine Management in Prussia in 1909.—[Official]. Pages 339-381.

Among other matters this article contains the following particulars: — The total output of the Prussian mining industry was: —

Year.	Tons.	Value.	
		£	Marks.
1909	207,750,335	86,800,000	1,735,770,173
1908	205,461,722	86,470,000	1,729,337,293
Increase	2,288,613	£330,000	M.6,432,880

The output of coal was as follows: —

Year.	Tons.	Value.	
		£	Marks.
1909	139,906,194	70,542,400	1,410,848,049
1908	139,002,378	70,675,000	1,413,500,108

This shows an increase in output, accompanied by a slight decrease in value.

The output of iron ore was: —

Year.	Tons.	Value.	
		£	Marks.
1909	4,389,950	1,863,750	37,275,087

1908	4,311,593	1,990,900	39,818,388
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This also shows an increase in output, accompanied by a decrease in value.

With regard to the crude iron and steel industry, the outputs were as under:—

Year.	Tons.	Year.	Tons.
1906	12,478,067	1909	11,813,511
1907	13,045,760	1908	12,917,653

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The wages paid per day in the pit districts are shown in the following table:—

District.	1908. Shillings.	1909. Shillings.
Upper Silesia	3.52	3.48
Lower Silesia	3.29	3.23
Dortmund	4.82	4.49
Saarbrucken	4.04	3.96
Aix-la-Chapelle	4.58	4.45

A. E. L.

Mineral Production of India during 1909.—By T. H. D. La Touche. Records Geol. Surv. India, 1910, vol. xl., pages 123-184.

There have again been more or less pronounced increases in the value of gold, petroleum, saltpetre, and jadestone; while manganese-ore, mica, ruby, iron-ore, and diamonds, the production of which had decreased in 1908, now show signs of recovery; but there was a decided drop in the value of coal, as was anticipated by Sir T. Holland in his report for 1908, due to the depression in trade that followed the extraordinary activity of the years 1906-1908. The production of amber, chromite, graphite, magnesite, salt, and tin-ore has also diminished. The total value of the mineral production has, therefore, decreased from £7,861,935 in 1908 to £7,499,228 in 1909, or 4.6 per cent. This fall in value does not denote any serious diminution of the activity displayed in exploiting the mineral resources of the country, for it was the over-speculation of the previous years that caused the abnormal production of coal (the mineral mainly responsible for the decrease) in 1908, leaving huge stocks to be disposed of in the next year.

The total amount of coal raised in 1909 was 11,870,064 tons, as compared with 12,769,635 tons in 1908. The decrease, however, is due to causes quite extraneous to the coal-mining industry, and it is probable that the industry will, in the future, be allowed to develop along normal lines. The deficiency in output is accounted for by the coal-fields of Bengal alone, where it amounted to 899,100 tons, the fluctuations in other provinces of India almost exactly balancing each other.

The value of the coal produced fell from £3,356,209 in 1908 to £2,779,865 in 1909 as a natural consequence of the over-production of the former year. This is shown by the fact

that, whereas the total value has been reduced by 17 per cent., the decrease in production was only 7 per cent.

The following table has been compiled from the statistics contained in the Report, and shows the quantities and values of the more important minerals produced during 1909, compared with those for the year 1908: —

Mineral.	Quantity.		Value, £	
	1908	1909.	1908.	1909.
Amber	-	-	364	287
Chromite, in tons	4,745	4,925	6,338	5,767
Coal, in tons .	12,769,635	11,870,064	3,356,209	2,779,865
Diamonds, in carats	14075	14735	940	1,089
Gold, in ounces	567,780	574,816	2,177,847	2,204,866
Graphite, in tons	2,873	3,132	14,365	12,529
Iron-ore, in tons	59,224	83,456	10,637	16,563
Jadestone, in hundredweights	3,211	4,088	73,400	84,400
Magnesite, in tons	7,534	737	2,009	196
Manganese-ore, in tons	674,315	642,675	465,593	508,483
Mica, in hundredweights	27,572	32,903	139,513	156,199
Petroleum, in gallons	176,646,320	233,678,087	702,009	910,172
Ruby, sapphire, and spinel, in carats	281,014	258,304	47,954	58,649
Salt, in tons .	1,279,937	1,255,598	522,794	453,630
Saltpetre, in hundredweights	386,199	404,946	292,758	296,838
Tin-ore, in hundredweights	1,906	1,672	11,015	9,645
Totals			£7,823,745	£7,499,228

A. P. A. S.

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## APPENDICES.

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I.-NOTES OF PAPERS ON THE WORKING OF MINES, METALLURGY, ETC., FROM THE TRANSACTIONS OF COLONIAL AND FOREIGN SOCIETIES AND COLONIAL AND FOREIGN PUBLICATIONS.

The following contractions are used in the titles of the publications abstracted: —

Ann. Min. Belg. Annales des Mines de Belgique.

Bull. Soc. An. Ateliers Constr. Electr. Charleroi. Bulletin de la Societe Anonyme des Ateliers de Constructions Electriques, Charleroi.

Bull. Depart. Geo. Univ. California. Bulletin of the Department of Geology of the University of California, Berkeley, Cal.

Bull. Soc. Geol. Normandie. Bulletin de la Societe Geologique de Normandie, Havre.

Bull. Soc. Oural. Amat. Sci. Nat. Bulletin de la Societe Ouralienne d'Amateurs des Sciences Naturelles, Yekaterinburg.

Chron. Trav. Pub. Chronique des Travaux Publics, Brussels.

Compt. Rend. Acad. Sci. Paris. Comptes-rendus Hebdomadaires des Seances de l'Academie des Sciences, Paris.

Eng. & Min. Journ. Engineering and Mining Journal, New York.

Geogn. Jahresh. Geognostische Jahreshefte, Koniglich Bayerisches Oberbergamt, Munich.

Journal Chem., Met., and Min. Soc., S. Africa. Journal of the Chemical, Metallurgical, and Mining Society of South Africa, Johannesburg.

Mem. & Trav. Soc. Ing. Civ. France. Memoires et Travaux de la Societe des Ingenieurs Civils de France, Paris.

Mem. Com. Geol. Russie. Memoires du Comite Geo'ogique, St. Petersburg.

Oesterr. Zeitschr. f. Berg. u. Huttwes. Oesterreichische Zeitschrift fur Berg- und Huttenwesen, Vienna.

Org. Indus. Organe Industriel, Liege.

Philipp. Journ. Sci. Philippine Journal of Science, Manila.

Proc. Colo. Sci. Soc. Proceedings of the Colorado Scientific Society, Denver, Colorado, U.S.A.

Rec. Geol. Surv. India. Records of the Geological Survey of India.

Zeitschr. f. Berg-, Hutt.- u. Salinenw. Zeitschrift fur das Berg-, Hutten- und Salinenwesen im preussischen Staate, Berlin.

Zeitschr. f. prakt. Geol. Zeitschrift fur pnaktische Geologie, Berlin.

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#### GEOLOGY, MINERAL DEPOSITS, Etc.

Mineral Industry of China.—By W. Pieper. Zeitschr. f. prakt. Geol. (Bergwirtsch. Mitt.), 1911, vol. xix., pages 47-50.

Despite China's extraordinary wealth in useful minerals, her industrial development is at present hindered by the uncertainty of jurisprudence (if such a term is applicable to the Celestial Empire), the deep-lying hatred of

the "outer barbarian," the shyness of capital, and the inadequate transport facilities (apart from rivers and canals). It is true that some reforms are being introduced, and others are foreshadowed, though as yet on paper only. The native methods of mining are primitive: ventilation and pumping, for instance, are matters to which the Chinese miner "on his own" is almost a complete stranger. Shafts are rarely sunk below the ground-water-level; haulage is conducted through adits, generally more remarkable for their number than for their length; and the number of workpeople employed on a single enterprise seldom exceeds 100, often does not exceed 10. The metallurgical industry is conducted on similarly primitive and small-scale methods.

Of late years, however, Europeans have been able to set agoing a respectable number of undertakings on modern lines and on a large scale; but further extensions are now as far as possible hindered by the Government, just as they were formerly by the uninstructed populace. These difficulties are in part surmounted by the formation of syndicates, jointly European and Chinese: the Chinese members alone coming forward when it is needful to have dealings with the authorities (mining concessions, etc.). The railways now constructed and under construction are especially intended to open up important mineral fields, and first

of all, the vast coal and iron-ore deposits. Yunnan is rich in anthracite, of which many seams occur 3 ¼ to 6 ½ feet in thickness. In Honan, brown coal is worked down to a depth of 215 feet or so (numerous seams 6 ½ to 10 feet thick). The thousand little coal-pits of Chingwha province yield between 200,000 and 300,000 tons of the mineral yearly. The great coal-fields of Shansi are situated on a plateau, not so very accessible, but quite free from water down to the depth of 328 feet below the surface (the maximum so far reached). The main seam varies from 13 to 33 feet in thickness, and the annual output is estimated at 1,700,000 tons. As is well-known, Europeans are now working the coal-fields of Chihli and Shantung. The one purely Chinese colliery that is worked on a large scale is that of the Ping-hsiang Company in Kiangsi province. The area was opened up in 1896, with the view of supplying the Hanyang steelworks, and associated with the same enterprise are the Tayeh iron-ore mines. German as well as Chinese officials direct the coal-mining operations: the daily output of 1,000 tons is capable of increase to 3,000, and the amount of coal in sight is estimated at 300,000,000 tons. Two seams are now being worked, at the respective depths of 164 and 500 feet: there are two modern built shafts, and electric haulage is in use. The coal is mostly coked in about 200 ovens, and is then sent by rail 57 miles to Chuchow, where it is loaded on to several vessels that take it down the Siangkiang (a navigable river) to Hankow. A mining school is attached to the colliery, where the subordinate Chinese officials are trained by the Germans (about 20 in number).

Allusion is made to other enterprises, in which foreign capital largely shares, the German predominance being especially marked (as might have been expected) in the province of Shantung.

Iron-ores are of widespread occurrence, often in the immediate neighbourhood of the coal-deposits. The iron industry is mainly centred in the provinces of Shansi, Shantung, Hunan, and Szechwan. In addition to innumerable small undertakings, there are some large ones, up to date in most respects, and financed by Government.

Copper-ores are worked in Yunnan and Kweichow, but the supply is far from meeting the home market's demand for the metal. The occurrence of gold and silver are of small importance, so far as known. Mercury is found

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and worked more especially in Kweichow. The ores of lead, zinc, and tin are more predominantly found in Yunnan province; and rock-salt in that province and in Szechwan. The output of salt is considerable, but salt-mines are a Government monopoly throughout the Empire. Oil has been struck in many localities, especially in Szechwan and Kansu provinces; the deposits, however, are so far all but untouched.

The author concludes with quotations from Dr. O. Junghann's vigorous appeal to his countrymen, to devote still more forethought and energy, especially by the multiplication of German technical schools, etc., for training the Chinese, than they have hitherto done (though apparently they have done a great deal) to the aim of securing for German industry and capital further outlets in China.

L. L. B.

Mineral Resources of the Philippines.—By W. D. Smith. Philipp. Journ. Sci., 1910, vol. v., pages 330-335.

Gold has been found in some quantity in nearly every part of the Archipelago, and has been mined in a more or less primitive fashion from time immemorial. The three principal gold-

mining districts at the present day are Ambos Camarines, Benguet, and Masbate. In the first-named district, near Paracale, mining operations are mainly centred on dredging, though development work on the auriferous lodes is making rapid progress. Despite their very moderate width, so far as known, these lodes are extremely rich, and "pockets running as high as \$1,000 or \$2,000 (U.S. currency) a ton have been encountered." The country-rocks are chiefly schistose diorites, gneissic granite, and slaty shales. Lode-mining is farther advanced near Mambulao, twenty stamps being at work on the San Mauricio property, and a Huntington mill operating on the Tumbaga.

In the Benguet district, the gold occurs in quartz and calcite fissure-veins which traverse the predominant diorites and andesites. The precious metal is found both native and in the form of a telluride: it is "not entirely free-milling," and resort is had to cyaniding. The chief characteristics are the all but complete absence of manganese and the abrupt change, within very short distances, from an entirely quartzose to an entirely calcific gangue.

In the Masbate district, the country-rock is chiefly andesite: this is traversed by a system of north-west and south-east quartz-veins, one of which exceeds 65 ½ feet in width. The ore contains large amounts of manganese oxide; it is oxidized to a much greater extent than in the Benguet district, but is only in part free-milling. Dredging operations have been unsuccessful in the Masbate district.

A list is given of other promising gold-bearing areas. Some silver is found in all the auriferous districts, usually alloyed with gold; small quantities of native silver have been recorded, from the Benguet district. Copper has been found in the form of arsenates and sulphides in the Mancayan-Suyoc district of the Mountain Province, Luzon. Recent development work has shown that what were thought to be merely narrow cupriferous gold-quartz veins in the diorite of that district really form a stock-work, and the deposits are probably of far greater importance than had been originally suspected. Native copper occurs in Masbate, Camarines, and Jolo Island. Lead and zinc-ores are associated in some of the Camarines deposits, and argentiferous lead occurs in many localities, especially in Cebu and Marinduque Island.

Haematite, magnetite, and limonite are of widespread occurrence. There

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is a fairly well-defined belt of iron-ore deposits which follows at first the eastern coast of Luzon, beginning in the Camarines, then turns inland, and attains its greatest development, so far as is known at present, near Angat in Bulacan province. A chemical analysis of the Angat ore shows that it contains 90 per cent. of oxides of iron and 2 ¼ per cent. of silica. Manganese nodules, "concentrated in shallow beds," occur in Ilocos Norte. Manganese is also found in small pockets in the quartz-veins of the auriferous districts of Benguet, Masbate, and Camarines.

Coal of sub-bituminous character occurs in nearly every island of the Archipelago. The mineral is of Tertiary age, contains on an average about 50 per cent. of fixed carbon, 40 per cent. of volatile substances, and yields from 4 to 6 per cent. of ash. A list of the principal localities is given. The output in 1909 was 31,000 metric tons. There is only one colliery working at present—that of the East Batan Coal Company on the little island of Batan, Seepage of oil has been noted at nine localities: three oil-wells have been drilled, one reaching a depth of 1,100 feet, but no appreciable flow has as yet been obtained. The petroleum occurs in Tertiary sandstones and shales.

L.L.B.

Metalliferous Deposits of the Shaitanskaya Dacha (Urals).—By N. Smyrnov. Bull. Soc. Oural. Amat. Sci. Nat., 1910, vol. xxx., pages 153-158.

This is one of the smallest mining properties in the Urals, and is situated some 25 miles west of Yekaterinburg, on the great road from Moscow. It is traversed by two lines of railway. Through the centre of the property runs from north to south the main range of the Urals, a granitic massif, down the flanks of which flow numerous small streams. The auriferous placers along these have been worked for a considerable time. Parallel to the granitic range trend belts of crystalline schists, diorites, porphyrites, gabbros, hornblendites, and serpentinized pyroxenites; the sedimentary deposits which abut on them are of Lower or Middle Devonian age. Of the igneous rocks, the basic are the richest in metalliferous ores. The lithology and mineralogy of all the various rocks having been dealt with in some detail, the author proceeds to describe the ores. Magnetite, industrially the most important mineral in this area, is, considered from the point of view of its origin, of two types: first, the magmatic, represented by bands in the basic rocks, extraordinarily numerous, more especially at the summit of one of the four Mounts Magnitnaya; the outcrop alone of magnetiferous hornblendites occupies hereabouts an area of  $2\frac{1}{3}$  square miles. Chemical analysis shows the ore to be a titanomagnetite, containing from 4 to 5 per cent. of titanium dioxide and from 50 to 60 per cent. of metallic iron. The second type, contact-metamorphic and metasomatic, is more especially observed in the Seversky and Zauralsky mines, in the form of nests and veins among the diorites and diabases. This latter ore never occurs at a depth exceeding 17 feet below the surface, and its invariable association with decomposed rocks and such minerals as epidote and garnet throws light on its formation—in a word, the deposits are manifestly of secondary origin.

Limonite occurs, containing a high percentage of silica; it is usually associated with talcose clays, and occasionally with limestones. The Geologorsky mine is opened up in an enormous stockwork of chromite, the country-rock being serpentine. There are several other, though smaller, deposits of chromite on the Shaitanskaya property. The occurrence of nickel-ores has

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been recorded, but nothing is known as to their quality and quantity. Manganese-ores are found among the quartzites and clays, and in the former haematite also occurs.

The auriferous placers were still actively worked about 15 years ago, but not much work, if any, is done on them now. Evidence is adduced to show that the original matrix of this placer-gold is in some instances a pyritiferous dioritic vein, and in others a pyritiferous quartz-vein.

L. L. B.

Coal-fields in North-Eastern Assam.—By H. H. Hayden. Rec. Geol. Surv. India, 1910, vol. xl., pages 283-319. \*f

This memoir deals more especially with the coal-bearing strata of the Safrai, Tichak, Tiok, and Tiru Valleys. A succinct description is given of the stratigraphy, the succession including the Disang Series (Mesozoic), the Tertiary Coal-measures and the Tipam Series—the third being often distinguishable with difficulty from the second. In the section dealing with the structural relations of the Tertiary Coal-measures, the author shows that there has been much thrusting and consequent faulting of the rocks.

Three groups of coal-outcrops can be traced in the beds and banks of the streams in the Safrai area, but the country is, on the whole, covered to a considerable depth by gravel-beds and alluvial deposits, and the continuity or otherwise of the seams from one locality to another will have to be tested by boring. The Safrai outcrops are briefly described at 43 localities, under the headings (a) Safrai-Chota-Taukok; (b) Safrai Valley below Punkung Ford; and (c) Safrai Valley under Kongan. Fifteen analyses of coal from this area are tabulated, showing a range in the percentages of fixed carbon from 41 to 57, of ash from 0.98 to 28.83, of volatile matter from 33 to 44, and of moisture from 4 to 10. The seams vary considerably in thickness, from a few inches to 15 feet; the quality of some of them "leaves little to be desired, except in the matter of sulphur content, which, as in the case of all Tertiary coals from Assam, is unduly high."

Along the streams which intersect the dense forest-growth of the somewhat inaccessible Tichak valley coal is seen in places, but "cannot be traced without extensive excavation for even a few yards beyond either bank." At one point seams respectively 9 feet and 5 feet 10 inches thick are recorded.

In the Tiru valley blocks of coal, "ranging in size from a cubic foot to small fragments," were found at intervals in the bed of the main stream; but the author was unable to trace any exposure of coal in situ. Oil-seepages are observed in the Tiok valley.

Of all the areas described, the Chota Taukok division of the Safrai district is the most promising. It comprises at least, four seams, one of which, as already mentioned is, at one locality at all events, 15 feet thick. Despite its comparatively high sulphur content and its extreme friability, the mineral is regarded by the author as of good quality; but the available quantity is unknown—it can only be said that the width of the Coal-measure belt in this field is less than 400 yards. Working could only be undertaken by means of shafts, and heavy pumping would be involved. It does not appear likely, therefore, that the Safrai district will, for a long time to come, compete with the Margherita and other Assamese coal-fields where mining operations are now in progress.

A table at the end of the memoir contains eight analyses, in addition to the fifteen already mentioned; and also an average calculated from eight analyses of Margherita coal, for purposes of comparison.

L. L. B.

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Coal-mining in Dutch Limburg.—By Dr. von Groenendack. *Org. Indus.*, 1910, No. 41.

Minerals are only worked in the Province of Limburg, whose coal-deposit constitutes a domanical mine—one of the oldest in Europe—let to a company in 1103 for 99 years; four concessions, and three State mines, of which one is worked and another laid out for working, while the lands of the third are in course of expropriation with a view to working. The net production of the six collieries worked in 1909 was 1,110,852 tons. Rich coal-seams have been discovered to the east and north-west of the State reserve; but the Government has come to no decision as to applications for their concession, nor to those for working the lignite deposits in the south of the Province.

Government explorations have proved the existence of a valuable coal-deposit in the north of Limburg; and potash, as well as coal, is believed to occur in Guelderland and Overijssel. The mining domain of Holland is therefore singularly increased, and yet vast deposits are left unwrought.

The 1810 law remains in force, except that in 1904 Articles 17 to 50 were replaced by a law regulating the forfeiture of concessions for non-working and by regulations as to mine inspection, while another in 1908 forbids exploration by individuals.

The State domain has lately been increased by 39,538 acres (16,000 hectares). Working is extending along the right bank of the Meuse to the German frontier towards Aachen (Aix-la-Chapelle).

J. W. P.

Find of Minerals in the Donetz.—Anon. *Org. Indus.*, 1910, No. 14.

A series of borings along the banks of the Boug between New Odessa and Gourievka, in the direction of Krivoi Rog, have revealed the existence of coal-seams which, though not thick, may be easily and profitably wrought, as they occur near the surface; iron-ore with high metal content; important deposits of graphite; and a thick bed of mica extending over a large area. Mica deposits have also been discovered in the government of Kherson.

J. W. P.

New Coal-field in Belgian Limburg.—By Florent Villers. *Org. Indus.*, 1910, No. 29.

Of the six Limburg colliery companies, three—the Beeringen, Genck-Sutendael, and the Andre Dumont—have definitely begun sinking. The first-named, with a concession of 12,355 acres (5,000 hectares), bored to a depth of 4,893 feet (1,491 metres), and struck the Coal-measures at 2,034 feet (620 metres).

The Societe Anonyme des Charbonnages de Ressaix, Leval, Peronnes, Sainte-Aldegonde et Genck, with 9,390 acres (3,800 hectares), has contracted for the sinking of two shafts with cementation, the first to be completed by the end of 1913. Bore-holes at Winterslag have proved seams of coal suitable for coking.

The Societe Anonyme Andre Dumont, at Asch, with 7,290 acres (2,950 hectares), has put down congelation holes for the first shaft, which is to be 1,410 feet (430 metres) deep; and an electric generating station is being put up for supplying power.

Among the companies whose works are less advanced, the Limburg-Meuse, with 12,355 acres (5,000 hectares), has put down two bore-holes—one 4,593 feet (1,400 metres) deep near the Eysden bridge, and the other 3,608 feet (1,100

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metres) deep, 1,640 yards (1,500 metres) north of it—which have proved rich seams occurring regularly. The company for working the Concession Charbonniere des Liegeois en Campine, of 9,884 acres (4,000 hectares) extent, has connected its mine with the Asch station of the Hasselt and Maaseyck line. The company for working the Zolder-Helchteren concession of 17,298 acres (7,000 hectares), put down three holes at Voort (where it is decided to sink the first shaft), which have proved thirteen seams, not including those less than 20 inches (50 centimetres) thick, giving a total coal thickness of 54 feet (16.53 metres).

J. W. P.

Outcrop of Coal in Styria.—By R. Granegg. *Oesterr. Zeitschr. f. Berg- u. Huttwes.*, 1910, vol. lviii., page 457.

The writer describes the prospecting for coal in the district lying along the eastern slope of the Alps, in that part of Styria which borders on Hungary and Croatia. There is here a sharply-defined line of demarcation between the Primary and Tertiary formations, the Tertiary being the coal-bearing strata. The district extends from Gratz to Marburg, and thence to Cilli, and lies chiefly along the banks of the Mar, a tributary of the Drave. It has been neglected for many years, but there are traces of old workings, and many outcrops of lignite or brown coal occur. Much exploration has been carried on during the last 10 years, and the coal is fairly abundant in seams of workable thickness: in some places a depth of 4 to 5 feet has been noted. Shale is frequently found, and is used as a combustible, and in the manufacture of black dye.

E. M. D.

Coal-fields on the Left Bank of the Rhine.—By Paul Krusch. *Zeitschr. f. prakt. Geol. (Bergwirtsch. Mitt.)*, 1911 vol. xix., pages 1-5.

Recent borings in the region lying on the left bank of the Rhine have thrown much light on the practically uninterrupted extension of the productive Coal-measures from Westphalia across the district north of Crefeld, through Holland, right up to the Aix-la-Chapelle coal-basin. The more especially interesting districts are those which lie north of Walbeck and Geldern and the eastern continuation of the Inde basin; the last-named has been proved as far as the Roer valley, and is shown to sink down eastwards (in consequence of faulting) and to contain an ever-increasing mass of coal in that direction. It follows that the Aix-la-Chapelle anticline, which separates the Inde basin from that of the Wurm, also sinks down eastwards, with a consequent narrowing of the belt of Devonian strata, and it may yet prove, in the neighbourhood of the Roer valley, to be already covered by productive Coal-measures.

The tectonics of the region are briefly sketched by the author, and he summarizes the results of his investigations in that direction in the pregnant statement that on the horsts (or fault-blocks) there are fewer covering strata and less productive Coal-measures, while in the graben (or rift-valleys) there is a greater thickness of covering strata and a greater mass of productive Coal-measures. He divides the region into three districts: (1) the Northern Crefeld district, north of the Crefeld anticlinal horst; (2) the Bruggen-Erkelenz district, south of the same anticline; and (3) the Wurm-Inde district, separated from (2) by the deep rift of the Roer valley.

In the first-mentioned of these three areas, the total amount of coal in sight, down to a depth of 3,935 feet, is estimated as 7,100 million tons. The author demonstrates incidentally that there is no relationship, on the left bank of the Rhine, between the thickness of the covering strata and the

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amount of gas present in the Coal-measures. The seams of the Bruggen-Erkelenz district cannot as yet be minutely correlated with those of the Northern-Crefeld district; but they appear likely to yield in the main coal "comparable with Cardiff coal," to the extent of 1,732 million tons out of the 1,746 million tons of coal in sight, the remainder (14 million tons) being defined as anthracite. In the Wurm-Inde district, the amount of coal in sight, down to the depth of 3,280 feet, is estimated at 1,567 million tons, of which barely more than 15,000,000 tons has been hewn so far. The region dealt with by the author contains about a fifteenth of the total amount of coal in sight in the German Empire, or about a tenth of that in sight in Great Britain. The author quotes approvingly Prof. Frech, who makes, it would appear, the rather hazardous assumption that the British coal-fields will be exhausted in about two

centuries and a half, while it will take more than a thousand years to exhaust the German coal-fields.

L. L. B.

Search for Coal in Upper Normandy.—By G. Negre. Bull. Soc. Geol. Normandie, 1909 (1910), vol. xxix., pages 57-104.

The author has devoted his attention more especially to the district known as the Pays de Bray, where the Jurassic strata crop out at the surface and are ringed round by the Chalk plateaux that form the characteristic feature of the Pays de Caux on the one hand, and Picardy on the other. Although, in some respects, the Pays de Bray is geologically analogous to the Lower Boulonnais, it is in others more similar to the districts of the Argonne and the French Ardennes. The author compares in detail the Portlandian and Kimmeridgian strata of Bray with those of the Lower Boulonnais; but points out that much older Jurassic series (such as the Callovian and Oxfordian) have been brought to the surface in the Boulonnais anticline than in that of Bray. Nevertheless, these older Jurassics (together with the Bathonian) are certain to be met with in that portion of Upper Normandy, but comparatively far below the surface and in much greater thickness than in the Boulonnais. Whether below these the Coal-measures are present, dislocated by tectonic movements (much as at Hardingham), or whether they are absent altogether, is the point in the underground geology of the Bray district which remains to be determined. If present, they will hardly be struck at a depth of less than 1,740 feet below the surface. The existence of the Devonian is already surmised at the depth of 2,590 feet or so.

The author discusses in some detail the theory which connects the Western European coal-basins with the so-called "Hercynian chains," and points out that in any case the improbability is great that the Pays de Bray will ever prove to be linked up with one of these chains. It had been mistakenly suggested that the Saarbrücken-Pont-a-Mousson Hercynian fold (carrying the Coal-measures) strikes under the Bray district south of the Portlandian and Kimmeridgian anticline.

In the fifth and final chapter of the memoir, a list is given of the fruitless borings for coal that have been put down in the department of the Seine Inferieure (Upper Normandy) between the years 1792 and- 1909. In August of the last-mentioned year, a bore-hole at St. Martin du Vivier, near Darnetal, a few miles away from Rouen, was terminated in the Lias, at a depth of 2,965 feet below the surface: thus, not even the possibly salt-bearing Trias was reached, and the astonishing thickness of the Jurassic strata here (1,780 feet) will be noted. In the Pays de Bray, the Lias would probably be struck 1,300

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feet nearer the surface. With regard to rock-salt or brine springs of any industrial consequence, the author thinks such an occurrence just as unlikely in the Bray district as that of workable coal at accessible depths.

L. L. B.

Upper Bavarian Pitch-coal.—By L. von Ammon. Geogn. Jahresh., 1909 (1910), vol. xxii., pages 289-302.

The author, having been requested for juridical purposes to give an expert decision, as to whether the Upper Bavarian Older Kainozoic (Molasse) pitch-coal may be classed, either with coals proper or with the lignites or brown coals, made an exhaustive study of that mineral. It may not be amiss to state here what he regards as the three most important

characteristics which differentiate the brown coals: (1) these contain much less carbon and much more oxygen than coal proper, and their heating power is far smaller; (2) they contain, except in the case of the older and better compacted varieties, more combined hydrogen than uncombined; (3) they are far more hygroscopic than ordinary coal.

From the purely geological standpoint, the fact that the Bavarian pitch-coal occurs in the Molasse (that is, the Upper Oligocene) series of strata would of itself classify that mineral among the brown coals. In appearance it resembles coal proper, being homogeneous in texture, deep black with a pitchy lustre, and yields a dark brown streak; it does not coke and rarely cakes together. The brown tinge in the streak is another significant characteristic of brown coals, as distinguished from coal proper.

A table of comparative analyses of this pitch-coal shows a percentage of carbon ranging from a minimum of 50.77 to a maximum of 67.80, and that of ash from 6.45 to 16.19. The sulphur percentage is comparatively high, averaging 3.5. The heating power averages 4,800 calories, and therefore it would require about twice the quantity of ordinary Bavarian lignite to produce the same calorific effect as a given quantity of this pitch-coal or of the best Bohemian brown coal. Although, strictly speaking, this pitch-coal belongs geologically, lithologically, and chemically to the group of the brown coals, the author thinks that it would be perhaps inequitable, from the industrial point of view, to describe the mineral as a brown coal and thus link it on to the really dissimilar lignites: its proper and "non-committal" designation is "Upper Bavarian pitch-coal," and it should be regarded commercially as approximating to ordinary or "stone-coal."

L. L. B.

Auriferous Deposits in Madagascar.—By J. Kuntz. *Zeitschr. f. prakt. Geol.*, 1910, vol. xviii., pages 249-254.

Premising that the climatic conditions, even in the comparatively healthy upland country, forbid Madagascar from ever fulfilling the destiny of a "white man's land," the author points out that the French have done much towards the improvement of the still very inadequate transport facilities: agriculture, however, is in a woeful plight, in part owing to a Gilbertian system of taxation; and prohibitive Customs duties have throttled British and American trade, although they have not quite extinguished the ubiquitous German. These points, of course, have some bearing on the future of the mineral industry of the island. Water, except in a few districts of the western uplands, is everywhere available in sufficient quantity; and timber is lacking only in the very heart of the innermost plateau-country. Ozokerite has been found in the west of the island; but workable

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coal, according to the author, is not accessible for industrial purposes. It may be noted in this connexion that roads suitable for wheeled traffic are scarce, and goods are carried about chiefly by native bearers.

The great mass of the rocks whereof the westward dipping plateau of Madagascar is built, consists of Archaean granites, gneisses, and crystalline schists, broken through in places by fissure-eruptives of various ages; but along the western coast stretches a broad strip of horizontally bedded Cretaceous deposits.

Nearly all the gold that is got in Madagascar is washed by the natives from alluvial gravels and sands; the island is, from the gold-miners' point of view, essentially a placer-region. The bottom bed or "floor" of the placers which lie along the river-courses is generally a mass of

decomposed crystalline rock, which, in cases where it has been converted into laterite, is auriferous below the placer proper to the thickness of a foot. The placers themselves vary in thickness from a few inches to 5 feet, and consist in the main of quartz-pebbles. If there be any "cover" it is usually made up of smaller pebbles and sands. Placers at higher levels than the valley-floor are also much worked, and on some hillsides there is a very conspicuous enrichment of the uppermost lateritic layer (below the placer proper). The alluvial deposits, of course, vary greatly in respect of the proportion of gold which they yield; at Mevatanana it averages only 15 ½ grains per ton, in the Betsilco district from 31 to 62 grains, and in the Ampoasary river-valley somewhere about 124 grains. Really rich deposits are scarce and of small extent.

The most important auriferous districts of the island range along the marginal heights that abut on the eastern coast, from Diego Suarez in the north to Fort Dauphin in the south: this is the region of greatest rainfall and of steepest slopes, and where the older eruptive rocks mostly occur. Perhaps the district in which more gold is got than in any other part of Madagascar is that of Southern Ambohimanga; the northern tributaries of the Mananjary river are more especially renowned for their rich alluvia.

The origin of the Malagasy placer-gold has been much debated. The author remarks that the precious metal is shown to exist in the form of minute crystalline granules as an accessory constituent of certain rocks (as, for instance, intergrown with felspar in the Mevatanana gneiss, and bespattering the dioritic gabbro of Sahofa). In the case of the Sahofa gabbro the sporadic enrichment is noteworthy, and the granules of gold are occasionally as big as peas. Since rich alluvia are found where older eruptives of the "greenstone" group occur, the inference is obvious that the gold is derived from these rocks. But then the gneiss also contains gold, especially where it passes into a greisen (the author says "quartzite"), and lenticles of auriferous quartz are not uncommon in the gneiss; such occurrences are worked in a primitive fashion in Andranofito, Vahinambo, and Tsimbolovolo. At the last-named locality, some extremely ferruginous "quartzite" lenticles, 328 feet long and 10 feet thick, yielded on an average 185 to 230 grains per ton, and in places as much as 6 ½ ounces; the alluvial gold amassed at the foot of the hill was, on an average, even richer.

At present the industry lies in the hands of the natives, from whom the generally ignorant French "prospectors," recruited from every calling under the sun, buy the gold in order to resell it at a profit of about 50 per cent. Inter-marriage with native women is said to afford facilities in this respect, as they introduce their husbands to vendors otherwise distrustful of Europeans.

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The hydraulicking method, so highly favoured in America, has been tried in Madagascar (especially at Mevatanana) but so far without success; it is probable, however, that there are localities in the island where, given skilful handling, the method would after all prove successful. The author does not speak hopefully of the prospects of dredging, even on the western coast where the conditions are more favourable than in other districts, but he recurs to this point later.

Geologically, the author compares Madagascar with Klondyke; he notes, however, that not a single auriferous quartz-reef of any consequence has yet been discovered in the island. The placers, generally situated in narrow river-valleys overhung by steep hill-slopes, are not of sufficient extent to justify exploitation on the grand scale. There is a bare possibility that dredging on the east-coast rivers might pay; but the unfavourable climatic conditions, and

the consequently frequent furloughs and high salaries needed by European supervisors are drawbacks which demand consideration, and may give pause to the venturesome capitalist.

L. L. B.

Natural Gas and Petroleum in Transylvania.—By Carl Schmidt. *Zeitschr. f. prakt. Geol. (Bergwirtsch. Mitt.)*, 1911, vol. xix., pages 73-76.

The author journeyed through this province and the neighbouring districts of Rumania in the autumn of 1909, investigating more especially the occurrences of natural gas, which many authors hold to be indicators of deeper-lying petroleum deposits. Boring for oil to a depth of at least 3,300 feet has been particularly recommended by experts in the neighbourhood of Mediasch and Baassen. For details the author refers to the extant literature, of which he supplies a bibliography.

Not very deep boring will be needed (say, from 330 to 1,000 feet) to strike industrially important supplies of natural gas, located in the Miocene saliferous strata. At Sarmas in County Kolosz, 43 ½ miles north of Baassen, a boring put down between November, 1908, and April, 1909, to a depth of 990 feet, struck a perfectly enormous reservoir of methane. It is customary to regard well-developed anticlinal structure as favourable for the occurrence of gas and oil, and at first sight the slightly undulating strata of the Baassen district are not very promising from this point of view; but the investigator need not despair, if only he will pursue his researches deep below the widespread outcrops of Pontic and Sarmatic deposits. The association of petroleum with natural gas is so frequent in Rumania, not to mention Louisiana and Eastern Texas, that the author is hopeful of a similar association in the Transylvanian natural-gas districts. He recommends especially the investigation of the Zugo, near Kis-Saros, and also a deep boring in the neighbourhood of Mediasch. Further, it remains to be seen whether the saliferous Miocene (Mediterranean stage) of Transylvania is at any point petroliferous also. The most recent geological work in the oil-districts of Galicia and Rumania has again emphasized the importance of the saliferous "Mediterranean" Series, as the natural reservoir of the oil; and its facies and development are similar on both flanks of the Carpathians, that is, in Transylvania as in Rumania. At the eastern margin of the Transylvanian Tertiary Basin, at Szekely-Udvarhely, unmistakable traces of petroleum have been recorded, and so too in the south-east of Transylvania, in the Feketeugy plain.

L. L. B.

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Petroliferous Strata of Cheleken Island, Caspian.—By K. Kalitzky. *Mem. Com. Geol. Russie*, 1910, n.s., No. 59, pages 81-89.

Many Russian geologists hold that petroleum as we now find it is a secondary deposit, and Dr. A. P. Ivanov has more especially upheld this view in regard to the oil-bearing strata of Cheleken. He makes a great point of the irregular distribution of the oil within a given stratum, and in this is followed by other well known investigators. The author sets himself to show that it is a purely arbitrary assumption, to regard primary deposition of the oil and regular distribution thereof within any one bed as mutually dependent conditions. If we consider an immense mass of sand and a smaller quantity of naphtha in presence of each other, it naturally follows that but a small portion of the sand will be impregnated with the oil; and there is no particular reason for assuming that at any given spot just enough petroleum would be present to saturate completely the stratum of sand which it had reached. During

the years 1907-1909 the author was officially engaged on the geological survey of Cheleken; he devoted much time and attention to the oil-bearing beds, and he has come to conclusions which are diametrically opposed to the theories of Dr. Ivanov.

He shows, first of all, that the oil in the Streptococera-beds is in its original locus, that is, it is a primary deposit; the same statement holds good of the pink clays with frequently interbedded, occasionally bituminous sands of the Lower Baku Series—strata which were evidently deposited in a sea much like the Caspian of our own day. All these beds are much faulted, yet the photographs submitted by the author show that the oil cannot have percolated into them by means of fault-fissures.

It is not denied that in some cases petroleum is a secondary deposit, and the author actually furnishes examples thereof from Cheleken in some of his plates. But he claims that oil which, in welling up through fissures, encounters porous strata on its way, penetrates into these to a very small extent.

Wherever in Cheleken oil is found at the surface, it may be taken for granted that so much oil has been thereby abstracted from the petroliferous strata of the island: wherever such finds are there made in the neighbourhood of faults, the primarily petroliferous beds, either of the Baku Series, or of the Apsheron Series, or of the Mottled Series, will be struck below the surface. The stratigraphical succession, in descending order, on Cheleken is as follows : —

- 1.—Barren Cardium-eclule. beds.
- 2.—Terrestrial formations. Unimportant secondary deposits of petroleum.
- 3.—Beds belonging to the great Caspian overlap. Secondarily deposited petroleum, which reached the surface in association with eruptions of natural gas, etc.
- 4.—Corbicula-fluminalis beds. (
- 5.—Upper Baku Series. (Primarily deposited petroleum.
- 6.—Lower Baku Series. Petroleum in situ, at one time worked by the native Turkis (or Turcomans) by means of wells.
- 7.—Upper Apsheron Series. Barren.
- 8.—Middle Apsheron Series. Primarily deposited petroleum, at one time worked by the natives.
- 9.—Lower Apsheron Series. Occasionally contains petroleum in situ.

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- 10.—Fish-beds. Petroleum in situ.
- 11.—Mottled beds, with primarily deposited petroleum.
- 12.—Rocks of the Aligul Massif. Barren of oil.

To resume, all oil-occurrences on Cheleken that are of any industrial importance are in their original locus of deposition, and will be found in those portions of the island where the strata which contain the oil do not crop out at the surface, but are struck at considerable depths below it. Hence they will have lost little of the natural gas and oil which they contained at the outset. These beds are either ridged up into domes, or, more frequently, wedged between faults.

L. L. B.

Sargent Oil-field, California.—By W. F. Jones. Bull. Depart. Geol. Univ. California, 1911, vol. vi., pages 55-78.

The area discussed in this paper embraces the south-eastern end of the Santa Cruz Mountains, the ridges and valleys of which trend predominantly north-west and south-east, with the single exception of the Pajaro River-valley. Geologically, the area may be defined as a basement complex of altered sediments invaded by a plutonic mass upon which rests the Franciscan Series (pre-Tertiary). Into the latter have intruded peridotites now altered to serpentine. The oldest rocks resting upon the Franciscan are of Miocene age, and it is the Lower Miocene which is the source of the oil found in the district. The petroleum reservoir has been tapped by borings along an anticline to the north of Chittenden. The occurrence of highly crystalline limestones among the oldest sedimentaries is mentioned: some of them are bespattered with particles of graphite, while the purer varieties are being used in the manufacture of Portland cement.

The petroliferous Lower Miocene is probably more than 1,500 feet thick; it includes clay-slates, sandstones, siliceous shales, and (more rarely) conglomerates. The oil appears to occur most frequently in the sandstones, but several of the wells have been sunk through richly petroliferous shales. The overlying series, the bituminous Monterey Shales, now of a maximum - thickness of 3,000 feet, was originally much thicker: it is a remarkably uniform formation, and includes at regular intervals throughout certain bands (1 to 3 feet thick) holding a high percentage of lime. Several beds of banded chert also occur in it, immediately north of Chittenden Lake. The next overlying (and unconformable) series, the San Pablo, which the author regards as geologically the most interesting formation in the district, is described in detail: it consists of sandstones and conglomerates, averaging a total thickness of 1,875 feet. Still later, Tertiary formations are also described in detail (including the Santa Margarita, Merced, and Purisima Series).

There seems to be little doubt that oil occurs in sufficient quantity to repay working on a large scale: the petroliferous Lower Miocene covers a wide area, and the general series of anticlines and synclines which these rocks and the overlying Monterey Shales occupy are good indications from a structural point of view. Oil-seepages are numerous and widespread, and, wherever seen, they point to the occurrence of Lower Miocene strata below the surface, whatever the outcropping rocks may be. At present two companies are at work in the field, but no great increase in the output can be looked for (in the La Brea anticline, at all events) until the borings have

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reached a depth exceeding 2,000 feet. Some oil-well records are given, and the paper is accompanied by longitudinal sections and a contoured geological map of the district.

L. L. B.

Sedimentary Deposition of Oil.—By Murray Stuart. *Rec. Geol. Surv. India*, 1910, vol. xl., pages 320-333.

The author having been struck with the fact that oil-bearing beds in Burma occur as if they were ordinary sedimentary deposits, and appear to be governed by the laws which apply to ordinary stratified sediments, conducted some experiments in order to determine the method of deposition of the oil. Using pulverized clay and powdered shale, both mixed with water, and pouring on the mixture a certain amount of oil, he found that the last-named was completely carried down to the bottom of the sediment, leaving the surface of the water perfectly clear and free from oil. Microscopical examination showed that the oil was merely mechanically mixed with the sediment, and that it was the small size of the shale-particles

that made it impossible for the globules of oil to escape between them and so reach the surface. There were no instances of globules of oil containing particles of shale. He is, therefore, of opinion that the oil in the Burma beds represents a contemporaneous flow, and was deposited in the sediments in the oil-bearing rocks in practically its present state, and not as undecomposed organic matter, either vegetable or animal.

From the information gained in his experiments, the author endeavours to trace the process of oil-formation from the beginning. The first step is that the oil on, say, the surface of a muddy stream is broken up into separate particles, the muddy particles in the water probably assisting in this work. Since oil and water are non-miscible, the particles of oil immediately assume a spherical shape, due to surface-tension, these globules corresponding exactly with those which exist in an emulsion of oil and water. There is this difference, however, between a simple emulsion and this muddy solution containing oil-globules: in an emulsion the globules can come into contact with one another and coalesce, forming finally two simple layers, the one of oil and the other of water, whereas in the muddy solution the oil-globules are held apart by the particles of mud. These particles of mud are wet with water, and therefore are not miscible with the oil-globules; neither can the oil-globules come together, owing to the fine state of division in which the mud-particles exist. The oil-globules, therefore, are carried down mechanically mixed with the mud-particles. When any further addition of oil results in leaving some on the surface which the sediment cannot apparently carry down, the point when the percentage of oil-globules in the whole mass of particles is so great that the oil-globules are almost in contact is reached. Increasing the oil beyond this percentage means that some of the oil-globules will come into contact, and coalesce into a larger globule of sufficient buoyancy to make its way to the surface against the downward stream of falling mud-particles. This explains why a greater percentage of oil of a low viscosity is carried down by the sediment. The deposition of oil, therefore, would appear to be purely a matter of gravitation. The oil becomes mechanically mixed with the sediment, and the fineness of that sediment renders it impossible for the oil to separate itself; the mixture of the sediment and oil, being still of higher specific gravity than water, falls to the bottom, and is deposited as a sedimentary deposit.

