



PROF. A. W. NASH, M.Sc.

PRESIDENT, 1939-1942.

DIED, MARCH 14TH, 1942.

TWENTY-EIGHTH ANNUAL REPORT.

1941.

THE Twenty-Eighth Annual Report of the Council, covering the activities of the Institute during 1941, is presented for the information of the members.

MEMBERSHIP.

The changes in membership recorded during 1941 are summarized in the Table below :—

	Total Dec. 31, 1940.	CHANGES DURING 1941.					Total Dec. 31, 1941.
		New.	Trans- ferred to.	De- ceased.	Re- signed.	Trans- ferred from.	
Hon. Members	17	—	—	1	—	—	16
Fellows	410	10	—	6	6	—	408
Members	502	13	2	1	9	—	507
Assoc. Members	537	21	10	2	15	2	549
Students	136	26	—	—	—	10	152
Totals	1602	70	12	10	30	12	1632

At the present time such a Table can only be regarded as approximate. The fate of more than 200 members in enemy-occupied countries and the Far East is unknown, though their names are retained on the roll of the Institute. It is satisfactory to note that the number of new entrants during 1941 was only six less than in 1940.

The Council has to record with deep regret the decease of the following members during 1941 :—

	Date elected.	Class of membership.
CADMAN, The Rt. Hon. Lord	1913	Fellow
CARPENTER, J. A.	1925	Fellow
EDELEANU, Dr. L.	1925	Hon. Member
ELLIS, C.	1933	Fellow
*HOLLOWAY, G. L.	1933	Assoc. Member
HOWARD, F. E.	1920	Fellow
HOWE, W. H.	1928	Fellow
MACNAB, W.	1913	Member
WARD, P. J.	1936	Fellow
*Woolgar, C. W.	1936	Assoc. Member

* Killed while serving with the R.A.F.

HONOURS.

His Majesty The King has conferred the following honours upon members of the Institute during 1941.

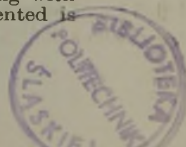
Baron : F. J. Leathers, Esq., was created a Baron and assumed the title of Baron Leathers of Purfleet. Lord Leathers was appointed to the new post of Minister of War Transport in May, 1941.

Knight Grand Cross of the Order of the Bath : Sir Frank E. Smith, F.R.S.

Distinguished Flying Cross : Flying-Officer R. A. Chisholm.

MEETINGS.

Seven meetings were held in London during 1941 and one (a joint meeting with the Society of Chemical Industry) in Birmingham. A list of papers presented is given below :—



Date, 1941.	Subject of Paper.	Authors.
5th Feb.	"Addition Agents for Lubricating Oils."	E. A. Evans and J. S. Elliott.
11th March.	"Octane Rating Relationships." (Read by Dr. A. E. Dunstan.)	G. Egloff and P. M. van Arsdell.
18th March.	"Soil Classification." "Bitumen in Soil Stabilization." "Petroleum as a Raw Material."	A. H. D. Markwick. H. Gardiner. A. W. Nash.
1st May.	"Hydrocarbon Solvents."	F. N. Harrap and E. B. Evans.
10th June.	"Oils for Cable Impregnation."	J. C. Wood-Mallock.
8th July.	"Asphaltic Bitumen in War-time." (Informal Discussion.)	A. W. Jarman.
12th Aug.	"Cyclization of Hydrocarbons." (Joint Meeting with S.C.I.)	S. W. Green and A. W. Nash.
17th Oct.		

The thanks of the Council are tendered to the Institute of Mechanical Engineers and the Royal Society of Arts for the loan of meeting-rooms.

An Institute Luncheon was held on 1st May. The President presided over a gathering of about 220 members and guests. Among those present were Mr. Geoffrey Lloyd, M.P., Sir Frank E. Smith, G.B.E., F.R.S., Sir Henry T. Tizard, K.C.B., F.R.S., and Dr. R. E. Priestley, M.A.

PUBLICATION.

Some reduction in the volume of the Institute's publications was inevitable in 1941 owing to the scarcity of contributions and the rationing of paper supplies. The *Journal* (Vol. 27) was therefore issued in ten parts, no publication being made in August or September. The Abstracts of technical literature have been well maintained though fewer in number than in recent years. In view of the difficulty experienced by many members in obtaining periodicals from abroad, a longer synopsis than was formerly the practice has been given whenever the importance of the original justified it.

Vol. 6 of the *Annual Reviews of Petroleum Technology* (covering 1940) was published in October and distributed in a paper-covered edition in lieu of the August and September *Journals*.

The voluntary submission of all publications of the Institute to the Ministry of Information for censorship continued in force throughout the year.