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The author does not apply this explanation to all oils. The limestone oils, for instance, seem to have a different chemical composition from those found in the shale series, and therefore it is possible that the explanation of their derivation from the decomposition of organic bodies in the limestone after it was deposited may be the true explanation in their case, the sedimentary deposition of oil appearing to depend upon the presence of mud or shale-particles.

A. P. A. S.

Khadyzhinskaya District of the Maikop (Kuban) Oil-field, Russia.—By K. I. Bogdanovich. Mem. Com. Geol. Russie, 1910, n.s., No. 57, pages 63-78.

A synopsis of the rock-succession in the district is given, ranging with three non-sequences from below the Aptian (Gault) up into the Tertiary Maeotic strata; and attention is drawn to the geological differences between this area and the Nephtyanaya-Shirvanskaya district of the same oilfield, surveyed by the author in conjunction with S.I. Charnotzky (the results being published in Memoir No. 47, 1909). We may note, in passing, the remarkable unconformity between the Upper and the Lower Cretaceous in the district here described ; as also the unconformable lie of the Oligocene deposits on the Upper Chalk, which the

author considers to be a consequence of the invasion by the Oligocene sea of a coast-line built up of Cretaceous and in part of Eocene rocks. He sketches briefly the geological history of the district in Tertiary times.

The outcrops of oil-bearing beds appear to be concentrated in the neighbourhood of the Khadyzhinskaya Stanitza, the Asphaltovaya Gora, and along the right bank of the Tsitse headwaters. They belong stratigraphically to the "Petroliferous Series" of the author and his colleagues on the Survey, defined in his synopsis as partly Upper Oligocene and partly Lower Miocene. It is true that at Ilsk, Abinskaya, and Kudako, oil occurs also in strata of later Tertiary age than these, but the occurrence would not seem to be comparatively of much importance; and a similar statement holds good of the oil occasionally recorded from the Middle and Lower Oligocene Foraminiferal Beds underlying the Petroliferous Series. The fact that some of the , marls in the Foraminiferal Series have yielded natural gas and others bitumen has not, however, escaped the author's notice; and he gives an account of certain borings put down near the Kadyzhinskaya Stanitza (visited by him in 1909) which do yield some amount of petroleum from clays belonging to that series. The point must be borne in mind, that the Petroliferous and the Foraminiferal Series pass one into the other so gradually and so imperceptibly, that it would be premature at present to fix very definitely a junction-line between them: the facies characteristic of one series seems to "crowd out" the other at one locality, and the converse phenomenon is observed at another locality. The author lays stress on the stratigraphical peculiarities, in order to warn persons interested in the petroleum industry of Maikop, that they must not assume that wherever they see "Petroliferous Series" appearing on the published maps, the strata so mapped will necessarily contain enough oil to justify boring operations; while, on the other hand, belts innocent of that label, but falling within the Foraminiferal Series near its junction with the Petroliferous Series, should not be passed over without some preliminary investigation.

Referring to the Nephtyanaya-Shirvanskaya district, he notes that the famous Selitrennikov No. 2 borehole and the Baku—Black Sea Company's No.

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1 boring had struck the boundary between the two above-mentioned series— oil-bearing sands yielding a good outflow. These sands have never been seen at the outcrop; investigation has proved, however, that they form a lenticle which pinches out along the strike, and it is still a question whether this same lenticle extends eastwards to the Baku Company's Boring No. 2: that boring has yielded gas and oil from sands at 40 fathoms below the surface, but these may either belong to the lenticle or be deeper-lying strata. The lenticular character of most of the oil-occurrences of the region is emphasized ; and it is shown how the optimistic forecasts of certain naphtha-prospectors are based on a misapprehension of the true stratigraphical conditions. The industrial future of the Maikop oilfield depends largely on the solution of the question, whether the favourable results now obtained from boreholes and from investigations at the outcrop, represent conditions repeated deeper down along the dip of the oil-bearing strata.

The author appears to lean to the opinion that the petroleum was derived from the bitumen of the underlying beds (although later on he rejects that theory as regards the upper horizons found in the Khadyzhinskaya district). He recommends as most favourable sites for boring operations the area north-east or north of the exposures of Cretaceous marl of the Podolskiye Khutora, the Morozhinaya Balka, and the first ravine east of the last-named. The productivity of the Khadyzhinskaya district, on the other hand, has still to be proved: its main characteristic, as contrasted with the Nephtyanaya-Shirvanskaya district, is the occurrence

of oil in a series of at first rather hopeless looking thin compact sandstones, etc., which are stratigraphically equivalent to the upper beds of the Petroliferous Series in that district. The author states that in the Pshish Valley borings to strike oil must be put down to a depth of 155 fathoms, and on the northern slope of the Asphaltovaya Gora, down to a depth of 150 fathoms. He discusses the possibility of the occurrence of productive oil-bearing beds hereabouts at lower horizons also, and adduces evidence in favour of that supposition.

L. L. B.

Radium Minerals and the Market for Radium.—By P. Krusch. *Zeitschr. f. prakt. Geol.*, 1911, vol. xix., pages 83-90.

Premising that, so far as our knowledge of industrially workable "radioactive" deposits extends, radium is exclusively associated with uranium, the author proceeds to a systematic description of the known occurrences, beginning with those which show the closest connexion with eruptive phenomena.

In the first group, arising from magmatic differentiation in pegmatite veins, he classes the strongly "radio-active" Lukwengule deposit, in the Ulugura Hills, district of Morogoro (German East Africa). The mineral here is a pitchblende, partly decomposed by weathering into a yellowish substance which chemical analysis shows to be a carbonate of uranium. Detailed exploration-work has yet to be accomplished, but it is at all events not unlikely that the deposit will yield a considerable quantity of paying ore. An analysis is also tabulated of a Morogoro fergusonite, which contains 136 per cent. of a lower oxide of uranium. The Norwegian occurrences of Evje, north of Christiansand, and of the neighbourhood of Stavanger, although yielding pitchblende rich in uranium, are but feebly radio-active. This again illustrates the warning which the prospector for radium should bear in mind, that the mere discovery of pitchblende is not enough without a careful test of its radio-activity.

In the second group, stanniferous veins with sulphidic ores carrying

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uranium-minerals, fall the deposits of South Devon and Cornwall; among these the uranium-mine at Grampound is noted as being especially rich, although the Cornish, like the Norwegian pitchblende, is but feebly radioactive.

To the third group, veins of cobalt-nickel and precious metals carrying uranium-minerals, belong the famous and oft-described deposits of Joachimsthal in Bohemia. Here the radio-activity varies pretty regularly, according to the percentage of uranium contained in the pitchblende. The author estimates that the probable maximum annual output of the two mines at work will amount to 16 or 20 tons for a considerable number of years (pitchblende containing on an average 55 per cent.  $U_8O_3$ ). Before the discovery of radium the mineral was used for the production of uranium dyes: these dyes are not radio-active, and it is possible to separate chemically the radium from the uranium in such wise that the residues from the dye-factory will contain all the radium originally present in the pitchblende in a concentrated form. With the auriferous and argentiferous pyrites of Gilpin County (Colorado), pitchblende is irregularly associated; but, on the whole, although they have fetched good prices at Swansea and in the United States, the uranium-ores here are characterized as "not rich."

Of altogether different character are the kolm deposits of Sweden, which of late have been extensively worked at Narke and in Vastergotland. Kolm is a mineral not unlike boghead coal in appearance, and occurs in the Cambrian alum-shales, in strings of thin flatfish lenticles,

irregularly dispersed among the shales. The consequence is that an enormous mass of alum-shale has to be worked in order to get a fair amount of kolm. This mineral, according to the analysis of a particularly rich sample yielding the minimum of ash, contains  $60 \frac{1}{4}$  per cent. of carbon and yields  $22 \frac{1}{3}$  per cent. of ash. It is in this ash that an oxide of uranium is found, to the extent of 1.82 per cent. on the average. The question of radium-production from this material is, so far as the mining company is concerned, still in the experimental stage.

The following axioms are laid down for the guidance of those who propose to search for industrially workable radio-active deposits: (1) Veins bereft of sulphidic ores do not afford hopeful prospects; (2) it is admissible that radium will be found to occur in nature in other associations than those with uranium; (3) the fact that a particular mineral fails to reveal radioactivity at a given locality, does not necessarily imply that another occurrence of the same mineral will be equally deficient.

Regarding Joachimsthal as at present the only possible source of a regular output of the raw material of radium, the author discusses in detail such matters as selling price, prime cost, etc.; and draws attention to the fact that since radium (unlike all other metals) cannot be used up, annual output of the raw material actually increases by so much the amount of radium available in the world. Thus a loan system has sprung up, a given quantity being hired out on the assumption that it will be returned to the lender undiminished, and this, of course, is another obstacle to the constitution of a radium market proper.

L. L. B.

Prospecting for Salt at Grubach, in the Salzburg; Salt District.—By H. Reinl. Oesterr. Zeitschr. f. Berg- u. Huttwes., .1910, vol. lviii., page 209.

The risk of exhausting the valuable salt-mines in Austria, which have been worked since Roman and Celtic times, is always present to Austrian

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mining engineers. The life of the Hallein salt-mine having been estimated at no more than 80 years, efforts have been made of late years to discover fresh mines in the district, and especially in the Lammerthal and its tributary the Russbachthal. The chief centre for exploration is Grubach, where there are clear traces of saliferous clay. Attention was drawn to the spot by the fall of a house into a depression of the ground, caused by the sinking in of old salt-works. There are many hollows throughout the district, which are attributed to the gradual disintegration of the soil by water percolating through it, and carrying in solution the salt with which it is impregnated. The numerous salt-springs are another feature of the district. One of them, much used for medicinal purposes, was found on analysis to contain 43 per cent. of rock-salt. These springs have evidently acted as lixiviating agents, for most of the rock is now sterile. By careful geological research, however, it is hoped in the near future to open up fresh and profitable fields for work.

E. M. D.

Production of Brine by Watering a Salt-mine.—By A. Schraml. Oesterr. Zeitschr. f. Berg- u. Huttwes., 1910, vol. lviii., page 221.

Attention has been paid in Austria for many years to the production of brine by watering the salt-mines. At the Dismas-Herrisch mine the saltworks have been extended, and an area of 630 square yards in the roof dissolved. It has not been found practicable to work at a height

of 20 feet, as the nozzles of the hose will not carry so far. In this mine 40 nozzles are used; a larger number gives no greater efficiency, and does not bring down any more salt. At Schorkmaier, a mine worked on the old system of quarrying the salt had been abandoned because it was apparently worked out, but has now been re-opened, and the new method successfully applied. Twenty-two hose are here at work, and the new area is 616 square yards in extent; 3,300,000 gallons of well-saturated brine have been raised, but care was needed to prevent the brine from overflowing into another mine. These mines were watered from below. At the Konig-Josef mines the water from the hose was applied at the top, and the brine was carried off below through funnel-shaped holes into drainage-basins and thence to the sump. It was, of course, necessary to prop up and support the rock carefully. The total amount of brine pumped from the four mines was 15,700,000 gallons, and the quantity of water required 14,500,000 gallons. E. M. D.

Stanniferous Deposits of El Paso County, Texas.—By Regis Chaurennet. Proc. Colo. Sci. Soc., 1911, vol. ix., pages 451-458.

Allusion is made to the extreme rarity of deposits of tin-ore in the United States, though it is claimed that workable cassiterite is actually to be found in South Dakota, a State which a generation ago was the scene of much fraudulent speculation in connexion with tin-mining propositions. There is a small tin-field in the Temescal district, San Bernardino County, California, but the lodes do not appear to be of industrial importance; and there are small deposits of cassiterite both in North and in South Carolina.

It was not in a very hopeful mood that the author went to Texas in 1908 to investigate the tin-ore deposit discovered in the Franklin mountain-range, 12 miles north of the town of El Paso. The deposit is on the eastern flank of the range, which divides a great plain or bolson from the Rio Grande, flowing along its western side. The base of the range is granitic, and the granite is overlain by pre-Cambrian and Cambrian quartzites, which are

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themselves overlain by Ordovician and Silurian limestone. The occurrence of the tin-ore is practically confined to the granite, the stanniferous belt extending, so far as at present known, for about four-fifths of a mile from north to south, while its breadth averages a quarter of a mile from east to west. Most of the ore could be described as cassiterite disseminated in pink felspar, though in places felspar and quartz are intermingled in the typical granitic structure; but mica is entirely absent in the stanniferous patches. The pegmatitic and greisenized dykes which traverse the granite, sometimes little more than an inch thick, and rarely exceeding 2 feet, also contain cassiterite; and, although they are not here the chief source of the ore, they are good indicators of its occurrence in the form of lenticles in the neighbouring country-rock. Stream-tin has been found in a "gulch" close to one of these dykes.

The ore in the lenticles is nearly black, its crystalline form is rarely visible to the naked eye, it is extraordinarily free from all other metals, and easily separable from the felspar, from which it differs of course enormously in specific gravity (: : 6.9 : 2.6).

Mining operations have, so far, been largely exploratory, and, as the greatest depth attained is less than 100 feet, the size of the ore-bodies is still a matter of surmise. Concentrates have been successfully smelted in a trial-furnace heated entirely by oil-flame, and the metal produced is of extraordinary purity, the metal running from the hearth 99.80 fine—the trivial impurity being iron. About 8 tons have been shipped so far, and the selling price was

enhanced to threehalfpence per lb. above the New York market quotations, owing to the purity of the tin.

L. L. B.

Uranium-bearing: Minerals in Madagascar.—By A. Lacroix. Compt. Rend. Acad. Sci. Paris, 1911, vol. clii., pages 559-565.

Since 1908 the author has repeatedly drawn attention to the existence in that island of uraniferous minerals, which will undoubtedly be of industrial importance if the deposits prove to be sufficiently extensive. Meanwhile, the zeal of prospectors has been stimulated, and the finds of minerals capable of furnishing radium are daily becoming more numerous. Most of the known deposits occur in the Ankaratra district, south and west of Antsirabe; but this restriction is probably deceptive, as the uraniferous minerals have been discovered incidentally in the course of prospecting work on pegmatites containing precious stones (beryl, tourmaline, etc.). It is now shown that the uranium-minerals occur also in other localities in pegmatites which do not contain gems, as, for example, south-east of Andronosomonta and between Beforona and Tamatave. The occurrence of pitchblende itself is not recorded, and the minerals described by the author are chiefly niobates, niobotantalates, and niobotitanates, some of which (fergusonite and euxenite) are rich in yttrium earths. The four chemical analyses which he tabulates show considerable variations in the percentage of combined uranium.

Monazite has been found for the first time in Madagascar in its matrix (pegmatite vein) accompanied by the uraniferous mineral hatchettolite, midway between Betafo and Antsirabe. The monazite which occurs in the auriferous sands of Mananjara, in sufficient quantity to suggest the possibility of working the deposit for the extraction of thorium, was doubtless derived from a similar source.

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Most of the minerals described are considerably hydrated, a result of alteration by atmospheric agencies, and regular exploration-work may well reveal unaltered minerals at some depth below the surface. Generally speaking, these are all heavy minerals (sp. gr. exceeding 4), possessing a very marked greasy lustre (occasionally semimetallic), and varying in colour from pale yellow to dense black. In contrast with these primary minerals is the secondary mineral autunite, discovered at a point  $6 \frac{1}{4}$  miles south of Antsirabe —its golden-yellow flakes impregnate the peaty clays which overlie a pegmatitic subsoil. It would appear to be derived from the leaching-out from the pegmatite of uranium, lime, and other salts in the course of the interactions induced by the presence of decomposing organic substances.

A similar explanation may possibly account for the uraniferous holm of Sweden, which looks like anthracite, and the ashes of which yield as much as 3 per cent. of oxide of uranium.

L. L. B.

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MINING TECHNOLOGY.

Sand-filling: on the Witwatersrand.—By Edgar Pam. Journ. Chem., Met., & Min. Soc, S. Africa, 1910, vol. x., pages 429-432.

The author describes the method adopted at the Robinson Gold Mining Company's mine, the owners (Messrs. H. Eckstein & Company) having secured the services of Mr. Waller, of Kattowitz (Silesia), who had had previous experience of the work. Mr. Waller recommends

that where there is a fall of 1 in 10 or more from the foot of the dump to the shaft, or where the ground can be excavated to get this fall, hydraulic sluicing should be adopted. Where this inclination cannot be obtained without great expense, either conveyor-belts or mechanical haulages should be used.

The sand is dumped into a brick-lined bin excavated near the shaft, and connected to it by a tunnel. The bins measure 40 feet in length, 30 feet in height, and 10 feet in width, and hold from 500 to 600 tons of sand. The bottom of the bin has a fall of 1 in 4 towards the tunnel, and four openings, each 10 feet high and 6 inches broad, are provided in the dividing wall, through which the water is sprayed. The dump-material consists of a mixture of sand and water, in the proportion of 60 parts of sand to 40 of water. The sluicing water has a pressure of 50 pounds per square inch, and is forced through four ½ -inch nozzles. With this plant 200 tons of sand can be washed into the mine per hour. An additional nozzle, fed with pure water, is used for washing out the pipes before and after use. The mixture of sand and water, after reaching the shaft, falls through a hopper into a 7-inch pipe, lined with jarrah wood. The pipes have loose flanges, so that they may be turned round or taken to pieces and replaced when necessary. Mr. Waller recommends 300 feet of horizontal pipes for every 100 feet of vertical head. In the present installation, however, 600 feet of horizontal pipes are working well at the 2,000-foot level. Valves are fixed in the pipe for the purpose of conducting the stream of sand and water from one branch to another. As the flow of sand can only be started or stopped from the surface, it is necessary to instal a system of efficient telephones in order that instructions may be given by those in charge underground. The outflow of sand and water is usually through openings 12 inches wide and the full height of the stopes. As the sand rises, the openings are closed from the bottom, so that only the water lying on the top of the sand can get away. Any crevices in the places to be filled are stopped up with grass, rammed in tight, and kept in place by a piece of wood. Where possible, the sand rests against a shaft or boundary-pillar on one side.

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The advantages claimed for this method of filling up the goaves are stated to be as under:— (1) Greatly increased safety for the mining population; (2) increased security of shafts and mine workings; (3) improved ventilation underground, because as practically the same amount of air will pass through a small area, its velocity must increase; the air can thus be guided into the places where men are working, and will not be dissipated in worked-out areas; (4) an increase of ore-reserves; (5) old pillars and footwalls can be reclaimed; (6) the removal of dumps from the surface, thus diminishing the dust nuisance, improving the aspect of the town, and setting free large areas of ground for useful purposes; and (7) the possibility of mining at greater depths.

A. P. A. S.

Settling of the Strata in Districts III. and IV. of the Consolidation Mine, June 10th, 1910.—  
By —. Rumbeeg. Zeitschr. f. Berg-, Hutt.- u. Salinenw., 1911, vol. lix., pages 68-73.

The part of the coal-measures most affected by the local earthquake here in question formed part of an undulation or "saddle." The forces at work were of such intensity, and so irregular in their action, that steel rails were twisted into corkscrew-like shapes, and in a section of the saddle 10 feet (3 metres) in length, two lines of rails, water-pipes, signal-wires, and ropeway were afterwards found crushed together into a bundle of about 12 to 16 inches thick.

The earth-movement is considered to have been entirely local. Above ground it was distinctly felt, but the damage done was not considerable. Gas was developed, and was

supposed to have been set free from the pores of the finely-crushed coal. Before and after the occurrence, very little gas was met with.

A. P. L.

On the Working: of Upper Seams after Lower Ones in the Upper Silesian Coal-mines.—By —. Puschmann. Zeitschr. f. Berg-, Hutt.- u. Salinenw., 1910, vol. lviii., pages 387-411.

The old rule, not to work upper seams before lower ones, has been departed from in the Upper Silesian mines, and the use of gobbing material pumped into the old workings in a semi-liquid state has given good results. Hand-gobbing with dry material compressed rather more than the foregoing material.

A case is mentioned in which work in a lower seam alternated with hand-gobbing and driving through "broken" workings, and very good economical results were obtained.

In regard to the question of the working of upper seams after lower ones, the Upper Silesian workings are reviewed. Four groups are distinguished: in Group 1 subsidence-effects are appreciable only by levelling; in Group 2 effects are visible, but are due to obvious superficial causes; in Group 3 subsidences are very considerable in extent, but show a certain uniformity, whilst group 4 includes the cases in which the regular subsidence phenomena are supplemented by exceptional fracture-effects.

In Group 1 the favourable effect is due to thick intermediate strata. The results with Group 2, which likewise has thick intermediate strata, show that these are not always effective. The lesson from Group 3, in which the intermediate strata are of less thickness, is that the more seams are worked below, the more the upper ones are endangered. In Group 4 the intermediate strata

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are still thinner than in Group 3, and the difficulties are correspondingly-accentuated.

The general review of the different cases is taken to show that an upper seam may safely be worked after the lower ones. To let the strata come to rest after a subsidence, much more than 4 years is found to be necessary. A term of 15 years has been found to be sufficient. Experience further shows that upper seams can be profitably worked after subsidences caused by workings in the lower seams.

A. E. L.

Earth-pressure and Mine-workings with Special Regard to Coal-mining. —By De. Niess. Zeitschr. f. Berg-, Hutt.- u. Salinenw., 1910, vol. lviii., pages 418-440.

Beginning with strata of loose materials, the author states that under 164 feet (50 metres) of water-bearing sand and 98 ½ feet (30 metres) of other such strata a pressure of 20 atmospheres may ensue, and working become impossible. Plastic strata are described as somewhat less dangerous in this respect. Clay-slate under pressure is found to exude—especially at the floor. Subsidences in such strata come to rest quickly. In certain favourable cases, it is shown that the earth-pressure may be made to assist in the winning of the coal or ore by extruding it. Blasting is thus partly avoided.

It is found that gobbing may, under pressure, lose four-tenths of its height, small-grained pit-heap material losing 25 per cent., and pure loose sand 8 per cent. The introduction of gobbing in a semi-fluid state is resorted to in order to reduce the percentage, but complete immunity from subsidence is obtained only in cases in which sand or other very close-grained material is flooded into thin seams.

The angle of fracture of limestones, conglomerates, etc., is found to be from 45 to 48 degrees—nearly the angle of repose. In quicksands the angle is greater, while in clay-slate and marl it may be 60 degrees, and with stone, under favourable conditions, even 75 degrees.

Sandstones with siliceous binding material are ranked as non-plastic strata. Initial subsidences in these are followed by others, but at longer intervals than in plastic strata. The originally hollow space becomes filled with large broken lumps, which do not again squeeze together into a homogeneous mass. The angle of fracture is generally not less than 82 degrees. Subsidences take a long time to reach the surface. Bord-and-pillar working back from the boundary is here recommended, except in the case of thick seams and exceptional pressures, when gobbing is considered desirable. The behaviour of the coal-seams, their faults, etc., are discussed with the help of text-illustrations, as are also different ways of winning, timbering, etc.

A.R.L.

Illumination of Cross-hairs in a Mining: Transit.—Eng. & Min. Journ., 1910, vol. xc, page 399.

A useful, convenient, and effective method of illuminating the cross-hairs in a mining transit is to drop a little molten candle-grease on the centre of the object-glass, and, after allowing the wax to cool, to pare it thin with a pen-knife, leaving a transparent circular film of candle-grease about  $\frac{1}{4}$  inch in diameter. This film of wax disperses the light so effectively that a lamp held almost anywhere in front of a telescope will illuminate the cross-hairs perfectly.

A. P. A. S.

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Latest Developments of the Freezing Process in Mines.—By —. Zaringer. Oesterr. Zeitschr. f. Berg- u. Huttwes., 1910, vol. lviii., page 701.

This method of overcoming the difficulties of sinking a shaft in moist clay or shifting sand, was first introduced in 1883, and is now well known, and much used in Germany and Austria.

A difficulty surmounted in a mine at Treves was to enlarge the area of freezing at a considerable depth. A shaft, 19  $\frac{1}{2}$  feet in diameter and 442 feet deep, had already been frozen. At this depth, after the shaft was in working order, water was encountered, and it was found necessary again to apply frost and carry the shaft 574 feet lower, without altering the original diameter. The shaft-bottom was enlarged to 23 feet, a crib put in and twenty-six holes bored in the outer circumference to the required depth. The water driven out by the frost rose to the surface through stand-pipes.

At the Deutsche Solvay mines, the largest to which the system has yet been applied, the depute is 1,080 feet, the diameter of the shaft 19  $\frac{1}{2}$  feet, the time occupied in freezing was 92 days, and the shaft was completed in 341 days. The pumps circulate 3,350 cubic feet of lye per hour. There are eleven refrigerators, fourteen condensers, three 450-horsepower engines, and thirty-five bore-holes.

E. M. D.

Sinking by the Freezing Process, and New Electric Plant at the Levant du Flenu Colliery.—Anon. Bull. Soc. An. Ateliers Constr. Elect. Charleroi, 1910, pages 147-159.

For improving the ventilation in some working-places distant from the winding shaft, and reducing the length of haulage, the Societe Anonyme des Charbonnages du Levant du

Flenu, near Mons, Belgium, entrusted the Societe de Foncage de Puits Franco-Beige, Brussels, with the work of putting down a pair of shafts about 7,215 feet (2,200 metres) east of the principal plant.

The Coal-measures here take the form of a hill, with its crest at the depth of about 250 feet (73 to 80 metres), dipping towards the east and having a watered cover of 1,050 feet (320 metres) at the site of the proposed shafts. Anticipated difficulties in sinking led to the adoption of the freezing method; and in each case twenty bore-holes for receiving the freezing pipes were distributed, 39 ½ inches (1 metre) apart, over a circle 30 feet (9.1 metres) in diameter, that of the shafts (placed 230 feet distant one from the other) being 16 ½ feet (5 metres).

Each of the three cold-producing plants, capable of giving 476,200 negative heat-units (120,000 frigories) per hour, comprises a 125-horsepower Corliss engine, driving a double ammonia-compressor. The freezing for No. 1 shaft, begun on March 9th, 1910, was successfully completed during the following June, when the bore-holes for No. 2 were finished, ready for freezing to begin. The actual sinking of No. 1 shaft commenced on July 7th, 1910; and by August 17th of the same year a depth of 274 feet (83.5 metres) had already been attained.

It was necessary to obtain the large quantities of water required without disturbing the underground water regime during the freezing; and accordingly a bore-hole was put down near a brook about 2/3 mile (1 kilometre) from the projected shafts. The company also decided to instal, not only a bank of boilers, but an electric generating-station to supply current for the pumps, for lighting, and eventually for all the services of the colliery.

The water from the bore-hole, and subsequently from the brook itself,

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though often muddy, is raised to a water-tower, a total height of 205 feet (63 metres), including loss of load, at the rate of 33,000 gallons (150 kilolitres) per hour, by one of two Bateau three-wheel centrifugal pumps, driven directly by a 60-horsepower 2,000-volt three-phase motor, making 1,500 revolutions per minute, the length of pipes being about 3,280 feet (1,000 metres). The starting is effected by a self-transformer and a two-position commutator. The necessity of often varying the delivery caused variation of pressure inside the pump, whereas this pressure ought to be constant for securing a good lateral balancing of the revolving portion. This difficulty was, however, overcome by means of the equilibrium-plate patented by the Soc. An. des Ateliers de Constructions Electriques de Charleroi, which supplied the Bateau pumps and all the electric plant.

The chief characteristic of the generating station is that its rooms are entirely above ground, and very well lighted, while provision is made for housing a double and even triple extension of the present plant. Motive power is furnished by a compound horizontal engine, made at the Ateliers de la Meuse, that can work with superheated as well as with saturated steam. With a pressure of 162 pounds per square inch (11 atmospheres) in the small cylinder, the engine gives out 400 electric horsepower on the shaft; but with that pressure and admission continued to 7.7 of the stroke, making 107 revolutions per minute, it can give out 430 indicated horsepower. Keyed on the engine-shaft is the flywheel-inductor of the 315-kilowatt-ampere three-phase alternator, as also a pulley which drives by means of a belt a 35-kilowatt shunt-wound generator that serves for exciting the alternator and lighting the station, while also affording a power reserve. Both engine and alternator can stand an overload of

535 indicated horsepower for an hour; and the stator can be turned over completely for examination of the winding coils.

Immediately below the switchboard is a 40-kilowatt-ampere static transformer with oil-bath, for reducing the 2,100-volt current to that of 190 volts for supplying the various motors, this voltage being chosen so as always to have 110 volts between any phase and the neutral point when it may be desired to utilize the transformer for lighting. The generating station is completed by a natural-ventilation chimney-refrigerator, capable of cooling 55,000 gallons (250 kilolitres) of water per hour, and susceptible of being doubled.

J. W. P.

Rapid Shaft-sinking: in Butte, Montane, U.S.A.—By C. J. Stone. *Eng. & Min. Journ.*, 1910, vol. xc, pages 107-108. The author describes the sinking of a shaft below the 1,500-foot level, belonging to the Butte-Alex. Scott Copper Company. Sinking operations were commenced in April, 1910, and 106 feet were sunk from the above level in thirty working days. The shaft had two compartments, each 4 feet square in the clear. The rock was hoisted to the surface in buckets 27 inches in diameter by 42 inches in depth, swung from the bottom of a skeleton sinking-cage of light construction, the bucket being hung from two chains. Eight-hour shifts were worked each day, with four machine-miners and one pumpman in each shift. Two 3 1/8 -inch Ingersoll-Rand drills were used, which worked under a pressure of 85 to 90 pounds per square inch at the compressor. The ground which, for the most part, was a hard granite, required from sixteen to nineteen holes before blasting took place, which was carried out with an electric battery. The hoisting was done as rapidly as possible, the buckets being brought from the 1,500-foot level in from 30 to 45 seconds. The hoisting-engine was of a first-

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motion type, built for high pressure, with cylinders measuring 12 by 36 inches, and a 5-foot drum. The water met with in the sinking was handled with a No. 7 Cameron sinking-pump. The air-exhaust was passed through a check-valve into the water or discharge pump, thus eliminating the roar of the exhaust in the shaft, and making it possible for either a Knowles or a Cameron sinker to lift water 200 feet instead of 100 feet, which is the normal lift of a No. 7 pump. The quantity of water met with varied from 20 to 30 gallons per minute. The timbering of the shaft was of the usual kind. The bonus or premium system was employed as one means of securing rapid work. The ordinary speed of shaft-sinking below the 1,200-foot level in Butte is from 65 to 85 feet per month, and in the present instance 75 feet were taken. The shaft miners and pumpmen were each given 4s. per foot for every foot accomplished above that distance during the month. This arrangement resulted in a total payment bonus of about £3 per foot, but expedited the sinking operations exceedingly. A. P. A. S.

1,225-fathom Bore-hole Czuchow II.—By —. *Jaeger. Zeitschr. f. Berg-, Hutt.- u. Salinenw.*, 1911, vol. lix., pages 89-100.

The deepest bore-hole in the world is stated to be that recently put down by the Royal Boring Administration of Schonebeck, on the Elbe, near Czuchow, in the Rybnik district of Upper Silesia, for the purpose of proving the seams in the coal-fields of the Royal Mining Administration of Knurów, the depth reached being 7,350 feet (2,240 metres).

The intention was to bore down to the saddle seams, which were expected to be found, at a depth of about 4,920 feet (1,500 metres), the apparatus used being wimbles, short-borers, diamond drills and water jet, and rapid-stroke drill appliances.

It was subsequently decided to bore to a greater depth; and the diameter of the hole was increased after a depth of about 4,600 feet (1,403 metres) had been reached. Of the eleven concentric tubes of about 17 ½ to 2 inches (440 to 50 millimetres) in diameter, all except the two smallest (of about 2 ¾ and 2 inches in diameter respectively) were recovered. The tubes used had a total length of about 13,140 fathoms (4,006.4 metres), weighed 1,245 tons (126,492 kilogrammes), and represented a value of about .£3,420 (69,758 marks). The boring began on December 10th, 1906, and ended on May 4th, 1909. A table of particulars and results is given, from which it appears that the cost of boring was in all £15,866 (323,712.17 marks), or about £2 3s. 4d. per foot (144.53 marks per metre). The subsequent determination to bore to a greater depth made the work more expensive than it would otherwise have been.

A.E. L.

Boring; in the Mons District of Belgium.—Anon. Chron. Trav. Pub., 1911, page 1379.

The Waudrez bore-hole entered the Coal-measures at a depth of 1,300 feet (396 metres), and passed through the Coal-measure conglomerate between 2,030 feet and 2,060 feet (619 and 628 metres). The results of this boring and that at Harmignies, which entered the Coal-measures at 1,530 feet (466.5 metres) go to prove that there exists, to the south of the unwrought portions of the Belle-Victoire and Levant-de-Mons concessions, a workable coal-deposit at great depth, hitherto unknown.

At Buvrines the Ressaix Coal Company has had a bore-hole put down to a depth of 3,336 feet (1,017 metres), which has proved a valuable group of seams.

J. W. P.

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Well-drilling: Methods.—By Isaiah Bowman. United States Geological Survey. Water-supply Paper No. 257, 1911, pages 1 to 139.

This paper is a complete treatise on the whole question of well-sinking, and supplies a long-felt want, as the information hitherto available on the subject is of a very scattered character.

The field studies that form the basis of the present report were undertaken in connexion with ground-water investigations made in the eastern portions of the United States. These studies extended over a period of 3 years, included actual observations of well-drilling in many parts of the eastern half of the country, and were supplemented by one season's observations in the south and in the middle west. The history of well-drilling as practised in Asia and Europe is also given.

As by far the most common object of well-drilling is to obtain water, oil, or gas, the report deals with the occurrence of these products and thus meets the desire among drillers for information that will enable them to select well sites with as definite an idea as possible of the rock-formations that may be encountered. The report does not, however, take up the geological relation of ore-deposits and the methods of ore-prospecting with drills, for such a discussion would involve the whole subject of structural and metamorphic geology and ore-deposition. After the oil and gas-bearing relations are discussed, a short account of the development of well-construction is given, and then the methods of drilling and boring are described in detail. The chief uses and general features of each method are stated, the different parts of the outfit required described, and the more common difficulties encountered

in its use mentioned, together with a description of the classes of material to which each method is best adapted.

The treatment of the separate methods is followed by the discussion of a number of special features and a few general estimates of the cost of well-sinking. Although such figures can be only approximate, because local conditions are important factors in their determination, they at least afford some indication of the expense of well-construction or of prospecting work by the ordinary methods of drilling and boring.

The chief points touched upon in the report deal with the following subjects:—(1) Methods of well-drilling, including the standard method, portable drilling rig, percussion-core drill, pole-tool method, self-cleaning or hollow-rod method, Californian or stove-pipe method, hydraulic rotary method, jetting method, core-drilling, minor methods of well-sinking, and special operations in drilling wells; (2) features of well-construction, including the difficulties encountered in sinking (such as the loss and recovery of tools and the geological difficulties), and the flooding of oil-wells, its causes and permanent effects; (3) contamination of water-wells, including the usual methods of prevention, results of defective casing, and recommendations for the prevention of pollution; (4) capacity of water-wells; (5) measurement of depth, including the cable, tape, and Bacon double-cone method; (6) deflection of drill-holes, with notes on the causes and results of deflection, and the instruments for measuring the same; and (7) the cost of well-sinking by different methods.

A. P. A. S.

Frictional Resistance in Winding-cages.—By J. Havlicek. Oesterr. Zeitschr. f. Berg- u. Huttwes., 1910, vol. lviii., page 282.

The usual formula for calculating frictional resistance in winding is made up of the unbalanced weight, plus the weight of the rope and the subsidiary

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resistances to the motion of the cage. The latter are assumed to be proportional to the total weight of both ropes, and are equal to 4 per cent. They comprise the stiffness of the rope, friction of the gudgeons on the pulley and of the guides, and resistance of the air to the revolution of the drum and rope, and to the winding of the cages in the shaft. The amount of all this subsidiary friction was determined on an electric winding-engine, on which tests were made at the Salomon Pit, Moravia. The friction was noted at different speeds, with the cages loaded and running empty, and especially at the point where they meet in the shaft, and the weight of the two ropes is in equilibrium. Loss of power at the winding-engine was determined by brake-tests. The results showed that the actual friction in the shaft is small, and consists mainly of the opposition of the air to winding. Since the extent of this friction determines to a certain degree the size of the winding-engine, it is desirable that it should be definitely determined, and light is thrown on the-subject by these careful tests.

E. M. D.

New Safety-clutch for Inclined Planes—By E. Kudiclka. Oesterr. . Zeitschr. f. Berg- u. Huttwes., 1910, vol. lviii., page 286.

Most accidents in connexion with underground haulage are due to the failure of the brake. What is required is a catch acting automatically, and independent of any carelessness or want of thought on the part of the workmen. A new clutch is here described, which is said to

ensure safety, because the brake is thrown on to the full truck all the time that it is running down the guide-rails of the incline, and the truck cannot overrun the latter. The apparatus consists of a guide, two running weights, and a catch. The weights hang suspended from a wire rope led over a pulley, and move, up to a certain height, between two U-shaped iron grooves. The catch, which is solid with them, acts against the inclined plane, and can only be released on the side away from it; it is held in position by a spring. The brake-apparatus is fixed at the top and bottom of the plane; the right-hand weight on the side away from it; it is held in position by a spring. The brake-apparatus is fixed at the top and bottom of the plane; the right-hand weight on the side of the full truck is the heavier. When a full truck is started at the top of the plane, the man working it draws up the weight, leaving the guide free for the truck to run down. A bell signals its descent automatically to the man below. The ascending empty truck opens the catch, and the weight runs down and blocks the way, so that the full truck cannot overrun the distance at the bottom. E. M. D.

Precautions in Working a Very Fiery Seam.—Anon. Chron. Trav. Pub.,. 1911, page 293.

The Bascoup Colliery Company, Belgium, has obtained authorization, renewable every 3 years, to work the Placard seam, classed as very fiery, at a depth of 846 feet (258 metres) in its No. 7 Pit, in derogation of the Royal Decree of December 13th, 1895, but upon the following conditions:—The air-current must never be less than a cubic foot (50 cubic decimetres) per man per second in the most numerous shift, nor less than, say,  $\frac{3}{4}$  cubic foot (30 cubic decimetres) per ton of coal got. None but safety-explosives may be used; and the charges must never be greater than those fixed by the regulations, while the tamping must be at least 8 inches (20 centimetres) high above the explosive. The shots must only be fired by electric current with detonators that

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do not give out isolated sparks; and only one shot may be fired at once. The shot-firing, which must be suspended if fire-damp should show itself at any point in the working-place, or on the first requisition of the mine inspectors, is to be entrusted to firemen specially appointed, who are provided with benzine lamps to facilitate testing for gas.

J. W. P.

Outburst of Gas in the Maximilian Pit, near Hamm, in Westphalia.—By —. Hollender. Zeitschr. f. Berg-, Hutt.- u. Salinenw., 1911, vol. lix., pages 62-67.

The above outburst, in which a man lost his life, occurred in April, 1910. In addition to the boring of holes in advance, which is required by the Government regulations for gassy pits, it is the custom at Hamm in working coal first to drive a passage about 40 inches (1 metre) square by 13 feet (4 metres) in length, and then to enlarge it to the size of the working section. On this occasion the small passage had reached a length of 12 feet when a crackling noise was heard, and an outburst of gas occurred, carrying with it about 40 tons of fine dust-coal. It turned out that a crushing-up and thickening of the seam had here taken place. The coal was so loosened that about 60 tons of it could be loaded into tubs and removed without further work. At a point about 196 feet (60 metres) from the point where the trouble was encountered, the seam was found to have its ordinary thickness of 5 feet 7 inches (1.7 metres) again. The pocket struck by the small passage was about 26 feet (8

metres) long by 16 ½ feet (5 metres) in breadth. After the removal of about a hundred tubfuls of crushed and broken coal, the seam became firm again. A. R. L.

Explosion of Dynamite in the "Siegfried" Potassic Salt-mine at Gross Giessen.—By —. Schroeder. Zeitschr. f. Berg-, Huttwes.- u. Salinenw., 1911, vol. lix., pages 75-89.

An explosion of four cases of blasting dynamite, causing eighteen deaths, occurred on October 18th, 1910, at the above-named mine. No noxious gases had hitherto been observed in the mine, and the explosion was attributed to careless handling of the explosive. The afterdamp, which killed fifteen men, was experienced mostly in the direction of the downcast shaft, because the flame of the explosion hastened to meet the air-current and take up its oxygen. The effect of the explosion on the general current of the ventilation was very slight. A. R. L.

Simultaneous Firing: of Mine-shots by the Detonating: Cord.—By L. Barthelemy. Mem. & Trav. Soc. Ing. Civ. France, 1910, pages 495-500.

The operation (described in detail) of reducing to small fragments the masonry of a tunnel of which 106 yards (97 metres) had fallen in, by the simultaneous firing of 2,125 shots, succeeded perfectly, thanks to the judicious arrangements, and also to the Lheure detonating cord, without which it would have been impossible. The detonating cord, or tape-fuse, supplied by Messrs. Davey, Bickford Smith, & Co., Rouen, is manufactured very simply by filling a leaden pipe with melted trinitro-toluene, the detonation speed of which is near upon 19,685 feet (6,000 metres) per second. The pipe is then drawn out to a diameter of 3/8 inch full (6 millimetres), so that owing to the melting and drawing out together, break of continuity is almost certainly avoided, while any length required is thus afforded, which is often (as in the application described) of great importance.

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This cord is used at several mines, especially at Lens; and M. Reumaux, general manager of that colliery, states in a letter to the Mines Administration that its use effects a saving of 20 per cent. on the quantity of explosives employed, or, in other words, that 80 weight-units of explosive fired by the cord produce the same effect as 100 with the detonator. This increased effect is explained, partly by the cord's own force, and partly because the molecular vibration which causes the detonation of the explosive occurs simultaneously over the whole length of the charge, instead of at a single point only, so that the detonation is more complete and instantaneous. With a plastic explosive, like dynamite-gomme (with 92 per cent. of nitroglycerine), the end of the cord is put at the bottom of the shot-hole, and the explosive is then charged in, so that it sticks to the cord; but with a dry explosive, like the Favier, the cartridges are drilled axially and threaded on the cord. J. W. P.

Necessity for the Use of Stron Detonators with High Explosives.—Eng. & Min. Journ., 1910, vol. xc, pages 498-499. It is well known that, in detonating high explosives, the stronger or sharper the initial shock is, the quicker and more thorough is the detonation of the charge; moreover, quick and complete detonation results in the production of a minimum of flame, a point of great importance in the case of coal-mines where inflammable gas or coal-dust is present.

The Technological Branch of the United States Geological Survey have demonstrated by experiment the desirability of using only strong detonators. As a result of their tests, it is stated that electric or other detonators containing not less than 1 gramme of fulminating composition (90 parts by weight of mercury-fulminate and 10 parts of potassium chlorate, or its equivalent) should be used in firing charges of "permissible" explosives and with high explosives in rock-blasting. Further, that an electric or other detonator of less strength than No. 5, containing 0.8 gramme of the fulminating composition, should under no circumstances be used, as the greater efficiency and certainty of the stronger detonator more than make up for the slightly increased cost.

Strong electric fuses and blasting caps should be used with all high explosives, because they reduce the chances of misfire, as their effect carries farther in the charge; they increase the execution of the explosive; they tend to counterbalance careless and improper usage; they offset, to some extent, deterioration due to improper storage; they reduce to a minimum fumes from the explosive; they decrease the size and duration of the flame ; and they prevent the loss of the charge by burning.

A. P. A. S.

Winding-rope Tests.—By Lucien Denoel. Ann. Min. Belg., 1910, vol. xv., pages 1497-1546.

This paper summarizes and completes that read before the Dusseldorf Mining Congress in June, 1910, some points requiring further investigation not having been quite cleared up so as to afford a basis for conclusion. Tests have since been carried out, chiefly as to a comparison of wet and dry Manila-fibre ropes, the results of which are recorded.

Considering the ensemble of the results, the influence of damp manifests itself by (1) diminution of the breaking strain, which is not, however, constant, appearing to vary with the degree of humidity; (2) increase of elongation, which was very marked in all the samples; and (3) increased resistance to

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fracture. The favourable influence of damp the elasticity of the fibre is, however, counterbalanced by a certain stiffness in winding up on the drum or pulley, and by increased weight, while excessive wetting is to be avoided for not abstracting the tar.

The various series of tests, considered separately, show that (1) the ropes most impregnated with moisture gave results distinctly confirming the above conclusions, and (2) that moderate wetting probably affords the best conditions, too great dryness and also an excess of water being unfavourable. This point is not yet settled, however; and the investigations are to be continued.

In the present state of our knowledge it is difficult to lay down an absolute rule for carrying out tests; but it is important that, for the ropes of one and the same pit, the conditions shall be uniform for all the samples taken for periodical testing. Without great complication the ropes may be subjected, before the test, either to dessication or to a watering, one or other of which, sufficiently applied, would give tolerably uniform results. If it be desired to make the test conditions approximately those of actual winding, it will suffice to weigh the sample at the mine immediately after the cutting and mark its weight on the note made out for the testing station.

For determining a rope's safety-coefficient the mine regulations, as a rule, only mention the breaking strain; but for the application of this rule the test should be made on a wetted rope, as being the most stringent and therefore favouring safety. If, however, the specific work of

breakage be in view, testing in the dry state—the most stringent in such case—is to be recommended.

J. W. P.

Elasticity of Smooth, Rusted, and Galvanized Wire-rope.—By J. Divis. Oesterr. Zeitschr. f. Berg- u. Huttwes., 1910, vol. lviii., page 47.

The extent to which iron wire stretches when subjected to great stress, in other words its elasticity, depends upon the kind of wire, whether smooth or galvanized, and its condition. To determine it, the writer tested various samples, both iron and steel wire, and hempen rope, and exposed them to bending stresses. The coefficient of expansion was noted for different thicknesses of iron and steel wire. The original length of the tested samples was a little more than an inch; for steel wire, plain and galvanized, it was  $\frac{3}{4}$  inch; with the latter expansion was less regular. All the samples were tested with weights gradually increasing from 66 to 400 pounds, and the coefficient of expansion was found to be the same for plain and galvanized wire. A number of experiments were made to determine the extent to which the elasticity of wire rope is affected by rust. After the rust had been removed, the wire was found to have a greater or less power of stretching, according to the degree of corrosion, but the quality of the wire always deteriorated if it had become rusted. Rust is therefore the great enemy to the life of iron wire. It was frequently observed that, when the wire was released, a longer time elapsed before it shrank to its original length than had been required to stretch it. The modulus of elasticity was determined at 11.4 to 12.7 tons per square inch.

E. M. D.

Power from Coal-tar Oil.—By P. du Bousquet. Mem. & Trav. Soc. Ing. Civ. France, 1911, pages 347-348.

Since 1905 the Lens Colliery Company has experimented on the use of heavy coal-tar oil in Diesel engines, several makers of which have succeeded

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in producing motors that work regularly with it under the best conditions, a 500-horsepower engine only consuming 7 ounces 6  $\frac{1}{2}$  drachms (210 grammes) per horsepower-hour, so that the horsepower-hour may fall, as regards combustible, to 0.168d. (1.68 centime). The Diesel motor, which occupies small space and is easy to drive, is quite indicated for powers up to 500 horsepower, comparing very favourably with the steam-engine and boiler or gas-motor and producer. New types of high power—four-period double-acting and two-period reversing, the former very suitable for power-stations—have been brought out. It was stated that at the Saint-Chamond station for generating electric current there are now two 1,000-horsepower Diesel engines to which one of 2,000 horsepower will be added in a few weeks, and also that the Sulzer firm is building a 12,000-horsepower Diesel engine with six cylinders. ````

J. W. P.

Underground Water in the Belgian Campine.—Report by F. and E. Putzeys and —. Rutot. Chron. Trav. Pub., 1910, pages 5161-5162.

The Moll white sand, consisting of pure silica, extends over an average width of 2 miles (2 to 4 kilometres) and a length of 25 miles (40 kilometres), with a mean depth of 40 feet (10 to 15 metres), overlying a bed of quicksand about 49 feet (15 metres) thick. The great body of underground water flows slowly towards the north, that which comes up to the surface being

an infinitesimal portion, although it forms innumerable rivulets. The water-bearing stratum proper extends over an area of 160,624 acres (65,000 hectares), with a mean depth of 90 feet (25 to 30 metres). Pumping has proved the great quantity of good water available, the rapidity with which it is renewed, and the possibility of its sufficing for the provinces of Antwerp as well as East and West Flanders, notwithstanding anticipated increase in the population owing to the opening of the new Campine coal-field. The self-purification of the water in sandy measures removes all danger of pollution due to the creation of populous centres.

The regime of the water in the sandy measures is quite independent of that which will have to be pumped at the Campine Collieries, the headings of which will be driven at a depth of more than 1,640 feet (500 metres), so that there is no danger of mining operations impoverishing the water resources. This circumstance is very fortunate for the coal-masters, because if they had to contend with the water in the sterile rocks of the Cretaceous Formation, as well as with that encountered by their own workings, pumping would cost so much as to render the collieries commercially unworkable. The mines will have a sterile cover of at least 1,640 feet (500 metres), constituted by alternating beds of chalk, sand, and clay; and every fissure formed will be at once filled up, owing to the formidable pressure of the superincumbent measures.

J. W. P.

Gold-dredging in French Guiana.—By Leon Delvaux. Mem. da Trav. Soc. Ing. Civ. France, 1911, vol. i., series 6, pages 46-56.

The dredge, which is described with illustrations, differs from those used in other gold-producing countries, but is adapted to the local conditions and perfectly answers its purpose. It was installed on the Roches Creek, a tributary of the River Lezard, which rises in the highly gold-bearing region of the Enfin placer. The tortuous creek is here about 33 feet (10 metres) wide, while the flat portion of its enclosing valley is from 98 to 328 feet (30 to 100 metres) wide. On the bed-rock of compact clay (glaise), formed by the decomposition

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in situ of the underlying diorite, is a bed of gravel, cemented by a mixture of clay and sand. It is this bed, called the "couche," which contains nearly all the gold, while the top of the bed-rock is often auriferous.

The couche varies in thickness from—say, an inch or two (a few centimetres) to more than a metre and its richness is often in inverse ratio to its thickness. It is overlain in places by a stratum of fine sand, which is sometimes auriferous, especially in the bed of the creek, but more frequently sterile. At other parts the couche is directly overlain by what is called the "deblai," an ochreous earth, always sterile, the thickness of which may attain 13 feet (4 metres). Actual working has shown that the distribution of gold is far from being regular over one and the same cross-section. Almost everywhere, sometimes in the sides of the valley, but generally near the creek itself, there is a rich vein varying in width from 13 to 49 feet (4 to 15 metres), and on either side the gold content diminishes.

The gold, occurring in larger particles than in California, for instance, is relatively fine, showing traces of displacement and attrition. The author attributes its origin to the deposits in the Enfin placer, 12 ½ miles (20 kilometres) distant up-stream, the auriferous quartz of which has, in his opinion, been drawn along by the current, and has deposited gold-particles along the banks. The cost of getting, less than 1s. per cubic yard (1 franc 50 centimes per cubic metre) dredged, would be greatly reduced if more than one dredge were employed.

Since operations were begun, in February, 1909, the monthly average of gold obtained has been 28 ½ pounds (13 kilogrammes).

As regards the dredging of auriferous alluvia, the conditions of Guiana differ greatly from those of most other countries in which this industry is practised. While the content is very high, working is costly. The chief difficulties are rigour of climate; long, precarious and onerous transports; absence of trained workmen, and high cost of labour; great distance of workshops ; obstacles in the alluvium; existence above the gold-bearing bed of a far thicker sterile portion; and, finally, the clayey nature of the deposit and its cover.

J. W. P.

Protecting Dykes, Water-way Banks, and Earth-slopes.—By R. de Muralt. Mem. & Trav. Soc. Ing. Civ. France: Resume de Quinzaine, 1911, pages 60-61.

The revetement, or facing, is constituted by slabs of ferro-concrete, generally measuring 8 by 6 feet (2.4 by 1.8 metres) and from 2 to 4 inches (5 to 10 centimetres) thick, the reinforcement of the concrete consisting of extended metal. The slabs, independent of each other, are kept in place by a framework, also of ferro-concrete, anchored in the ground and covering their edges, thus forming cover-joint. Though held securely, so that they cannot be torn away, the slabs are free to expand, and can yield to shock.

For protecting water-way banks, square or rectangular slabs are formed, some with a lower and others with an upper rim, or flange, the latter fitting exactly on the former, so that one slab with upper flanges keeps in place four with lower flanges, being fastened at its middle by a ferro-concrete spike driven into the bank.

J. W. P.

Corrosion of Iron in Concrete Structures.—Anon. Science Conspectus, 1911, vol. i., page 128.

A series of tests have been made in the laboratories of the Massachusetts Institute of Technology, Boston (U.S.A.), in order to obtain data on the

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electrolytic action of iron embedded in concrete. It is well-known that if iron be surrounded with another substance, and then subjected to the action of an electric current from some external source, and if the current flows in the right direction, the iron will be deposited on the surrounding substance in a manner analogous to the common process of plating. The iron is not, however, deposited in the form of pure iron, but is irregularly distributed throughout the surrounding medium in the form of oxide of iron (rust). Although investigations have hitherto shown that iron embedded in concrete and properly protected does not rust, it has been demonstrated that should the structure be subjected to an electric current rapid disintegration may take place.

In the experiments mentioned above, bars of steel were embedded in concrete, the blocks of concrete were covered so that the current flowed through at least 3 ½ inches of the structure, and were then immersed in a salt solution. The blocks split, and the result of the tests is to show that if unstressed iron in concrete is subjected to a current as small as 0.015 ampere flowing from the iron to the concrete, rapid decay is inevitable, no matter what the thickness of the concrete may be. Other tests appear to show that the greater the stress which the material is undergoing, the less rapid is the corrosion.

A. P. A. S.

Remedy for Dampness in Structures.—By A. Knapen. Mem. & Trav. Soc. Ing. Civ. France: Resume de Quinzaine, 1911, pages 74-77.

[It is highly important to preserve from damp the pump and engine-rooms (surface and underground) of mines, and also their electric-power stations, to say nothing of managers', overmen's, and workmen's dwellings, and this from an economical as well as a sanitary standpoint.]

All structural materials are porous in different degrees; and it is owing to this porosity that capillarity and osmosis, saturation and condensation oblige moisture to penetrate them in either a liquid or a gaseous state. The imbibition heights, at different periods, of terra-cotta prisms having different degrees of porosity, with their bases dipping in distilled water, show strikingly how capillarity can act on foundations in contact with damp ground; and ravages in walls built of various materials and of different orientation prove conclusively that complete water tightness of walls above ground-level is wrong and unnatural. Entrance of water from the outside must be prevented; but, in walls subject to thermic variations, their internal porosity should be preserved, and the gases in tension behind the impermeabilized faces allowed to escape, or the water which may have accumulated there owing to capillarity and condensation must be evaporated and expelled.

For accomplishing this the author employs a brick of ordinary form, but perforated obliquely, and a terra-cotta prism, also perforated, which are introduced over one course or more up to the median vertical plane of the wall. They must be set a certain distance apart, so that their radii of action, which depend upon the slope of the channel and the porosity-coefficient of the materials, may intersect one another. The triangular form has been adopted because, at the intersection of two planes in the porous bodies, the edges are the parts which first arrive at the dew-point; and a definite porosity coefficient has been given to each of the new elements which, set permanently in the walls, constitute accumulators of humidity, each containing in its interior a "single-branch atmospheric syphon with continuous automatic action" which, in turn, expels the moisture accumulated by the porous

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element. The air, entering at a lower hygrometric degree, penetrates to the bottom of the channel, becomes saturated with the circumambient humidity, and is expelled owing to its difference of density and the difference of temperature caused by evaporation. This action continues so long as there is unstable equilibrium between the inside and outside of the wall.

In the abutments of a railway-bridge the visible effects of the Knapen appliances were photographed on several occasions and at different periods, the damage thus revealed, affording conclusive proof that, by the action of their system, the problem has been solved of definitely modifying the physical state of a structure's materials without altering their nature or stability.

J. W. P.

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#### MECHANICAL ENGINEERING, ELECTRICITY IN MINES, Etc.

Latest Experiments on the Effect of Boiler-scale.—By H. Hempel. Oesterr. Zeitschr. f. Berg- u. Huttwes., 1910, vol. lviii., page 267.

It has hitherto been assumed that the scale formed on the inner side of a boiler from the impurities in the feed-water greatly hinders the transmission of heat to the water. It is asserted that it largely affects the heat efficiency, and also causes the boiler-plate to become

red-hot. Various methods of getting rid of it have been proposed, some of them claiming to effect a saving in coal of 15 per cent. In a paper read by Herr Eberle at the meeting of the International Association of Boiler Inspectors, doubt was thrown on this assertion, and a series of careful experiments were made to establish the facts.

It was found that the action of boiler-scale on the transmission of heat was not so great as that of the sooty deposit on the other side of the boiler-plate. A special experimental boiler was constructed, fed with water charged with lime, and worked continuously night and day. Experience had shown that, when the tests were stopped at night, pieces of scale chipped off, because of the unequal contraction of the iron and the scale: therefore, in order to have a uniform layer for the purposes of the test, it was necessary to stoke uninterruptedly. After 8 days of continuous work, a layer had formed 1/16 inch thick, containing 81 per cent. of sulphate of lime, 15 per cent. of carbonate of lime, and also oxide of iron, carbonate of magnesia, and silicic acid. Another experiment gave a deposit of scale of practically the same composition, 3/16 inch thick; in a third a tarry deposit 1/75 inch. was artificially produced, to represent the effect on the transmission of heat when the feed-water is not wholly purified from lubricating oil.

The total transmission of heat was found to be less when the boiler-walls were covered with scale, but there was a slower fall in temperature of the hot gases through the flues, and therefore the mean range of temperature between the gases and the water was less with than without the boiler-scale. The reduction in the heat transmitted with the dirty boiler was partly compensated by the greater mean temperature-range in the clean boiler. Thus the effect of scale on the heat efficiency is much less than has hitherto been supposed. The experimental boiler had a heating surface of 1,765 cubic feet, the thickness of the boiler-walls was  $\frac{3}{4}$  inch. The heat-efficiency in the clean boiler was 74.9 per cent.; in the boiler with scale 3/16 inch thick, 72.5 per cent.; while in the tests with the thin film of tarry deposit it varied from 68 to 71 per cent. The conclusion arrived at was that, if the scale was never allowed to exceed this thickness, the heat-efficiency of the boiler would only be reduced by 5 per cent.; if the scale were a moderately good heat-conductor, the

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efficiency would only be reduced by 2 to 3 per cent., and if the boiler were regularly cleaned at stated intervals, the loss might be no more than 1 to 2 per cent. E. M. D.

Heating of Boilers with Blast-furnace Gases.—By Gustav Oelwin. Oesterr. Zeitschr. f. Berg- u. Huttwes., 1910, vol. lviii., pages 393-397 and 407-411.

The author gives the results of tests carried out at the ironworks of the Archduke Friedrich, at Trzynietz, in Austrian Silesia, on a set of boilers installed to supply steam for the blast to the furnaces. The Lurmann system of firing with furnace-gas was applied, in which a gas-jet enters horizontally through a nozzle set low in each of three sides of the combustion-chamber and is impinged upon at right angles by two pre-heated air-jets, both the gas-and air-inflow being regulated by hand. As the results were unsatisfactory, a new form of burner was devised by Wladimir Dolinske, in co-operation with Peter Ritter von Mertens and Auton Gwiggner, and has been most successful in its working. The apparatus automatically, and independently of the variations in the pressure of the incoming gas, feeds the combustion-chamber with the required quantity of gas intimately mixed at the time of injection with the proportion of air necessary for complete combustion. The improved burner employed has furnished an increase of nearly 54 per cent. of steam from the combustion of a given

quantity of gas, thereby rendering possible firing with furnace-gas alone. The new system, therefore, ensures (1) a more perfect mingling of the gases and air in the requisite proportions; and (2) the independent and automatic regulation of the inflowing air.

A. P. A. S.

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Lehmann Multiple High-pressure Centrifugal Pump.—By Otto Wechsberg. Oesterr. Zeitschr. f. Berg- u. Huttwes., 1910, vol. lviii., page 101.

Modern high-pressure centrifugal pumps are generally so constructed that each blade is placed close behind the other, and the water is easily guided from wheel to wheel, but the axial thrust set up is often very great, and to relieve the pressure is an important matter. In the Lehmann patent each blade is separately relieved. Each rotor-blade has two packing rings, which caulk the wheel against the casing, and form equal clearance-spaces in front of, and behind the blade. A connexion is made between these spaces, and the pressure in them is rendered uniform throughout. To establish this equilibrium of pressure, and make it independent of the rotation of the pump, is the object of the patent.

The water passes at a given velocity from the rotor to the guide-blades, where the speed is reduced by side-blades, and is then led to the next wheel through an intermediate ribbed chamber with overflow pipes. The ribbed divisions are utilized to form an axial clearance. Each space between them is connected both with the clearance behind the blade, and through the guide-blade with the overflow pipe of the previous set of blades. Here the pressure being the same as in the blade-inlet of the wheel, it is thus relieved, and no axial thrust can be set up. The water in the overflow channel passes the opening to the clearance at a certain velocity, and this again contributes to the maintenance of the equilibrium. It is independent of the speed of rotation of the wheel, and is not liable to disturbance, as when the boss is pierced to relieve the pressure.

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The system has been worked for some time at the Brunn-Konigsfelder Maschinen-Fabrik, where the Lehmann patent is made. In a high-pressure pump with six expansions a delivery of 550 to 660 gallons of water per minute, raised to a height of 1,150 feet, is obtained at a speed of 1,480 revolutions per minute. Two such mines are working at Funfkirchen, in Hungary. It is claimed for the turbine that it is easy to unmount if necessary, and the brasses on the shaft, being of bronze, are not attacked by the water. This is of special importance at the Funfkirchen mine, where the water is impregnated with sulphuric acid. After 3 months' work one of the pumps was unmounted, and oil from the erection still adhered to the shaft. The automatic lubrication is on the same principle as the rest of the turbine, and the bearings act on the oil like small centrifugal pumps.

E. M. D.

Chart for Reading off the Vacuum in a Mercury Pressure-gauge.—Anon. Oesterr. Zeitschr. f. Berg- u. Huttwes., 1910, vol. lviii., page 21.

In an ordinary pressure-gauge, the pressures, when read off the scale, are only correct when the barometric pressure of the external air corresponds to the scale of the instrument, otherwise it must be corrected for atmospheric pressure. A mercury pressure-gauge is much preferable to a spring-gauge, which soon gets out of order.

The instrument described by the writer consists of a thin vertical glass tube 34 inches high, open at each end; one end is connected by a rubber tube to an air-pump or suction-main,

the other rests in a bulb filled with mercury. Both bulb and tube are marked to scale. The zero (or atmospheric line) lies in the upper half of the bulb, while the scale on the glass tube starts from it, and is numbered upwards. As soon as connexion with the vacuum is established, the scale on the glass tube gives the corresponding distance from the atmospheric line, but the results must be divided by the reading of the barometer, and corrected for atmospheric pressure.

To obviate this difficulty, the writer has invented a small chart, which is fixed behind the glass tube. To plot it, the fluctuations in the pressure of the air in a given district must first be noted, and a mean taken. Assuming that the maximum is 760 millimetres, and the minimum 720 millimetres, the mean will be 740 millimetres. A horizontal line representing this mean is then drawn and marked off into 40 equal parts, each 1 millimetre in length. At one end of this line a perpendicular line at right-angles to it is traced, and divided off into 100 equal parts, the length of each being determined by the height of the barometer. If this, say, is 740 millimetres, each part will be 7.4 millimetres, or, reckoning from the top, one ninety-ninth of the whole. This process is continued till 70 per cent. of the whole line has been thus marked off. At the other end of the horizontal, a second perpendicular line is drawn, and divided off into 100 parts, each 7 millimetres in length. Lines are now drawn connecting the points marked off on either perpendicular line, and a series of transverse parallel lines are thus obtained. Where the ordinates of the horizontal line cut the abscissae of the perpendicular, the height of the barometer at the time of the reading will be shown. The chart is fastened to a rod, and fixed behind the glass tube in such a way as to correct its reading. By raising or lowering it, the point on the chart giving the exact height of the barometer at the time is brought exactly behind the mercury column in the glass tube. E. M. D.

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Fire-damp-proof Motor for Mining Use.—By A. Thomalen. Gluckauf, 1910, vol. xlv., pages 1884-1886.

The author describes a fire-damp-proof guard for electro-motors, intended for use in fiery mines. The open ends of the motor-casing are closed by guards formed of a solid disc that fits over the shaft by means of a sleeve, and carries on the inner side an open ring composed of a large number of annular plates set not more than 1/25 of an inch apart. Even if the mixture of air and fire-damp be exploded inside the motor-casing by an electric spark, the flame cannot extend to the outside air, owing to the cooling action of the annular plates, although the gases produced by the explosion are able to escape through the intermediate spaces. C. S.

Electric Plant in Fiery Workings.—Anon. Chron. Trav. Pub., 1911, pages 2746-2747.

The Belgian Mine Administration has authorized the Ressaix, Leval, Peronnes, Sainte-Aldegonde Colliery Company to put down, in a chamber along a communication-drift between the two shafts of the Albert pit, at the level of 1,266 feet (386 metres), an armoured 35-horsepower three-phase asynchronous motor, with short-circuit rotor, driving directly and with rigid coupling a Gebauer centrifugal pump capable of raising 8,803 gallons (40 kilolitres) per hour to the height of 360 feet (110 metres). At the Sainte-Marie pit, under similar conditions at the level of 393 feet (120 metres), a 35-horsepower three-phase hermetically-encased asynchronous motor, with ring rotor, will drive directly a Weisse-and-Monsky centrifugal pump. Lighting of the communication-drift by hermetically enclosed incandescent lamps is permitted. The Richesse seam, between the levels of 1,042 and 867 feet (318 and

264 metres), is to be worked with descending ventilation, coal being sent off along part of the return airway.

The La Louviere and Sars-Longchamps Company is authorized to put down electric pumps at the levels of 1,890 feet (576 metres) and 2,536 feet (773 metres) in the Leopold pit of La Louviere Colliery, which is classed as very fiery.

The Strepv-Bracquengnies Company is permitted to use the same air-current for ventilating two working-places in different seams, at the levels of 1,788 feet (545 metres) and 1,525 feet (465 metres), subject to the following conditions:—(1) The faces of rising stalls must be so arranged as to avoid gas-accumulation, and the ventilation must be ascending at all points between the levels of 1,788 and 1,240 feet (545 and 378 metres); (2) the air-current for ventilating the places in question must never be less than 7,700 cubic feet (35 cubic decimetres) per second per workman of all classes in the most numerous shift.

J. W. P.

New Electric Plant at the Houssu Colliery.—Anon. Chron. Trav. Pub., 1911, pages 292-293.

At the depth of 2,306 feet (703 metres), 328 feet (100 metres) north of the double shaft, 8 and 9, of the Houssu Colliery, Haine-Saint-Paul, Belgium, it is arranged to lay down a 150 horsepower three-phase asynchronous motor, to be supplied by 2,000-volt alternating current, for belt-driving an "express" pump, capable of raising 7,920 gallons (36 kilolitres) per hour to a total manometric height of 2,330 feet (710 metres) at 115 revolutions per minute; a 15-kilovolt-ampere static transformer for reducing the pressure from 1,000 to

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250 volts; two 7 ½ -horsepower asynchronous motors, with rotor in short circuit, supplied by 250-volt alternating current and directly driving two centrifugal pumps, and also supplying ten incandescent lamps for lighting the landing and pump-room, which latter measures 49 by 13 by 12 feet (15 by 6.8 by 3.5 metres) and ventilated by a fresh-air current. In pit No. 2, at the depth of 1,280 feet (390 metres) and 56 feet (17 metres) east of the shaft, a 50-horsepower asynchronous motor, with ring-rotor, supplied by 500-volt three-phase alternating current, will belt-drive a rotary pump capable, at 105 revolutions per minute, of raising 4,400 gallons (20 kilolitres) per hour to a height of 1,365 feet (416 metres); a 1.5-kilovolt-ampere single-phase static transformer, will reduce the pressure to 110 volts, for lighting the engine-room.

At the Bois-du-Luc Colliery, in the same district, the Quesnoy plant will be provided with an electric haulage-engine at the level of 1,443 feet (440 metres) for bringing up the material excavated in sinking a staple-pit. The working parts, especially the spur-gear, will be carefully encased; and the timber frames supporting the roof near the haulage-engine will be protected by iron plates.

J. W. P.

Electric Winding at the Elisabeth Collieries, Auvélais.—Anon. Bull. Soc. An. Ateliers Constr. Electr. Charleroi, 1910, pages 162-163 and 166-167.

For a depth of 1,640 feet (500 metres) with intermediate landing half way, 2-ton cages carrying four 6-hundredweight tubs, superposed, and a net coal load of 2.4 tons (or 3.2 tons of stone), the Societe Anonyme des Ateliers de Constructions Electriques, Charleroi, has provided the Velaine-sur-Sambre division of the above collieries with an electric winder for

flat manila-fibre ropes. The two winding-pulleys, 13 feet (4 metres) in diameter, and the brake-pulley are keyed on the principal portion of the main shaft, which is in two parts connected by forged flanges, and driven direct by the motor, the other part carrying the armature. The cast-iron bodies of the winding-pulleys, in two parts and carrying channel-iron arms, are 13 feet (4 metres) in diameter. The brake is kept on by a weight at the end of a horizontal lever, unless taken off by the piston of a compressed-air cylinder that can, if required, be supplied with steam. The depth-indicator consists of two vertical threaded rods with bells, actuated through a train of spur-wheels encased hermetically. Lubrication is effected under pressure; and the oil is filtered for use over again.

The 240-280-horsepower winding-motor, with 220-volt continuous current, making 28 revolutions per minute, has independent 110-volt excitation. A "buffer" (tampon) or regulating group consists of (1) a three-phase asynchronous motor, giving out 300 horsepower with 3,000-volt current, making 333 revolutions per minute; (2) a continuous-current generating dynamo of 220 kilowatts at 220 volts, the two armatures being carried by couplings on the same shaft on which it keyed; (3) a turned cast-steel flywheel, 12 feet (3.6 metres) in diameter, balanced by a 24 ½ -ton counterweight. The starting rheostat of the motor is placed in the basement; but the lever of the rheostat of the generating dynamo field and that of the brake are arranged on the engineman's platform. The air-compressor is driven by a three-phase asynchronous motor, making 1,500 revolutions per minute.

Similar plant has also been supplied to the Baulet division of the same colliery; but the winder-motor of 190-226 horsepower with 250-volt continuous current is capable of exerting 400 horsepower on starting, and the 10-foot flywheel of the "buffer" regulating group weighs 13 tons. The weight wound in 8 hours is 600 tons, from three different landings, the deepest of which is

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1,312 feet (400 metres), in 2-ton cages, carrying four 6-hundredweight tubs, each with a useful load of 0.6 ton coal or 0.8 ton stone. The speed of winding is 131 feet (42 metres) per second at both divisions; and changing the tubs takes from 40 to 45 seconds.

J. W. P.

Electric Winder at the Anderlues Colliery.—Anon. Bull. Soc. An. Ateliers Constr. Electr. Charleroi, 1910, pages 163-169.

This colliery, of sinister fame, has been provided with an electric winder, designed in accordance with the following data:—Quantity wound in 8 hours, 300 tons; depth of winding, 2,296 feet (700 metres); weight of a cage, 1.3 tons; number of tubs, 4; weight of tub empty, 3 cwt. (150 kilograms); tub-load of coal, 8 cwt. (400 kilograms); tub-load of stone, 11 cwt. (550 kilograms); caging operations at each lift, 40 seconds; gross weight, 1.9 tons; net weight of coal, 1.6 tons; net weight of stone, 2.2 tons, and weight of flat steel-wire rope per yard, 9 pounds (4.3 kilograms per metre).

The mechanical portion comprises:—(1) The two winding pulleys, cast of iron in two parts, 14 ½ feet (4.4 metres) in outside diameter, and the brake-pulley 9 feet (2.75 metres) in diameter, keyed on the main shaft, which is in two parts connected by flanges cast on; (2) the two-block brake-gear, fitted with a system of rods that can be regulated, and two blocks put on by a weight with very long lever-arm and taken off by a small electro-motor, the starting lever being, handy to the engineman, and a dash-pot preventing shock; (3) a depth-

indicator consisting of two vertical screws with bells, driven by spur-gear hermetically encased; (4) a special arrangement of wedges that acts on the main working lever, for automatically slowing the motor and even causing stoppage; and (5) the control by levers of the various motors' rheostats.

The electrical portion comprises : —(1) The continuous-current winder motor that can give out 140 horsepower with 220-volt current at 33 revolutions, but is capable of yielding 180 horsepower for starting; (2) a regulating set consisting of a three-phase asynchronous motor of 230 horsepower with 500 volts, a 130-kilowatt continuous-current generator with independent 220-volt excitation and giving 220-volt current, a 2-ton turned and balanced fly-wheel, 6 ½ feet (2 metres) in diameter, interposed between motor and generator, and a 220-volt hyper-compound exciter for the generator of the compensating set and the winder motor, besides the 2-horsepower brake-motor, rheostats for regulating the exciter of the generating dynamo, for starting the motor of the compensating set and for regulating the excitation of its generator, and also interruptors for the circuit of the winder motor, for that of the intensity of the latter's excitation and for the prevention of overwinding.

J. W. P.

Progress in Electrical Winding-engines in 1910.—By J. Blazek. Oesterr. Zeitschr. f. Berg- u. Huttwes., 1910, vol. lviii., page 345.

Among the most important improvements in the application of electric power to mining engineering are a reduction in the first-cost of the plant, in the working-costs, including attendance, and an increased heat-efficiency of the engine. Under the first head may be reckoned a decrease in the diameter of the drum, which varies from 51 to 143 inches, according to the thickness of the winding-rope. The speed of both drum and engine may often be increased with advantage, and a smaller diameter of drum and thickness of rope are also desirable. The method of throwing the cages on and off also affects the space occupied by the engine, the time of winding, and hence the cost. Two

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trucks, one behind the other at each level, are the best arrangement, and the useful load should be carefully determined. Given the depth of the shaft, and the quantity of stuff to be raised per wind, a certain definite useful load, to be separately determined in each case, will be found most conducive to efficiency. Various systems of electric winding have their several merits and demerits; the writer describes an arrangement of his own, in which, steam being taken continuously from the boiler, there is a complete equilibrium of load, and thus greater efficiency is ensured. It is not only the efficiency in running, but also many other factors, such as depreciation, simplicity, and ease in erecting and driving the engine, which determine the total efficiency of the plant.

The writer gives unqualified preference to electric brakes, as the simplest and most practical for winding-engines. In an Igner electric engine now working in a mine at Kreka, in Bosnia, the diameter of the drum is 6 ½ feet, and the width, 4 feet 1 inch; the useful load raised per wind is 2,640 lbs. coal, or 3,520 pounds of rock. The winding speed is 23 feet per second from a depth of 360 feet. The cages are double-decked, each to take one truck, and the weight of each cage when empty is 770 pounds. So great has been the development of electric winding-engines in the short time that has elapsed since their adoption, that they have already reached a stage of efficiency which does not seem likely to be greatly improved upon in the near future.

E. M. D.

New Electric Plant at the Mariemont and Bascoup Collieries.—By P. Bouzanquet. Mem. & Trav. Soc. Ing. Civ. France, 1910, pages 408-412.

These collieries, held by the same owners, but keeping separate accounts, in the central district of Belgium, have together an output of 1,200,000 tons per annum, with eleven winding shafts and more than 7,000 workmen. The latest plant (Bascoup No. 7) comprises two shafts, 14 feet (4.25 metres) in diameter, fitted with Briart metal guides. Winding is as yet effected by the downcast shaft only; but the upcast shaft is provided with Briart valves for concurring eventually in the winding. Both shafts are to be sunk to a depth of 2,624 feet (800 metres). For each shaft there is a duplex winding-engine, all the parts of which are got out for permitting replacement of the present cylinders, 2 feet 8 inches (80 centimetres) in diameter, by others 3 feet 3 3/8 inches (1 metre) in diameter. The three-deck cages, carrying six tubs, end to end, are fitted with the Hypersiel safety-catch with progressive action; and an overhead traveller facilitates the caging operations.

The same building that covers the bank and winding-engines also contains the improved Guibal fans (one in reserve), 20 feet (4 metres) in diameter and 5 1/2 feet (1.66 metres) wide, rope-driven by one or two single-cylinder engines at 174 revolutions per minute, and giving a water-gauge of about 4 inches (100 millimetres). Wolff benzine lamps with re-lighters are used. Separated from the lamp-room only by the giving-out wicket, are the lockers, drying rooms, and baths, for which latter douche-baths are to be substituted. The coal of No. 7 Bascoup is sent by chain-haulage to the central screening station; and a wire-rope tramway is being put up for leading the rubbish to a new tip. A building, erected entirely of metal, contains the haulage-motors, two large silos, or bins, for the rubbish, two transporters on which the rubbish is spread out on arrival, and three tippers. One of the latter will tip directly into the silos the rubbish from cross-cuts and the other two into the transporters that come from the faces, in which there are inevitably pieces of coal and old timbers. These are

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picked out by hand, the wood being sold for firewood. It is firmly believed that this plant will largely pay for its cost.

Adjoining No. 7 Bascoup is an electric generating station for serving the two collieries. The large building consists of a ferroconcrete framework (filled in with brick masonry) to withstand the subsidence which there is reason to fear may take place. The Mathot water-tube boilers, each with 2,151 square feet (200 square metres) of heating-surface, and a pressure of 176 pounds per square inch (12 atmospheres), are provided with superheaters that can raise the temperature of the steam to 570° Fahr. (300° Cent.). Three Brown-Boveri-Parsons steam-turbines coupled direct to 1,750-kilowatt alternators, making 1,500 revolutions per minute, produce 3,150-volt three-phase current, and will, when the fourth turbo-alternator is erected, give out 10,000 horsepower. The current will be used, as generated, in large motors, such as that for driving the pump at No. 7 and other pits, the winder at No. 6 and the fan at No. 5; but it will be transformed to 190 volts for smaller motors, so as to lessen danger and facilitate lighting.

J. W. P.

Remarkable Performance of an Induction-motor.—Eng. & Min. Journ., 1910, vol. xc, page 123.

A 20-horsepower three-phase 220-volt standard induction-motor, made by the General Electric Company, recently demonstrated its ability to operate successfully in a mine belonging to the Richmond Iron Works, Massachusetts. The motor was only partly enclosed, and was geared to a mine-pump located at the bottom of a shaft. Surface-water broke into one of the upper levels and flooded the mine, and, owing to the rapid rise of the water, the electric pump and motor were covered to a depth of 2 feet. The motor commenced to work, and, after 2 hours, managed to pump itself clear, when the opportunity was taken to clean the dirt and chips from about the rotor and to oil the bearings. The motor was started immediately afterwards, and the pump has worked about 20 hours per day ever since, the motor having apparently suffered no injury from its submergence. A. P. A. S.

Girod Electrical Furnace.—By W. Borchers. Oesterr. Zeitschr. f. Berg- u. Huttwes., 1910, vol. lviii., page 149.

The Girod electrical furnace is made in two sizes, namely, of 300 and 1,200 kilowatts respectively. The principle of the furnace is that the metal charge constitutes one of the poles; the opposite pole is formed by one or more blocks of coal, introduced vertically into the furnace from the top, and arranged in parallel. The liquid metal is overlaid with an electrolytic conducting layer of molten, chiefly basic, refining slag, in which the fluxes for purifying the iron are dissolved. Between the slag and the blocks of coal a voltaic arc is passed. Although the main heat is generated here, the slag resting on the metal and the metal itself participate in the transfer of heat, and become active conductors of the current. The method by which this is done is the leading principle of the Girod furnace. Solid contact-pieces of the same metal pass through the metal bath, and convert it into one of the electrodes. Thus the whole mass is permeated by the electric current, and the block of coal forms the other electrode. The latter is withdrawn from the furnace before the hot or cold charge is introduced.

The cost of a furnace for a charge of 2 ½ tons is £600 (15,000 francs). If the dynamo is near the furnace-house, the price of a furnace taking a charge

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of from 10 to 12 ½ tons is double the above. At the Campagne des Forges et Acieries Electriques (P. Girod), at Ugine, in Savoy, there are thirty-one furnaces dealing with iron alloys. Six firms in Germany and Austria, and also the well-known Seraing firm, in Belgium, have adopted the system. In a small furnace the charge consisted of from 2 to 2 ½ tons of scrap-iron, 66 pounds of burnt lime, and from 450 to 770 pounds of oxidized iron-ore. The whole process of smelting takes about 8 hours, according to the purity of the iron. Allowing for a waste of 10 or 11 per cent., the expenditure in a small furnace is from 1,000 to 1,200 kilowatts per hour per ton of finished steel, and in the larger furnaces from 800 to 900 kilowatts. The waste of the electrodes is about 26 to 33 pounds per ton of steel.

E. M. D.

Automatic-signalling Device for the Safe Working of Electric Locomotives at Underground Junctions.—By —. Meyer. Gluckauf, 1910, vol. xlvi., pages 1658-1661.

An automatic signalling device has been installed at an underground junction of two haulage-roads in the Hugo Zwang colliery, Barenhof, Upper Silesia, to replace the pointsman and prevent collisions, whilst indicating to the drivers of empty trains the number

of trains in each branch. For the latter purpose, a square horizontal shaft is rotatably mounted in the roof of each road, a short distance from the junction, and carries two wooden crosses on either side of the trolley-wires. Each cross is turned through 90 degrees by contact with the trolley-pole of the passing locomotive, and causes the shaft to operate signal lamps (by electrical connexions), which indicate whether 1, 2, 3, or 4 trains have passed along the branch. On the return of a full train, the movement of the shaft is reversed, and the number previously indicated is diminished by one. At the same time, the train passing the junction operates the ordinary signals, blocking the line until the next section has been traversed. The cost of installing the system amounted to £51 10s. (1,030 marks), namely, eight switches, £28; wiring, £15; insulators, 10s.; fixings, £2; and erecting, £6. The annual cost of maintenance is estimated at 12s., and the saving in comparison with the old system, operated by a pointsman, at £36 5s. per annum. C. S.

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METALLURGY, CHEMICAL INDUSTRIES, ETC.

Treatment of Blue and Black Blast-furnace Slag.—By H. Fleissner. *Oesterr. Zeitschr. f. Berg- u. Huttwes.*, 1910, vol. lviii., page 75.

The object of the writer's experiment was to detect, if possible, the presence of ultramarine in blue slag. In this he failed, although the slag was treated both by wet and dry processes. The colour in blue slag appeared to be due to the position of the particles, as they showed blue only in a bright light, and when in shadow were of a dull, brown. As black slag formed the chief constituent even of blue slag, attention was next directed to the colouring matter in it.

This has hitherto been attributed entirely to the presence of oxide of iron, and the larger the quantity present the blacker the slag is said to be. To test this theory, the writer smelted iron with and without charcoal. When treated with charcoal, the colour of the iron was a deep black; when the charcoal was omitted it was colourless; in other words, the colouring matter was apparently due to carbon. Various slags were then tested for their proportion of carbon, and it was found that from  $\frac{1}{2}$  to 1 per cent. was sufficient to produce

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the hue. Black slag containing little oxide of iron therefore owes its colour to carbon, which is embedded in fine veins in the whole mass of slag, and sometimes both colouring agents are combined. By examining it under a microscope, the writer proved that the colour of blue slag depended chiefly on the extent to which the slag was decrystallized. Blue slag is formed by partial decrystallization of the particles of black slag, and is produced by the annealing which takes place during the process of smelting. E. M. D.

Chemical Characteristics of the Roof-rock in Brown and Bituminous Coal-mines.—By A. Lissner. *Oesterr. Zeitschr. f. Berg- u. Huttwes.*, 1910, vol. lviii., page 580.

The question which these experiments were intended to elucidate was whether brown coal (lignite) and bituminous coal differed in their composition, or only represented different stages in the transformation of the same original substance. The gradual increase in carbon, and decrease in oxygen and hydrogen, which has been traced progressively in peat, brown coal, bituminous coal, and anthracite, appears to confirm the latter view. To determine whether these differences are due to the nature of the roof-rock, the author tested sampler from the roof of bituminous coal-seams from Moravia, and Bohemian brown coal. Both kinds

of samples were tested by dry distillation, then with solutions of potash, nitric acid, alcohol, ether, etc. The degree of moisture was determined, and the residuum of various chemical elements and compounds, after raising the rock to a red heat. The bitumen extracted from the sample of both kinds of rock was next examined, and their specific weight, elementary composition, amount of acids, ether, iodine, and various chemical reactions determined. In the action of oxidation, the bitumen in brown coal showed phenomena different from those manifested in bituminous coal, and these effects were so marked that there can be no question that the bitumen in the one is absolutely distinct from that in the other.

The differences in the roof-rock were chiefly organic, the specific weight of bituminous coal being 2.7, and that of brown coal 1.8. It was possible to eliminate completely the methyl from the bituminous coal, but lignite always showed traces of it. With both kinds of coal, chemical analysis of the roof rock shows that it contains less carbon and more hydrogen and oxygen than the coal-seams themselves, and that it has a tendency to spontaneous ignition, due to the bromide with which it is charged.

E. M. D.

Concentrating and Briquetting Iron-ore in Norway.—Anon. *Org. Indus.* 1910, No. 48.

Works at Bogen, about 20 miles from Narvik, concentrate 100 tons of ore daily by the magnetic method; and 25 miles farther north another establishment turns out yearly 100,000 tons of concentrated ore, which is sent to Germany, where it is made into briquettes.

There is a project for working a deposit of magnetite at Tromsø with power furnished by the neighbouring water-falls, concentrating the ore on the spot, and perhaps making it into briquettes.

A German-Swedish Company is putting up works for concentrating the ore mined at Sydvaranger, at the extreme north-east of the Finnish frontier. Briquettes are to be made with 100,000 tons of the 700,000 tons of concentrate that the works will be capable of producing.

J. W. P.

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Percentage of Sulphur in Iron-ores.—By Rudolf Schafer. *Zeitschr. f. Berg-, Hutt.- u. Salinenw.*, 1910, vol. lviii., pages 411-418.

After enumerating the different forms in which sulphur occurs in iron-ores, the author reviews the different methods of removing it, laying particular stress on the magnetic processes. He points out, however, that the ores thus prepared, as also fine ores in general, give trouble in working in the blast-furnace. The Grondal process receives special attention, as being in itself a good one, and suitable to the conditions obtaining in Sweden, where it is in use. In connexion with the sulphur question, the briquetting of ore is discussed, and in general recommended.

A. R. L.

Removing Graphitic Incrustations from the Vertical Pipes of Bye-product Coke-ovens.—By A. Thau. *Gluckauf*, 1910, vol. xlvi., pages 1839-1845.

For scraping the graphitic incrustation from the interior of the pipes, the author has devised a conical device, which can be lowered down the pipes, and, when drawn up again, expands in such a manner that its cutting edges come into operation. The device consists of a threaded bar bent round into an eye at the top, and provided there with a welded collar, below which is a loose ring that carries four cast-steel cutters which in the collapsed position form a closed hollow cone. The lower end of the bar passes through a solid cast-iron cone,

which is held in position by a nut. When lowered into the pipe to be cleaned, and drawn up again by means of a travelling crab running along a track on the top of the ovens, the cutters slide downwards over the solid cone, and are thus expanded so as to scrape the sides of the pipe. To prevent injury to the latter, the working diameter of the scraper can be adjusted, by means of a double nut, so as not to exceed the diameter of the pipe; and in the event of the tool jamming, the cutters can be collapsed by pulling on a chain, which displaces their supporting ring vertically on the bar.

C. S.

Towns lighted by Coke-oven Gas.—Org. Indus., 1910, No. 26.

For some time past the town of Essen, in Westphalia, has been partially lighted by coke-oven gas; and now Bochum, with nearly 100,000 inhabitants, has given up its gas-works, and is entirely lighted by gas from the coke-ovens of the Hannover and Hannibal Collieries, owned by the Krupp Company, at a cost of less than 1s. 2d. per thousand cubic feet (4 pfennigs per cubic metre).

J. W. P.

Cockerill Colliery and Coke-ovens.—By P. Bouzanquet. Mem. & Trav. Soc. Ing. Civ. France, 1910, pages 418-422.

All the coal worked in the company's concession of 758 acres (307 hectares) is now sent to bank by the Colard plant with its two shafts, both 2,073 feet (635 metres) deep and 14 ½ feet (4.5 metres) in diameter, and both used for winding, the upcast, by which the workmen travel, being closed by Briart valves. This shaft is provided with a winding-pulley for flat manila-fibre ropes, and the downcast with a conical drum for round steel-wire ropes, the former being capable of raising 200 and the latter 150 tons of coal daily. All the water of the concession, 132,000 gallons (600 kilolitres) per hour, is raised to the surface from the level of 1,716 feet (523 metres) by four steam pumping-engines, a water-pressure engine, and an electric turbo-pump, supplied by a

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800-horsepower 2,000-volt rotary transformer, the water of the lower levels being raised to that named by other electric water-pressure and compressed-air pumping-engines.

The ventilation is ensured by a Guibal, a Rateau, and a Capell fan, while a Mortier fan is held in reserve. Compressed air is now furnished by steam semi-humid compressors; but a gas power-station is being put up for driving high-speed compressors to supply all the motors in the mine. Underground lighting is effected by accumulator lamps of the Sussmann type at the landings, and Wolff benzine lamps with relighter and Debus magnetic locking arrangement in the workings. The benzine is introduced under pressure by carbonic acid.

The rescue-station is provided with eleven Securitas oxygen-appliances (Shamrock modified) and smoke-helmets, with air-pump, an oxygen-inhaler, ambulances, and a magnetic telephone station with double insulated wire. Every Friday five brigades, each of four men and a leader, exercise in the workings.

There are three different groups of coke-ovens—162 Appolt, with crushers and washeries; two banks of 26 and two of 28 Semet-Solvay bye-product-recovery ovens, charged by an electrically-moved wagon with three hoppers, and also discharged electrically. The coke is quenched—first in an extincteur, and then in a "coke-car," a trap in which allows it to fall into a railway-wagon.

J. W. P.

Peters Coke-oven Door.—Anon. Eng. & Min. Journ., 1910, vol. xc, page 180.

The door, which can be used for either a beehive or a longitudinal oven, swings on a shaft supported at the bottom by a concrete pier, and held in place at the top by a cast-iron anchor. The door, which is made of a special firebrick, and is held in position by a clamp, opens and shuts by means of two hinges, turning on two rollers and supported by steel pins. The chief features claimed by this type of door are the following:—(1) No metal is exposed to the heat of the oven, as, owing to its construction, the metal parts are on the outside; (2) there is no strain on the oven, as the entire weight of the door, when being operated, rests on the pier; (3) owing to its rigidity of construction, the door will last for many years; (4) that it will save its cost in one year, and two-thirds of the labour required to build up the doors by hand as in the old method; (5) it obviates the waste of brick and loam; and (6) owing to the quickness of operation, it can be closed immediately after the coke has been drawn, thus retaining the heat of the oven.

A. P. A. S.

Burkheiser Sulphate-of-Ammonia Process.—By O. Dobbstein. Gluckauf, 1911, vol. xlvii., pages 194-201.

The process is based on the oxidation of the sulphuretted hydrogen in coke-oven gas, and in employing the resulting sulphurous acid for combining the ammonia, thus saving the usual addition of purchased sulphuric acid for that purpose. It is applicable to all coke-oven gases from coal containing about 1 ½ per cent. of sulphur, this amount furnishing the requisite quantity of sulphuretted hydrogen. The gas is first freed from tar and ammonia, in the usual way, the ammoniacal liquor being distilled by steam, over milk of lime, to expel the ammonia, sulphuretted hydrogen, and cyanogen compounds, all of which are returned to the crude gas. The latter is then put through a

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purifier, charged with granulated bog-iron ore, which eliminates the sulphuretted hydrogen and cyanogen, ammonium sulphocyanide being formed. On regenerating the spent purifying material with a current of air, the sulphuretted hydrogen is recovered in the form of sulphurous acid, which is employed for absorbing the ammonia. For this purpose, the gas is passed through a saturator, charged with semi-neutral liquor from the ammonia-scrubber, which liquor absorbs ammonia and deposits mixed crystals of sulphite and sulphate of ammonia. This liquor is afterwards passed through the scrubber for eliminating the sulphurous acid gas, and subsequently through the scrubber for removing the final traces of ammonia from the gas, after which it returns to the saturator, and the cycle is repeated. The purifiers are duplicated, so that while one is in action, the other is being regenerated. The heat given off in the regenerating process is absorbed by water, which is used in turn to warm the purifiers and prevent deposition of moisture therein. The cooling of the purifying material during regeneration checks the tendency to form ferric sulphate, which would have to be removed by lixiviation. The Burkheiser salt can be transformed into sulphate of ammonia by heating it in a drum so as to volatilize the sulphite of ammonia, which is then oxidized to sulphate by a current of air. An experimental plant has been in use at the Tegel gasworks, Berlin, for some time, with satisfactory results.

C. S.

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ADMINISTRATION AND STATISTICS, Etc.

French Mining: Code of 1810.—Anon. Org. Indus., 1910, No. 41.

The most important of the resolutions passed at the International Congress of Mine Property, held at Brussels on the one-hundredth anniversary of the application of the 1810 French law, which forms the basis of mining legislation in many European countries, holds that the principal of this law should be maintained; that modifications necessary for placing it on a level with fresh requirements should be the result of serious legislative debate after previous examination by commissions embracing competent authorities of all kinds, and that no attempt, direct or indirect, should be made at mine nationalization (etatisation), which would prove the ruin of mining enterprise.

The papers and discussions brought out the following points:—In connection with the new Campine (Limburg) coalfield of Belgium, the formalities of concession were simplified, the responsibility of mine workers towards surface-owners was recognized, with the possibility of renouncing a concession, while it is liable to forfeiture after five years' non-working.

Poland has a mining law greatly resembling that of 1810; and the surface owner has no right to the minerals as in Russia, where the owner can work them without authorization. Bulgaria has also adopted the old law with but few modifications. Servia has a mining legislation inspired by that of Austria (1854), and not by Russia (as might have been expected). Under certain conditions the mine concessionnaire who pays a nominal royalty, may acquire ownership of the surface.

In Norway, mines are governed by the law of 1847, founded on the old German legislation, the dominant principle of which is the freedom of mines (Bergbaufreiheit), as distinguished from Bergregalitset, or regalian right (which separates ownership in the minerals from that of the surface), and at the same time right to their disposal by the sovereign. The law of 1888, however, forbids foreigners to acquire landed property without the King's permission;

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and in 1903 this interdiction was extended to mines. Finally, in 1909, the principle of freedom in mines was modified by subjecting their working, even by Norwegians, to royal permission.

The mining legislation of the Belgian Congo embraces two decrees separating the surface-ownership from that in underlying minerals, and subjecting to government rights all underground workings, which revert to the State after 99 years. A royalty is due by concessionnaires to the Government, which grants the use of domanial lands necessary for the working.

J. W. P.

Training of the Higher Government Mining: Officials in Prussia.—By —. Zix. Zeitschr. f. Berg-, Hutt.- u. Salinenw., 1911, vol. lix., pages 1-61.

This review of the past and present Prussian methods of training mining engineers for the service of the Government takes cognizance of three principal periods. The first embraces the time of preparation, from 1778 to 1839, when no uniform system had yet been adopted; the second, from 1839 to 1856, in which a group of aspirants for technical posts alone and another of aspirants for technical and (eventually) administrative posts existed side by side; and the third beginning with the issue of the Regulations of 1863, in which the division into groups is abandoned and the same training required of all Government mining officials. In the second of the above periods, three examinations were required and the students had to undergo a training lasting from 2 to 3 years longer than before or since. In the third period the curriculum is simplified again, and the time shortened. The writer of the article traces the connexion of these variations in the training with the growth of political ideas in the following

order:— Mercantilism, Free Trade, and gradual return to Protection, the present tendency being for the State to take over the working of some of the mines. It already manages a number of coal- and salt-mines.

A. R. L.

Belgium's Coal-production in 1910.—Anon. Org. Indus., 1911, No. 9.

The total coal-production of Belgium (Hainaut, Liege, and Namur) with 140,947 surface and underground hands, was 23,927,228 tons last year, against 23,517,550 tons with 140,717 hands in 1909 and 23,557,900 tons in 1908. These are the net outputs, which have been returned during the last 7 years instead of the gross outputs as formerly.

J. W. P.

Great Increase of Coal-production in Germany.—Anon. Org. Indus., 1911, Nos. 9 and 14.

Last year Germany's coal-production, 152,881,509 tons (against 148,966,316 tons in 1909), was the highest yet attained, the progression having been specially marked during the later six months. Indeed, the production has increased 50 per cent., very regularly, during the last ten years. The increase is chiefly due to the mining inspection districts of Dortmund (for 3,770,000 tons), Bonn, Bavaria, Saxony, and Alsace-Lorraine, while in that of Breslau there was a falling off.

While the fuel imports, chiefly those from Great Britain, fell off last year by about 10 per cent., or a million tons, the exports of coal, coke, lignite, and briquettes greatly increased, the first-named by 906,750 tons.

J. W. P.

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Ankylostomiasis in Liege Collieries.—By Dr. Malvooz. Org. Indus., 1911, No. 13.

Since 1903, when stringent measures were taken to combat the outbreak of miners' anaemia, which invaded all the collieries of the Liege district, the proportion of those affected fell from 26 per cent. in that year to 5 per cent. in 1906, and has continued to diminish slowly until the present time, when a stationary period seems to have been attained. In a paper to the Conference on Professional (Trade) Maladies, held at Brussels in 1910, it was stated that the chief reason for the persistence of this plague is the impossibility of expelling the parasite from the last miners affected, whose constitution resists the medical treatment prescribed, and whose lives might be endangered by administration of the high doses necessary to ensure a thorough cure. In such cases the men must be allowed to work, or be reduced to want.

At the end of 1910, the situation was so far improved that the number of those affected was reduced to 830, who were collectively subjected to 1,584 days of treatment. Out of the 16,886 miners examined on passing from one colliery to another, 684 were found to be affected, which gives a proportion of 4 per cent., the lowest yet recorded. Of the two collieries that were formerly the most troubled in this respect and where the measures taken were the most methodical, the proportion of cases at Gosson-Lagasse fell from 50 per cent. in 1903 to 2.6 per cent. in 1910, and at Patience et Beaujonc from 54 per cent. in 1899 to 2.4 per cent. in 1910. The above-named Conference declared that the only efficient measures against ankylostomiasis are those taken in the Liege district, and that they must not be relaxed for fear of recrudescence.

J. W. P.

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LIST OF EXPLOSIONS, 1910. Table III.—Continued.

Aug. 11, 14-0

„ 11, 2330

„ 12, 13-15

„ 19, 1-0

„ 24, 8-30

„ 27, 11-15

., 29, 7-30

Colliery.

Sept

Oct,

29, 11-30 3, 130 6, 12-45

11, 16-30

12, 11-0

12, 19-0

13, 930 13,23-10

14, 930

16, 17-30 23, 17-35

25, 170

26, 7-0 30,11-0

5, 15-45 12, 0-30 12, 645

15, 20 18, 23-0

20, 16-0

21, 130

22, 10-40

28, 6-20 31, 16-40 31,17-45 31,21-30 2, 6-40

2, 22-30

3, 7-30 7, 9-30

10, 11-0 11,12-0 15, 10-0 17, 7-0

„ 18, 8-0

„ 18, 17-0

„ 30, 12-30 Dec. 1, 14-0

„ 5, 4-30

„ 5, 10-30

Bardykes

Wirral

South Longrigg (No. 2 Pit)

Auchinreoch

Springhill

East Plean

Corngreaves

Spa Wood

Copper Pit

Bardykes

Woodhall

Broomhouse

Brayton (No. 5 Pit)

Frances

Coombs Wood

County.

Nov

New London Nottinghamshire

Lanark Cheshire

Lanark

Stirling Ayr

Stirling Staffordshire .

Yorkshire Glamorgan Lanark

Do.

Do. Cumberland . Fife Worcestershire.

Mines-inspection District.

No. of Persons. Injured.

Old Silkstone

Dunnikier

Gilbertfield

Ladyha'

Cousland (No. 2 Pit)

Gurnos

Milfraen  
Hattonrigg  
Auchenharvie  
Wallbutts  
Park Mill  
Highhouse (No. 1 Pit) New London  
Gilfach  
Emma  
Dunyston  
Hillrigg  
Bothwell Castle (No. 3  
Pit)  
Parc-y-Bryn  
Philpstoun  
Braidhurst (No. 2 Pit) Broomhouse  
Glynea .i  
Bog  
Lumphinnans (No. 11  
Pit) Pennyvenie (No. 2 Pit) Torycoed  
Daldowie  
Digby  
Yorkshire  
Fife  
Lanark  
Ayr  
Linlithgow  
Brecon  
Monmouth  
Lanark  
Ayr  
Staffordshire  
Yorkshire  
Ayr Nottinghamshire  
Glamorgan Durham Lanark  
Do.  
Do.  
Glamorgan Linlithgow Lanark Do. Carmarthen Lanark Fife  
Scotland Liverpool and North Wales Scotland  
Do. Do. Do.

Midland and  
 Southern Durham South Wales Scotland Do. Do. Newcastle Scotland Midland and  
 Southern York and North Midland Do. Scotland Do. Do. Do. South Wales  
 Do. Scotland  
 Do. Midland and  
 Southern York and North  
 Midland Scotland York and North  
 Midland South Wales Newcastle Scotland Do. Do.  
 South Wales Scotland  
 Do.  
 Do. South Wales Scotland  
 Do.  
 Ayr  
 Glamorgan Lanark Nottinghamshire  
 Upper Hartshay Dalmeny  
 j Derbyshire I Linlithgow  
 Do. South Wales Scotland York and North  
 Midland York and North  
 Midland Scotland

LIST OF EXPLOSIONS, 1910.

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Table III.—Continued.

1910.	Colliery.	County.	Edinburgh	Ayr	Do.	Renfrew	Ayr	Lanark	Do.	Glamorgan																
	No. of Mines-																									
	inspection																									
	District.																									
	Injured.																									
Dec. 5,	10-30	5,	11-0	8,	23-0	„	10,	7-0	„	12,	12 0	„	13.	110	„	16,	230	,	22,	13-45						
	Newbattle		Annandale		Springhill		Victoria		Springside		Lochwood		Gilbertfield													
	Torycoed		Scotland		Do.		Do.		Do.		Do.		Do.		Do.		South Wales		2	1	1	1	2	1	1	1

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Table IV.—Summary of Explosions of Fire-damp ob Coal-dust in the several Mines-inspection Districts during the period 1901-1910.

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II.—LIST OF FATAL AND NON-FATAL EXPLOSIONS OF FIRE-DAMP OR COAL-DUST, AND BAROMETER, THERMOMETER, etc., READINGS FOR THE YEAR 1910.

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Compiled by PERCY STRZELECKI.

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The barometer, thermometer, etc., readings have been supplied by the permission of the authorities of Glasgow and Kew Observatories, and give some idea of the variations of

atmospheric temperature and pressure in the intervening districts in which mining operations are chiefly carried on in this country.

The barometer at Kew is 34 feet and at Glasgow 180 feet above sea-level. The barometer readings at Glasgow have been reduced to 32 feet above sea-level, by the addition of 0.150 inch to each reading, and the barometrical readings at both observatories are reduced to 32° Fahr.

The statistics of fatal and non-fatal explosions have been obtained from H.M. Inspectors of Mines.

The times recorded are Greenwich mean time, in which midnight equals 0 or 24 hours.

Table I.—Summary of Explosions of Fire-damp or Coal-dust in the several Mines-inspection Districts during 1910.

Mines-inspection District.	Fatal Accidents.			Non-fatal Accidents.	
	No.	Deaths.	Injured.	No.	Injured.
Durham	0	0	0	2	2
Liverpool and North Wales	1	2	3	1	1
Manchester and Ireland	1	344	13	0	0
Midland and Southern	2	2	6	10	14
Newcastle	1	136	0	3	4
Scotland	11	13	6	70	90
South Wales	1	1	0	24	33
York and North Midland	1	3	0	12	21
Totals	18	501	28	122	165

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Table II.—List of Fatal Explosions of Fire-damp or Coal-dust in Collieries in the several Mines-inspection Districts during 1910.

1910.	Colliery.	County.	Mines-inspection District.	Deaths	No. of Persons Injured.
1909 Dec. 13,* 7.30	Brora	Sutherland	Scotland	1	0
1910. Jan. 17, 10.0	Starlaw (Deans Oil Shale)	Linlithgow	Do.	1	0
„ 19, 21.15	Jammage	Staffordshire	Midland and Southern	1	1
Feb. 21, 8.20	Cousland (Oil Shale)	Linlithgow	Scotland	1	1
Mar. 4, 10.15	Old Hill (Gawn)	Staffordshire	Midland and Southern	1	0
„ 5, 12.45	Gain	Lanark	Scotland	1	1
„ 7, 7.15	Govan (No. 5 Pit)	Do.	Do.	2	2

May 11, 19.40	Whitehaven (Wellington Pit)	Cumberland.	Newcastle	136	0
July 21, 19.30	Rotherham Main	Yorkshire	York and North Midland	3	0
Aug. 5, 1.30	Main Coal	Flint	Liverpool and North Wales	2	3
,. 13, 14.0	Llanmorlais	Glamorgan	South Wales	1	0
„ 14, 16.30	Newbattle	Edinburgh	Scotland	1	0
Nov. 11, 2.0	Viewpark	Lanark	Do.	1	0
Dec. 1, 12.0	Prestongrange	Haddington	Do.	1	0
„ 4, 23.0	Lochwood	Lanark	Do.	1	1
„ 13, 6.30	Craig	Ayr	Do.	1	0
„ 21. 7.50	Hulton	Lancashire	Manchester and Ireland	344	13
„ 28, 20.0	Deans (No. 3 Pit)	Linlithgow	Scotland	2	1
				501	28

\*Died on January 10th, 1910.

Table III.—List of Non-fatal Explosions of Fire-damp or Coal-dust in Collieries in the several Mines-inspection Districts during 1910.

1910.	Colliery.	County.	Mines-inspection District.	No. of Persons Injured.
Jan. 5, 22.15	Berthlwyd	Glamorgan	South Wales	7
„ 11. 22.45	Cwmilynfell	Do .	Do.	1
„ 17, 13.45	Copper Pit	Do .	Do,	1
„ 24, 7.20	Schoolfield	Staffordshire	Midland and Southern	3
„ 28, 6-30	Energlyn	Glamorgan	South Wales	1
Feb, 3, 9.45	Glynea	Carmarthen	Do.	1
„ 8, 17.0	Killan	Glamorgan	Do.	2
„ 14, 6.0	Werntarw	Do.	Do.	1
„ 14, 11.50	Selston	Nottinghamshire	York and North Midland	1
„ 16, 0.15	Oxcroft	Derbyshire	Do.	9
„ 16, 0.30	North Motherwell	Lanark	Scotland	1
„ 17, 1.10	Hattonrigg	Do.	Do.	1
„ 21, 12.0	Polmaise (No. 4 Pit)	Stirling	Do.	6
„ 24, 7.30	Cymmer (No. 2 Pit)	Glamorgan	South Wales	1
„ 25, 13.30	Aitkenhead	Lanark	Scotland	1
Mar.1, 12.30	Giffnock	Renfrew	Do.	1
„ 4, 10.15	Pollington	Nottinghamshire	York and North Midland	1

Table III.—Continued.

1910.	Colliery.	County.	Mines-inspection District.	No. of Persons Injured.
Mar. 12, 11.0	Raploch	Lanark	Scotland	3
„ 14, 12.30	Bannockburn	Stirling	Do.	1
„ 18, 11.15	Mynydd Newydd	Glamorgan	South Wales	1
April 1, 7.10	Bog (No. 3 Pit)	Lanark	Scotland	1
„ 1, 7.30	Gain	Do .	Do.	1
„ 4, 7.15	Garth Mountain	South Wales	South Wales	1
„ 7, 18.0	Brusselton	Durham	Durham	1
„ 13, 3.30	Glynea	Carmarthen	South Wales	1
„ 20, 2.15	Haunchwood	Warwickshire	Midland and Southern	
„ 21, 6.45	Corby Craigs (No.8 Pit)	Ayr	Scotland	1
„ 23, 7.45	Great Wyrley	Staffordshire	Midland and Southern	3
„ 23, 11.0	Parkneuk	Lanark	Scotland	1
„ 23, 22.0	Woodhall (No. 3 Pit)	Do .	Do.	1
„ 24, 22.20	Blairmuckhill	Do	Do.	2
„ 25, 8.0	Netherton	Yorkshire	York and North Midland	1
May 1, 18.30	Dalmeny	Linlithgow	Scotland	1
„ 3, 9.0	Hattonrigg	Lanark	Do.	2
„ 3, 11.0	Windyedge	Ayr	Do.	1
„ 4, 5.0	Seafield (No. 3 Pit)	Linlithgow	Do.	1
„ 4, 10.0	Viewfield (No. 4 Pit)	Lanark	Do.	1
„ 5, 5.0	Gilbertfield	Do	Do.	2
„ 12, 5 0	Burngrange	Edinburgh	Do.	1
„ 19, 13.30	Warrix	Ayr	Do.	3
„ 23, 8.30	Lochwood	Lanark	Do.	1
„ 23, 8.30	Coursington	Do .	Do.	2
„ 30, 2.0	Bowhill	Fife	Do.	1
June 1, 5.0	Milnwood	Lanark	Do.	1
„ 2, 11.30	Penlan	Glamorgan	South Wales	1
„ 4, 11.45	Grovesend	Do	Do.	2
„ 7, 8.15	Salterwood	Derbyshire	York and North Midland	1
„ 11, 10.15	Aitken	Scotland	Scotland	1
„ 18, 7.15	Hattonrigg	Lanark	Do.	1
„ 21, 7.45	Highhouse (No. 2 Pit)	Ayr	Do.	2
„ 24, 14.30	Aldridge	Staffordshire	Midland and Southern	1
„ 24, 23.0	Craig	Ayr	Scotland	1
„ 25, 7.45	Park Lane	Staffordshire	Midland and Southern	1
„ 25, 11.0	Saron Level	Glamorgan	South Wales	1

„ 27, 16.30	Allanton	Lanark	Scotland	1
„ 28, 23.30	Glengarw	Glamorgan	South Wales	1
July 6, 9.45	Cousland (No. 2 Pit)	Linlithgow	Scotland	1
„ 12, 13.30	Gartshore (No. 9 Pit)	Dumbarton	Do.	1
„ 12, 22.0	Whateley	Warwickshire	Midland and Southern	1
„ 13, 14.45	Philpstoun (No. 6 Pit)	Linlithgow	Scotland	1
„ 16, 7.30	Hanham	Gloucestershire	Midland and Southern	1
„ 19, 5.0	Milfraen	Monmouth	South Wales	1
„ 21, 3.30	Prestwick	Northumberland	Newcastle	1
„ 21, 12.30	Whinny Moor	Yorkshire	York and North Midland	2
„ 21, 22.45	Auchencruive	Ayr	Scotland	1
„ 23, 9.0	Whitehill (No. 1 Pit)	Ayr	Do.	1
Aug. 4, 18 0	Cornsilloch	Lanark	Do	1

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Table III.—Continued.

1910.	Colliery.	County.	Mines-inspection District.	No. of Persons Injured.
Aug. 11, 14.0	Bardykes	Lanark	Scotland	1
„ 11, 23.30	Wirral	Cheshire	Liverpool and North Wales	1
„ 12, 13.15	South Longrigg (No. 2 Pit)	Lanark	Scotland	1
„ 19, 1.0	Auchinreoch	Stirling	Do.	1
„ 24, 8.30	Springhill	Ayr	Do.	1
„ 27, 11.15	East Plean	Stirling	Do.	1
„ 29, 7.30	Corngreaves	Staffordshire	Midland and Southern	1
„ 29, 11-30	Spa Wood	Yorkshire	Durham	1
Sept. 3, 130	Copper Pit	Glamorgan	South Wales	1
„ 6, 12.45	Bardykes	Lanark	Scotland	1
„ 11, 16.30	Woodhall	Do.	Do.	2
„ 12, 11.0	Broomhouse	Do.	Do.	2
„ 12, 19.0	Brayton (No. 5 Pit)	Cumberland	Newcastle	2
„ 13, 9.30	Frances	Fife	Scotland	1
„ 13, 23.10	Coombs Wood	Worcestershire	Midland and Southern	1
„ 14, 9.30	New London	Nottinghamshire	York and North Midland	1
„ 16, 17.30	Old Silkstone	Yorkshire	Do.	1
„ 23, 17.35	Dunnikier	Fife	Scotland	1
„ 25, 17.0	Gilbertfield	Lanark	Do.	1
„ 26, 7.0	Ladyha'	Ayr	Do.	1
„ 30, 11.0	Cousland (No. 2 Pit)	Linlithgow	Do.	1

Oct. 5, 15.45	Gurnos	Brecon	South Wales	1
„ 12, 0.30	Milfraen	Monmouth	Do.	2
„ 12, 6.45	Hattonrigg	Lanark	Scotland	1
„ 15, 2.0	Auchenharvie	Ayr	Do.	1
„ 18, 23.0	Wallbutts	Staffordshire	Midland and Southern	1
„ 20, 16.0	Park Mill	Yorkshire	York and North Midland	1
„ 21, 1.30	Highhouse (No. 1 Pit)	Ayr	Scotland	1
„ 22, 10.40	New London	Nottinghamshire	York and North Midland	1
„ 28, 6.20	Gilfach	Glamorgan	South Wales	1
„ 31, 16-40	Emma	Durham	Newcastle	1
„ 31, 17.45	Dunyston	Lanark	Scotland	1
„ 31, 21.30	Hillrigg	Do.	Do.	1
Nov. 2, 6.40	Bothwell Castle (No. 3 Pit)	Do.	Do.	2
„ 2, 22.30	Parc-y-Bryn	Glamorgan	South Wales	1
„ 3, 7.30	Philpstoun	Linlithgow	Scotland	1
„ 7, 9.30	Braidhurst (No. 2 Pit)	Lanark	Do.	1
„ 10, 11.0	Broomhouse	Do.	Do.	1
„ 11, 12.0	Glynea	Carmarthen	South Wales	1
„ 15, 10.0	Bog	Lanark	Scotland	1
„ 17, 7.0	Lumphinnans (No. 11Pit)	Fife	Do.	1
„ 18, 8.0	Pennyvenie (No. 2 Pit)	Ayr	Do.	1
„ 18, 17.0	Torycoed	Glamorgan	South Wales	1
„ 30, 12.30	Daldowie	Lanark	Scotland	1
Dec. 1, 14.0	Digby	Nottinghamshire	York and North Midland	1
„ 5, 4.30	Upper Hartshay	Derbyshire	York and North Midland	1
„ 5, 10.30	Dalmeny	Linlithgow	Scotland	1

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Table III.—Continued.

1910.	Colliery.	County.	Mines-inspection District.	No. of Persons Injured.
Dec. 5, 10.30	Newbattle	Edinburgh	Scotland	2
„ 5, 11.0	Annandale	Ayr	Do.	1
„ 8, 23.0	Springhill	Do.	Do.	1
„ 10, 7.0	Victoria	Renfrew	Do.	1
„ 12, 12.0	Springside	Ayr	Do.	2
„ 13, 1.10	Lochwood	Lanark	Do.	1
„ 16, 2.30	Gilbertfield	Do.	Do.	1

„ 22, 13.45	Torycoed	Glamorgan	South Wales	1
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Table IV.—Summary of Explosions of Fire-damp or Coal-dust in the several Mines-inspection Districts during the period 1901-1910.

Year.	Fatal Accidents.			Non-fatal Accidents.	
	No.	Deaths.	Injured.	No.	Injured.
1901	21	125	47	120	167
1902	23	63	33	133	172
1903	11	14	10	133	183
1904	17	22	25	134	190
1905	14	178	46	124	173
1906	17	55	18	127	157
1907	18	44	15	168	220
1908	23	128	19	130	157
1909	20	227	23	161	206
1910	18	501	28	122	165
Totals	182	1,357	264	1,353	1,790

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[Tables of barometer readings omitted.]

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[Illustration of Wood memorial Hall]

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[Diagram: Graph of Membership, 1853-1912]

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THE NORTH OF ENGLAND INSTITUTE  
OF  
MINING AND MECHANICAL ENGINEERS

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ANNUAL REPORT OF THE ACCOUNTS FOR THE YEAR 1910-1911;  
LIST OF

COUNCIL, OFFICERS AND MEMBERS  
FOR THE YEAR 1911-1912;  
ETC.

-----  
1910-1911.  
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NEWCASTLE-UPON-TYNE : PUBLISHED BY THE INSTITUTE.

Printed by Andrew Reid & Company, Limited, London and Newcastle-upon-Tyne.  
1911

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THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.

-----  
ANNUAL REPORT OF THE COUNCIL, 1910-1911.  
-----

The Council regret to have to record the loss through death of Mr. William Henry Wood, a member since 1857, and of Mr. Emerson Bainbridge, a member since 1863, both of whom have served upon the Council and rendered services to the Institute.

The following table shows the progress of the membership during recent years : —

Year ending August 1st.	1906.	1907.	1908.	1909.	1910.	1911.
Honorary members	25	21	21	22	26	27
Members	931	903	942	935	926	921
Associate members	114	108	115	103	106	107
Associates	190	194	209	210	214	209
Students	56	47	48	54	54	43
Subscribers	33	34	33	34	35	35
Totals	1,349	1,307	1,358	1,358	1,361	1,342

The decrease in the membership during the past year is due to the number of members elected not being so high as in the immediately preceding years. The additions to the register number 72, and the losses by death, resignation, etc., 91.

The deaths (14) included the following :—Members : Emerson Bainbridge, James Stedman Dixon, Charles Prattman Douglas, Percy Grave, James McCreath, John Matthews, John Henry Miller, Ithel Treharne Rees, James Shaw, William Haggerstone Telford, Cedric Vaughan and William Henry Wood. Associate member: Edward Eccles. Associate: Andrew Pattison.

The resignations (41) include the following:—Honorary members: Sir Henry Hall, I.S.O.,\* Joseph Samuel Martin, I.S.O.,\* Richard Donald Bain\* and Frederick Augustus Gray.\* Members: Fritz Baare, Henry Bennett, James Bookless, Wallace Broad, Charles Hamilton Eden, Matthias Stokoe Hall, Edward Halse, J. Howard Johnston, John Matthews Liddell, George Christopher Lloyd, W. H. F. Maddison, Henry Nettle, Henry Palmer, Auguste Rateau, Francis Bell Forsyth Rhodes, Hugh Ross, William Thomas Saunders, Henry Livingstone Sulman, Arthur Thomas, Charles Edward Turner, George Herbert Tweddell, Thomas Varty and Charles Robert Western.

\* Expiration of term of office.

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Associate members: William Courtenay Dawes Cruttenden, Oswald William Ellis, George Percy Lishman and George Young Wall. Associates: William Armstrong, Jun., Harold Cresswell Bayldon, John Chapman, Walter Easom Goodenough, William Handyside, Jun., James Edmund Marr, John Smith Tweddell, Harry Walton, Robert Wardle and Alfred Osborn Wraith.

The following gentlemen (36) have ceased to be members during the past year:—Members: Carl Andersen, Archibald Duncan Bailey, Ivo William Baldwin, J. S. Chambers, John Abel Chapman, Stener August Fangen, Martin Fishback, Lewis Warner Fogg, Frederick Hall, Howard Harris, Robert William Heads, John William Hutchinson, Philip Thomas Jenkins, Thomas Bryant Jennings, Cecil William Jordan, George Augustus Longbotham, James Duncan Macarthur, James Joseph Hunter McCann, Beverley S. Randolph, Jacob Sharp,

William Thompson, James Tinsley, John James Whitehead, George Whyel and Arthur Hamilton Williams. Associate members : H. P. Harris-Edge, William John Quince and Christoph George Sigismund Sandberg. Associates: Joseph William Kipling, Farrer William Morson and Thomas Sharp. Students : Andrew Dempster Brydon, William Calland, Tom Edward Hull and Ralph Percy Wilkinson.

The Library has been maintained in an efficient condition during the year; the additions, by donation, exchange and purchase, include 778 bound volumes and 17 pamphlets, reports, etc.; and the Library now contains about 12,939 volumes and 422 unbound pamphlets. A card-catalogue of the books, etc., contained in the Library renders them easily available for reference.

Members would render useful service to the profession by the presentation of books, reports, plans, etc., to the Institute, to be preserved in the Library, and thereby become available for reference.

The North-east Coast Institution of Engineers and Shipbuilders having now established themselves in Bolbec Hall, with a communication through the Library of the Literary and Philosophical Society, with the Library of the Institute, arrangements have been made for an interchange of library privileges, so far as reference purposes are concerned.

Exchanges of Transactions have been arranged, during the year, with the Engineers' Society of Western Pennsylvania and the United States Bureau of Mines.

The gallery of portraits of past-presidents of the Institute has been added to during the year, Mr. Thomas Emerson Forster having presented his portrait.

The courses of lectures for colliery engineers, enginewrights and apprentice mechanics have been continued at Armstrong College, Newcastle-upon-Tyne. The lectures are delivered on Saturday afternoons, and the three years' course embraces the following subjects:—

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1911-1912. Michaelmas Term, (1) Transmission of Power, and (2) Pumping and Ventilation. Epiphany Term, (3) Metallurgy of Iron and Steel, and (4) Mining Machinery (mainly machinery used underground).

1912-1913. Michaelmas Term, (5) Machine Drawing, and (6) The Chemistry of Fuel. Epiphany Term, (7) Strength of Materials (with experimental illustrations), and (8) Experimental Mechanics.

1913-1914. Michaelmas Term, (9) The Steam-engine, and (10) Theoretical Electricity. Epiphany Term, (11) Electrical Engineering, and (12) Haulage and Winding.

Several colliery-owners have paid the fees (£1 10s. per annum) and railway expenses of pupils attending the classes from their collieries. During the past year, the lectures of the Michaelmas Term on The Steam-engine and on Theoretical Electricity were attended by 32 students, 29 of whom sat for examination and 25 passed; and during the Epiphany Term, the lectures on Electrical Engineering were attended by 30 students, and on Haulage and Winding by 29 students, 26 of whom sat for examination and 23 passed. Certificates have been awarded to the following students, who have completed the three years' course: Messrs. J. J. Clough, T. Forster, J. Hepburn, F. S. Hylton and T. V. Snaith. The first and second prizes for- the Session 1910-1911 have been awarded to Messrs. J. J. H. Jefferson and R. O. Carr respectively.

A loyal and dutiful address was forwarded to His Majesty King George the Fifth and Her Majesty Queen Mary, on the occasion of Their Majesties' Coronation on June 22nd, 1911.

Mr. Thomas Douglas continues to represent the Institute as a Governor of Armstrong College, and Mr. John H. Merivale, in conjunction with the President (Mr. M. W. Parrington), represents the Institute on the Council of the College.

Mr. Thomas Edgar Jobling continues to represent the Institute upon the Board of Directors of the Institute and Coal-trade Chambers Company, Limited.

The President continues a Representative Governor upon the Court of Governors of the University of Durham College of Medicine during his term of office.

Prof. George Alexander Louis Lebour will represent the Institute at the Conference of Delegates of the Corresponding Societies of the British Association for the Advancement of Science, to be held in Portsmouth, commencing on August 30th, 1911.

The representatives of the Institute upon the Council of The Institution of Mining Engineers during the past year were as follows:—Messrs. R. S. Anderson, William Armstrong, W. C. Blackett, Frank Coulson, Benjamin Dodd, T. E. Forster, J. W. Fryar, Reginald Guthrie, Tom Hall, A. M. Hedley, T. E. Jobling, J. P. Kirkup, C. C. Leach, Henry Louis, J. H. Merivale, W. C. Mountain, J. H. Nicholson, R. E. Ornsby, M. W. Parrington, J. J. Prest, F. R. Simpson, John Simpson, J. B. Simpson, C. H. Steavenson and J. G. Weeks.

Under the will of the late Mr. John Daglish, funds have been placed at the disposal of Armstrong College for founding

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a Travelling Fellowship, to be called the "Daglish" Fellowship, candidates for which must be nominated by the Institute. No application was made for the Fellowship for the current year.

G. C. Greenwell gold, silver and bronze medals may be awarded annually for approved papers "recording the results of experience of interest in mining, and especially where deductions and practical suggestions are made by the writer for the avoidance of accidents in mines."

Prizes have been awarded to the writers of the following papers, communicated to the members during the year 1910-1911: —

"The Fire- and Rescue-station of the Durham and Northumberland Collieries Fire- and Rescue-brigade." By Mr. William Cuthbert Beckett, M.I.M.E.

"The Pench Valley Coal-field." By Mr. Francis Ivan Leslie Ditmas, M.I.M.E.

"The Electrification of the Underground Machinery at Trimdon Grange Colliery." By Mr. Simon Tate, M.I.M.E.

"The Advantages of Freezing as a Method of Sinking Through Heavily-watered or Difficult Ground." By Mr. William Brumwell Wilson, M.I.M.E.

The papers printed in the Transactions during the year are as follows : —

"The Occurrence of Diamonds in German South-west Africa." By Mr. George Percy Ashmore, M.I.M.E.

"The Fire- and Rescue-station of the Durham and Northumberland Collieries Fire- and Rescue-brigade." By Mr. William Cuthbert Blackett, M.I.M.E.

"A New Method of Testing for Gas in Mines with Safety-lamps." By Mr. Ralph D. Cochrane, Assoc. M.I.M.E.

"The Pench Valley Coal-field." By Mr. Francis Ivan Leslie Ditmas, M.I.M.E.

"The Rescue-station at the Kleophas Mine, Zalenze, Upper Silesia, Germany." By Mr. Berent Conrad Gullachsen, M.I.M.E.

"Electric Winding, with Special Reference to its Development in Upper Silesia." By Mr. Henry Moore Hudspeth, Assoc. I.M.E.

"The Holmes-Alderson Automatic Fire-damp Cut-out." By Mr. George J. Ralph.

"Appliance for Collecting Coal-dust in Mines." By Mr. Charles Rollin.

"The Electrification of the Underground Machinery at Trimdon Grange Colliery." By Mr. Simon Tate, M.I.M.E.

"The Advantages of Freezing as a Method of Sinking Through Heavily-watered or Difficult Ground." By Mr. William Brumwell Wilson, M.I.M.E.

"Blackhall Colliery."

"Horden Colliery."

"Consett Iron-works."

In connection with the General Meeting held upon April 8th, 1911, a visit was paid to the Fire- and Rescue-station of the Durham and Northumberland Collieries Fire- and Rescue-brigade at Elswick, where the station and appliances were inspected, and a turn-out, etc., by the brigade was witnessed.

Excursion meetings were held at Blackhall and Horden Collieries upon September 23rd, 1910, and at the Consett Ironworks upon July 21st, 1911.

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The thanks of the Institute have been sent to the owners of collieries, works, etc., visited during the year.

The Committee appointed, with Mr. Stanley Smith as Secretary, to report upon the Carboniferous Limestone Formation of the North of England, with Special Reference to its Coal Resources, has practically completed its investigations, and the report will be published at an early date.

The Supplementary Volume to An Account of the Strata of Northumberland and Durham, as proved by Borings and Sinkings, having completed that work, the Council are inviting members and others to contribute sections of strata in the Counties of Cumberland and Lancashire, with a view to their being published at some future date.

The Council regret that the collection of safety-lamps, which was loaned to the Brussels Exhibition, has been entirely destroyed by fire, and with a view to forming another collection invite members having old lamps in their possession to present them to the Institute. The collection has been awarded a Grand Prize Diploma, which carries with it a bronze medal.

The following gentlemen have already presented one or more lamps:—Messrs. Thomas Bell, William Clifford, Ralph D. Cochrane, Thomas Emerson Forster, Christopher Heaps, Edward Watson (through Mr. T. R. Hamber) and William Brumwell Wilson, Jun.

The rooms of the Institute have been used, during the year, by the Newcastle-upon-Tyne Association of Students of the Institution of Civil Engineers; the Newcastle District Telephone Society; the Newcastle-upon-Tyne Economic Society; the Northumberland and Durham Provincial Committee of the Surveyors' Institution; the Foremen's Mutual Benefit Society; the North of England Gas Managers' Association; the St. John Ambulance Brigade; the Charity

Organisation Society; and the Local Members of the Auctioneers' Institute of the United Kingdom, of the Estate Agents' Association, and of the Newcastle Law Society.

The Council, in reporting that the North-eastern Railway Company had granted reduced railway-fares to members attending general or excursion meetings of the Institute, expressed the hope that the concession would lead to an increased attendance at the meetings. They regret that no great material increase has resulted, but trust- that in the future a larger number of members will avail themselves of the privilege.

The Institution of Mining Engineers has now entered upon its twenty-third year, and the members are to be congratulated upon its continued success. Meetings were held in Nottingham in September, 1910, and in London in June, 1911.

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#### ANNUAL REPORT OF THE FINANCE COMMITTEE, 1910-1911.

The Finance Committee submit herewith a statement of accounts for the twelve months ending June 30th, 1911, duly audited.

The total receipts were £3,015 17s. 4d. Of this amount, £48 was paid for life-compositions in lieu of annual subscriptions, and £26 9s. as subscriptions in advance, leaving £2,941 8s. 4d. as the ordinary income of the year, compared with £2,872 10s. 1d. in the previous year, but included in the income is the sum of £100, received for the safety-lamps destroyed by fire at the Brussels Exhibition. The amount received for ordinary current-year subscriptions was £2,209 1s., and arrears £230 13s., as against £2,240 7s. and £203 10s. respectively in the year 1909-1910. Transactions sold realised £31 2s. 8d., as compared with £23 15s. 6d. in the earlier period; and the sum received for interest on investments was £370 11s. 8d., the amount in the former year being £353 17s. 7d.

The expenditure was £2,651 8s. 10d., the amount for the previous year being £2,988 18s. 3d. The difference was practically all due to special expenditure in the earlier period, as referred to in the last Annual Report. The sum of £57 10s. expended in connection with the Committee appointed to Report upon the Carboniferous Limestone Formation of the North of England, with Special Reference to its Coal Resources, may be regarded as special expenditure.

From the above figures it will be seen that the balance of income over expenditure was £364 8s. 6d., and adding to this the amount of £87 2s., brought forward from the previous year, leaves a credit balance of £451 10s. 6d.

The final call of £420 for the purchase of new shares in the Institute and Coal-trade Chambers Company, Limited, referred to in the last Annual Report, has been paid out of this surplus, leaving a nett sum of £31 10s. 6d. to be carried forward.

The names of 36 persons have been struck off the membership list in consequence of non-payment of subscriptions. The amount of subscriptions written off was £191 6s., of which £93 19s. was for sums due for the year 1910-1911, and £97 7s. for arrears. It is probable that a considerable proportion of these amounts will be recovered and credited in future years. Of the amount previously written off £40 4s. was recovered during the past year.

Thomas Douglas, Past-President.

August 5th, 1911.

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THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS :  
GENERAL STATEMENT, JUNE 30TH. 1911.

LIABILITIES.

	£ s. d.	£ s. d.
Subscriptions paid in advance during the current year		34 17 0
The George Clementson Greenwell prize fund	100 0 0	
Less, paid for medals	70 3 10	
	-----	29 16 2
Capital		12,804 13 7
		-----
		£12,869 6 9

ASSETS.

	£ s. d.	£ s. d.	£ s. d.
Balance in Treasurer's hands	88 7 4.		
Less. due to bankers	57 13 10		
	-----	30 13 6	
Outstanding accounts due from authors for excerpts		17 0	
		-----	31 10 6
Arrears of subscriptions			273 18 0
207 shares in the Institute and Coal-trade Chambers Company, Limited (at cost)		4,800 0 0	
Institute and Coal-trade Chambers Company, Limited (mortgage)		1,400 0 0	
£340 consolidated 5 per cent. preference stock of the Newcastle and Gateshead Water Company (at cost)		499 17 6	
£450 ordinary stock of the Newcastle and Gateshead Gas Company (at cost)		487 13 6	
(Of the above amount. £1,710 is due to life-subscriptions account.)		-----	7,187 11 0
Value of Transactions and other publications. as per stock account		326 7 3	
Books, pictures, maps, furniture and fittings	5,150 0 0		
Less, received for safety-lamps destroyed at Brussels Exhibition	100 0 0	5,050 0 0	
		-----	5,376 7 3
			-----
			£12,869 6 9

We have examined the above balance-sheet with the books, vouchers and securities relating thereto, and certify that, in our opinion, it is correct. We have accepted the assets, books, pictures, maps, etc. and Transactions and other publications, as valued by your officials.

JOHN G: BENSON AND SONS,

CHARTERED ACCOUNTANTS.

Newcastle-upon-Tyne,



1 new member, paid a life-composition	27 0 0	
	-----	
	2,257 1 0	
Add, arrears received	230 13 0	
	-----	
	2,487 14 0	
Add, subscriptions paid in advance during current year	26 9 0	
	-----	2,514 3 0
To amount received for safety-lamps destroyed at Brussels Exhibition		100 0 0
		-----
		£3,102 19 4

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Cr.

June 30th, 1911.	£ s. d.	£ s. d.
By salaries and wages	485 11 4	
„ insurance	13 5 9	
„ rent, rates and taxes	31 5 9	
„ heating, lighting, etc.	44 13 3	
„ furniture and repairs	6 15 8	
„ bankers' charges	21 5 3	
„ library	21 11 6	
„ printing, stationery, etc.	196 5 0	
„ postages, etc.	82 8 9	
„ incidental expenses	64 16 10	
„ travelling expenses	28 0 11	
„ prizes for papers	11 11 0	
„ reporting of general meetings»	12 12 0	
„ library catalogue	5 10 0	
„ Committee to report upon the Carboniferous Limestone Formation of the North of England, with Special Reference to its Coal Resources	57 10 0	
„ expenses of meetings	28 10 7	
„ engraving medals	2 6	
	-----	1,111 16 1
By The Institution of Mining Engineers	1,332 13 2	
“ “ : Guarantee Fund	207 3 6	
	-----	
	1,539 17 1	
Less, amounts paid by authors for excerpts	4 4	
	-----	1,539 12 9
		-----
		2,651 8 10
By balance:		
Paid on account of 28 new shares in the Institute and Coal-trade Chambers Company, Limited (final call)	420 0 0	
Balance in Treasurer's hands	88 7 4	

Less, due to bankers	57 13 10		
	-----		
	30 13 6		
Outstanding accounts due from authors for excerpts	17 0		
	-----	31 10 6	
		-----	451 10 6
			-----
			£3,102 19 4
			-----

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Dr.

The Treasurer of The North of England Institute of Mining and Mechanical Engineers in  
Account with Subscriptions, 1910-1911.

	£	s.	d.	£	s.	d.	£	s.	d.
June 30th, 1911.									
To 926 members,									
<u>53</u> of whom have paid life-compositions.									
873									
5 not included in printed list.									
<u>878</u> @ £2 2s.	1,843	16	0						
1 paid a life-composition		21	0 0						
			-----	1,864	16	0			
To <u>106</u> associate members,									
9 of whom have paid life-compositions.									
97 @ £2 2s.				203	14	0			
To 214 associates,									
1 of whom has paid a life-composition.									
<u>213</u>									
4 paid as members.									
209 @ £1 5s.				261	5	0			
To 54 students.									
1 not included in printed list.									
55 @ £1 5s.				68	15	0			
To 35 subscribing firms				121	16	0			
							-----	2,520	6 0
To 41 new members,									
1 of whom paid last year in advance.									
40 @ £2 2s.	84	0	0						
1 new member paid a life-composition.		27	0 0						
			-----	110	0	0			
To 10 new associate members @ £2 2s.				21	0	0			
To 9 new associates @ £1 5s.				11	5	0			
To 5 new students @ £1 5s.				6	5	0			
							-----	149	10 0
To arrears, as per balance-sheet, 1909-1910				287	16	0			
Add, arrears considered irrecoverable, but since paid				40	4	0			

	-----	328 0 0
		-----
		2,997 16 0
To subscriptions paid in advance during the current year		26 9 0
		-----
		£3,024 5 0

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Cr.

		Paid	Unpaid	Struck off list
		£ s. d.	£ s. d.	£ s. d.
By 746 members paid	@ £2 2s.	1,566 12 0		
98    unpaid	@ £2 2s.		205 16 0	
4    „    resigned	@ £2 2s.			8 8 0
1    excused payment	@ £2 2s.			2 2 0
4    „    dead	@ £2 2s.			8 8 0
<u>25</u> struck off list	@ £2 2s.			52 10 0
<u>878</u>				
1    paid a life-composition		21 0 0		
By 83 associate members, paid	@ £2 2s.	174 6 0		
11    „    „    unpaid	@ £2 2s.		23 2 0	
<u>3</u> „    „    struck off list	@ £2 2s.			6 6 0
<u>97</u>				
By 170 associates, paid	@£1 5s.	212 10 0		
31       unpaid	@£1 5s.		38 15 0	
3       resigned	@£1 5s.			3 15 0
1       excused payment	@£1 5s.			1 5 0
1       dead	@£1 5s.			1 5 0
<u>3</u> struck off list	@£1 5s.			3 15 0
<u>209</u>				
By 45 students, paid	@£1 5s.	56 5 0		
5    „    unpaid	@£1 5s.		6 5 0	
<u>5</u> „    struck off list.	@£1 5s.			6 5 0
<u>55</u>				
By 35 subscribing firms, paid ,		121 16 0		
By 40 new members, paid	@ £2 2s.	84 0 0		
1    „    „    paid a life-composition		27 0 0		
By 10 new associate members, paid.	@ £2 2s.	21 0 0		
By 9 new associates, paid	@ £1 5s.	11 5 0		
By 5 new students, paid	@ £1 5s.	6 5 0		
		-----	-----	-----
		2,301 19 0	273 18 0	93 19 0
By arrears		230 3 0		97 7 0
		-----		
		2,532 12 0		

By subscriptions paid in advance during the current year

26 9 0

-----  
2,559 1 0    273 18 0    191 6 0

-----  
£3,024 5 0

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LIST OF COMMITTEES APPOINTED BY THE COUNCIL,  
1911-1912.

Finance Committee

Mr. W. C. Blackett.	Mr. T. Y. Greener.	Mr. John Simpson.
Mr. Thomas Douglas.	Mr. T. E. Jobling.	Mr. J. B. Simpson.
Mr. T. E. Forster.	Mr. George May.	Mr. J. G. Weeks.

Arrears Committee.

Mr. W. C. Blackett.	Mr. T. Y. Greener.	Mr. John Simpson.
Mr. Thomas Douglas.	Mr. T. E. Jobling.	Mr. J. B. Simpson.
Mr. T. E. Forster.	Mr. George May.	Mr. J. G. Weeks.

Library Committee.

Mr. R. S. Anderson.	Mr. T. E. Forster.	Mr. F. R. Simpson.
Mr. J. B. Atkinson.	Mr. A. M. Hedley.	Mr. John Simpson.
Mr. Frank Coulson.	Prof. Henry Louis.	Mr. J. G. Weeks.
	Mr. George May.	

Prizes Committee.

Mr. W. C. Blackett.	Mr. C. C. Leach.	Mr. John Simpson.
Mr. T. E. Forster.	Prof. Henry Louis.	Mr. J. G. Weeks.
Mr. Samuel Hare.	Mr. A. D. Nicholson.	

Committee to Report upon the Carboniferous Limestone Formation of the North of England,  
with Special Reference to its Coal Resources.

Mr. J. B. Atkinson.	Mr. T. E. Forster.	Mr. A. D. Nicholson.
Mr. David Burns.	Mr. J. P. Kirkup.	Mr. F. R. Simpson.
Mr. W. Cochran Carr.	Prof. G. A. L. Lebour.	

Reference Committee for Papers to Read.

(a) Coal-mining.

Mr. Henry Armstrong.	Mr. T. E. Forster.	Mr. John Simpson.
Mr. R. W. Berkley.	Mr. T. Y. Greener.	Mr. A. L. Steavenson.

Mr. W. C. Blackett.  
Mr. C. S. Carnes.  
Mr. Benjamin Dodd.  
Mr. Mark Ford.

Mr. A. M. Hedley.  
Mr. C. C. Leach.  
Prof. Henry Louis.  
Mr. George May.

Mr. Simon Tate.  
Mr. J. G. Weeks.  
Mr. R. L. Weeks.

(b) Metalliferous Mining.

Mr. R. Donald Bain.  
Mr. W. Cochran Carr.

Mr. A. M. Hedley.  
Prof. Henry Louis.  
Mr. A. D. Nicholson.

Mr. A. L. Steavenson.  
Mr. C. H. Steavenson.

(c) Geological.

Mr. R. S. Anderson.  
Mr. J. B. Atkinson.

Mr. R. Donald Bain.  
Mr. Samuel Hare.  
Mr. T. E. Jobling.

Prof. G. A. L. Lebour.  
Mr. John Simpson.

(d) Mechanical and Electrical Engineering.

Mr. Sidney Bates.  
Mr. W. C. Blackett.  
Mr. C. S. Carnes.  
Mr. T. E. Forster.  
Mr. Austin Kirkup.

Mr. J. P. Kirkup.  
Mr. C. C. Leach.  
Mr. John Morison.  
Mr. W. C. Mountain.  
Mr. J. H. Nicholson.

Hon. C. A. Parsons.  
Mr. A. L. Steavenson.  
Mr. J. G. Weeks.  
Mr. E. S. Wood.

(e) Civil Engineering.

Mr. Benjamin Dodd.  
Mr. J. H. B. Forster.  
Mr. T. E. Forster.

Mr. Philip Kirkup.  
Mr. W. C. Mountain.  
Mr. F. R. Simpson.

Mr. J. B. Simpson.  
Mr. A. L. Steavenson.

(f) Chemical.

Prof. P. Phillips Bedson.

Mr. R. W. Berkley.

Mr. Benjamin Dodd.

N.B. —The President is ex-officio on all Committees.

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OFFICERS, 191 1-1912.

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PAST-PRESIDENTS (ex-officio).

Sir LINDSAY WOOD, Bart., The Hermitage. Chester-le-Street.

Mr. JOHN BELL SIMPSON, Bradley Hall, Wylam, Northumberland.

Mr. ADDISON LANGHORNE STEAVENSON, Durham.

Mr. THOMAS DOUGLAS, The Garth, Darlington.

Mr. GEORGE MAY, Clervaux Castle, Croft, Darlington.

Mr. WILLIAM ARMSTRONG, Elmfield Lodge, Gosforth, Newcastle-upon-Tyne.

Mr. JOHN GEORGE WEEKS, Bedlington, Northumberland.

Mr. WILLIAM OUTTERSON WOOD, South Hetton, Sunderland.

Mr. THOMAS WALTER BENSON, Collingwood Buildings, Collingwood Street, Newcastle-upon-Tyne.

Mr. JOHN HERMAN MERIVALE, Togston Hall, Acklington, Northumberland.

Mr. THOMAS EMERSON FORSTER, 3, Eldon Square, Newcastle-upon-Tyne.

PRESIDENT.

Mr. MATTHEW WILLIAM PARRINGTON, Wearmouth Colliery, Sunderland.

VICE-PRESIDENTS.

Mr. RICHARD DONALD BAIN, Aykleyheads, Durham.

Mr. FRANK COULSON, Shamrock House, Durham.

Mr. PHILIP KIRKUP, Leafield House, Birtley, County Durham.

Mr. CHARLES CATTERALL LEACH, Seghill Hall, Northumberland.

Mr. FRANK ROBERT SIMPSON, Hedgefield House, Blaydon-upon-Tyne, County Durham.

Mr. JOHN SIMPSON, Follonsby, Hawthorn Gardens, Monkseaton, Whitley Bay, Northumberland.

RETIRING VICE-PRESIDENTS (ex-officio).

Mr. JOHN BOLAND ATKINSON, H.M. Inspector of Mines, 16, Belle Grove Terrace, Newcastle-upon-Tyne.

Mr. THOMAS YOUNG GREENER, West Lodge, Crook, County Durham.

COUNCILLORS.

Mr. ROBERT SIMPSON ANDERSON, Highfield, Wallsend, Northumberland.

Mr. HENRY ARMSTRONG, Collingwood Buildings, Collingwood Street, Newcastle-upon-Tyne.

Mr. WILLIAM CUTHBERT BLACKETT, Acorn Close, Sacriston, Durham.

Mr. CHARLES SPEARMAN CARNES, Marsden Hall, South Shields.

Mr. WILLIAM COCHRAN CARR, Benwell Colliery, Newcastle-upon-Tyne.

Mr. BENJAMIN DODD, Percy House, Neville's Cross, Durham.

Mr. MARK FORD, Washington Colliery, Washington Station, County Durham.

Mr. JOHN HENRY BACON FORSTER, Whitworth House, Spennymoor.

Mr. SAMUEL HARE, Howlish Hall, Bishop Auckland.

Mr. ARTHUR MORTON HEDLEY, Blaydon Burn, Blaydon-upon-Tyne, County Durham.

Mr. THOMAS EDGAR JOBLING, Bebside, Northumberland.

Mr. HENRY LOUIS, 4, Osborne Terrace, Newcastle-upon-Tyne.

Mr. WILLIAM CHARLES MOUNTAIN, 8, Sydenham Terrace, Newcastle-upon-Tyne.

Mr. ARTHUR DARLING NICHOLSON, H.M. Inspector of Mines, Red Hill, Durham.

Mr. JOHN HODGSON NICHOLSON, Cowpen Colliery Office, Blyth.

Mr. SIMON TATE, Trimdon Grange Colliery, County Durham.  
Mr. RICHARD LLEWELLYN WEEKS, Willington, County Durham.  
Mr. ERNEST SEYMOUR WOOD, Cornwall House, Murton, County Durham.

TREASURER.

Mr. REGINALD GUTHRIE, Neville Hall, Newcastle-upon-Tyne.

HONORARY SECRETARY.

Mr. JOHN HERMAN MERIVALE, Neville Hall, Newcastle-upon-Tyne.

SECRETARY.

Mr. LAWRENCE AUSTIN, Neville Hall, Newcastle-upon-Tyne.

AUDITORS.

Messrs. JOHN G. BENSON and SONS, Newcastle-upon-Tyne.

BANKERS.

LLOYDS BANK LIMITED (LAMBTON'S BRANCH), Grey Street, Newcastle-upon-Tyne.

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LIST OF MEMBERS,  
AUGUST 5, 1911.

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PATRONS.

His Grace the DUKE OF NORTHUMBERLAND.  
The Most Honourable the MARQUESS OF LONDONDERRY.  
The Right Honourable the EARL OF DURHAM.  
The Right Honourable the EARL GREY.  
The Right Honourable the EARL OF LONSDALE.  
The Right Honourable the EARL OF WHARNCLIFFE.  
The Right Reverend the LORD BISHOP OF DURHAM.  
The Right Honourable LORD ALLENDALE.  
The Right Honourable LORD BARNARD.  
The Right Honourable LORD RAVENSWORTH.  
The Very Reverend the DEAN AND CHAPTER OF DURHAM.

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HONORARY MEMBERS (Hon. M.I.M.E.).

\* Honorary Members during term of office only.

	Date of Election
1*JOHN BOLAND ATKINSON, H.M. Inspector of Mines, 16, Belle Grove Terrace, Newcastle-upon-Tyne	Aug. 4, 1888
2* WILLIAM NICHOLAS ATKINSON, H.M. Inspector of Mines, Bridgend	Aug. 4, 1888
3 RICHARD DONALD BAIN, Aykleyheads, Durham	June 10, 1911
4*Prof. PETER PHILLIPS BEDSON, Armstrong College, Newcastle-upon-Tyne	Feb. 10, 1883

5 THOMAS BELL, 40, Esplanade Road, Scarborough	Dec. 12, 1896
6 JOSEPH DICKINSON, 3, South Bank, Sandy Lane, Pendleton, Manchester	Dec. 13, 1852
7 Prof. WILLIAM GARNETT, London County Council Education Office, Victoria Embankment, London, W.C.	Nov. 24, 1894
8* JOHN GERRARD, H.M. Inspector of Mines, Worsley, Manchester	June 11, 1892
9*Dr. WILLIAM HENRY HADOW, Armstrong College Newcastle-upon-Tyne	Feb. 12, 1910
10 Sir HENRY HALL, I.S.O., Brookside, Chester	June 10, 1911
11*HUGH JOHNSTONE, H.M. Inspector of Mines, 3, Priory Road, Edgbaston, Birmingham	Oct. 13, 1906
12*Prof. GEORGE ALEXANDER LOUIS LEBOUR, Armstrong College, Newcastle-upon-Tyne. Transactions, etc., sent to Radcliffe House, Corbridge, Northumberland	Nov. 1, 1879
13*JOHN DYER LEWIS, H.M. Inspector of Mines, Glanrhyd, Sketty Road, Swansea	Dec. 11, 1909
14*Prof. HENRY LOUIS, Armstrong College, Newcastle-upon-Tyne. Transactions sent to The Librarian, Armstrong College, Newcastle-upon-Tyne	Dec. 12, 1896
15*ROBERT McLAREN, H.M. Inspector of Mines, Craigmore, 77, Colinton Road, Edinburgh	Dec. 13, 1902
16 JOSEPH SAMUEL MARTIN. I.S.O., The Vikings, 16, Durdham Park, Bristol	June 10, 1911
17*THOMAS HARRY MOTTRAM, H.M. Inspector of Mines, 1, Marmion Road, Sefton Park, Liverpool	June 10, 1911
18 DANIEL MURGUE, 1, rue St. Honore, St. Etienne, Loire, France	June 20, 1908
19*ROBERT NELSON, H.M. Electrical Inspector of Mines, Mines Department, Home Office, Whitehall, London, S. W.	Dec. 11, 1909
20*ARTHUR DARLING NICHOLSON, H.M. Inspector of Mines, Red Hill, Durham	June 10, 1911

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	Date of Election
21*WILLIAM HENRY PICKERING, H.M. Inspector of Mines, Doncaster	Dec. 11, 1909
22*RICHARD AUGUSTINE STUDDERT REDMAYNE, H.M. Chief Inspector of Mines, Mines Department, Home Office, Whitehall, London, S.W .	Dec. 11, 1909
23*Prof. HENRY STROUD, Armstrong College, Newcastle-upon-Tyne	Nov. 5, 1892
24*JETHRO JUSTIMAN HARRIS TEALL, Director of the Geological Survey of the United Kingdom, 28, Jermyn Street, London, S.W	Aug. 3, 1901
25*Prof. WILLIAM MUNDELL THORNTON, Armstrong College, Newcastle-upon-Tyne	Feb. 12, 1910
26* WILLIAM WALKER, H.M. Inspector of Mines, Tyne Lodge, Grange Loan, Edinburgh	Oct. 14, 1905
27*Prof. ROBERT LUNAN WEIGHTON, Armstrong College, Newcastle-upon-Tyne	April 2, 1898

MEMBERS (M.I.M.E.).

Marked \* have paid life composition.

	Date of Election and of Transfer.
1 Abbott, Henry Arnold, H.M. Inspector of Mines, 1, Highbury, West Jesmond, Newcastle-upon-Tyne	Feb. 13, 1904
2 Abel, Walter Robert, Scottish Provident Buildings, Mosley Street, Newcastle-upon-Tyne	Dec. 8, 1906
3 Acutt, Sidney, The Barrett Gold-mining Company, Limited, Kaapoche Hoop, Transvaal	Dec. 10, 1904
4 Adair, Hubert, Gillfoot, Egremont, Cumberland	April 8, 1905
5 Adams, George Francis, Inspector of Mines in India, Dhanbaid, E.I. Railway, Manbhum District, Bengal, India	Aug. 5, 1905
6 Adams, Henry Hopper, c/o H. Gilfillan, Jun., 108 and 109, Victoria Arcade, Auckland, New Zealand	April 10, 1897

7 Adams, Phillip Francis Burnet, Surveyor-General for the Orange River Colony, Government Office, Bloemfontein, Orange River Colony, South Africa	Oct. 12,1901
8 Adamson, Thomas, Jherriah P.O., District Manbhoom, Bengal, India .	Feb. 10,1894
9 Ainsworth, Herbert, P.O. Box 1553, Johannesburg, Transvaal	Feb. 14, 1903
10 Ainsworth, John W., Bridgewater Offices, Walkden, Manchester	Dec. 14, 1895
11 Aldridge, Walter Hull, 603, Central Building, Los Angeles, California, U.S.A .	Feb. 8,1908
12 Allan, John Frederick, 62, London Wall, London, EC.	A.M. Feb. 10, 1883
	M. June 8, 1889
13 Allan, Philip, Mina de San Domingos, Mertola, Portugal	June 10, 1905
14 Allison, J. J. C, Woodland Collieries, Butterknowle, County Durham	A.M. Feb 13, 1886
	M. June 8,1889
15 Anderson, Robert Hay, Apartado Postal 866, Mexico, D.F.	Aug. 4,1894
16 Anderson, Robert Simpson, Highfield, Wallsend, Northumberland (Member of Council)	S. June 9, 1883
	A.M.Aug. 4,1888
	M. Aug. 3, 1889
17 Andrews, Arthur, 10, Ashwood Terrace, Sunderland	Aug. 2, 1902
18 Andrews, Edward William, 4, Ashwood Terrace, Sunderland	Aug. 4, 1906
19*Angwin, Benjamin, 3, Penlu Terrace, Tuckingmill, Camborne	Nov. 24, 1894
20 Appleby, Harry Walton, c'o The St. John del Rey Mining Company, Limited, Villa Nova de Lima, Estado de Minas, Brazil, South America	Oct. 8, 1898
21 Appleby, William Remsen, Minnesota School of Mines, The University of Minnesota, Minneapolis, Minnesota,U.S. A.	April 14, 1894

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	Date of Election and of Transfer.
22 Archer, Thomas, Mardale Parade, Gateshead-upon-Tyne	July 2, 1872
23 Archer, William, Victoria Garesfield, Lintz Green, County Durham	A. Aug. 6, 1892
	M. Aug. 3, 1895
24 Armstrong, George Herbert Archibald, Castle View, Chester-le-Street	April 8, 1905
25 Armstrong, Henry, Collingwood Buildings, Collingwood Street, Newcastle-upon-Tyne (Member of Council)	A.M. April 14, 1883
	M. June 8, 1899
26 Armstrong, William, Elmfield Lodge, Gosforth, Newcastle-upon-Tyne (Past-President, Member of Council)	JS. April 7, 1867
	M. Aug. 6, 1870
27 Arnold, Thomas, Castle Buildings, Llanelly	April 13, 1907
28 Ashmore, George Percy, 9, Argyll Mansions, Kensington, London, W	Feb.13, 1897
29 Athron, Harold Vivian, Windy Arbour, Longton, Staffordshire	Feb. 13, 1904
30 Atkinson, John Boland, H.M. Inspector of Mines, 16, Belle Grove Terrace, Newcastle-upon-Tyne (Retiring Vice-President, Member of Council)	Oct.11, 1902
31 Attwood, Alfred Lionel, Remolinos, por Pedrola, Provincia de Zaragoza, Spain	Aug. 5, 1905
32 Aubrey, Richard Charles, Desborough, near Kettering	Feb. 5, 1870
33 Bagnoli, Ugo, Orbetello, Italy	Feb. 8, 1908
34 Bailes, Thomas, Jesmond Gardens, Newcastle-upon-Tyne	Oct. 7, 1858
35 Bailey, Edward Trenholm	A. M. June13, 1896
	M. June 12, 1897
36 Bain, Richard Donald, Aykleyheads, Durham (Vice-President, Member of Council)	S. March 1, 1873

	M. Aug. 5, 1876
37 Bainbridge, Emerson Muschamp, Shipcote, Newbiggin-by-the-Sea, Northumberland	Feb. 8, 1902
38 Barber, George Marriott, c/o Tracey Brothers, Medellin, Antioquia, Republic of Colombia, South America	April 28, 1900
39 Barker, Matthew Wilson, Glyncoed, Laurie Park Road, Sydenham, London, S.E.	April 8, 1893
40 Barnard, Robert, 53, York Road, Birkdale, Southport	Dec. 11, 1897
41 Barnes, James, Heddon Greta, via West Maitland, New South Wales, Australia	Oct. 9, 1909
42 Barrass, Matthew, Wheatley Hill Colliery Office, Thornley, County Durham	S. Feb. 9, 1884
	A. Aug. 1, 1891
	M. Dec. 8, 1900
43 Barrett, Charles Rollo, Whitehill Hall, Pelton Fell, County Durham	S. Nov. 7, 1874
	A M. Aug. 7, 1880
	M, Dec. 11, 1886
44 Barrow, William, Seaton Burn Colliery, Dudley, Northumberland	Feb. 8, 1902
45 Barrs, Edward, Cathedral Buildings, Newcastle-upon-Tyne	Aug. 7, 1909
46*Bartholomew, Charles William, Blakesley Hall, near Towcester . .	Dec. 4, 1875
47 Bartlett, George Pilcher, c o Thomas Owens, Rozel House, Turret Grove, Clapham, London, S. W.	Dec. 11, 1909
48 Bates, Matthew John, Highbury, Stocksfield, Northumberland	Feb. 11, 1905
49 Bates, Sidney, The Grange, Prudhoe, Ovingham, Northumberland	A. Feb. 8, 1890
	M. June 18, 1895
50 Bates, Thomas Lionel, Alfred Street, Waratah, New South Wales, Australia	Feb. 12, 1898
51 Bateson, Walter Remington, c/o The Chilian Longitudinal Railway Construction Company, Limited, Agustinas 718, Santiago, Chile, South America	Feb. 11, 1905
52 Batey, John Wright, Elmfield, Wylam, Northumberland	Feb. 9, 1901
53 Bawden, William, Tolcarne House, Greta Street, Keswick	Feb. 10, 1906
54 Bayliss, Ernest John, Inglenook, Beedell Avenue, Westcliff-on-Sea, Southend-on-Sea	April 13, 1901

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	Date of Election and of Transfer.
55 Beard, James Thom, 815, Sunset Avenue, North Park, Scranton, Pennsylvania, U.S.A .	Feb. 14,1903
56 Bekenn, Alexander Richard, Dundee Coal Company, Limited, Talana. Natal, South Africa	Feb. 9,1907
57 Bell, Harold Percy, Pendlebury Colliery, Bentley, near Walsall A. Aug. 4, 1906	S. Aug. 2, 1902
	M. June 12, 1909
58 Bell, Joseph Fenwick, Bunker Hill, Fence Houses	April 12,1902
59 Bell, Reginald, Shildon Lodge Colliery, Darlington	Dec. 13, 1902
60 Bell, Walter, c/o Pyman, Bell and Company, Hull	S. Oct. 8,1889
	M. Feb. 10, 1894
61 Bell, William, Wallsend Colliery, Wallsend, Northumberland	S. Feb. 13, 1897
	A. Aug. 6, 1904
	M. Oct. 12, 1907
62 Bell, William Ralph, Wearmouth Colliery, Sunderland	A. Oct. 13, 1894
	M. Dec. 12, 1903

63 Bement, Alburto, 2114, Fisher Building, Chicago, Illinois, U.S.A .	Aug. 3, 1907
64 Bennett. Alfred Henry, Bedminster, Easton, Kingswood and Parkfield Collieries, Limited. Easton Colliery ,Bristol	A.M. April 10, 1886 M. June 8, 1889
65 Benson, Robert Seymour, Teesdale Iron Works, Stockton-upon-Tees .	April 8, 1911
66 Benson, Thomas Walter, Collingwood Buildings, Collingwood Street, Newcastle-upon-Tyne (Past-President, Member of Council)	Aug. 2, 1866
67 Berkley, Cuthbert, Highfield House, Durham	Aug. 21, 1852
68 Berkley, Richard William, Marley Hill, Swalwell, County Durham	S. Feb. 14, 1874 A.M. Aug. 7, 1880 M. June 8, 1889
69 Bigg-Wither, Harris, The Mount, Gathurst, Wigan	Jan. 19, 1895
70 Bigge, Denys Leighton Selby, 27, Mosley Street, Newcastle-upon-Tyne	June 10, 1903
71 Bigland, Hubert Hallam, c/o J. H Holmes and Company, 19, Waterloo Street, Glasgow	Dec. 14, 1901
72 Bigland, John, Henknowle, Bishop Auckland	June 3, 1857
73 Binnie, William, E. Ipswich, Queensland, Australia	April 9, 1910
74 Bird, Edward Erskine, c/o George Elliot and Company, Limited, 16, Great George Street, Westminster, London, S.W	A.M. Aug. 5, 1905 M. Dec. 14, 1907
75* Birkinshaw, Frederick Edson, Marbella, Province of Malaga, Spain	Dec 10, 1910
76 Blackett, William Cuthbert, Acorn Close, Sacriston, Durham (Member of Council)	S. Nov. 4, 1876 A.M. Aug. 1, 1885 M. June 8, 1889
77 Blaiklock, Thomas Henderson, Bebside Colliery, Bebside, Northumberland	April 13, 1901
78 Blair, Robert Richmond, 5, Hamilton Terrace, Whitehaven	A. Aug. 2, 1902 M. Feb. 11, 1911
79 Blandford, Thomas, Main Street, Haltwhistle, Northumberland	S. Dec. 12, 1903 A. Aug. 3, 1907 M. June 12, 1909
80 Bonniwell, Percival Ormond, 222-225, Strand, London, W.C .	Dec. 12, 1903
81 Booth, Frederic Lancelot, Ashington Colliery, Morpeth	S. Feb. 10, 1894 A. Aug. 4, 1900 M. April 8, 1911
82 Borlase, William Henry, Greenside Lodge, Glenridding, Penrith	Aug. 4, 1894
83 Bowen, David, The University, Leeds	April 3, 1909
84 Bowman, Francis, Ouston Colliery Office, Chester-le-Street	A. June 8, 1895 M. Feb. 13, 1904
85* Bracken, Thomas Wilson, 40, Grey Street, Newcastle-upon-Tyne	Oct. 14, 1899
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	Date of Election and of Transfer.
86 Braidford, William, Jun., South Garesfield Colliery, Lintz Green. County Durham	June 14, 1902
87 Bramwell, Hugh, Great Western Colliery, near Pontypridd	S. Oct. 4, 1879 A.M. Aug. 6, 1887 M. Aug. 3, 1889
88 Breakell, John Edwin, Glenthorne, 4, Cedar Road, Teddington, London, S.W.	April 25, 1896
89* Brinell, Johan August, Jernkontoret, Stockholm, Sweden	June 9, 1900

90 Brodigan, Charles Bernard, P.O. Box 3, Brakpan, Transvaal	Oct. 13, 1906
91 Bromly, Alfred Hammond, Petatlan, Distrito de Galeana, Guerrero, Mexico	Nov. 24, 1894
92 Broome, George Herbert, State Coal Mines, Mines Department, Melbourne, Victoria, Australia	Oct. 9, 1897
93 Brough, Thomas, New Seaham Colliery, Sunderland	S. Feb. 4, 1873 A.M. Aug. 2, 1879 M. June 8, 1889 June 11, 1898
94 Brown, Douglas Philip, The Old House, Sowerby, Thirsk	June 11, 1898
95 Brown, John, Bengal Coal Company, Limited, Giridih, Bengal, India	S. June 8, 1907 A. Aug. 7, 1909 M. Feb. 11, 1911
96 Brown, John Connell, Westport Coal Company, Limited, Denniston, New Zealand	Feb. 8, 1908
97 Brown, Robert Oughton, Elswick Collieries, Newcastle-upon-Tyne	S. Oct. 8, 1892 A. Aug. 3, 1895 M. Oct. 12, 1901
98 Brown, Ralph Richardson, Pekin Syndicate, Limited, Honan, North China	Aug. 3, 1907
99 Brown, W. Forster, Cefn Coed, Malpas, Newport, Monmouthshire	S. Aug. 6, 1887 M. Aug. 5, 1893
100 Browne, Robert John, Bhowra Colliery, Jheria, E.I.R., Bengal, India	Feb. 10, 1906
101 Browning, Walter James, c/o Rio Tinto Company, Limited, Provincia de Huelva, Spain	Oct. 12, 1907
102 Bruce, John, Port Mulgrave, Hinderwell, Yorkshire	S. Feb. 14, 1874 A.M. Aug. 7, 1880 M. June 8, 1889 Dec. 8, 1900
103 Bryham, William, Bank House, Wigan	Dec. 8, 1900
104 Buckle, Christopher Ernest, Elmwood, Denville, Havant	Feb. 10, 1900
105 Bull, Henry Matthews, Gopalichak Coal Company, Limited, Bansjora, Bengal, India	April 9, 1904
106 Bulman, Edward Hemsley, The North Randfontein Gold-mining Company, Randfontein, Transvaal	Feb. 13, 1892
107 Bulman, Harrison Francis, Priestfield, Burnopfield, County Durham	S. May 2, 1874 A.M. Aug. 6, 1881
108 Bunning, Charles Ziethen, c/o The British Vice-Consul, Panderma, near Constantinople, Turkey	M. June 8, 1889 S. Dec. 6, 1873 A.M. Aug. 5, 1882 M. Oct. 8, 1887 Feb. 9, 1889
109*Burls, Herbert Thomas, c/o Edward Riley and Harbord, 16, Victoria Street, Westminster, London, S.W.	Feb. 9, 1889
110*Burn, Frank Hawthorn, 9, Sandhill, Newcastle-upon-Tyne. Transactions sent to Pattishall House, Towcester	S. Feb. 9, 1889 A. Aug. 4, 1894 M. Aug. 3, 1895
111 Burne, Cecil Alfred, Earham, Bishopswood Road, Highgate, London, N	S. Aug. 4, 1894 M. Aug. 3, 1901 June 8, 1895
112 Burnett, Cuthbert, Grange Iron Works, Durham	June 8, 1895
113*Burns, David, Vallum View, Belle Vue, Carlisle	May 5, 1877
114 Burton, George Augustus, Highfield, Nunthorpe, Yorkshire	Dec. 9, 1905
115 Butters, Charles, Capel House, 54, New Broad Street, London, E.C. : .	Feb. 10, 1894

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	Date of Election and of Transfer.
116 Carey, Joseph Macleod, H.M. Inspector of Mines, Malpas, Newport, Monmouthshire	April 4, 1903
117 Carnegie, Alfred Quintin, 31, Manor House Road, Newcastle-upon-Tyne	Oct. 11, 1902
118 Carnes, Charles Spearman, Marsden Hall, South Shields [Member of Council]	Aug. 1, 1891
119 Carroll, James, Brilliant and St. George Gold-mine, Charters Towers,	Dec. 10, 1898

Queensland, Australia

120 Carroll, Miles T., Antsirabe, Madagascar	Feb. 10,1906
121 Casebourne, Samuel Ward Jackson, Cleveland Terrace, Darlington	Dec. 10, 1904
122 Casson, William Walter, St. Bees, Cumberland	Aug. 5, 1905
123 Chambers, Arthur Leo	Feb. 8,1902
124 Chambers, David Macdonald, 23, St. Mary's Mansions, Paddington, London, W .	A.M. Oct. 8, 1904 M. June 12, 1909
125 Chambers, R. E., Nova Scotia Steel and Coal Company, Limited, New Glasgow, Nova Scotia	June 9,1900
126 Channing, J. Parke, 42, Broadway, New York City, U.S.A	April 25, 1896
127*Chappel, Walter Richard Haighton, Ipok, Perak, Malay Peninsula	Feb. 14,1903
128 Charleton, Arthur George, 5, Avonmore Road, Kensington, London, W .	Aug. 6, 1892
129 Charlton, William, Guisborough	Feb. 12, 1898
130 Charlton, William John, Ashington Colliery, Morpeth	April 25, 1896
131 Charlton, William John, Jun., H.M. Inspector of Mines, 32, Western Hill, Durham .	A. April 12, 1902 M. Aug. 7, 1909
132 Cheesman, Edward Taylor, Clara Vale Colliery, Ryton, County Durham	A. Aug. 2, 1890 M. Aug. 6,1892
133 Cheesman, Herbert, Hartlepool	Aug. 6,1892
134 Cheesman, Isaac Taylor, Throckley Colliery, Newburn, Northumberland	Feb. 1, 1873
135 Cheesman, Nicholas, Blucher Pit, Newburn, Northumberland	Dec. 8, 1900
136 Chicken, Bourn Russell, 212, Osborne Road, Jesmond, Newcastle-upon-Tyne	Dec. 12, 1903
137 Childe, Henry Slade, 59, Westgate, Wakefield	A. M. Feb. 12,1887 M. Aug. 3, 1889
138 Church, Robert William, Government of India Railway Board, Secretariat Buildings, Calcutta, India	S. Dec. 9, 1905 A. Aug. 3,1907 M. Oct. 12, 1907
139 Claghorn, Clarence R., Northwestern Improvement Company, Headquarters Building, Tacoma, Washington, U.S.A.	Aug. 5, 1899
140 Clark, Henry, Lynndale, Richmond Road, Stockton-upon-Tees	April 8, 1899
141 Clark, Robert, Rothalie, Fife Road, Darlington	Feb. 15,1896
142 Clark, Robert Blenkinsop, Springwell Colliery, Gateshead-upon-Tyne	S. May 3, 1873 M. Aug. 4, 1877
143 Clark, William Henry, Craigengower, Grange-over-Sands, Lancashire	April 28, 1900
144 Claudet, Arthur Crozier, 6 and 7, Coleman Street, London, E.C.	Aug. 3,1895
145 Clifford, Edward Herbert. Rand Club, Johannesburg, Transvaal	S. Oct. 13, 1894 A. Aug. 6,1898 M. April 8, 1911
146 Clifford, William, Jeannette, Pennsylvania, U.S.A.	Feb. 9, 1895
147 Climas, Arthur Bertram, Botallack, St. Just, Cornwall	Dec 10, 1910
148 Clothier, Henry William, 3, Park Villas, The Green, Wallsend, Northumberland	June 12, 1909
149 Clough, Edward Stokoe, Bomarsund House, Bomarsund, Bedlington, Northumberland	A Feb. 14, 1903 M. April 8,1911
150 Clough, James, Bomarsund House, Bomarsund, Bedlington, Northumberland	S. April 5, 1873 A. M. Aug. 3,1878 M. June 8, 1889

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	Date of Election and of Transfer.
151 Cochrane, Brodie, Low Gosforth House, Newcastle-upon-Tyne	Dec. 6, 1866
152 Cock, Ben, Woodbine, Beacon Hill, Camborne	June 11, 1910
153 Cockburn, Evan, Rush Run Mines, Fayette County, West Virginia, U.S. A .	A. Aug. 5, 1893 M. Dec. 8,1906

154 Colley, John, Indwe Railway, Collieries and Land Company, Limited, P.O. Box 4, Indwe, Cape Colony, South Africa	Feb. 9, 1901
155*Collins, Hugh Brown, Auchinbothie Estate Office, Kilmacolm, Renfrewshire	April 14, 1894
156 Collins, Victor Buyers, Lewis Street, Islington, via Newcastle, New South Wales, Australia	June 11, 1904
157 Colquhoun, Thomas Grant, The Durban Navigation Collieries, Limited, Dannhauser, Natal, South Africa	Dec. 14, 1898
158 Commans, Robert Edden, 9, Queen Street Place, London, E.C	Nov. 24, 1894
159 Comstock, Charles Worthington, Boston Building, Denver, Colorado, U.S.A.	June 10, 1905
160 Cook, Joseph., Washington Iron Works, Washington, County Durham	May 8, 1869
161 Cook, Joseph, Jim., Washington Iron Works, Washington, County Durham	Oct. 9, 1897
162 Cook, James Falshaw, Washington Iron Works, Washington, County Durham	Feb. 12, 1898
163 Cook, John Watson, Binchester Hall, Bishop Auckland	Oct. 14, 1893
164 Cooke, Henry Moore Annesley, The Balaghat Goldmining Company, Limited, Coromandel P.O., Mysore State, South India	Dec. 12, 1896
165*Coppee, Evence, 71, Boulevard d'Anderlecht, Brussels, Belgium	Feb. 9, 1907
166 Corbett, Vincent. Blackett Colliery, Haltwhistle, Northumberland	A. June 11, 189 M. Feb. 13, 19048
167 Corbett, Vincent Charles Stuart Wortley, Chilton Moor, Fence Houses	Sept. 3, 1870
168 Corlett, George Stephen, Wigan	Dec. 12, 1891
169 Coste, Eugene, 210, Poplar Plains Road, Toronto, Ontario, Canada	June 9, 1900
170 Coulson, Frank, Shamrock House, Durham (Vice-President, Member of Council)	S. Aug. 1, 1868 M. Aug. 2, 1873
171 Couves, Harry Augustus, 64, Osborne Road, Newcastle-upon-Tyne	Feb. 10, 1906
172 Cowell, Edward, Horden Colliery, Horden, Sunderland	A. Oct. 8, 1904 M. June 20, 1908
173 Cowell, Joseph Stanley, Vane House, Seaham Harbour, County Durham	Dec. 12, 1908
174 Coxon, William Bilton, Seaton Hill, Boosbeck, Yorkshire	S. Feb. 12, 1898 A. Aug. 2, 1902 M. Feb. 12, 1910
175 Cragg, James Horace Maitland, 53, Manor House Road, Newcastle-upon-Tyne	Aug. 6, 1910
176 Craster, Walter Spencer, P.O. Box 216, Kopje, Salisbury, Rhodesia, South Africa	Dec. 8, 1900
177 Craven, Robert Henry, The Libiola Copper-mining Company, Limited, Sestri Levante, Italy	Feb. 11, 1905
178 Crawford, James Mill, Denehurst, Ferry Hill	Feb. 14, 1903
179 Crofton, Charles Arthur, 3, Hardy Terrace, Crook, County Durham	S. Dec. 10, 1898 A. Aug. 1, 1903 M. Dec. 14, 1907
180 Crookston, Andrew White, 188, St. Vincent Street, Glasgow	Dec. 14, 1895
181 Crosby, Arthur, Douglas Colliery, Limited, Balmoral, Transvaal	A.M. Aug. 7, 1897 M. April 12, 1902
182 Cross, William Haslam, 77, King Street, Manchester	Feb. 8, 1902

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	Date of Election and of Transfer.
183 Croudace, Francis Henry Lambton, The Lodge, Lambton, Newcastle, New South Wales, Australia	June 8, 1907
184 Croudace, Sydney, New Lambton, Newcastle, New South Wales, Australia	June 8, 1907
185 Cruz y Diaz, Emiliano de la, Director-General de l'Empresa Minas et Minerales, Limited, Ribas, Provincia de Gerona, Spain	June 14, 1902
186 Cullen, Daniel, P.O. Box 4352, Johannesburg, Transvaal	Dec. 11, 1909
187 Cullen, Matthew, The Clydesdale (Transvaal) Collieries, Limited, Springs, Transvaal	Feb. 12, 1910

188 Cummings, John, Hamsterley Colliery, Ebchester, County Durham	A. Aug. 2, 1902 M. Dec. 14, 1907
189 Cunningham, John Allan, Inspector of Boilers, P.O. Box 343, Pietermaritzburg, Natal, South Africa	Dec. 8, 1906
190 Currie, Walter, P.O. Box 220, Bulawayo, Rhodesia, South Africa	April 25, 1896
191 Curry, George Alexander, Thornley House, Thornley, County Durham	Oct. 12, 1907
192 Curry, Michael, Cornsay Colliery, Durham	Aug. 6, 1898
193 Daggar, Henry James, 13, Macquarie Place, Sydney, New South Wales, Australia	Oct. 12, 1901
194 DGLISH, William Charlton, Littleburn Colliery, near Durham	Dec. 12, 1896
195 Dakers, William Robson, Tudhoe Colliery, Spennymoor	A. M. Oct. 14, 1882 M. Aug. 3, 1889 April 14, 1894
196 Dan, Takuma, Mitsui Mining Company, 1, Suruga-cho, Nihonbashi-ku, Tokyo, Japan	
197 Daniel, Peter Francis, Greymouth, New Zealand	April 8, 1893
198 Darling, Fenwick, Sowerby Grange, Thirsk	Nov. 6, 1875
199 Darlington, Cecil Ralph, c/o Tata, Sons and Company, Nausari Buildings, Fort, Bombay, India	Dec. 10, 1910
200 Darlington, James, Black Park Colliery, Ruabon	S. Nov. 7, 1874 M. Aug. 4, 1877 April 13, 1907
201 Davidson, Allan Arthur, c/o F. F. Fuller, 638, Salisbury House, London Wall, London, E.C.	
202 Davidson, Christopher Cunnion, Hardheads, Egremont, Cumberland	Oct. 10, 1908
203 Davies, David, Cowell House, Llanelly	Dec. 9, 1899
204 Davies, William Stephen, Maesydderwen, Tredegar	Feb. 14, 1903
205 Davis, Charles Henry, South Yarmouth, Massachusetts, U.S.A .	Oct. 13, 1900
206 Daw, Albert William, 11, Queen Victoria Street, London, E.C	June 12, 1897
207 Daw, John W., Walreddon Manor, Tavistock	Dec. 14, 1895
208 Dean, Harry, Eastbourne Gardens, Whitley Bay, Northumberland	June 10, 1905
209 Dean, John, The Wigan Coal and Iron Company, Limited, Wigan	Feb. 13, 1904
210 Dean, Samuel, Delagua, Colorado, U.S.A	Oct. 13, 1906
211* Dewhurst, John Herbert, 32, Bishopsgate, London, E.C.	April 2, 1898
212 Dick, William, 5, Avonmore Gardens, West Kensington, London, W .	April 13, 1907
213 Dickinson, Arthur, 353, Mansion House Chambers, 11, Queen Victoria Street, London, E.C.	April 14, 1894
214 Dietzsch, Ferdinand, 652-655, Salisbury House, London Wall, London, E.C	Aug. 5, 1899
215* Dingwall, William Burleston-Abigail, Apartado 13, Matehuala, San Luis Potosi, Mexico	Aug. 4, 1900
216* Ditmas, Francis Ivan Leslie, Resolven, Neath	A. June 11, 1898 M. June 14, 1902
217 Dives, Robert, 42, Hazelwood Road, Northampton	Feb. 8, 1902
218 Dixon, Charles Willis, Westport Coal Company, Limited, Denniston, New Zealand	Feb. 8, 1908

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	Date of Election and of Transfer.
219 Dixon, David Watson, Lumpsey Mines, Brotton, Yorkshire	Nov. 2, 1872
220 Dixon, George, Seeterampore Coal Company, Limited, Asansol, E.I. R., Bengal, India .	S. June 13, 1896 A. Aug. 6, 1904 M. Dec. 8, 1906
221 Dixon, Jonathan, Westport Coal Company, Limited, Denniston, New Zealand	Oct. 13 1894
222 Dixon, Joseph Armstrong, Shilbottle Colliery, Lesbury, Northumberland	Dec. 14, 1901
223 Dixon, William, CleatOr, Cumberland	April 10, 1897

224 Dobb, Thomas Gilbert, Brick House, Westleigh, Leigh	Dec. 8, 1894
225 Dodd, Benjamin, Percy House, Neville's Cross, Durham (Member of Council)	S. May 3, 1866 M. Aug. 1, 1868
226 Dodd, Michael, Rand Club, Johannesburg, Transvaal	S. Dec. 4, 1875 A. M. Aug. 7, 1880 M. June 8, 1889 Oct. 14, 1905
227 Donald, William E., Eppleton House, Hetton-le-Hole, County Durham	
228*Donkin, William, Macequece, Portuguese East Africa	S. Sept. 2, 1876 A.M. Aug. 1, 1885 M. June 8, 1889 A. Dec. 9, 1893 M. Aug. 3, 1901 Feb. 13, 1904 .
229 Dormand, Ralph Brown, Cambois House, Cambois, Blyth	
230 Douglas, Arthur Stanley, Bearpark Colliery, near Durham	
231 Douglas, James, 99, John Street, New York City, U.S.A.	Oct. 14, 1899
232 Douglas, Matthew Heckels, Stella House, Low Fell, Gateshead-upon-Tyne	A.M. Aug. 2, 1879 M. Aug. 3, 1889 Aug. 21, 1852
233 Douglas, Thomas, The Garth, Darlington (Past-President, Member of Council)	
234 Draper, William, Silksworth Colliery, Sunderland	A. Dec. 14, 1889 M. Dec. 12, 1903 Feb. 9, 1907
235 Dunkerton, Ernest Charles, 53, Grosvenor Place, Newcastle-upon-Tyne	
236 Dunn, George Victor Septimus 7, St. James' Buildings, William Street, Melbourne, Victoria, Australia	June 20, 1908
237 Dunn, Thomas Bowman, Redburn House, Bardon Mill, Northumberland	Aug. 6, 1910
238 Eastlake, Arthur William, Grosmont, Palace Road, Streatham Hill, London, S.W	June 11, 1892
239 Ede, Henry Edward, Rectory Chambers, Norfolk Row, Sheffield	July 14, 1896
240 Edmond, Francis, Clock Face Colliery, near St. Helens	Dec. 10, 1910
241 Edwards, Edward, Ocean Collieries, Nantymoel, Bridgend	Feb. 9, 1895
242 Edwards, Herbert Francis, 104, Stanwell Road, Penarth	Oct. 12, 1901
243 Edwards, Owain Tudor, Fedwhir, Aberdare	Aug. 4, 1906
244 Eliet, Francis Constant Andre Benoni Elie du, Compagnie Lyonnaise de Madagascar, a Ambositra, Madagascar	Aug. 3, 1901
245*Elsdon, Robert William Barrow	April 13, 1901
246 Eltringham, George, Eltringham Colliery, Prudhoe, Ovingham, Northumberland	A. Dec. 8, 1894 M. Aug. 2, 1902 Oct. 13, 1888
247 Elwen, Thomas Lee, Brandon Colliery, County Durham	
248 Embleton, Henry Cawood, Central Bank Chambers, Leeds	April 14, 1894
249 Emmerson, Thomas, The British India Coal Company, Limited, Nowpara Colliery, Asansol P.O., E.I. Railway, India	A. Oct. 12, 1907 M. June 10, 1911
250 Englesqueville, Rene d', 7, rue Henri Martin, Paris, France	Feb. 8, 1908
251 English, John, North Learn, Felling, County Durham	Dec. 9, 1899
252 English, William, North Walbottle Colliery, Newburn, Northumberland	Dec. 14, 1907

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	Date of Election and of Transfer.
253 Epton, William Martin, Mumford's Chambers, Stanley Avenue, Salisbury, Rhodesia, South Africa	Oct. 12 1895
254 Esmarch, Cecil August, 80, Commercial Street, Middlesbrough	April 9, 1904
255 Etherington, John, 39a, King William Street, London Bridge, London, E.C.	Dec. 9, 1893
256 Evans, John William, Glynderw House, Penllergaer, near Swansea	April 8, 1911
257 Evans, Lewis, P.O. Box 447, Salisbury, Rhodesia, South Africa .	Oct. 14, 1893
258 Everard, John Breedon, 6, Millstone Lane, Leicester	March 6, 1869
259 Fairley, James, Craghead and Holmside Collieries, Chester-le-Street	A.M. Aug. 7, 1880 M. Aug. 3, 1889

260 Fawcett, Edward Stoker, Battle Hill House, Walker, Newcastle-upon-Tyne	A. June 11, 1892 M. Aug. 6, 1904
261*Fenwick, Barnabas, 66, Manor House Road, Newcastle-upon-Tyne	Aug. 2, 1866
262 Fergie, Charles, The Linton, Sherbrook Street, Montreal, Canada	Dec. 9, 1893
263 Fergie, George, Copiapo, Chile, South America	Dec. 12, 1908
264 Ferguson, David, 140, Hyndland Road, Glasgow, W.	A.M. Dec. 8, 1883 M. Aug. 3, 1889
265 Ferguson, James, The Cedars, High Wycombe	Dec. 12, 1896
266 Fevre, Lucien Francis, 1, place Possoz (XVII0), Paris, France	Feb. 8, 1908
267 Figari, Alberto, Apartado 516, Lima, Peru, South America	April 25, 1896
268 Fisher, Edward Robert, Wansbeck, Ammanford, Carmarthenshire	A.M. Aug. 2, 1884 M. Aug. 3, 1889
269 Fisher, Henry Herbert, Calle Sucre, 1841, Belgrano, near Buenos Aires, Argentine Republic, South America	Oct. 8, 1904
270 Fleming, Henry Stuart, 1, Broadway, New York City, U.S.A	June 10, 1905
271 Fletcher, James, Taupiri Coal-mines, Limited, Huntly, New Zealand	Oct. 14 1905
272 Fletcher, Lancelot Holstock, Allerdale Coal Company, Limited, Colliery Office, Workington	A.M. April 14, 1888 M. June 8, 1889
273*Fletcher, Walter, The Hollins, Bolton	Dec. 14, 1895
274 Flint, John, Benmont, Forest Hall, Newcastle-upon-Tyne	Jan. 19, 1895
275 Ford, Mark, Washington Colliery, Washington Station, County Durham [Member of Council)	Aug. 3, 1895
276 Ford, Stanley Horace, 42, Dacre Park, Blackheath, London, S.E.	June 10, 1893
277 Forster, Alfred Llewellyn, Newcastle and Gateshead Water Company, Engineer's Office, Pilgrim Street, Newcastle-upon-Tyne	June 8, 1901
278 Forster, Charles, 2, Killowen Street, Low Fell, Gateshead-upon-Tyne	April 9, 1910
279 Forster, John Henry Bacon, Whitworth House, Spennymoor (Member of Council)	S. Nov. 24, 1894 A. Aug. 7, 1897 M. Feb. 10, 1900 Feb. 13, 1904
280 Forster, Joseph William, P.O. Box 56, East Rand, Transvaal	S. Oct. 7, 1876
281 Forster, Thomas Emerson, 3, Eldon Square, Newcastle-upon-Tyne (Past-President, Member of Council)	A.M. Aug. 1, 1885 M. June 8, 1889 Feb. 14, 1903
282 Fox, George Charles, P.O. Box 1030, Johannesburg, Transvaal	Feb. 14, 1903
283 Fryar, John William, Eastwood Collieries, near Notting- ham	A. June 14, 1890 M. June 12, 1897
284 Fryar, Mark, Denby Colliery, Derby	S. Oct. 7, 1876 A.M. Aug. 4, 1883 M. June 8, 1889

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	Date of Election and of Transfer.
285 Fryer, George Kellett, Woodhouse, Whitehaven	Dec. 14, 1901
286 Futers, Thomas Campbell, 17, Balmoral Gardens, Monkseaton, Whitley Bay, Northumberland	Aug. 6, 1904
287 Galloway, Thomas Lindsay, 109, Hope Street, Glasgow	Sept. 2, 1876
288 Galloway, William, Cardiff	April 23 1887
289 Gibson, James, c/o W. E. Robarts. Acutts Arcade, Durban, Natal, South Africa	A.M. Dec. 9, 1899 M. Feb. 13 1904
290 Gifford, Henry J., The Champion Reef Gold-mining Company of India, Limited, Champion Reefs P.O., Mysore State, South India	Oct. 14 1893
291 Gillman, Gustave, Aguilas, Provincia de Murcia, Spain	Aug. 2, 1902
292 Gipps, F. G. de Visme, Irvinebank, North Queensland, Australia	April 25, 1896

293 Glass, Robert William, Axwell Park Colliery, Swalwell, County Durham	S. June 10, 1899 A. Aug. 1, 1903 M. Oct. 12, 1907 June 10, 1906
294 Goninon, Richard, Menzies Consolidated Gold-mines, Limited, Menzies, Western Australia	
295 Goodwin, Robert Harvey, Karabournou Mercury-mine, c/o C. Whittall and Company, Smyrna, Turkey	Oct. 13, 1900
296 Goodwin, William Lawton, School of Mining, Kingston, Ontario, Canada	Feb. 11, 1899
297 Gough, George Henry, Singareni Collieries, Yellandu (Deccan), India	Aug. 4, 1900
298 Gouldie, Joseph, 48, Standard Bank Chambers, Johannesburg, Transvaal	Aug. 5, 1893
299 Gowland, Joseph Edwin, Minas de Rio Tinto, Provincia de Huelva, Spain	June 11, 1904
300 Graham, Edward, Jun., Bedlington Colliery, Bedlington, Northumberland	Aug. 1, 1896
301 Greaves, J. O., Westgate, Wakefield	Aug. 7, 1862
302 Green, Edwin Henry, P.O. Box 1978, Johannesburg, Transvaal	Aug. 1, 1903
303 Green, Joseph, Crag House, Ferry Hill	Dec. 13, 1902
304 Green, John Dampier, P.O. Box 340, Johannesburg, Transvaal	A.M. Dec. 14, 1901 M. Aug. 2, 1902 Dec. 11, 1909
305 Green, Leonard Clifford, Wienholt Street, Torwood, Brisbane, Queensland, Australia	
306 Greener, Herbert, Swallowhurst, Thorne, Doncaster	Feb. 13, 1909
307 Greener, Thomas Young, West Lodge, Crook, County Durham (Retiring Vice-President, Member of Council)	S. July 2, 1872 A.M. Aug. 2, 1879 M. June 8, 1889 June 11, 1910
308 Greener, William James, Reliance Coal Company, Limited, Charanpur Colliery, Charanpur P.O., via Asanscl, E.I.R., Bengal, India	
309 Greenwell, Allan, 30 and 31, Furnival Street, Holborn, London, E.C .	Aug. 4, 1900
310 Greenwell, Alan Leonard Stapylton, Eldon Colliery, Bishop Auckland	S. Oct. 8, 1898 A. Aug. 5, 1905 M. Dec. 14, 1907
311 Greenwell, George Clementson, Poynton, Stockport	S. March 6, 1869 M. Aug. 3, 1872
312 Greenwell, George Harold, c/o Kilburn and Company, 4, Fairlie Place, Calcutta, India	S. Dec. 12, 1903 A. Aug. 4, 1906 M. April 8, 1911
313 Gresley, William Stukeley, Middlesex Road, Bexhill-on-Sea, Sussex	A.M. Oct. 5, 1878 M. Aug. 3, 1889
314 Griffith, Thomas, Maes Gwyn, Cymmer, Porth, Pontypridd	April 9, 1904
315 Griffith, William, Waterloo House, Aberystwyth	Dec. 9, 1893
316 Griffiths, John Norton, 62, London Wall, London, E.C.	April 11, 1908
317 Grose, Frank, c/o Mrs. Richards, Grants Walk, St. Austell, Cornwall	April 9, 1910
318* Grunoy, James, 8, Grosvenor Gardens, Cricklewood, London, N.W .	June 13, 1896

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	Date of Election and of Transfer.
319 Grunson, Robert, Minas Errazuriz, Lebu, Chile, South America	June 12, 1909
320 Gjilachsen, Berent Conrad, P.O. Box 5, Cleveland, Transvaal	S. April 8, 1905 M. Aug. 3, 1907
321 Gummerson, James M., 35, Birkbeck Road, Acton, London, W .	A.M. June 10, 1899 M. Dec. 12, 1903
322*Haddock, William Thomas, Cornelia Colliery, Viljoen's Drift, Orange River Colony, South Africa	S. Oct. 7, 1876 A. M. Aug. 1, 1885 M. June 8, 1889 Dec. 11, 1909
323 Haggie, John Douglass, Walbottle Colliery, Newcastle-upon-Tyne .	
324 Haines, Charles George Padfield, 10, Picton Place, Swansea	Oct. 8, 1910
325 Halbaum, Henry Wallace Gregory, 7, Mafeking Road, Roath Park, Cardiff	April 8, 1899

326 Hale, Alfred Edward, Mountjoy Lodge, Cinderford, Gloucestershire	April 8, 1911
327 Hall, John Charles. Black Boy Colliery, Bishop Auckland	A. Dec. 14, 1889 M. Aug. 3, 1895 Dec. 10, 1904
328 Hall, Joseph John, Ashington Colliery, Morpeth	S. Oct. 9, 1897 A. Aug. 2, 1902 M. Oct. 9, 1909
329 Hall, Joseph Percival, Talbot House, Birtley, County Durham	A. Dec. 13, 1902 M. June 8, 1907 June 8, 1889
330 Hall, Robert William, Fairlawn, Leeholme, Bishop Auckland .	S. Oct. 7, 1876 A.M. Aug. 4, 1883 M. June 8, 1889 Dec. 14, 1889
331 Hall, Tom, Ryhope Colliery, Sunderland	
332 Hallas, George Henry. Claremont, Huyton, Liverpool	S. Nov. 1, 1873 A.M. Aug. 2, 1879 M. June 8, 1889 Oct. 10, 1908
333 Hallimond, William Tasker, c/o Rose Deep, Limited, P.O. Box 6, Germiston, Transvaal	
334 Hamilton, Edward. Rig Wood, Saltburn-by-the-Sea	Oct. 12, 1907 Dec. 14, 1895
335 Hamilton, James, Blackhills Road, Horden, Sunderland	
336 Hance, Henry Malkin	
337*Hancock, Henry Lipson, Wallaroo and Moonta Mining and Smelting Company, Limited, Moonta Mines, South Australia	
338 Hancock, Henry Richard	A.M. Aug. 4, 1894 M. Nov. 24, 1894 Oct. 14, 1895
339 Hann, Robert, Jun., Harton House, Harton Colliery, South Shields	
340 Hannah, David, Brynderwen, Ferndale, Pontypridd	Feb. 9, 1895
341 Hare, George, Seghill Colliery, Seghill, Dudley, Northumberland	A. Feb. 12, 1898 M. Dec. 14, 1907 S. Aug. .2, 1879 M. Aug. 1, 1891 Oct. 8, 1892
342 Hare. Samuel, Howlish Hall, Bishop Auckland {Member of Council}	
343 Harle, Peter, Page Bank Colliery. County Durham	April 7, 1877
344 Harle, Richard, Browney Colliery, Durham	
345 Harle, Robert Alfred, Alma Cottage, Campbells Hill, West Maitland, New South Wales, Australia	A. April 14, 1894 M. Oct. 12, 1901 Dec. 12, 1908
346 Harle, William, Bowburn Colliery, Coxhoe, County Durham	
347 Harrts, David, Elands Laagte Collieries, Limited, Elands Laagte, Natal, South Africa	A.M. June 12, 1897 M. April 13, 1901 S. Feb. 14, 1874 A.M. Aug. 7, 1880 M. June 8, 1889 June 21, 1894
348 Harris, William Scorer, Kibblesworth, Gateshead-upon-Tyne	
349 Harrison, Charles Augustus, North Eastern Railway, Newcastle-upon-Tyne	April 6, 1867
350 Harrison, William B., Brownhills Collieries, near Walsall	

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	Date of Election and of Transfer.
351 Haselden, Arthur, Linares, Provincia de Jaen, Spain	A.M. Dec. 11, 1897 M. April 2, 1898 Oct. 12, 1895
352*Hawker, Edward William, Adelaide Club, Adelaide, South Australia	Aug. 6, 1904
353 Hawkins, Thomas Spear, c/o The St. John del Rey Mining Company, Limited, Villa Nova de Lima, Estado de Minas, Brazil, South America	
354 Hawxhurst, Robert, Jun., 623, Salisbury House, London, E.C .	Feb. 13, 1989
355 Hedley, Arthur Morton, Blaydon Burn, Blaydon-upon-Tyne, County Durham (Member of Council)	A. Nov. 24, 1894 M. Dec. 12, 1903
356 Hedley, Septimus H., Langholme, Roker, Sunderland	S. Feb. 15, 1879 A.M. Aug. 1, 1885 M. Aug. 3, 1889

357 Heise, Fritz, Hernerstrasse, 45, Bochum, Germany	Aug. 5, 1905
358 Henderson, Charles, Cowpen Colliery Office, Blyth	Dec. 9, 1899
359 Henderson, Willtam, Alston House, Littleton, Durham	Aug. 7, 1909
360 Hendy, John Cary Baker, Etherley, via Darlington	Oct. 14, 1893
361 Henriksen, Gudbrand, Inspector of Mines, Minde, near Bergen, Norway	Aug. 6, 1904
362 Herdman, William, St. John's Chapel, County Durham	April 11, 1908
363 Herrmann, Henry J. A., a Am-Sedjera, par Lafayette, Algeria	Dec. 10, 1898
364 Heslop, Christopher, Woodside. Marske Mill Lane, Saltburn-by-the-Sea	S. Feb. 1, 1868 M. Aug. 2, 1873
365 Heslop, Grainger, North Moor House, Sunderland	Oct. 5, 1872
366 Heslop, Michael, Rough Lea Colliery, Willington, County Durham	A. Feb. 10, 1894 M. June 21, 1894
367 Heslop, Septimus, New Beerbhoom Coal Company, Limited, Asansol, Bengal, India	Oct. 12, 1895
368 Heslop, Thomas, Randolph Colliery, Evenwood, Bishop Auckland	S. Oct. 2, 1880 A.M. Aug. 4, 1888 M. Aug. 3, 1889
369 Heslop, William Taylor, St. George's Colliery, Hatting Spruit, Natal, South Africa	Aug. 3, 1895
370*Hewitt, George Colthurst, Serridge House, Coalpit Heath, Bristol	June 3, 1871
371 Hewlett, Alfred, Haseley Manor, Warwick	March 7, 1861
372 Hewlett, Alfred, The Cossall Colliery Company, Limited, Cossall, near Nottingham	June 20, 1908
373 Hewlett, Erne, Ammanford Colliery Company, Limited, Ammanford, Carmarthenshire	Oct. 10, 1896
374 Hewlett, Howe, The Pontyberem Collieries Company, Limited, Pontyberem, Carmarthenshire	Feb. 13, 1904
375 Higson, Jacob, Crown Buildings, 18, Booth Street, Manchester	Aug. 7, 1862
376 Hill, Frank Cyril Gibson, 12, Bigg Market, Newcastle-upon-Tyne	April 9, 1910
377 Hill, William, Station Road, Polesworth, Tamworth	A.M. June 9, 1883 M. Aug. 3, 1889
378 Hilton, Thomas Worthington, Wigan Coal and Iron Company. Limited, Wigan	Aug. 3, 1865
379 Hindmarsh. Joseph Pakker, Corrimal, South Coast, New South Wales, Australia	June 20, 1908
380 Hindson, Thomas, Framwellgate Colliery, near Durham	Dec. 9, 1905
381 Hodgkin, Jonathan Edward, Shelleys, Darlington	Dec. 13, 1902
382 Hodgson, Jacob, Cornsay Colliery, Durham	June 8, 1895
383 Hogg, Charles Edward	Oct. 12, 1895
384 Hogg, John, Thornley Colliery Office, Thornley, County Durham	Dec. 12, 1903
385 Holberton, Walter Twining, Compania Estanifera de Llallagua, Llallagua, Bolivia, South America, via Buenos Aires i Tupiza	June 9, 1900
386 Holland, Charles Henry, Auckland, New Zealand	April 9, 1910

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	Date of Election and of Transfer.
387 Holliday, Martin Forster, Park House, Durham	May 1, 1875
388 Holliday, Norman Stanley, Boyne Villa, Langley Moor, Durham	S. April 10, 1897 M. Feb. 13, 1904
389 Holman, Nicholas, The Gibraltar Consolidated Gold-mines, Limited, Sheppardstown, New South Wales, Australia	Dec. 11, 1909
390 Homersham, Edwin Collett, The Randfontein Estates Gold-mining Company, Limited, P.O., Randfontein, Transvaal	Feb. 9, 1901
391 Homersham, Thomas Henry Collett, Vulcan Iron Works, Thornton Road, Bradford	Aug. 6, 1898
392 Hood, George, 9, Agents Terrace, Boldon Colliery, County Durham	Dec. 14, 1907

393 Hood, William Walker, Tredean, near Chepstow	April 9, 1904
394 Hooper, Edward, 3, London Wall Buildings, London, E.C .	A.M. June 4, 1881 M. April 14, 1894
395 Hooper, James Augustus, Lansdown, Bream, Gloucestershire	Dec. 12, 1908
396 Hopper, Samuel Jackson, 53, Victoria Road, Hebburn, County Durham	Feb. 11, 1911
397 Hopwood, Howell Arthur, East Indies Development Syndicate, Limited, Singapore	Oct. 12, 1907
398 Hopwood, Isaac John, c/o McAlister and Company, Limited, Ipok, Federated Malay States, via Penang	Oct. 12, 1907
399 Hopwood, Kingsley, c/o Effuenta and Wassau Mines, Limited, Effuenta, Tarquah, Gold Coast Colony, West Africa	June 20, 1908
400 Hopwood, William, Vron Haul, Buckley, Chester	Aug. 3, 1901
401 Hobswill, Frederick Alva, Stone Canon, Monterey County, California, U.S.A.	Feb. 13, 1909
402 Horswill, Frederick J., 1070, Sixteenth Street, Oakland, California, U.S.A .	Oct. 14, 1899
403*Hoskold, Carlos A. Lynes	June 8, 1895
404 Hoso, Shonosuke, Mitsui Yamano Colliery, Chikuzen, Japan	April 11, 1908
405 Hotchkis, Daniel, Coal Cliff Collieries, Limited, Clifton, New South Wales, Australia	June 20, 1908
406 Howe, Richard Algeo, Sunnyside, Willington, County Durham .	April 9, 1910
407 Howes, Frank Tippet, Chipping Sodbury, Gloucestershire	A. Dec. 10, 1892 M. Oct. 14, 1893 S. Dec. 14, 1901
408 Howson, Charles, Harraton Colliery, Chester-le-Street	A. Aug. 4, 1906 M. June 8, 1907 S. Feb. 14, 1903
409 Humble, Ernest, Killingworth Colliery, West Wallsend, New South Wales, Australia	A. Aug. 3, 1907 M. April 11, 1908 Feb. 8, 1902
410 Humble, John, Harperley Hall, Tantobie, County Durham	Oct. 14, 1893
411 Humble, William, Lawson Street, Hamilton, Newcastle, New South Wales, Australia	Oct. 13, 1900
412 Humphris, Henry, Blaenau Festiniog	A. Dec. 10, 1892 M. Dec. 12, 1903
413 Hunter, Christopher, Cowpen Colliery Office, Blyth	June 14, 1902
414 Hunter, Robert, Gympie, Queensland, Australia	S. April 14, 1883 M. Aug. 1, 1891
415 Hurst, George, Lauder Grange, Corbridge, Northumber- land	Aug. 7, 1909
416 Hutchinson, George Weymouth, Greensburg, Westmoreland County, Pennsylvania, U.S.A.	Dec. 10, 1904
417 Hutton, John George, Barfield, East Maitland, New South Wales, Australia	Aug. 3, 1907
418 Hylton, Frederick William, Ryhope Colliery, Sunderland	Aug. 6, 1910
419 l'Anson-Robson, William Leonard, Emerson Chambers, Blackett Street, Newcastle-upon-Tyne	

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	Date of Election and of Transfer.
420 Inskipp, Dudley James, The Bulawayo Club, Bulawayo, Rhodesia, South Africa	June 8, 1907
421 Ivey, Joseph Henry, Stray Park House, Camborne	Aug. 7, 1909
422 Jackson, Walter Geoffrey, Bramham Hall, Boston Spa, Yorkshire	June 7, 1873
423 Jacobs, Lionel Asher, Raghunathbatty, Sitarampur, E.I.R., India	S. Aug. 4, 1900 A. Aug. 4, 1906
424 Jacobs, Montagu, 18, Greville Road, London, N.W.	M. April 13, 1907 Oct. 9, 1909
425 James, William Henry Trewartha, Finsbury House, Blomfield Street, London, E.C .	Dec. 12, 1896
426 Jamieson, John William, Medomsley, County Durham	Aug. 2, 1902

427 Jarvie, James, Kembla Heights, near Wollongong, New South Wales, Australia	Feb. 8, 1908
428 Jefferson, Frederick, Whitburn Colliery, South Shields	Dec. 11, 1897
429 Jeffreys, James Henry, co R. R. Needham and Company, .Finsbury Circus Buildings, 18, Eldon Street, London, E.C.	Oct. 8, 1904
430 Jenkins, William, Ocean Collieries, Treorchy, Pontypridd	Dec. 6, 1862
431 Jennings, Albert, 12, Grainger Street, Darlington	June 20, 1908
432 J epson, Henry, 39, North Bailey, Durham	S. July 2, 1872 A.M. Aug. 2, 1879 M. June 8, 1889 S. Oct. 7, 1876
433* Jobling, Thomas Edgar, Bebside, Northumberland (Member of Council)	A.M. .Aug. 4, 1883 M. June 8, 1889 Dec. 9, 1905
434 Johns, Bennet, Station Road, Keswick	June 21, 1894
435* Johns, John Harry (Henry), Elmfield, Westbury-on-Trym, Bristol	Dec. 9, 1905
436 Johnson, Edward, 104, Briton Ferry Road, Neath	Dec. 9, 1905
437 Johnson, Henry Howard, 216-217, Moorgate Station Chambers, London, E.C	Feb. 13, 1904
438 Johnson, James, Boldon Lodge, East Boldon, County Durham	A. Aug. 6, 1898 M. Dec. 12, 1903
439 Joicey, William James, Sunningdale Park, Berkshire	March 6, 1869
440 Jones, Clement, Neath Colliery, Cessnock, New South Wales, Australia	Dec. 8, 1906
441 Jones, Evan, Plas Cwmorthin, Blaenau Festiniog	April 13, 1907
442 Jones, Jacob Carlos. Wollongong. New South Wales, Australia	Aug. 6, 1892
443 Jones, John Elias, 38, Trent Road, Brixton Hill, London, S. W.	June 14, 1902
444 Jones, Percy Howard, Ty Ceirios, Pontnewynydd, Pontypool	Oct. 11, 1902
445 Jones, Robert, 11, The Square, Blaenau Festiniog	April 3, 1909
446 Jones, Thomas, 5, Little George Street, Westminster, London, S.W .	June 12, 1897
447 Joynes, John James, Ferndale, Lydbrook, Gloucestershire	Aug. 6, 1904
448 Kayll, Alfred Charles, Gosforth, Newcastle-upon-Tyne	S. Oct. 7, 1876 M. Aug. 3, 1889 Aug. 1, 1903
449 Kearney, Joseph Musgrave, Lismore, Whitehaven	Aug. 4, 1900
450 Keighley, Frederick Charles, Uniontown, Fayette County, Pennsylvania, U.S.A.	S. April 11, 1891 M. Aug. 3, 1895
451 Kellett, Matthew Henry, Eldon, Bishop Auckland	Aug. 6, 1910
452 Kennaway, Thomas William, Killingworth, near Newcastle, New South Wales, Australia	June 11, 1910
453 Kennedy, Percy Joseph Emerson, 4, St. Nicholas' Buildings, Newcastle-upon-Tyne	Dec. 14, 1907
454 Kerr, Andrew, Flimby Colliery, Maryport	

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	Date of Election and of Transfer.
455 Kerr, David Gillespie, Room 129-130, Confederation Life Building, Toronto, Canada	Aug. 4, 1900
456 Kidd, Thomas, Jun., Linares, Provincia de Jaen, Spain	Aug. 3, 1895
457 Kirby, Matthew Robson, c/o Addison Langhorne Steavenson, Holywell Hall, Durham	S. June 9, 1900 A. Aug. 1, 1903 M. Oct. 12, 1907
458 Kirkby, William, c/o Aire and Calder Navigation, Leeds	A.M. April 2, 1898 M. Aug. 6, 1904
459 Kirkup, Austin, Mining Office, Bunker Hill, Fence Houses	S. April 9, 1892 M. June 12, 1897
460 Kirkup, Frederic Octavius, Medomsley, County Durham	S. April 9, 1892 A.M. April 25, 1896 M. Feb. 14, 1903
461 Kirkup, John Philip, Burnhope, Durham	April 11, 1891

462 Kirkup, Philip, Leafield House, Birtley, County Durham (Vice-President, Member of Council)	S. March 2, 1878 A.M. Aug. 7, 1886 M. Aug. 3, 1889 June 9, 1900
463 Kirsopp, John, Jun., Lamesley, Gateshead-upon-Tyne	
464 Kirton, Hugh, Kimblesworth Colliery, Chester-le-Street	S. April 7, 1877 A.M. Aug. 1, 1885 M. June 8, 1889 Aug. 5, 1905
465 Kitchin, James Bateman, Woodend House, Bigrigg, Cumberland	
466 Klepetko, Frank, 307, Battery Park Building, 21-24, State Street, New York City, U.S. A .	Oct. 13, 1900
467*Knowles, Robert, Ednaston Lodge, near Derby	April 10, 1886
468 Kondo, R., c/o Furukawa Mining Office, 1, Icchome Taesucho, Kojimachi, Tokyo, Japan	June 21, 1894
469 Korte, Christian, Standard Buildings, 38, Park Row, Leeds	Feb. 13, 1909
470*Kwang, Kwong Yung, Mines de Lincheng, Lin Tchong Sien, Lu-Han Railway, via Peking, North China	June 8, 1895
471 Kyle, George Robert, 6, Ravensworth Road, Dunston, Gateshead-upon-Tyne	Dec. 14, 1907
472 Lamb, Robert Ormston, Hayton, How Mill, Carlisle	Aug. 2, 1866
473 Lancaster, John, Dunchurch Lodge, Rugby	March 2, 1865
474 Lancaster, John, Auchenheath, Hamilton	Sept. 7, 1878
475*Landero, Carlos F. de	Feb. 15, 1896
476 Langford, George Sherwin, Taupiri Coal-mines, Limited, Huntly, New Zealand	Oct. 9, 1909
477*Laporte, Henry, 35, rue de Turin, Brussels, Belgium	May 5, 1877
478 Lathbury, Graham Campbell, Giridih, E.I.R., Bengal, India	Feb. 14, 1903
479 Latimer, Hugh, St. Helen's Colliery, Bishop Auckland	S. Feb. 15, 1896 A. Aug. 1, 1903 M. Feb. 11, 1905 July 14, 1896
480 Lawn, James Gunson, University College, Johannesburg, Transvaal	
481 Lawson, William, Seaham No. 2 Colliery, West Wallsend, near Newcastle, New South Wales, Australia	Aug. 6, 1910
482 Leach, Charles Catterall, Seghill Hall, Northumberland (Vice-President, Member of Council)	S. March 7, 1874 A.M. Aug. 6, 1881 M. Aug. 4, 1883 Feb. 1, 1873
483 Lebour, George Alexander Louis, Armstrong College, Newcastle-upon-Tyne. Transactions, etc., sent to Radcliffe House, Corbridge, Northumberland	
484 Leck, William, H.M. Inspector of Mines, Cleator Moor, Cumberland	Nov. 24, 1894
485 Lee, John Wilson Richmond, 70, St. Helen's Gardens, North Kensington, London, W .	Aug. 5, 1893
486 Lee, Percy Ewbank, Westfield, Annfield Plain, County Durham	Feb. 11, 1905
487 Lee, Richard Henry Lovelock, 1, Burghley Road, Highgate Road, London, N.W.	Aug. 5, 1905
488 Lurch, Arthur Henry, 11, King Street, Wigan	Feb. 9, 1901

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	Date of Election and of Transfer.
489 Liddell, Christopher, Houghton Main Colliery, near Barnsley	A. Aug. 6, 1904 S. Dec. 14, 1901 M. June 10, 1911 Feb. 11, 1905
490 Liddell, Hugh, 21, Framlington Place, Newcastle-upon-Tyne	
491 Lidster, Ralph, Langley Park Colliery, Durham	April 4, 1903
492 Lisboa, Miguel Arrojado Ribeiro, 426, Praia de Botafogo, Rio de Janeiro, Brazil, South America	Aug. 5, 1905
493 Lishman, Robert Richardson, Bretby Colliery, Burton-upon-Trent	S. June 9, 1883 M. Aug. 1, 1891

494 Lishman, Thomas, Sunbury, 28, Ripon Road, Harrogate	S. Nov. 5, 1870 M. Aug. 3, 1872
495 Lishman, Tom Alfred, Horden Dene, Easington, Castle Eden, County Durham	S. Nov. 24, 1894 A. Aug. 7, 1897 M. April 13, 1901 June 10, 1893
496 Lishman, William Ernest, 4, Field House Terrace, Durham	S. July 2, 1872
497 Lisle, James, Kroonstad Coal Estate Company, Limited, - P.O. Box 118, Klerksdorp, Transvaal	A.M. Aug. 3, 1878 M. June 8, 1889
498 Liveing, Edward H., Brookfield House, Long Stanton, Cambridge	S. Sept. 1, 1877 A.M. Aug. 2, 1884 M. Aug. 3, 1889 June 12, 1897
499 Lockwood, Alfred Andrew, 46, Marmora Road, Honor Oak, London, S.E .	June 12, 1897
500 Long, Ernest, Calico Wood Farm, Shevington, Wigan	Aug. 4, 1906
501 Longworth, William, Ocean House, Moore Street, Sydney, New South Wales, Australia	June 11, 1910
502 Lonsdale, Talbot Richard, Fell House, Burnhope, Durham	June 14, 1902
503*Louis, David Alexander, 123, Pall Mall, London, S.W.	April 8, 1893
504 Louis. Henry, 4, Osborne Terrace, Newcastle-upon-Tyne (Member of Council)	Feb. 15, 1896
505 Lowdon, Thomas, Hamsteels, near Durham	Dec. 14, 1889
506 Lukis, Ernest du Bois, Peruvian Corporation, Limited, Lima, Peru, South America	Feb. 11, 1911
507 Lupton, Arnold, 7, Victoria Street, Westminster, London, S.W	Nov. 6, 1869
508 Lyall, Edward, Barton, Yorkshire	Oct. 14, 1905
509 Lyall, William, 4, Vane Terrace, Darlington	Feb. 13, 1909
510 MacArthur, John Stewart, 74, York Street, Glasgow	April 8, 1893
511 McCarthy, Edward Thomas, 125, Victoria Street, London, S.W	A.M. Oct. 8, 1887 M. Aug. 3, 1889 Dec. 11, 1909
512 McCowan, Robert David, Barnhill, Distington, Cumberland .	Dec. 11, 1909
513 Macfarlane, Rienzi Walton, c/o Parral Foreign Club, Parral, Estado Chihuahua, Mexico, via New York	April 9, 1904
514 McGeachie, Duncan, West Wallsend, New South Wales, Australia	Nov. 24, 1894
515 McInerney, Augustin Joseph, 16, rue d'Autriche, Tunis	Aug. 4, 1906
516 McIntosh, Stewart, c, o Alexander Leith and Company, Sun Buildings, Collingwood Street, Newcastle-upon-Tyne	Feb. 12, 1910
517 Mackenzie, Joseph Charles Duke, c/o Ernest Hawkins and Company, Limited, Army and Navy Mansions, 109, Victoria Street, Westminster, London, S.W.	April 9, 1910
518 Mackintosh, James, Burrea Coal Company, Salanpur Colliery, Sitarampur, E.I.R., Bengal, India	Oct. 12, 1895
519 McLellan, Neil, Idsley House, Spennymoor	Dec. 13, 1902
520 McMurtrie, George Edwin James, Radstock, Bath	S. Aug. 2, 1884 M. Dec. 12, 1891
521 McMurtrie. James, 5, Belvedere Road, Durdham Park, Bristol	Nov. 7, 1863
522 McNeill, Bedford, 1, London Wall Buildings, London, E.C .	Dec. 11, 1897

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	Date of Election and of Transfer.
523 Maitland, Lionel Clinton, Highfield, Pemberton, Wigan	April 9, 1910
524 Mammatt, John Ernest, 1, Albion Place, Leeds	Aug. 3, 1865
525 Manderson, John Thomas, Siddick Villa, Workington	Dec. 10, 1910
526 Manning, Arthur Hope, P.O. Box 88, Heidelberg, Transvaal	Dec. 11, 1897
527*Markham, Gervase Edward, Gloucester Villa, Darlington	S. Dec. 4, 1875 A.M. Aug. 7, 1880 M. June 8, 1889

528 Marks, Arthur Tristman, c/o The Nile Valley Gold-mining Company, Limited, 15, Cophall Avenue, London, E.C.	June 12, 1909
529 Marks, Herbert T., c/o Royal Colonial Institute, Northumberland Avenue, London, W.C.	Oct. 12, 1901
530 Marley, Frederic Thomas, Heatherlands, Barnard Castle	S. Oct. 8, 1898 A. Aug. 5, 1905 M. Dec. 14, 1907
531 Marr, James Heppell, Castlecomer, County Kilkenny	A. Feb. 13, 1897 M. Dec. 12, 1903
532*Marriott, Hugh Frederick, c/o The Central Mining and Investment Corporation, Limited, 1, London Wall Buildings, London, E.C	Dec. 12, 1896
533 Marsh, Thomas Aspinall, Leaders Buildings, Wigan	Oct. 10, 1908
534 Marshall, Alexander Gilchrist, Denniston, New Zealand	Dec. 10, 1910
535 Martin, Henry Stuart, c/o H. Eckstein and Company, Johannesburg, Transvaal	April 13, 1907
536 Martin, Henry William, Sherwood, Newport Road, Cardiff	Oct. 9, 1897
537 Martin, Tom Pattinson, 22, Station Road, Workington	April 4, 1903
538 Mathieson, Alexander, Hetton Colliery, Carrington, near Newcastle, New South Wales, Australia	Nov. 5, 1892
539 Matthews, Frederick Berkley, Lartington Hall, Darlington	A.M. Dec. 9, 1882 M. June 8, 1889
540 Maurice, William, The Elms, Hucknall Torkard, Nottingham	Dec. 14, 1907
541 Mawson, Robert Bryham, Elm Bank, Wigan	June 11, 1892
542 May, George, Clervaux Castle, Croft, Darlington (Past-President, Member of Council)	March 6, 1862
543 Mein, Henry Johnson, Carterthorne Colliery, Toft Hill, Bishop Auckland	Dec. 9, 1899
544 Mellon, Henry, Brook Lea, Askam, Lancashire	April 25, 1896
545 Menzies, Joseph Frederick, Roslyn, Washington, U.S.A.	June 10, 1905
546 Merivale, Charles Herman, Middleton Estate and Colliery Company, Middleton, Leeds	S. June 9, 1900 A. Aug. 6, 1904 M. Dec. 14, 1907
547 Merivale, John Herman, Togston Hall, Acklington, Northumberland (Honorary Secretary, Past-President, Member of Council)	May 5, 1877
548 The Right Honourable Lord Merthyr, Mardy. Aberdare	Sept. 3, 1864
549 Merz, Charles Hesterman, Collingwood Buildings, Collingwood Street, Newcastle-upon-Tyne	June 10, 1903
550 Metcalf, Alfred T., United Reefs (Sheba), Limited, Eureka City, De Kaap, South Africa	
551 Michell, Thomas Henry, The Woodlands, Kings Road, Colwyn Bay	April 3, 1909 June 21, 1894
552 Middleton, John Thomas, 28, Victoria Street, Westminster, London, S.W .	Dec. 10, 1910
553 Middleton, Robert, Sheep Scar Foundry, Leeds	Aug. 1, 1891
554 Miller, J. P. K., H. C. Frick Coke Company, Scottdale, Pennsylvania, U.S.A.	Dec. 14, 1895
555 Millett, Cornish, Pentire, Carbis Bay, Cornwall	Dec. 11, 1909
556 Milne, Norman Boarer, Inspector of Mines Office, Boksburg, Johannesburg, Transvaal	Dec. 11, 1909
557 Minns, Thomas Tate, Binchester Blocks, Bishop Auckland	S. April 10, 1897 A. Aug. 11, 1903 M. Feb. 12, 1910

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	Date of Election and of Transfer.
558 Mitchinson, Robert, Catchgate House, Annfield Plain, County Durham	Feb. 4, 1865
559 Moir, Charles Main, Royal Colonial Institute, Northumberland Avenue, London, W.C.	Aug. 6, 1910

560 Molengraaff, Gustaaf Adolf Frederik, 43, van Stolberglaan, The Hague	Oct. 14, 1899
561 Montgomery, Alexander, State Mining Engineer, Department of Mines, Perth, Western Australia	Dec. 9, 1899
562 Moore, Marshall Greene, Moorland, Johnstown, Pennsylvania, U.S.A.	Feb. 11, 1905
563 Moore, Robert Thomas, 142, St. Vincent Street, Glasgow	Oct. 8, 1892
564 Moore, Richard Walker, Somerset House, Whitehaven	S. Nov. 5, 1870 M. Aug. 4, 1877
565 Moore, William, Westfield, Loftus, Yorkshire	A.M. Nov. 19, 1881 M. Aug. 3, 1889 Nov. 7, 1874
566 Moreing, Charles Algernon, 20, Cophall Avenue, London, E.C .	Nov. 7, 1874
567 Morgan, John, Stanley Villa, Crook, County Durham	Dec. 9, 1905
568 Morison, John, 14, Saville Row, NewcSfstle-upon-Tyne	A.M. Dec. 4, 1880 M. Aug. 3, 1889
569 Morland-Johnson, Edward Thomas, Bank of England Chambers, Tib Lane, Cross Street, Manchester	April 10, 1897
570 Morris, John, Lydbrook Colliery, Lydbrook, Gloucestershire	A. April 4, 1903 M. Aug. 6, 1904
571 Morris, William, Waldrige Colliery, Chester-le-Street	Oct. 8, 1892
572 Morrison, Edward	June 20, 1908
573 Morse, Willard S., Seaford, Delaware, U.S.A .	June 13, 1896
574*Mort, Arthur, Khost, N. W. R., Baluchistan, India	Dec. 9, 1899
575 Morton, Reginald Charles,, 548, Ecclesall Road, Sheffield	Aug. 3, 1907
576 Morton, William Rostern, 57, Sanderson Road, Newcastle-upon-Tyne	Aug. 7, 1909
577 Mountain, William Charles, 8, Sydenham Terrace, Newcastle-upon-Tyne (Member of Council)	April 9, 1892
578 Mundle, Arthur, Murton Chambers, 8, Grainger Street, Newcastle-upon-Tyne	S. June 5, 1875 M. Aug. 4, 1877
579 Murdoch, Arthur Stanley, Largiemore, Camborne	Aug. 7, 1909
580 Murray, William Cuthbert, Littletown, Durham	June 10, 1903
581 Nagazumi, Junjiro, Kannonsaki, Shinionoseki, Japan	Dec. 12, 1908
582 Nesbtt, John Straker, Marley Hill Colliery, Swalwell, County Durham	S. Oct. 9, 1897 A. Aug. 5, 1905 M. Oct. 12, 1907
583 Ness, William Waters van	A.M. Aug. 7, 1897 M. Dec. 11, 1897
584 Nevin, John, Littlemoor House, Mirfield, Yorkshire	S. May 2, 1868 M. Aug. 5, 1871
585 Newbery, Frederick, 230, Camden Road, London, N.W.	A.M. April 2, 1898 M. Feb. 13, 1904
586 Newbigin, Henry Thornton, 3, St. Nicholas' Buildings, Newcastle-upon-Tyne	Oct. 13, 1894
587 Nicholas, Benjamin, Levant Mining Company, Levant Mine, Pendeen, Cornwall	Oct. 8, 1910
588 Nicholson, Arthur Darling, H.M. Inspector of Mines, Red Hill, Durham (Member of Council)	S. June 13, 1885 A. Aug. 4, 1894 M. Feb. 12, 1898
589 Nicholson, John Hodgson, Cowpen Colliery Office, Blyth (Member of Council)	S. Oct. 1, 1881 A. Aug. 3, 1889 M. April 8, 1893
590 Nicholson, Marshall, Middleton Colliery, Leeds	Nov. 7, 1863
591 Nierses, J. W., Budroochuck Colliery, Sijua P.O., E. I. Railway, Bengal, India	Dec. 10, 1904
592 Nisbet, Norman, Houghton Colliery Office, Houghton-le-Spring, County Durham	S. Nov. 24, 1894 A. Aug. 3, 1901 M. Aug. 6, 1904

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Date of Election  
and of Transfer.

593 Noble, Thomas George, Sacriston Colliery, Durham	A. Feb. 13, 1892 M. June 8, 1895 Dec. 14, 1907
594 Nogara, Bernardino, Galata, Constantinople, Turkey	Aug. 5, 1899
595 Nōmi, Aitaro, Shinnyu Colliery, Province of Chikuzen, Japan	Feb. 13, 1909
596 Norris, Robert Van Arsdale, Wilkes-Barre, Pennsylvania, U.S.A	June 10, 1903
597 Northey, Arthur Ernest, Laurel House, Litton, Buxton	S. Feb. 10, 1883 A.M. Aug. 1, 1891 M. Dec. 12, 1891 A.M. Dec. 14, 1895
598 Oates, Robert Joseph William, Rewah State Collieries, Umaria, C. India, Bengal Nagpur Railway	M. Oct. 9, 1897 A. Aug. 1, 1908 M. Oct. 9, 1909
599 O'Donahue, Thomas Aloysius, The Poplars, Wigan	Dec. 9, 1905
600 Oliver. Ernest Hunter, Ravensworth Colliery, Low Fell, S. Feb. 8, 1902 Gateshead-upon-Tyne	Dec. 8, 1900
601 Olsen, Arnold Carl Louis, P.O. Box 1056, Johannesburg, Transvaal	June 11, 1898
602 Ornsby, Edward Thomas, Benwell Colliery, Newcastle-upon-Tyne	Feb. 14, 1903
603 Ornsby, Robert Embleton, Seaton Delaval Colliery, Northumberland	April 10, 1897
604 Osborne, Francis Douglas, The Grove, Balrath, County Meath .	Feb. 8, 1908
605*Oshima, Rokuro, No. 121, Yoyogi, Toyotama-gun, Tokyo, Japan	Feb. 11, 1905
606 Oughton, William, Milburn House, Newcastle-upon-Tyne	Feb. 13, 1909
607 Owens, William David, Lehigh Valley Coal Company, 239, Philadelphia Avenue, Pittston, Pennsylvania, U.S.A.	Aug. 3, 1907
608 Padbury, John, 54, Westbourne Avenue, Gateshead-upon-Tyne	Oct. 12, 1901
609 Page, Arthur Herbert Sheepshanks, Escomb, Bishop Auckland	A.M. Nov. 5, 1892 M. June 8, 1895 S. Sept. 5, 1868 M. Aug. 5, 1877 Aug. 1, 1903
610 Paley, George, Glebe House, Whitburn, Sunderland	Feb. 10, 1900
611 Palmer, Claude Bowes, Wardley Hall, Pelaw, Newcastle-upon-Tyne	S. Feb. 13, 1904 A. Aug. 3, 1907 M. Aug. 7, 1909 S. Dec. 1, 1864 M. Aug. 6, 1870
612 Pamely, Caleb, 64, Cromwell Road, Bristol	S. Aug. 3, 1895 A. Aug. 1, 1903 M. Oct. 12, 1907
613 Pamplin, Elish George, Cherry Hinton, Cambridge	M. Aug. 3, 1889 A.M. June 12, 1886 A.M. April 10, 1897 M. June 12, 1897 S. Feb. 7, 1880 A.M. Aug. 7, 1886 M. Aug. 3, 1889 June 10, 1899
614 Parish, Charles Edward, 31, Hanger Lane, Ealing, London, W	June 11, 1904
615 Parrington, Henry Mason, Dene House, Castletown, Sunderland	Feb, 12, 1910
616 Parrington, Matthew William, Wearmouth Colliery, Sunderland (President, Member of Council)	
617 Parrington, Thomas Elliot, Carley Hill, Monkwearmouth, Sunderland	
618 Parsons, Hon. Charles Algernon, Heaton Works, Newcastle-upon-Tyne	
619 Pascoe, Thomas, 44, Bowen Road, Harrow	
620 Peake, R. Cecil, Cumberland House, Redbourn, St. Albans	
621 Pearse, John Walter, aux Quatre Vents, Arlon, Belgium	
622 Pearson, Clement Alfred Ritson, South End Avenue, Darlington	
623 Pearson, Reginald George, Planet Mine, Box 123, Salisbury, Rhodesia, South Africa	
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	Date of Election and of Transfer.
624 Pedelty, Simon, Broomhill Colliery, Acklington, Northumberland	A. Dec. 10, 1892 M. Dec. 14, 1907
625 Peel, Robert, New Brancepeth Colliery, Durham	Aug. 6 1892

626 Percy, Frank, Mining College, Wigan. Transactions sent to The Librarian, Wigan Free Library, Wigan	Dec. 12, 1903
627 Percy, Robert McLeod, Karagandy Colliery, Spassky Copper-mines, Limited, Spassky Zabod, Akmolinsk, Siberia	Dec. 14, 1907
628 Peterkin, John Alexander, 66, Cawdor Road, Pallowheld, Manchester	Oct. 8, 1910
629 Phelps, Charles, c/o Wragg and Company, Gatooma, Southern Rhodesia, South Africa	A. Aug. 3, 1901 M. April 8, 1911
630 Phillips, Percy Clement Campbell, Bettisfield Colliery, Bagillt, Flintshire	June 10, 1903
631 Pingstone, George Arthur, P.O. Box 445, Bulawayo, Rhodesia, South Africa	8 A.M. June 11, 1898 M. Dec. 10, 1899
632 Plummer, John, Bishop Auckland	June 8, 1889
633 Pockson, Melville John Hastings, Kenilworth, East Avenue, Benton, Newcastle-upon-Tyne	Oct. 8, 1910
634 Pollitzer, Samuel Joseph, Terrys Chambers, 14, Castlereagh Street, Sydney, New South Wales, Australia	April 12, 1902
635 Poole, William, School of Mines, Charters Towers, Queensland, Australia	Feb. 13, 1909
636*Poore, George Bentley, 1730, Cupouse Avenue, Scranton, Pennsylvania, U.S.A .	A.M. Dec. 10, 1898 M. April 8, 1898
9	
637 Porter, John Bonsall, McGill University, Montreal, Quebec, Canada	Dec. 8, 1900
638 Powell, Charles Henry, International Mines, Limited, Biggenden, via Maryborough, Queensland, Australia	June 14, 1902
639 Prest, John Joseph, Hardwick Hall, Castle Eden, County Durham	Feb. 9, 1901
640 Price, Francis Holborrow Glynn, Longlands Place, Swansea	June 10, 1899
641 Price, Stephen Richard, Dilston House, Corbridge, Northumberland	S. Nov. 3, 1877 A.M. Aug. 1, 1885 M. Aug. 3, 1889 Aug. 3, 1895
642 Price, Samuel Warren, The Wern, Peterston-super-Ely, Cardiff	Aug. 3, 1895
643 Price, William Frederick, A Floor, Milburn House, Dean Street, Newcastle-upon-Tyne	June 20, 1908
644 Pringle, John Archibald, The Mysore Gold-mines, Marikuppam, Southern India	Dec. 10, 1898
645 Pringle, Robert William, 25, Ellerker Gardens, Richmond, Surrey	Aug. 1, 1903
646*Prior, Hon. Edward Gawler, Victoria, British Columbia. Transactions sent to Thomas R. Stockett, Western Fuel Company, Nanaimo, British Columbia	Feb. 7, 1880
647 Pullon, Joseph Thomas, Rowangarth, North Park Road, Roundhay, Leeds	Feb. 11, 1905
648 Purdy, Richard, Katrasgarh P.O., E.I.R., Bengal, India	Aug. 1, 1908
649 Rae, John Livingston Campbell, 75, King Street, Newcastle, New South Wales, Australia	Oct. 14, 1899
650 Raine, Frederick James, Malton Colliery, near Durham	S. Feb. 15, 1896 A. Aug. 6, 1904 M. Feb. 9, 1907
651 Ramsay, John, Tursdale Colliery, Ferry Hill	A. April 27, 1895 M. Feb. 13, 1904 Feb. 12, 1910
652 Ramsay, William, Bentinck House, Pegswood, Morpeth	Feb. 12, 1910
653 Ramsay, William Henry, South Tanfield Colliery; Stanley, County Durham	June 8, 1907
654 Rankin, Thomas Thomson, Mining and Technical College, Wigan	April 9, 1904

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	Date of Election and of Transfer.
655 Ray, Charles Edmund, Whinfield, near Ulverston	Aug. 3, 1907
656 Redfearn, Walter Maurice, 24, Beach Avenue, Whitley Bay, Northumberland	Feb. 12, 1910
657 Redman, Sydney George, Collingwood Buildings, Newcastle-upon-Tyne	Feb. 10, 1906
658 Redwood, Sir Boverton, Bart. Wadham Lodge, Wadham Gardens, London, N.W	June 21, 1894

659 Rees, Robert Thomas, Glandare, Aberdare	Aug. 7, 1897
660 Rees, William Thomas, Maesyffynon, Aberdare	A.M. Oct. 9, 1897 M. Feb 12, 1898
661 Renwick, Thomas Charlton, Luinley Thicks, Fence Houses	April 14, 1894
662 Rhodes, Charles Edward, Lane End House, Rotherham	Aug. 4, 1883
663 Rich, Francis Arthur, Vincent Road, Remnera, Auckland, New Zealand	Aug. 5, 1899
664 Richards, Fred, Montgomery, Methuen Park, Muswell Hill, London, N	Aug. 3, 1907
665 Richards, Thomas J., 53, Strand, Ferndale, Pontypridd	Oct. 10, 1896
666 Richardson, Henry, Grand Hotel, Newcastle-upon-Tyne	March 2, 1865
667 Richardson, Nicholas, c/o Mrs. James Richardson, South Ashfield, Newcastle-upon-Tyne	S. Dec. 12, 1896 A. Aug. 3, 1901 M. Dec. 14, 1901
668 Richardson, Robert, Park Avenue, Hexham	A. Feb. 8, 1890 M. Aug. 3, 1895
669 Ridge, Harry Mackenzie, 62, London Wall, London, E.C .	Dec. 14, 1907
670 Ridley, Norman Backhouse, Union Chambers, 32, Grainger Street West, Newcastle-upon-Tyne	June 8, 1895
671 Ridpath, Thomas Rossiter, Longshaw House, Billinge, Wigan .	A. Aug. 4, 1906 S. June 8, 1901 M. April 9, 1910
672 Rigby, Thomas Henry, Leaders Buildings, King Street, Wigan	Dec. 12, 1908
673 Ritson, John Ridley, Burnhope Colliery, Lanchester, Durham	S. April 11, 1891 A.M. Aug. 3, 1895 M. Feb. 14, 1903
674 Ritson, Utrick Alexander, Milburn House, Newcastle-upon-Tyne	Oct. 7, 1871
675 Roberts, James, Jun., Perran House, Perranporth, Cornwall	Dec. 14, 1895
676 Roberts, John, Laxey, Isle of Man	Dec. 9, 1905
677 Roberts, Stephen, P.O. Box 361, Salisbury, Rhodesia, South Africa	April 28, 1900
678 Roberts, William, Bella Vista, Perranporth, Cornwall	Aug. 4, 1906
679 Robertson, Andrew, 49, Mining Exchange, Ballarat, Victoria, Australia	Aug. 7, 1897
680 Robertson, Daniel Alexander Wilberforce, Metropolitan Colliery, Helensburgh, near Sydney, New South Wales, Australia	Aug. 6, 1892
681*Robertson, James Robert Millar, Vanduara, Kirribilli Point, North Sydney, New South Wales, Australia	Aug. 2, 1890
682*Robins, Samuel Matthew. Transactions sent to Thomas R. Stockett, Western Fuel Company, Nanaimo, British Columbia	Oct. 12, 1895.
683 Robinson, George, Boldon Colliery, County Durham	June 10, 1899
684 Robinson, George Henry, Jun., The Itabira Iron Ore Company, Limited, c/o Wilson, Sons and Company, Limited, Rio de Janeiro, Brazil, South America	S. Dec. 9, 1899 M. April 8, 1905
685 Robinson, J. B., Colliery Offices, Tow Law, County Durham	Aug. 5, 1893
686 Robinson, John Thomas, South Medomsley Colliery, Dipton, County Durham	Feb. 13, 1892
687 Robinson, Robert Dobson, Woodside, Boothstown, Manchester	Feb. 9, 1901
688 Robinson, Timothy, Ryhope Colliery, Sunderland	Feb. 8, 1902
685 Robinson, J. B., Colliery Offices, Tow Law, County Durham	Aug. 5, 1893

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	Date of Election and of Transfer.
689 Robson, J. S., Butterknowle Colliery, Butterknowle, County Durham	May 15, 1862
690 Rochester, William, Highfield, Beechwood Avenue, Ryton, County Durham	A. Dec. 10, 1898 M. Dec. 12, 1908
691 Rodewald, Rudolf, Nenthead Mines, Nenthead, Alston, Cumberland	April 7, 1906
692 Roelofsen, Jean Adolf, Post Office Buildings, Middlesbrough	Aug. 3, 1907

693 Rogers, John, Widdrington Colliery, Acklington, North- umberland	S. April 8, 1899 A. Aug. 4, 1906 M. Feb. 11, 1911
694 Ronaldson, James Henry, P.O. Box 1763, Johannesburg, Transvaal	Aug. 6, 1892
695 Routledge, William Henry, Woodfield Park, Blackwood, Newport, Monmouthshire	S. Oct. 7, 1876 A.M. Aug. 1, 1885 M. June 8, 1889 Aug. 3.1907
696 Rowe, Joseph Seymour, Metropolitan Colliery, Helensburgh, New South Wales, Australia	
697 Rowley, Walter, 20, Park Row, Leeds	Aug. 5, 1893
698 Rumbold, William Richard, Oruro, Bolivia, South America, via Buenos Aires i Tupiza	June 14, 1902
699 Russell, Robert, Coltness Iron Works, Newmains, Lanarkshire	Aug. 3, 1878
700 Rutherford, Robert, The Lawn, Rhymney, Cardiff	Oct. 11, 1902
701 Rutherford, William, West Stanley Colliery, Stanley, County Durham	Feb. 9, 1901
702 Ryan, William Arthur	Dec. 12, 1908
703*Saise, Walter, Stapleton, Bristol	A.M. Nov. 3, 1877 M. Aug. 3, 1889 Aug. 5.1893
704 Sam, Thomas Birch Freeman, Domkodu, Cape Coast Castle, West Africa	Aug. 1, 1891
705 Samborne, John Stukely Palmer, Timsbury House, Bath	
706 Sample, James Bertram, 17, Tynedale Terrace, Hexham	S. Jan. 19, 1895 A. Aug. 4, 1900 M. Oct. 10, 1903 Oct. 9, 1909
707 Sampson, William, 33, Queen Street, Singapore	
708*Samwell, Nicholas, P.O. Box 385, Rangoon, Burma, India	April 13, 1901
709 Sandow, William John Josiah, Elder Cottage, Chacewater, Scorrier, Cornwall	Feb. 8, 1908
710 Saner, Charles Benjamin, Village Deep, Limited, P.O. Box 1064, Johannesburg, Transvaal	A. April 10, 1897 M. June 10, 1911
711 Saunders, David William Alban, Worcester Chambers, Swansea	A.M. Feb 12, 1898 M. June 11, 1898 S. Dec. 6, 1873 A.M. Aug. 2, 1879 M. June 8, 1889 Aug. 1, 1908
712*Sawyer, Arthur Robert, 824, Salisbury House, London Wall, London, E.C .	
713 Schmidt, Henry Morton, United Coal Company, 804, Bank for Savings Building, Pittsburgh, Pennsylvania, U.S.A	
714 Schnabel, Leberecht Ferdinand Richard, Sun Buildings, Corner of Bourke and Queen Streets, Melbourne, Victoria, Australia	April 13, 1907
715 Schwarz, Paul, Dortmund, Crook, County Durham	April 9, 1904
716 Scott, Anthony, Nethererton Colliery, Nedderton. Newcastle-upon-Tyne	April 8, 1905
717 Scott, Charles F., Newbell, Consett, County Durham	S. April 11, 1874 M. Aug. 4, 1877 April 9, 1892
718 Scott, Ernest, Sun Buildings, Newcastle-upon-Tyne	
719 Scott, Edward Charlton, Woodside Cottage, Totley Rise, Sheffield	A. Oct. 8, 1892 M. Feb. 11, 1899 S. April 12, 1902 M. Dec. 8, 1906
720 Scott, George Henry Hall, c/o Thomas Emerson Forster, 3, Eldon Square, Newcastle-upon-Tyne	

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	Date of Election and of Transfer.
721 Scott, Herbert Kilburn, 46, Queen Victoria Street, London, E.C	Oct. 11, 1902
722 Scoular, George, St. Bees, Cumberland	July 2, 1872
723 Selby, John Baseley, Leigh	April 25, 1896
724 Severs, Joseph, North Walbottle, Newburn, Northumberland	June 8, 1901
725 Severs, William, Beamish, County Durham	A. Nov. 5, 1892 M. Dec. 8, 1900

726 Shanks, John, Coal Creek, Fernie, British Columbia	Aug. 5, 1905
727 Sharp, Robert Rich, Union Miniere du Haut Katanga, Star of the Congo Mine, via Ndola, North Western Rhodesia, South Africa	April 3, 1909
728 Sheaffer, Arthur Whitcomb, Pottsville, Pennsylvania, U.S.A .	Aug. 4, 1894
729 Shiel, John, South Garesfield Colliery, Rowlands Gill, Newcastle-upon-Tyne	May 6, 1871
730 Simon, Frank, Rand Club, Johannesburg, Transvaal	Dec. 14, 1895
731 Simpson, Charles Liddell. 13, Montagu Place, Montagu Square, London, W .	April 8, 1893
732 Simpson, Francis L. G., Mohpani Coal-mines, Gadawarra, C.P., India	A.M. Dec. 13, 1884 M. Aug. 3, 1889
733 Simpson, Frank Robert, Hedgefield House, Blaydon-upon-Tyne, County Durham (Vice-President, Member of Council)	S. Aug. 4, 1883 M. Aug. 1, 1891
734 Simpson, John, Follonsby, Hawthorn Gardens, Monkseaton, Whitley Bay, Northumberland (Vice-President, Member of Council)	S. Dec. 6, 1866 M. Aug. 1, 1868
735 Simpson, John Bell, Bradley Hall, Wylam, Northumberland (Past-President, Member of Council)	Oct. 4, 1860
736 Simpson, Robert Rowell, Inspector of Mines, Dhanbaid, E.I.R., Bengal, India	A. S. Aug. 3, 1895 Aug. 2, 1902
737 Simpson, Thomas Ventress, Throckley Colliery, Newburn, , Northumberland	M. Oct. 11, 1902 S. Dec. 14, 1895 A. Aug. 2, 1902 M. Dec. 13, 1902 April 13, 1901
738 Skertchley, Sydney A. R., Apartado Postal Num. 3023, Sucursal V., Paseo de la Reforma, Mexico, D.F.	
739 Slinn, Thomas, 40, Park Avenue, Whitley Bay, Northumberland	July 2, 1872
740 Sloan, Robert Patrick, Craiglea, Graham Park Road, Gosforth, Newcastle-upon-Tyne	Oct. 8 1910
741 Smallwood, Percy Edmund, The Garth, Medomsley, County Durham .	A. Oct. 11, 1902 M. Oct. 12, 1907
742 Smart, Alexander, c/o Fraser and Chalmers, Limited, Erith, Kent	Feb. 10, 1894
743 Smith, Ernest Arthur, H.M. Office of Works (Supplies Division), 18, Queen Anne's Gate, Westminster, London, S.W.	S. Dec. 9, 1905 A. Aug. 1, 1908 M. Dec. 11, 1909
744*Smith, Richard Clifford, Grovehurst, Tunbridge Wells	Dec. 5, 1874
745 Smith, Robert Fleming, Hunters Villa, Parkside, Cleator Moor, Cumberland	Aug. 6, 1904
746 Smith, William, P.O. Box 653, Johannesburg, Transvaal	Oct. 11, 1902
747 Smith, William Woodend, The Sycamore, Hensingham, Whitehaven .	Aug. 6, 1904
748 Sopwith, Arthur, Wavertree, Handsworth, Staffordshire	Aug. 6, 1863
749 Southern, Edmund Octavius, North Seaton Hall, Morpeth	S. Dec. 5, 1874 A.M. Aug. 1, 1885 M. June 8, 1889
750 Southern, John, Heworth Colliery, Felling, County Durham	A. Dec. 14, 1889 M. April 8, 1899
751 Southern, R. W. A., 33, The Parade, Cardiff	Aug. 3, 1865
752 Southwood, Reginald Thomas Enfield, Nether House, Spencer Road, Putney, London, S. W .	Feb. 10 1906

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	Date of Election and of Transfer.
753 Spence, Robert Foster, Backworth, Newcastle-upon-Tyne	S. Nov. 2, 1878 A.M. Aug. 2, 1884 M. Aug. 4, 1889
754 Spencer, Francis H .	Dec. 13, 1890
755 Stainton, William, Black Lion Hotel, Mold	Feb. 13, 1909
756 Stanley, George Hardy, Technical Institute, Johannesburg, Transvaal	April 12, 1902

757 Steavenson, Addison Langhorne, Durham (Past-President, Member of Council)	Dec. 6, 1855
758 Steavenson, Charles Herbert, Redheugh Colliery, Gateshead-upon-Tyne	S. April 14, 1883 A. Aug. 1, 1891 M. Aug. 3, 1895 Aug. 5, 1905
759 Steel, Robert, Woodhouse, Whitehaven	Oct. 12, 1907
760 Stephens, Francis Joseph, c/o Mrs. Stephens, Ashfield, near Falmouth	Dec. 10, 1904
761 Stephenson, Ralph, Fern Cottage, Poolstock Lane, Wigan	April 8, 1893.
762 Stevens, Arthur James, Uskside Iron Works, Newport, Monmouthshire	Feb. 14, 1885
763 Stevens, James, 9, Fenchurch Avenue, London, E.C.	June 8, 1895
764 Stewart, William, Tillery Collieries, Abertillery, Monmouthshire	S. Aug. 2, 1873 A.M. Aug. 5, 1882 M. June 8, 1889 S. Oct. 2, 1880 A.M. Aug. 4, 1888 M. Aug. 3, 1889
765 Stobart, Frank, Selaby Hall, Gainford, Darlington	Oct. 11, 1890
766 Stobart, Henry Temple, Wearmouth Colliery, Sunderland	June 11, 1910
767 Stobart, William Ryder, Etherley Collieries, County Durham	S. Oct. 6, 1877 A.M. Aug. 1, 1885 M. Aug. 3, 1889 A. Nov. 24, 1894 M. Dec. 10, 1904
768 Stoek, Harry Harkness, University of Illinois, Urbana, Illinois, U.S.A	A. Dec. 9, 1899 M. Feb. 11, 1911 June 13, 1896
769 Stoker, Arthur P., Ouston House, near Chester-le-Street	June 11, 1904
770 Stokoe, James, Herrington Lodge, West Herrington, via Sunderland	April 12, 1902
771 Stokoe, John George, Alston House, Crigglestone, Wakefield	Feb. 13, 1909
772 Stone, Arthur, Heath Villas, Hindley, Wigan	Oct. 3, 1874
773* Stonier, George Alfred, 726, Salisbury House, London, E.C.	A.M. June 8, 1889 M. Aug. 3, 1889 June 8, 1895
774 Storey, William, Urpeth Villas, Beamish, County Durham	A. Dec. 9, 1905 M. Dec. 14, 1907 June 14, 1902
775 Stow, Audley Hart, Maybeury, McDowell County, West Virginia, U.S.A	Dec. 10, 1904
776 Straker, J. H., Howden Dene, Corbridge, Northumberland	April 28, 1900
777 Streatfeild, Hugh Sidney, Ryhope, Sunderland	May 2, 1874
778 Stuart, Donald McDonald Douglas, Redland, Bristol	A. Dec. 9, 1899 M. Dec. 12, 1903 S. Dec. 9, 1893 A. Aug. 3, 1901 M. Aug. 2, 1902
779 Summerbell, Richard, Preston Colliery, North Shields	A.M. Aug. 4, 1894 M. June 14, 1902
780 Sutcliffe, Richard, Horbury, Wakefield	
781 Sutherland, Edgar Greenhow, Brereton, Rugeley	
782 Sutton, William, Grosmont, 46, Palace Road, Streatham Hill, London, S.W.	
783 Swallow, John, 2, Percy Gardens, Tynemouth, North Shields	
784 Swallow, Ralph Storey, Langley Park, Durham	
785 Swallow, Wardle Asquith, Tanfield Lea, Tantobie, County Durham	
786 Swinburne, Umfreville Percy, Inspector of Mines, Pretoria, Transvaal	

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	Date of Election and of Transfer.
787 Swindle, Jackson, West House, Swalwell Road, Dunston, Gateshead-upon-Tyne	June 14, 1902
788 Swinney, Alfred John George, Lorne Villa, Elm Road, Sidcup, Kent	June 11, 1898
789 Symons, Francis, Ulverston	Feb. 11, 1899
790 Tallis, John Fox, 84, High Street, Newport, Monmouthshire	Dec. 12, 1903
791 Tate, Robert Simon, Saint Hilda Colliery, South Shields	S. Aug. 3, 1901 A. Aug. 4, 1906

792 Tate, Simon, Trimdon Grange Colliery, County Durham (Member of Council)	M. Dec. 11, 1909 Sept. 11, 1875
793 Tate, Walker Oswald, Usworth Hall, Washington, County Durham	S. Oct. 12, 1895 A. Aug. 1, 1903 M. Feb. 13, 1904
794 Taylor, Henry William, 45, Canonbury Square, Highbury, London, N .	April 8, 1911
795 Taylor, Neil, St. Ives Consolidated Mines, Limited, St. Ives, Cornwall	April 13, 1907
796 Taylor, Thomas, Chipchase Castle, Wark, Northumberland	July 2, 1872
797 Teasdale, Thomas, Middridge Colliery, New Shildon, County Durham	April 9, 1892
798 Tennant, John Thomas, James Street, Hamilton, Newcastle, New South Wales, Australia	Dec. 12, 1903
799 Terry, Arthur Michael, 1, Clifton Road, Newcastle-upon-Tyne	Aug. 6, 1904
800 Thom, Archibald, Jun., Moresby Parks, near Whitehaven	Aug. 5, 1905
801 Thomas, David, Quay Street, Ammanford, Carmarthenshire	June 20, 1908
802 Thomas, Ernest Henry, Tredegar House, Llanharran, Pontyclun, Glamorgan	Feb. 10, 1900
803 Thomas, Iltud Edward, Glanymor, Swansea	Feb. 10, 1900
804 Thomas, J. J., Hawthorn Villa, Kendal	June 21, 1894
805 Thomas, Richard, Cambria Villa, Stockton, New South Wales, Australia	Feb. 11, 1899
806 Thomlinson, William, Seaton Carew, West Hartlepool	April 25, 1896
807 Thompson, Alfred, Throapham House, near Rotherham	Dec. 13, 1902
808 Thompson, Errington, 3, Tynemouth Terrace, Tynemouth, North Shields	June 8, 1907
809 Thompson, John William, East Holywell Colliery, Shiremoor, Newcastle-upon-Tyne	A. June 10, 1893 M. Feb. 10, 1900 Dec. 10, 1910
810 Thompson, Robert Reginald, Elm House, Lelant, Cornwall	Dec. 10, 1910
811 Thomson, John, Eston Mines, by Middlesbrough	April 7, 1877
812 Thomson, Thomas, Westport Coal Company, Limited, Denniston, New Zealand	Feb. 8, 1908
813 Thornton, Norman Muschamp, 344, Jasper Avenue East, Edmonton, Alberta, Canada	S. April 27, 1895 A. Aug. 2, 1902 M. June 10, 1903
814 Todd, John Thomas, Blackwell Collieries, Alfreton	M. June 8, 1889 S. Nov. 4, 1876 A.M. Aug. 1, 1885
815*Townsend, Harry Poyser, Village Deep, Limited, P.O. Box 1064, Johannesburg, Transvaal	M. June 8, 1889 April 12, 1902
816 Trelease, William Henwood, Via dei Cattaneo, Novara Italy ; and Ceppomorelli per Macugnaya, Vall' Anzasca, Prov. di Novara, Italy	April 8, 1893
817 Trevor, Earle Wellington Jenks, 78, Palace Chambers, Westminster, London, S. W.	Aug. 2, 1902
818 Trotman, Henry Leigh, Singareni Collieries, Deccan, India	Feb. 13, 1904
819 Tulip, Samuel, Bunker Hill, Fence Houses	June 12, 1897
820 Turnbull, John James, 6, Queens Road, Jesmond, Newcastle-upon-Tyne	Feb. 12, 1898

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	Date of Election and of Transfer.
821 Turnbull, Robert, Usworth Colliery, Washington, County Durham	Aug. 2, 1902
822 Tuxen, Peter Vilhelm, 60, Market Street, Melbourne, Victoria, Australia	April 7, 1906
823*Tyers, John Emanuel, Rewah State Collieries, Umaria, Central India	A.M. Dec. 10, 1877 M. Aug. 3, 1889 Feb. 14, 1874
824 Tyzack, David, Bellingham, Northumberland	Feb. 14, 1874
825 Upton, Prescott, P.O. Box 1026, Johannesburg, Transvaal	June 12, 1897
826 Veasey, Harvey C, c/o The National Bank of India, 26, Bishopsgate, London, E.C.	June 21, 1894
827 Verey, Joseph Crosby, Apartado 1723, Mexico City, Mexico	April 9, 1910

828 Verny, George, Pont d'Aubenas, Ardeche, France	Oct. 8, 1898
829 Verschoyle, William Denham, Tanrago, Ballisodare, County Sligo	Dec. 11, 1897
830 Voskule, Gedeon A., P.O. Box 1242, Johannesburg, Transvaal	A.M. Dec. 10, 1904
	M. Oct. 8, 1910
831 Wadham, Walter Francis Ainslie, Millwood, Dalton-in-Furness, Lancashire	Dec. 10 1898 '
832 Wales, Henry Thomas, Bank Chambers, Castle Square, Swansea	Feb. 11, 1893
833 Walker, Henry, H.M. Inspector of Mines, Walden, Widcombe Hill, Bath	June 8, 1907
834 Walker, James Howard, Bank Chambers, Wigan	Dec. 9, 1899
835 Walker, John Scarisbrick, Pagefield Iron Works, Wigan	Dec. 4, 1869
836 Walker, Sydney Ferris, Bloomfield Cres cent. Bath	June 11, 1898
837 Walker, Thomas A., Pagefield Iron Works, Wigan	June 8, 1895
838 Walker, William Edward, Lowther Street, Whitehaven	Nov. 19, 1881
839 Wall, Henry, Tower Buildings, Wallgate, Wigan	June 8, 1895
840 Wall, William Henry, 748, Burrard Street, Vancouver, British Columbia	June 14, 1902
841 Walsh, George Paton, 143, Stadhouderskade, Amsterdam, Holland	Nov. 24, 1894
842 Walton, Arthur John, P.O. Box 149, Johannesburg, S. Feb. 12, 1898 Transvaal	
A. Aug. 1, 1903 M. April 9, 1910	
843 Walton, Jonathan Coulthard, Writhlington Colliery, Radstock, Bath	S. Nov. 7, 1874
	A.M. Aug. 6, 1881
	M. June 8, 1889
	June 10, 1903
844 Walton, William Henry, Bridgewater Offices, Walkden, Manchester	
845 Ward, Alexander Houstonne, Bhujudih, B.N.R., Bengal, India	April 14, 1894
846* Ward, Thomas Henry, Giridih, E.I.R., Bengal, East India	A.M. Aug. 5, 1882
	M. Aug. 3, 1889
	June 11, 1910
847 Ware, Francis Thomas, The Croft, Corbridge, Northumberland	
848 Watson, Claude Leslie, Ravenstone, Brislington, Bristol	Dec. 8, 1900
849 Watson, Edward, c/o F. Harle, Solicitor, Chester-le-Street	S. Feb. 13, 1892
	M. Aug. 4, 1894
850 Watson, John, Outtrim Colliery Office, Victoria, Australia	Dec. 12, 1908
851 Watson, Siddell, Settlingstones, Fourstones, Northumberland	April 8, 1911
852 Watson, Thomas, Trimdon Colliery, County Durham	Oct. 11, 1890
853 Watts, Frank Reginald, Blytheswood North, Osborne Road, Newcastle-upon-Tyne	Oct. 12, 1907
854 Watts, J. Whidbourne, P.O. Box 179, Barberton, Transvaal	Dec. 12, 1896
855 Webster, Alfred Edward, Manton, Worksop	June 12, 1897

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	Date of Election and of Transfer.
856 Wedderburn, Charles Maclagan, 8, East Fettes Avenue, Edinburgh	Oct. 14, 1905
857 Weeks, John George, Bedlington, Northumberland (Past-President, Member of Council)	Feb. 4, 1865
858 Weeks, Richard James, Bedlington, Northumberland	Oct. 8, 1910
859 Weeks, Richard Llewellyn, Wellington, County Durham (Member of Council)	A.M. June 10, 1882
	M. Aug. 3, 1889
860*Weinberg, Ernest Adolph, 19, Queen Street, Melbourne, Victoria, Australia	A.M. Feb. 12, 1898
	M. Oct. 8, 1898
861 Welsh, Thomas, Maindee House, Upper Pontnewydd, Monmouthshire	Feb. 14, 1903
862 Welton, William Pitt, Santa Ana, Departamento del Tolima, Republic of Colombia, South America	Dec. 9, 1905
863 Welton, William Shakspeare, Elm Road, Wembley, Middlesex	Dec. 14, 1901
864 Westmacott, Percy Graham Buchanan, Rose Mount, Sunninghill, Ascot	June 2, 1866
865 White, Charles Edward, Wellington Terrace, South Shields ,	S. Nov. 4, 1876
	A.M. Aug. 1, 1885

866 White, Frederick Napier, H.M. Inspector of Mines, 30, Stow Park Avenue, Newport, Monmouthshire	M. Aug. 3, 1889 June 11, 1898
867 White, Henry, Western House, Little Benton, Newcastle-upon-Tyne	S. March 2, 1867
868 Whitfield, Thomas Cuthbert, Colliery Office, Whitehaven	M. Aug. 5, 1871 A. Oct. 8, 1904
869 Widdas, C., North Bitchburn Colliery, Howden, Darlington	M. Feb. 12, 1910 Dec. 5, 1868
870 Widdas, Henry, Whitehaven Castle Estate, Somerset House, Whitehaven	April 7, 1906
871 Widdas, Percy, Oakwood, Cockfield, County Durham	Aug. 6, 1904
872 Wight, Edward Septimus, Glen Road, Devonport, Auckland, New Zealand	A.M. Dec. 12, 1885 M. Aug. 3, 1889
873 Wight, Frederick William, 5, Bondicar Terrace, Blyth	Aug. 5, 1905
874 Wight, Robert Tennant. Deaf Hill Terrace, Trimdon Colliery, County Durham	Oct. 13, 1900
875 Wilbraham, Arthur George Bootle, 28, Ovington Square, London, S.W.	S. Dec. 11, 1897 M. Feb. 8, 1902
876 Wild, Matthew Brown, 37, Arthur Road, Erdington, Birmingham	Oct. 12, 1907
877 Wilkins, William Glyde, Westinghouse Building, Pittsburg, Pennsylvania, U.S.A.	Dec. 11, 1897
878 Wilkinson, John Thomas, East Hetton Colliery, Coxhoe, County Durham	Dec. 8, 1900
879 Wilkinson, Maurice Hewson, High Marley Hill Office, Swalwell, County Durham	A. Dec. 12, 1903 M. Oct. 10, 1908
880*Wilkinson. William Fischer, School of Mines, Camborne	Oct. 10, 1896
881 Willey, Joseph Leonard, P.O. Box 3, Brakpan, Transvaal	Aug. 1, 1908
882 Williams, Foster, Miniera di Libiola, Sestri Levante, Italy	A. April 13, 1907 M. June 20, 1908
883 Williams, Griffith John, H.M. Inspector of Mines, Bangor	Aug. 2, 1902
884 Williams, James, 45, Dartmouth Park Hill, Highgate, London, N.W.	April 11, 1908
885 Williams, John, Dolavon, Llanrwst, Denbighshire	Oct. 8 1904
886 Williams, James Wilson, 15, Valley Drive, Harrogate	April 4, 1903
887 Williams, Luke, Claremont, Moonah, Tasmania	April 10, 1897
888 Williams, Robert, 30, Clements Lane, Lombard Street, London, E.C	June 13, 1896
889 Willis, Henry Stevenson, Weardale House, St. John's Chapel, County Durham	S. Feb. 13, 1892 A. Aug. 4, 1900 M. June 8, 1907
890 Wilson, Anthony, Thornthwaite, Keswick	A.M. Feb. 10, 1900 M. Dec. 13, 1902
891 Wilson, Archibald Laurence, The New Ravenswood, Limited, Ravenswood, Queensland, Australia	A.M. June 12, 1897 M, April 2, 1898

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	Date of Election and of Transfer.
892 Wilson, Frederick, Hebburn Colliery, Hebburn, County Durham	Dec. 12, 1908
893 Wilson, James, Wellington House, Edmondsley, Durham	April 13, 1901
894 Wilson, Lloyd, Flimby Colliery, Maryport	Jan. 19 1895
895 Wilson, Nathaniel, 2, East India Avenue, Leadenhall Street, London, E.C.	Dec. 9 1899
896 Wilson, Peregrine Oliver, c/o F. F. Wilson, 7, Devonshire Square, Bishopsgate Street, London, E.C.	Dec. 9 1893
897 Wilson, Robert Gott, Battle Green, Pelton Fell, County Durham	A. Aug. 6, 1892 M. Dec. 12, 1903
898 Wilson, William, Chilton Colliery, via Ferry Hill	June 8, 1907
899 Wilson, William Brumwell, 19, West Parade, Newcastle-upon-Tyne	S. Feb. 6, 1869 M. Aug. 2, 1873
900*Wilson, William Brumwell, Jun., Chopwell Colliery, Ebchester, County Durham	Feb. 9, 1901

901 Winchell, Horace V., 505, Palace Building, Minneapolis, Minnesota, U.S.A	Nov. 24, 1894
902 Wolff, Mark Arthur, 623, Salisbury House, London Wall, London, E.C .	Aug. 6, 1910
903 Wood, Ernest Seymour, Cornwall House, Murton, County Durham (Member of Council)	Oct. 10, 1891
904 Wood, John, Coxhoe Hall, Coxhoe, County Durham	S. June 8, 1889 A. Aug. 4, 1894 M. Aug. 3, 1895 Oct. 1, 1857
905* Wood, Sir Lindsay, Bart., The Hermitage, Chester-le-Street (Past-President, Member of Council)	
906 Wood, Richard, Barley Brook Foundry, Wigan	June 14, 1902
907 Wood, Robert, 8, Olympia Gardens, Morpeth	April 13, 1907
908 Wood, Thomas, Rainton House, Fence Houses	S. Sept. 3, 1870 M. Aug. 5, 1871 Feb. 14, 1903
909 Wood, Thomas Outterson, Cramlington House, Cramlington, Northumberland	
910 Wood, William Outterson, South Hetton, Sunderland (Past-President, Member of Council)	Nov. 7, 1863
911 Woodburne, Thomas Jackson, Bultfontein Mine, De Beers Consolidated Mines, Limited, Kimberley, South Africa	Feb. 10, 1894
912 Woodeson, William Armstrong, Clarke, Chapman and Company, Limited, Victoria Works, Gateshead-upon-Tyne	Dec. 10, 1904
913 Wright, Abraham, East Indian Railway, Engineering Department, Giridih, Bengal, India	Feb. 11, 1905
914 Wrightson, Sir Thomas, Bart., Stockton-upon-Tees	Sept. 13, 1873
915 Wrightson, Wilfrid Ingram, Neasham Hall, Darlington	A.M. Dec. 9, 1899 M. Feb. 8, 1908 Aug. 1, 1903
916 Yeoman, Thomas Pressick, Hingir-Rampur Coal Company, Limited, Jharsuguda Post Office, Sambalpur District, Bengal Nagpur Railway, Bengal, India	
917 Youll, Gibson, Bulli, New South Wales, Australia	Oct. 12, 1901
918 Young, Andrew, Bede House, Hebburn Colliery, Hebburn, County Durham	Dec. 11, 1909
919 Young, Harben Robert, Public Works Department, Dunedin, New Zealand	Feb. 9, 1901
920 Young, John Andrew, Joseph Crawhall and Sons, Newcastle-upon-Tyne. Transactions, etc., sent to 3, Fountain Avenue, Gateshead-upon-Tyne	A.M. Dec. 10, 1887 M. Aug. 3, 1889
921 Young, John Huntley, Wearmouth Colliery, Sunderland	June 21, 1894

ASSOCIATE MEMBERS (Assoc. M.I.M.E.).

Marked \* have paid life composition.

	Date of Election and of Transfer.
1 Ainsworth, George, The Hall, Consett, County Durham	Dec. 9, 1905
2 Armstrong, John Hobart, St. Nicholas' Chambers, Newcastle-upon-Tyne	Aug. 1, 1885

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	Date of Election and of Transfer.
3 Atkinson, George Blaxland, Prudential Assurance Buildings, Mosley Street, Newcastle-upon-Tyne	Nov. 5, 1892
4 Barrett, William Scott, Abbotsgate, Blundellsands, Liverpool	Oct. 14, 1899
5* Bell, Sir Hugh, Bart., Middlesbrough	Dec. 9, 1882
6 Bishop, Clarence Adrian, Engineering and Building Works, Mooi River, Natal, South Africa	Oct. 10, 1903
7 Blagdon, George, Framwellgate Leather Works, Durham	Oct. 8, 1910
8 Borradaile, Noel Collingwood Dickson, Farm Sabonabon, near Motor Mine, Gatooma, Rhodesia, South Africa	Oct. 12, 1907

9*	Broadbent, Denis Ripley, Royal Societies Club, St. James' Street, London, S. W. Transactions sent to The Library, Royal Societies Club, St. James' Street, London, S.W.	Oct. 14, 1899
10	Brown, Edward Otto Forster, Springfort, Stoke Bishop, Bristol	S. Dec. 14, 1901 A. Aug. 3, 1907 A.M. Oct. 12, 1907
11	Brown, John Coggin, Geological Survey of India, 27, Chowringhee, Calcutta, India	Dec. 11, 1909
12	Brutton, P. M., 17, Sandhill, Newcastle-upon-Tyne	Oct. 13, 1900
13	Cackett, James Thoburn, Pilgrim House, Newcastle-upon-Tyne	Oct. 10, 1903
14	Cabell, Rev. George Marie, Passenham Rectory, Stony Stratford	Oct. 8, 1892
15	Carr, John Thomas, Sixhills Street, Grimsby	Feb. 11, 1911
16*	Carr, William Cochran, Benwell Colliery, Newcastle-upon-Tyne (Member of Council)	Oct. 11, 1890
17*	Chewings, Charles, Eton Street, Malvern, South Australia	April 25, 1896
18	Cochrane, Ralph D., Hetton Colliery Offices, Fence Houses. Transactions sent to W. Cochrane, The Willows, Willington, County Durham	June 1, 1878
19	Cochrane, William James, York Chambers, Fawcett Street, Sunderland	April 3, 1909
20	Cook, Arthur Geoffrey Harold, Vine Cottage, Corbridge, Northumberland	Oct. 9, 1909
21	Cooper, R. W., Newcastle-upon-Tyne	Sept. 4, 1880
22	Cope, William Henry, The University, Birmingham	Dec. 9, 1905
23	Cory, Sir Clifford John, Bart., c/o Cory Brothers and Company, Limited, Cardiff	Dec. 11, 1897
24	Coxon, Samuel, 1, Fern Gardens, -Low Fell, Gateshead-upon-Tyne	Feb. 13, 1909
25	Edwards, F. Henry, Bath Lane, Newcastle-upon-Tyne	June 11, 1887
26	Ellam, Albert Spencer, c/o Sawhee Gold-mines (West Africa), Limited, 50 and 51, Lime Street, London, K.T.G,	April 25, 1896
27	Fairless, Joseph, Wensleyville, Holywell Avenue, Monkseaton, Whitley Bay, Northumberland	June 10, 1899
28	Fenwick, Featherstone, County Chambers, Westgate Road, Newcastle-upon-Tyne	June 8, 1907
29	Ferguson, Colin Armstrong, P.O. Box 21, Randfontein, Transvaal	July 14, 1896
30	Foster, T. J., Coal Exchange, Scranton, Pennsylvania, U.S.A.	Dec. 12, 1891
31	George, Edward James, Beech Grove, Consett, County Durham	Dec. 9, 1905
32	Gibson, George Ralph, Tyne Saw Mills, Hexham	June 20, 1908
33	Gibson, Thomas William, Bureau of Mines, Toronto, Ontario, Canada	June 8, 1901
34	Giddy, Thomas Grantham James, High Street, Newcastle, New South Wales, Australia	April 8, 1911
35*	Graham, John, Findon Cottage, near Durham	Oct. 9, 1897

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		Date of Election and of Transfer.
36	Graham, James Parmley, 26, Cloth Market, Newcastle-upon-Tyne	Dec. 8, 1906
37	Gulley, Frederick Elford, 4, Park Terrace, North Shields	Feb. 12, 1910
38	Gunn, Scott, 23, Thornhill Park, Sunderland	Aug. 6, 1910
39	Guthrie, Reginald, Neville Hall, Newcastle-upon-Tyne (Treasurer, Member of Council)	Aug. 4, 1888
40	Haggie, Arthur Jamieson, The Manor House, Long Benton, Newcastle-upon-Tyne	Feb. 8, 1908
41	Haggie, Peter Norman Broughton, The Limes, Whitburn, Sunderland	Oct. 10, 1908
42	Haswell, William Spence, Beverley Gardens, Cullercoats, Whitley Bay, Northumberland	April 13, 1901
43	Hedley, John Hunt, 1, Elms West, Sunderland	June 13, 1891
44	Heeley, George, East Avenue, Benton, Newcastle-upon-Tyne	Dec. 14, 1895
45	Henderson, Charles William Chipchase, c/o John George Weeks, Bedlington,	Dec. 9, 1882

Northumberland

46	Henzell, Robert, Northern Oil Works, Newcastle-upon-Tyne	April 11, 1891
47	Hesketh, Richard, Neville Hall, Newcastle-upon-Tyne	Feb. 13, 1909
48	Hodgetts, Arthur, c/o G. W. Hodgetts, Vaal River Estate, Sydney, via Delport's Hope, District Kimberley, South Africa	Oct. 9, 1897
49	Hopper, George William Nugent, The Ropery, Thornaby-upon-Tees, Stockton-upon-Tees	Oct. 10, 1908
50	Hoste-Turner, Francis, 164, Rye Hill, Newcastle-upon-Tyne .	Feb. 12, 1910
51	Humphreys-Davies, George, 5, Laurence Pountney Lane, Cannon Street, London, E.C .	Oct. 8, 1892
52	Innes, Thomas Snowball, Prudential Buildings, Mosley Street, Newcastle-upon-Tyne	Dec. 10, 1898
53	James, Henry M., Colliery Office, Whitehaven	June 10, 1893
54	Jeans, James Stephen, 165, Strand, London, W.C.	April 2, 1898
55	Jeffrey, Joseph Andrew, c/o The Jeffrey Manufacturing Company, Columbus, Ohio, U.S.A.	Dec. 11, 1897
56	Jeffries, Joshua, Abermain Colliery, New South Wales, Australia	Dec. 10, 1898
57*	Joicey, James John, The Homestead, Bourne End, Bucks.	Oct. 10, 1891
58	Jopling, Ford Stafford, Jun., 8, Thornhill Terrace, Sunderland	Feb. 12, 1910
59	Kidson, Arthur, c/o Glaholm and Robson, Limited, Rope Manufacturers, Sunderland	April 8, 1899
60	Kirkley, James, Cleadon Park, Cleadon, Sunderland	June 8, 1907
61	Krohn, Herman Alexander, 103, Cannon Street, London, E.C	Oct. 14, 1893
62	Lamb, Edmund George, Borden Wood, Liphook, Hants.	Feb. 12, 1898
63	Langslow-Cock, Edward Arthur, c/o Way and Company, Dewar House, Haymarket, London, W .	Aug. 2, 1902
64	Latimer, William, 3, St. Nicholas' Buildings, Newcastle-upon-Tyne	Oct. 14, 1905
65	Lawson, Henry Alfred, c/o Robert Frazer and Sons, Limited, Milburn House, Newcastle-upon-Tyne	April 8, 1911
66	Leake, Percy Collinson, c/o Deanbank Chemical Company, Ferry Hill .	Aug 3, 1907
67	Loewenstein, Hans von Loewenstein zu, Friedrichstrasse, 2, Essen-Ruhr, Germany. Transactions sent to Biblio-theek des Vereins fur die bergbaulichen Interessen im Oberbergamtsbezirk Dortmund, Essen-Ruhr, Germany	April 13, 1907

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		Date of Election and of Transfer.
68	Marshall, Patrick, University School of Mines, Dunedin, New Zealand J	June 12, 1897
69	Moore, Frederic George, Parke Mineral Estate Office, 9, Fleet Street, Torquay 9	Aug. 7, 190
70	Morris, Percy Copeland, 79, Elm Park Gardens, London, S.W .	Feb. 14, 1903
71	Oliff, Thomas Millen, c/o P.O. Box 1666, Johannesburg, Transvaal	April 3, 1909
72	Palmer, Sir Alfred Molyneux, Bart., John Bowes and Partners. Limited, Milburn House, Newcastle-upon-Tyne	Nov. 24, 1894
73	Patterson, Robert Oliver, Thorneyholme, Wylam, Northumberland	Feb. 12, 1910
74*	Pickup, Peter Wright Dixon, Rishton Colliery, Rishton, Blackburn	Feb. 12, 1898
75	Postlethwaite, John, Chalcedony House, Eskin Place, Keswick	Feb. 11, 1905
76	Prior-Wandesforde, Richard Henry, Castlecomer House, Castlecomer, County Kilkenny	Dec. 9, 1905
77*	Proctor, John Henry, 29, Side. Newcastle-upon-lyne ;	June 8, 1889
78	Redmayne, Robert Norman, 14, Neville Street, Newcastle-upon-Tyne	Dec. 8, 1906
79	Reid, Sidney, Printing Court Buildings, Newcastle-upon-Tyne	Dec. 13, 1902
80	Ridley. James Cartmell, 1, Bentinck Terrace, Newcastle-upon-Tyne	Feb. 11, 1893

81 Rogerson, John Edwin, Oswald House, Durham	June 8, 1895
82 Russell, James, Westgate Road, Newcastle-upon-Tyne	Feb. 13, 1901
83 Sadler, Basil, Craigmere, Lanchester, Durham	Feb. 11, 1905
84 Samuel, David, Arcade Chambers, Llanely	Dec. 13, 1902
85 Sanders, Charles William Henry, Sherburn House, near Durham	Dec. 14, 1901
86 Schumacher, Raymond William, c/o H. Eckstein and Company, P.O. Box 149, Johannesburg, Transvaal	April 9, 1904
87 Scott, John Oliver, Milburn House, Newcastle-upon-Tyne	Dec. 11, 1897
83 Simonds, Guy, Elswick Works, Newcastle-upon-Tyne	June 11, 1910
89 Smith, Arthur Herbert, Broad Street House, London, E.C .	June 14, 1902
90 Steuart, Douglas Stuart-Spens, Royal Societies Club, St. James' Street, London, S.W.	June 10, 1899
91 Strange, Harold Fairbrother, P.O. Box 2527, Johannesburg, Transvaal	Dec. 11, 1897
92 Strzelecki, Algernon Percy Augustus de, 39, Victoria Street, Westminster, London, S.W .	Dec. 12, 1908
93 Todd, James, Overdale, Jesmond, Newcastle-upon-Tyne	Aug. 6, 1892
94 Valentine, James, 1, West View, Horwich, Lancashire	June 14, 1902
95 Waley, Frederick George, The Bellambi Coal Company, Limited, 9, Bridge Street, Sydney, New South Wales, Australia	Feb. 9, 1907
96 Walmesley, Oswald, 2, Stone Buildings, Lincoln's Inn, London, W.C.	June 8, 1895
97 Watson, John Robert, 3, Whitburn Terrace, Marsden, South Shields	April 9, 1910
98 Watts, James, Sheldon Cottage, Perranwell Station, Cornwall	Feb. 11, 1911
99 Watts, John, Blytheswood North, Osborne Road, Newcastle-upon-Tyne	April 8, 1911

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	Date of Election and of Transfer.
100 Wedgwood, Ralph Lewis, North Eastern Railway Company, Newcastle-upon-Tyne	Dec. 11, 1909
101 Welford, Thomas, Wallarah Colliery, Catherine Hill Bay, New South Wales, Australia	June 10, 1903
102 Whitehead, Thomas, Brindle Lodge, Preston	June 12, 1897
103 Williams, Henry, Llwyngwem, Pontardulais, Glamorgan	Dec. 9, 1905
104 Wilson, Hugh Russell, 50, Langholm Crescent, Darlington	Dec. 12, 1908
105*Wood, Arthur Nicholas Lindsay, The Hermitage, Chester-le-Street	July 14, 1896
106 Young, Mrs. H. E., 617, Michigan Street, Victoria, British Columbia	April 4, 1903
107 Young, Roland Francis	June 11, 1910

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ASSOCIATES (Assoc. I.M.E.).

Marked \* have paid life composition.

	Date of Election and of Transfer.
1 Adam, Thomas Walter, Andrew Knowles and Sons, Limited, Pendlebury, Manchester	S. April 3, 1909
2 Allan, Herbert Durham, Rewah State Collieries, Umaria, Central India, Bengal Nagpur Railway	A. Dec. 10, 1910
3 Almond, Charles Percy, 14, Queen Anne's Gardens, Bush Hill Park, Enfield, Middlesex	Feb. 10, 1906
4 Annett, Hugh Clarkson, Office Row, East Cramlington, Cramlington, Northumberland	Oct. 9, 1909
5 Archer, Matthew William, Grosvenor House, Manchester Road, Stocksbridge, Sheffield	S. Feb. 15, 1906
6 Armstrong, Henry, 29, William Street, New Seaham, Seaham Harbour, County	A. June 20, 1908
	S. June 8, 1895
	A. Aug. 4, 1900
	Dec. 12, 1903

Durham

7 Askew, Alfred Hill, 16, Telford Street, Gateshead-upon-Tyne	Feb. 9, 1907
8 Bamborough, Jacob, Preston Colliery, North Shields	Oct. 8, 1904
9 Barkes, Percy, Houghton Colliery, Fence Houses	June 12, 1909
10 Barrett, Rollo Samuel, Whitehill Hall, Pelton Fell, County Durham	S. Dec. 9, 1905 A. Aug. 1, 1908
11 Bates, Johnson, 5, Grange Villa, County Durham	Feb. 11, 1905
12 Bates, Thomas, West Wylam Terrace, Prudhoe, Ovingham, Northumberland	April 13, 1907
13 Battey, Thomas, Station Road, Shiremoor, Newcastle upon-Tyne	O ct. 13, 1894
14 Bell, John Valentine, 5, Blackett Street, Catchgate, Annfield Plain, County Durham	S. Dec. .14, 1907 A. Aug. 5, 1911
15 Benson, Herbert Sydney, Seaton Burn Colliery, Seaton Burn, Dudley, Northumberland	S. Feb. 11, 1905 A. Aug. 5, 1905
16 Bewick, George, Johnson Terrace, West Auckland, Bishop Auckland	April 10, 1897
17 Bewley, Thomas, Stobswood Colliery, Acklington, Northumberland	Aug. 5, 1905
18 Blunden, Philip Sidney, The Villas, Dean Bank, Ferry Hill Village, Ferry Hill	June 8, 1907
19 Booth, James Frederick, 8, Uxbridge Terrace, Felling, County Durham	Dec. 11, 1909
20 Bowes, Thomas, Overdale, Catchgate, Annfield Plain, County Durham	Feb. 13, 1892
21 Brailsford, Cuthbert Hale, Leasons, Chislehurst, Kent	June 11, 1910
22 Brandon, Geoffry, 9, Beech Grove, Benton, Newcastle-upon-Tyne	S. Dec. 8, 1900 A. Aug. 3, 1907
23 Burt, Thomas, Hill House, Washington, Washington Station, County Durham	April, 4 1909

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	Date of Election and of Transfer.
24 Carroll, John, Spring Bank House, Newfield, Willington, County Durham	Feb. 12, 1898
25 Cheesman, Edward Taylor, Jun., Clara Vale Colliery, Ryton, County Durham	Dec. 10, 1910
26 Cheesman, Matthew Forster, Throckley Colliery, Newburn, Northumberland	S. Dec. 13, 1902 A. Aug. 5, 1905
27 Chicken, Ernest, Woodlea, Murton, County Durham	Oct. 8, 1910
28 Clark, Nathaniel J., c/o A. R. Cant, 7, Watt Street, Newcastle, New South Wales, Australia	S. April 13, 1901 A. Aug. 1, 1903
29 Clark, Thomas, Dipton Colliery, Lintz Green Station, County Durham	Oct. 11, 1890
30 Clephan, Guy, Killingworth Hall, near Newcastle-upon-Tyne	Dec. 10, 1910
31 Clive, Robert, Bentley Colliery, near Doncaster	S. Feb. 10, 1900 A. Aug. 1, 1903
32 Coade, Samuel, Steel Green, Millom, Cumberland	Dec. 10, 1904
33 Cockbain, Tom Stewartson, Usworth Colliery, Washington Station, County Durham	Dec. 8, 1906
34 Cockburn, John, Fatfield Road, Washington, County Durham	April 9, 1904
35 Cook, George, Binchester Hall, Bishop Auckland	S. Aug. 2, 1902 A. Aug. 5, 1905
36 Cowx, H. F., The Villa, Thornley, County Durham	April 14, 1894
37 Coxon, Samdel George, Hamsteels Colliery, Durham	Feb. 9, 1901
38 Crawford, Thomas, Eighton Banks, Gateshead-upon-Tyne	Dec. 8, 1906
39 Crowle, Percy, Mysore Mine, Marikuppam, Mysore State, India	Feb. 11, 1905
40 Cummings, William, Beamish View, Stanley, County Durham	Dec. 14, 1907
41 Daghlish, Frank, 1, Wilson Terrace, Broughton Moor, Maryport	Dec. 14, 1907
42 Daniell, Henry Edmund Blackburne, 5, Wallace Terrace, Ryton, County Durham	S. Aug. 3, 1907 A. Aug. 6, 1910
43 Danskin, Thomas, Springwell Colliery, Gateshead-upon-Tyne	Dec. 10, 1898
44 Davies, Daniel John, Cymru, Corrimal, Illawarra Line, New South Wales, Australia .	Oct. 12, 1907

45 Davis, James E., South Medomsley Colliery, Dipton, County Durham	Feb. 12, 1898
46 Davison, Francis, Ash Grove House, Hedley Hill Colliery, near Waterhouses, Durham	Feb. 12, 1898
47 Dawson, Charles, Bettisfield Colliery, Bagillt, Flintshire	Oct. 9, 1909
48 Dick-Cleland, Archibald Felce, Apartado 157, Guadalajara, Jalisco, Mexico. Transactions sent to Ria Ora, Trelawny Road, Camborne .	Dec. 8, 1906
49 Dixon, Edwin Carr, Hallgarth, Lanchester, Durham	Aug. 7, 1909
50 Dixon, George, High Park Colliery, Newthorpe, Nottingham	S. Feb. 9, 1901 A. Aug. 3, 1907
51 Dunnett, Samuel, West View House, Coomassie Road, Waterloo, Blyth	June 8, 1895
52 Eadie, John Allan, Jun., Eller Bank, Harrington, Cumberland .	S. Oct. 10, 1903 A. Aug. 5, 1905
53 Elliot, Arthur, Springfield, Cressington Park, Liverpool	S. Dec. 13, 1902 A. Aug. 1, 1908
54 Elliott, George, South View, Mickley Colliery, Stocksfield, Northumberland	June 8, 1907
55 English, Henry Edward, Lumley Manor House, Fence Houses	S. Aug. 7, 1909 A. Feb. 11, 1911
56 English, Thomas Weddle, Ingram House, Corbridge, Northumberland .	Feb. 11, 1905
57 Eskdale, John, Ashington Colliery, Morpeth	Oct. 11, 1902
58 Evans, Vincent. Great Houghton, Barnsley	S. Dec. 12, 1908 A. Aug. 6, 1910

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	Date of Election and of Transfer.
59 Fairbrother, Charles James, The Durban Navigation Collieries, Dannhauser, Natal, South Africa	Feb. 8, 1908
60 Falcon, Michael, Ebbw Vale, Monmouthshire	S. Oct. 13, 1894 A. Aug. 4, 1900
61 Field, Benjamin Starks, Layabad Colliery, Kusunda P.O., District Manbhoom, Bengal, India	S. Aug. 2, 1902 A. Aug. 3, 1907
62 Flint, Frederic John, 27, Carlton Street, Blyth	4 Aug. 7, 1909
63 Foggo, John Frederick, Old Hall, Denby, Derby .	S. June 14, 1902 A. Aug. 6, 1904 .Aug. 2, 1902
64 Ford, Thomas, Blaydon Burn Colliery, Blaydon-upon-Tyne, County Durham	April 7, 1906
65 Forster, Edward Baty, 15, Grange Road, Ryton, County Durham	Feb. 8, 1902
66 Forster, Frank, Black Hills Road, Horden Colliery, Castle Eden, County Durham	S. Aug. 2, 1902 Aug. 3, 1907
67 Fowler, Robert Norman, Havannah Terrace, Washington, County Durham A.	April 8, 1911
68 French, Alexander, Institute, Peases West, Crook, County Durham	Dec. 13, 1902
69 Gallagher, Patrick, Clifton Row, Netherton Colliery, Nedderton, Newcastle-upon- Tyne	Oct. 9, 1909
70 Geary, George Edward, Osmond Croft, Winston, Darlington	S. Dec. 14, 1901 A. Aug. 1, 1908
71 Gilchrist. George . Atkinson, South Pelaw Colliery, Chester-le-Street	Feb. 10, 1906
72 Gore-Langton, Robert Lancelot, Hatch Park, Taunton	Oct. 12, 1907
73 Graham, Robert, 31, Railway Terrace, Willington, County Durham	June 10, 1905
74 Grey, John Neil, c/o Naworth Coal Company, Limited, Hallbankgate Offices, Brampton, Carlisle	Feb. 12, 1898
75 Hampson, Alexander, Windlestone Colliery, Ferry Hill	S. Feb. 8, 1902 A. Aug 3, 1907
76 Harper, George Octavius	Dec. 12, 1903
77 Hawes, George Arthur, . 2, Sandringham Terrace, Leeholme, Bishop Auckland	S. Dec. 13, 1902 A. Aug. 6, 1910
78 Hawkins, John Bridges Bailey, Staganhoe Park, Welwyn	S. Feb. 10, 1900 A. Aug. 4, 1900
79 Heaps, Christopher, 12, Richmond Terrace, Gateshead-upon-Tyne	

80 Hedley, George William, Kimblesworth House, Chester-le-Street	Dec. 13, 1902
81 Hedley, Morton, Medomsley, County Durham	Feb. ,13, 1909
82 Hedley, Rowland Frank Hutton, 59, John Street, Sunderland	S. April 4, 1903 A. Aug. 7, 1909
83 Henderson, William, 8, Victoria Terrace, Bedlington Colliery, Bedlington, Northumberland	Oct. 12,1901
84 Herdman. Fred 3, Derwent Gardens, Low Fell, Gateshead-upon-Tyne	S. Dec. 14,1907 A. Aug. 6, 1910
85 Herriotts, Joseph George, South View, Middlestone Moor, Spennymoor	April 28, 1900
86 Herron, Edward, 4, Holly Terrace, Stanley, County Durham	Feb. 15, 1896
87 Heslop, George, St. George's Colliery, Hatting Spruit, Natal, South Africa	Oct. 9,1909
88 Heslop, James, Stobswood Colliery, Acklington, Northumberland	Dec. 12, 1908
89 Heslop, Wardle, Wyncote, Holywell Avenue, Monkseaton, Whitley Bay, Northumberland	S. Dec. 10, 1904 A. Aug. 7,1909
90 Heslop, William, High Grange, Howden-le-Wear, County Durham	Oct. 8, 1898
91 Hornsby, Demster, Choppington Colliery, Scotland Gate, Morpeth	Feb. 12, 1898

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	Date of Election and of Transfer.
92 Hudson, Mark, 115, Gurney Valley, Bishop Auckland	Dec. 9, 1905
93 Hudspeth, Henry Moore, c/o John William Hudspeth, Willington, County Durham	S. Oct. 12, 1907 A. Feb. 13,1909
94 Hughes, Thomas, Fan Terrace, Urpeth Busty, Birtley, County Durham	Feb. 10,1906
95 Humble, John Norman, West Pelton House, Beamish, County Durham	S. Aug. 2, 1902 A. Aug. 5, 1905
96 Humble, William Henry, Waldrige Colliery, Chester-le-Street	Dec. 14, 1907
97 Hunter, Andrew, 2, Abbotsford Terrace, South Shields	Feb. 13, 1897
98 Hyde, George Alfred, 96, New Row, New Delaval, Newsham, Northumberland	S. Feb. 13, 190 A. Aug. 5, 19119
99 Imrie, Henry Marshall, 22, Western Hill, Durham	Feb. 14, 1903
100 Jeffery, Albert John, 8, Agents Terrace, Boldon Colliery, County Durham	April 28, 1900
101 Jobling, John Swanstone, 10, Langley Street, Langley Park, Durham	Oct. 12,1907
102 Johnson, Thomas, The Villas, Dean Bank, Ferry Hill	Dec. 9, 1905
103 Jones, Walter, West House, Wheatley Hill Colliery, Thornley, County Durham	S. Feb. 9, 1901 A. Aug. 1,1908
104 Kirkley, Aidan, Cleadon Park, Cleadon, Sunderland	June 11, 1910
105 Lascelles, Walter Reginald, Palana, Bikaner State, Rajputana, India	Feb. 8, 1908
106 Lawson, John, Fair View, Burnopfield, County Durham	Oct. 10, 1908
107 Lawson, Richard Forster, Holmside Villa, Holmside, Edmondsley, Durham	S. Feb. 13, 190 A. Aug. 5, 19114
108 Lewiss, Edward Middle mass, 3, Eighth Row, Ashington, Morpeth	Oct. 12, 1907
109 Liddell, Henry Norman John, Ovingham-upon-Tyne, Northumberland	S. June 10, 1905 A. Aug. 5, 1911
110 Lightley, John, Byers Green, Spennymoor	April 25, 1896
111 Lister, John Alfred, Mulgrave House, Dalehouse, Staithes, Yorkshire	S. Dec. 8, 1906 A. Aug. 6, 1910
112 Logan, Reginald Samuel Moncrieff, 33, Boyd Terrace, Blucher Pit, Newburn, Northumberland	S. Feb. 9, 1901 A. Aug. 1, 1903
113 Longridge, John, 12, St. James' Terrace, Morpeth	Feb. 11, 1905
114 Lowry, Joseph Thompson, 25, Montreal Street, Cleator Moor, Cumberland	April 3, 1909
115 McCarthy, Michael Dodds, 49, North Street, Perkinsville, Pelton, County Durham	Dec. 14, 1901
116 McDonald, Francis, The Avenue, Durham Road, Leadgate, County Durham	Oct. 13,1906

117 MacGregor, Donald, Moorgreen, Newthorpe, Nottingham	S. Feb. 9, 1901 A. Aug. 1, 1908
118 McKie, Thomas, Ashington Colliery, Morpeth	Oct. 9, 1909
119 Mason, Benjamin, Burnopfield Colliery, Burnopfield, County Durham	April 11, 1891
120 Melville, John Thomas, 4, Poplar Gardens, Gosforth, Newcastle-upon-Tyne	April 8, 1899
121 Milburn, Edwin Walter, 4, First Row, Ashington, Morpeth	S. Feb. 10, 1900 A. Aug. 5, 1905
122 Milburn, William, Hill House, Ouston, Birtley, County Durham	June 8, 1895
123 Milburne, John Etherington, Thinford Mill, Metal Bridge, Ferry Hill	S. Oct. 14, 1899 A. Aug. 6, 1904
124 Miller, Alexander, South Greta Colliery, near West Maitland, New South Wales, Australia	Oct. 10, 1903
125 Millne, David, 1, Burdon Street, Bedlington, Northumberland	Aug. 3, 1907
126 Minto, George William, Harraton Colliery, Chester-le-Street	Oct. 10, 1891

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	Date of Election and of Transfer.
127* Mitchell-Withers, William Charles, P.O. Box 2969, Johannesburg, Transvaal	S. April 28, 1900 A. Aug. 2, 1902
128 Muse, Thomas John, Jun., 32, Beaconsfield Avenue, Low Fell, Gateshead-upon-Tyne	S. Dec. 8, 1906 A. Aug. 5, 1911
129 Musgrove, William, Heddon Colliery, Northumberland	S. June 8, 1895 A. Aug. 1, 1903
130 Mvcock, William, Front Street, Shotton Colliery, Castle Eden, County Durham	Oct 10, 1908
131 Nelson, George Catron, Brancepeth Colliery, Willington, County Durham	Feb. 8, 1902
132 Nichols, Henry Herbert, Kibblesworth, Gateshead-upon-Tyne	Aug. 3, 1907
133 Nicholson, George Thompson, Dene House, Scotswood, Northumberland	S. Dec. 10, 1904 A. Aug. 5, 1911
134 Oswald, George Robert, British North Borneo Exploration Company, Sandakan, British North Borneo. All communications to be sent to E. William Oswald, Blackwell Colliery Company, Limited, Alfreton	S. June 9, 1900 A. Aug. 3, 1907
135 Oughton, Ernest, Minas de Soria, Gergal, Provincia de Almeria, Spain	Dec. 11, 1909
136 Owen, Arthur Lewis Scott, 6, Success Terrace, Fence Houses	S. June 12, 1909 A. Aug. 6, 1910
137 Owens, George, Westerton Village, Bishop Auckland	Oct. 9, 1909
138 Paddon, Neville Blackmore, Thornley, County Durham	Dec. 14, 1907
139 Palmer, Harry, Langley Park, Durham	S. June 14, 1902 A. Aug. 7, 1909
140 Palmer, Meyrick, Jobs Hill, near Crook. County Durham	S. June 8, 1901 A. Aug. 1, 1908
141 Parker, Joseph William, Glencoe Colliery, Hatting Spruit, Natal, South Africa	June 11, 1910
142 Pattinson, Charles Werner, Greenhead Terrace, Chopwell, Ebchester, County Durham	June 12, 1909
143 Pattison, Charles Arthur, High Grange, Howden-le- Wear, County Durham	S. April 13, 1901 A. Aug. 5, 1905
144 Pattison, William, Cornelia Colliery, Viljoen's Drift, Orange River Colony, South Africa	Dec. 13, 1902
145 Pearson, John Charlton, Hotchpudding Farm, Denton, Scotswood, Northumberland	Feb. 14, 1903
146 Peel, George, Jun., 27, Langley Street, Langley Park, Durham	April 4, 1903
147 Potts, Laurance Wylam, 77, Mowbray Road, South Shields	April 4, 1903
148 Pratt, George Ross, Springwell Colliery, Gateshead-upon-Tyne	June 8, 1895
149 Proctor, Thomas, Woodhorn Colliery, Morpeth	Oct. 13, 1894
150 Pumphrey, Charles Ernest, Greenside House, Ryton, County Durham	S. Dec. 10, 1904 A. Aug. 4, 1906

151 Ramsay, John Gladstone, 2, Steavenson Street, Bowburn, Coxhoe, County Durham	Dec. 10, 1892
152 Rayner, Sydney, The Marshes, Atherton Road, Hindley Green, Wigan	S. Feb. 13, 1909 A. Aug. 5, 1911
153 Richardson, Frank, Ravensworth, Ashton-under-Lyne	S. Oct. 12, 1901 A. Aug. 1, 1908
154 Richardson, Henry, Clara Vale Colliery, Ryton, County Durham	Dec. 8, 1906
155 Ridley, George Dinning, 14, First Row, Ashington, Morpeth	Feb. 8, 1890
156 Ridley, Henry Anderson, Burnbrae, Blaydon Burn, Blaydon-upon-Tyne, County Durham	Dec. 14, 1907

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	Date of Election and of Transfer.
157 Ridley, William, Jun., School House, Burnside, Blaydon-upon-Tyne, County Durham	Dec. 8, 1906
158 Rivers, John, The Villas, Thornley, Durham	Feb. 9, 1895
159 Robinson, John William, 3, The Terrace, Boldon Colliery, County Durham	S. April 12, 1902 A. Aug. 5, 1905
160 Robinson, Stanley, Chesterholm, North Biddick, Washington Station, County Durham	S. Oct. 12, 1901 A. Aug. 1, 1908
161 Rochester, William, 1, Office Row, Nether-ton Colliery, Nedderton, Newcastle-upon-Tyne	Dec. 9, 1905
162 Roose, Hubert F. G., Royal School of Mines, South Kensington, London, S.W 7	S. Dec. 9, 1899 A. Aug. 3, 190
163 Rutherford, Robert Archibald, Wellington Terrace, Edmondsley, Durham	Dec. 14, 1907
164 Rutherford, Thomas Easton, West Shield Row Colliery, Stanley, County Durham	S. June 10, 1899 A. Aug. 4, 1906
165 Schollick, Thomas, 13, Model Street, New Seaham, Sunderland	Dec. 12, 1903
166 Scobie, Isaac, Woonona, near Sydney, New South Wales, Australia	Oct. 13, 1906
167 Scott, Thomas Amour, 5, Swarland Terrace, Acklington, Northumberland	Oct. 9, 1909
168 Seed, Alexander, 1, College Terrace, Brandon Colliery, County Durham	April 4, 1903
169 Severs, Jonathan, Orton House, Westerhope, Newcastle-upon-Tyne	S. June 8, 1895 A. Aug. 4, 1900
170 Sharp, Charles Gordon, Union Miniere du Haut Katanga, Star of the Congo Mine, via Ndola, North Western Rhodesia, South Africa	S. Feb. 10, 1906 A. Aug. 6, 1910
171 Simpson, Richard Charlton, Wellington Terrace, Edmondsley, Durham	Feb. 13, 1904
172 Smith, James, View Lane, Stanley, County Durham	Dec. 11, 1909
173 Snaith, Joseph, South Pontop Colliery, Annfield Plain, County Durham	Oct. 12, 1907
174 Snowden, Thomas. Jun., Oakwood, Cockfield, County Durham	S. June 12, 1897 A. Aug. 3, 1901
175 Southern, Charles, Radstock, Bath	S. June 10, 1903 A. Aug. 7, 1909
176 Southern, Stephen, Heworth Colliery, Felling, County Durham	S. Dec. 14, 1895 A. Aug. 3, 1901
177 Spence, Arthur Magnus, Fell House, Medomsley, County Durham	Feb. 12, 1910
178 Stewart, Roland, 17, Normanton Terrace, Newcastle-upon-Tyne	Aug. 6, 1910
179 Stobart, Thomas Carlton, Ushaw Moor Colliery, Durham	Aug. 2, 1902
180 Stoker, Nicholas, South Pelaw Colliery, Chester-le-Street	Feb. 13, 1904
181 Strong, George Adamson, Oakwood, Catchgate, Annfield Plain, County Durham	S. Aug. 2, 1902 A. Aug. 1, 1908
182 Summerside, Edward, 22, Lefroy Street, Newcastle-upon-Tyne	Dec. 11, 1909
183 Swan, William Edward, Stanley House, King Street, Alfreton	April 9, 1904
184 Swann, Joseph Todd, 6, Victoria Terrace, Throckley, Newburn, Northumberland	S. Dec. 13, 1902 A. Aug. 4, 1906
185 Taylor, Herbert William, El Bote Mine, Zacatecas, Mexico	Aug. 2, 1902
186 Thirlwell, Thomas A., 18, Lynwood Avenue, Bentinck Road, Newcastle-upon-Tyne	S. Dec. 13, 1902

187 Thirtle, James, Grant Street, Horden, Sunderland	A. Aug. 7, 1909 Oct. 10, 1908
188 Thomas, Robert Clark, 15, Success Cottages, Bunker Hill, Fence Houses	S. Aug. 3, 1907 A. Aug. 6, 1910

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	Date of Election and of Transfer.
189 Thompson, Cyril, Home Farm Cottages, Mealsgate, Cumberland	Aug. 7, 1909
190 Thompson, George Heron Dinsdale, Dinsdale Vale, Windsor Avenue, Waterloo, Blyth	S. Feb. 14, 1903 A. Aug. 5, 1911
191 Thompson, William, Stone House, Broughton Moor, Maryport	Dec. 14, 1907
192 Thornton, Frank, 2. Pilgrim Street, Murton, County Durham	S. Feb. 8, 1902 A. Aug. 7, 1909
193 Turnbull, William, West Holywell, Backworth Colliery, Newcastle-upon-Tyne	Oct. 8, 1904
194 Turner. George, Widdrington Colliery, Widdrington, Acklington, Northumberland	June 8, 1895
193 Wainwright, William, Heworth Colliery, Felling, County Durham	April 2, 1898
196 Walton, Isaac, 10, Wilson Terrace, Broughton Moor, Maryport	Dec. 14, 1907
197 Watson, Thomas, Jun., Rosebank, Darlington	S. June 8, 1907 A. Aug. 5, 1911
198 Welsh, Arthur, Red House, Tunstall Village, near Sunderland	S. Aug. 1, 1896 A. Aug. 1, 1903
199 Whinn, John, High Spen, Newcastle-upon-Tyne	Feb. 8, 1908
200 Widdas, Frank, Thrislington Hall, West Cornforth, County Durham	Dec. 8, 1900
201 Widowfield, John Gilbert, Wellington Terrace, Edmondsley, Durham	Dec. 14, 1907
202 Wild, Robert Powley, c/o R. H. Moore, St. Day, Scorrier, Cornwall	S. Dec. 8, 1906 A. Aug. 1, 1908
203 Wilson. Hugh, Sudreadih Coal Company, Limited, Nowaghur P.O., District Manbhum, Bengal, India. Transactions sent to c/o Frederick Wilson, Hebburn Colliery, Hebburn, County Durham	Feb. 13, 1904
204 Wood, George, Dudley Colliery, Dudley, Northumberland	April 13, 1907
205 Wraith, Charles Osborn, P.O. Box 178, Germiston, Transvaal	S. June 10, 1905 A. Aug. 5, 1911
206 Yelder, Hugh Lishman, 14, Moor View, Ryton, County Durham	April 7, 1906
207 Young, Charles, Laburnum House, Rowlands Gill, Newcastle-upon-Tyne	Dec. 10, 1910
208 Young, George Ellis, Ben well Colliery, Newcastle upon-Tyne	S. Aug. 3, 1901 A. Aug. 5, 1905
209 Young, John Edward, Nelson Street West, Washington Station, County Durham	June 12, 1909

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STUDENTS (Stud. I.M.E.).

	Date of Election
1 Atkinson, William Henry, Dans Castle, Tow Law, County Durham	Aug. 7, 1909
2 Avery, William Ernest, Wentworth House, The Avenue, Birtley, County Durham	June 8, 1907
3 Barber, Norman Elsdale, Seghill Colliery, Seghill, Dudley, Northumberland	June 20, 1908
4 Brooks, Douglas Roy, 83, Victoria Road, Hebburn, County Durham	Dec. 14, 1907
5 Browell, Jasper Geoffrey, East Boldon House, East Boldon, County Durham	Oct. 8, 1910
6 Coxon, Samuel Bailey, Washington Colliery, Washington Station, County Durham	Oct. 12, 1907

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Date of Election

7	Daglish, James Wilson, Blaydon Burn Colliery, Blaydon-upon-Tyne, County Durham	Dec. 10, 1910
8	Dakers Edgar Walton, Tudhoe Colliery, Spennymoor	Dec. 14, 1907
9	Douglas, Albert Edward, Beethoven House, Horden, Castle Eden, County Durham	Aug. 1, 1903
10	Earnshaw, Oscar, Kiln Bank House, Amble, Acklington, Northumberland	Feb. 8, 1908
11	Ford, Eric Loufwin, Nant-y-Gaer, Chopwell, Ebchester, County Durham	April 11, 1908
12	Fowler, Albert Ernest, Usworth Villa, Washington Station, County Durham	Oct. 12, 1907
13	Gallon, Joseph, 71, Seventh Row, Ashington, Morpeth	Oct. 9, 1909
14	Grace, William Grace, Hall Garth Hall, Winlaton, Blaydon-upon-Tyne, County Durham	Feb. 9, 1907
15	Graham, William, Jun., Solway House, Moresby, Whitehaven	Oct. 13, 1906
16	Hare, Ralph Victor, Howlish Hall, Bishop Auckland	Dec. 10, 1910
17	Hepburn, Henry, Greenhead Terrace, Chopwell, Ebchester, County Durham	Oct. 12, 1907
18	Huggup, Ralph, 33, Wingrove Road, Newcastle-upon-Tyne	Feb. 10, 1906
19	Hunter, Herbert Stanley, Blakelaw, Kenton, Newcastle-upon-Tyne	.Feb. 9, 1907
20	Hunter, John, West View, Front Street, Sacriston, Durham	Dec. 11, 1909
21	Hutton, Allan Robinson Bowes, Nine Mile Point Colliery, Cross Keys, Newport, Monmouthshire	April 8, 1905
22	Inman, William St. John, Thornfield, Ryhope Road, Sunderland	Feb. 11, 1911
23	Jacobs, George, 6, St. George's Square, Sunderland	Dec. 11, 1909
24	Kirkup, Ernest Hodgson, Eighton Lodge, Low Fell, Gateshead-upon-Tyne	April 13, 1907
25	Magee, Charlie Sharpe, Sharpe's House, Hetton-le-Hole, County Durham	Aug. 7, 1909
26	Maughan, Thomas, Ferry Hill Engine Works, West Cornforth, County Durham	Dec. 14, 1907
27	Merivale, Vernon, Togston Hall, Acklington, Northumberland	Oct. 8, 1910
28	Parrington, Matthew Lilburn, Hill House, Monkwearmouth, Sunderland	Oct. 9, 1909
29	Ridley, William, 10, Railway Street, Tow Law, County Durham	Aug. 1, 1908
30	Ritson, John Anthony Sydney, Bridge End House, Hexham	Aug. 4, 1906
31	Rutherford, Hooper, The Lawn, Rhymney, Cardiff	Dec. 11, 1909
32	Scott, John Linton, St. Stephen's House, Seaton Delaval, Newcastle-upon-Tyne	Dec. 12, 1908
33	Simpson, Joseph, Wheatley Hill Colliery Office, Thornley, County Durham	June 10, 1905
34	Slater, Thomas Edward, School House, Rowlands Gill, Newcastle-upon-Tyne	April 13, 1907
35	Strong, John William, 7, Earl's Drive, Low Fell, Gateshead-upon-Tyne	Oct. 9, 1909
36	Turnbull, John James, Jun., 6, Queens Road, Jesmond, Newcastle-upon-Tyne	Feb. 8, 1908
37	Varvill, Wilfred Walter, Colombian Mining and Exploration Company, c/o Tracey Brothers, Medellin, Republic of Colombia, South America	Dec. 12, 1908

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		Date of Election
38	Walton-Brown, Stanley, Seghill Colliery, Seghill, Dudley, Northumberland	June 20, 1908
39	Watts, Hubert, Blytheswood North, Osborne Road, Newcastle-upon-Tyne	June 8, 1907
40	Weeks, Francis Mathwin, Bentley Colliery, Doncaster	Feb. 10, 1906
41	Welch, William Hall, 32, Beaconsfield Avenue, Low Fell, Gateshead-upon-Tyne	Feb. 10, 1906
42	Williamson, George Armstrong, 59, Coatsworth Road, Gateshead-upon-Tyne	Feb. 13, 1909
43	Wrightson, Philip B. H .	April 11, 1908

#### SUBSCRIBERS.

- 1 Owners of Ashington Colliery, Newcastle-upon-Tyne.
- 2 Birtley Iron Company (3), Birtley, County Durham.
- 3 The Broken Hill Proprietary Company, Limited, 3, Great Winchester Street, London, E.C.

- 4 Brunner, Mond and Company, Limited, Northwich.
- 5 The Most Honourable the Marquess of Bute. Bute Estate-Offices, Aberdare.
- 6 The Charlaw and Sacriston Collieries Company, Limited, 34, Grey Street, Newcastle-upon-Tyne.
- 7 M. Coulson and Company, Limited, Merrington Lane Iron Works, Spennymoor.
- 8 Cowpen Coal Company, Limited (2), F, King Street, Newcastle-upon-Tyne.
- 9 The Honourable Lord Ninian Edward Crichton-Stuart, House of Falkland, Falkland, Fifeshire.
- 10 Crompton and Company, Limited, Pearl Buildings, Northumberland Street, Newcastle-upon-Tyne.
- 11 Dominion Coal Company, Limited, Glace Bay, Nova Scotia.
- 12 The Right Honourable the Earl of Durham (2), Lambton Offices, Fence Houses.
- 13 The Right Honourable the Earl of Ellesmere (2), Bridgewater Offices, Walkden, Manchester. Transactions sent to Capt. Henry Vaughan Hart-Davis, Bridgewater Offices, Walkden, Manchester.
- 14 Elswick Coal Company, Limited, Newcastle-upon-Tyne.
- 15 D. H. and G. Haggie, Wearmouth Patent Rope Works, Sunderland.
- 16 Harton Coal Company, Limited (3), Harton Collieries, South Shields.
- 17 Hetton Coal Company (5), Fence Houses.
- 18 James Joicey and Company, Limited (2), Newcastle-upon-Tyne.
- 19 Lambton Collieries, Limited (2), E, Queen Street, Newcastle-upon-Tyne.
- 20 The Most Honourable the Marquess of Londonderry (5), c/o Vincent Charles Stuart Wortley Corbett, Londonderry Offices, Seaham Harbour.
- 21 Mavor and Coulson, Limited, 47, Broad Street, Mile-End, Glasgow. All communications and Transactions sent to P. J. E. Kennedy, 4, St. Nicholas' Buildings, Newcastle-upon-Tyne.
- 22 North Brancepeth Coal Company, Limited, Crown Street Chambers, Darlington.
- 23 Owners of North Hetton Colliery (3), Fence Houses.
- 24 Osbeck and Company, Pit Timber Merchants, Newcastle-upon-Tyne.
- 25 Ryhope Coal Company (2), Ryhope Colliery. Sunderland.
- 26 Owners of Seghill Colliery, Seghill, Dudley, Northumberland.
- 27 Siemens Brothers and Company, Limited, 39, Collingwood Buildings, Newcastle-upon-Tyne.
- 28 Societe Houillere de Lievin (Pas-de-Calais), Lievin, Pas-de-Calais, France.
- 29 Owners of South Hetton and Murton Collieries (2), 50, John Street, Sunderland.
- 30 Owners of Stella Colliery. Hedgefield, Blaydon-upon-Tyne, County Durham.
- 31 Owners of Throckley Colliery, Newcastle-upon-Tyne.
- 32 Owners of Victoria Garesfield Colliery, Victoria Garesfield Colliery, Lintz Green, County Durham. Transactions sent to H. Peile, Priestman's Collieries, Limited, Milburn House, Newcastle-upon-Tyne.
- 33 Owners of Wearmouth Colliery (2), Sunderland.
- 34 Westport Coal Company, Limited (2), Dunedin, New Zealand.
- 35 Worthington Pump Company, Limited, Milburn House, Dean Street, Newcastle-upon-Tyne.

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## ENUMERATION.

August 5, 1911

Honorary Members	27
Members	921
Associate Members	107
Associates	209

Students	43
Subscribers	35
TOTAL	<hr/> 1,342 <hr/>

Members are desired to communicate all changes of address, or any corrections or omissions in the list of names, to the Secretary.

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## INDEX TO VOL. LXI.<sup>1</sup>

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### Explanations.

The — at the beginning of a line denotes the repetition of a word; and in the case of Names, it includes both the Christian Name and the Surname ; or, in the case of the name of any Firm, Association or Institution, the full name of such Firm, etc.

Discussions are printed in italics.

"Abs." signifies Abstracts of Foreign Papers at the end of the Proceedings.

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