INFORMATION SERVICES AND LIBRARY.

The Institute has continued to render all possible assistance to Government departments in the supply of technical information, and has been consulted by the Admiralty, the War Office, the Air Ministry and the Ministry of Supply. The Institute's technical committees co-operate closely with the Ministry of Aircraft Production and the Petroleum Department, and include representatives of both Departments.

The postal lending service of the library has been well used, particularly the system of linking-up the *Journal* abstracts with the original papers available on loan. Binding of periodicals has been kept up to date.

The thanks of the Council are accorded to authors, publishers, and others who have kindly presented books to the library; to the executors of the late Dr. V. Henny, who presented to the Institute a large number of reference and text-books from his personal library; and to the Institution of Mechanical Engineers, the Royal School of Mines and the Science Library for their courtesy in allowing members the facilities of their libraries.

CHEMICAL STANDARDIZATION.

The type and greater part of the stock of the 3rd (1935) edition of *Standard Methods for Testing Petroleum* were destroyed by enemy action in May, 1941. A new edition was put in hand almost immediately by the Chemical Standardization Committee. This will incorporate various changes planned before the war, including considerable revision of some of the methods in the 3rd edition and several new methods. The following Reports were published in the *Journal*:—

"Calibration of C.F.R. Reference Fuels," May 1941, p. 192.

"Distillation of Liquid Asphaltic Bitumen (Tentative)," June 1941, p. 226.

"Calibration of Tetraethyl Lead in C.12," June 1941, p. 230.

"Report on Coefficients of Expansion of Crude Petroleum, by Sub-Committee J," Nov. 1941, p. 402.

FINANCE.

The audited accounts for the year, the Balance Sheet at 31st December, 1941, the accounts of the Benevolent Fund, and the list of contributors to the latter are given in the following pages.

Both income and expenditure are on a lower scale than in pre-war years. A net surplus of income over expenditure amounting to £210 14s. 1d. has been transferred to the Balance Sheet. During the year £1025 was invested in Savings Bonds, £75 deposited in the Post Office Savings Bank on Institute Account, and £150 invested in Defence Bonds on Benevolent Fund account. The total investments in Government securities and in the Post Office Savings Bank at 31st December, 1941, amounted to £6583, or approximately 70 per cent. of the total investment. As further funds become available they will be invested in Government securities.

The protracted negotiations over the Institute's offices at the Adelphi, requisitioned by the Ministry of Works in 1939, were concluded in November. A settlement was finally agreed for compensation at the rate of £1000 per annum, exclusive of rates. Arrears of compensation received and adjustments for rent have resulted in an addition of £514 1s. 0d. to the War Contingencies Reserve shown on the Balance Sheet.

The Council again expresses its thanks to the University of Birmingham and the Department of Oil Engineering and Refining for the provision of office facilities; also to the Council of the Institution of Chemical Engineers for the loan of rooms at 56 Victoria Street for the holding of Council and Committee meetings.

AWARDS.

The following awards were made :—

Scholarship of £40, tenable at the Royal School of Mines : E. B. Turner.
Students' Medal and Prize : J. G. Perks (Birmingham University).
Students' Prize : F. W. Longbottom (Birmingham University).
Burgess Prizes : A. K. Davies and V. D. Daft (Birmingham University).

COUNCIL AND OFFICERS.

It is with deep regret that we have to record the death of Professor A. W. Nash on 14th March, 1942, whilst serving as President of the Institute—an office he had held since 1939. His lovable personality and sound judgment will be greatly missed in the counsels of the Institute.

Mr. C. Dalley, M.I.E.E., F.Inst.Pet., has been elected by the Council to be President of the Institute for the year 1942–43.

Messrs. Ashley Carter, C. Dalley, F. H. Garner, J. McConnell Sanders and F. B. Thole were elected Vice-Presidents; and Messrs. R. Crichton, A. F. Dabell, V. C. Illing, E. R. Redgrove and W. J. Wilson were elected members of Council at the Annual General Meeting.

Six meetings of the Council and ten meetings of Committees of the Council were held during 1941.

STAFF.

Miss B. M. H. Tripp left the staff in January 1942 to take up an appointment with the British Council.

ACKNOWLEDGMENTS.

The Council records its appreciation of the services to the Institute of the Rt. Hon. Lord Plender, G.B.E., Honorary Treasurer; Messrs. Price Waterhouse & Co., Auditors; Messrs. Ashurst, Morris, Crisp & Co., Solicitors; the Midland Bank, Ltd., Selly Oak, Birmingham; and the members of the Staff.

Approved for publication on behalf of the Council of the Institute.

CHRISTOPHER DALLEY, President.
 ARTHUR W. EASTLAKE } Joint Honorary Secretaries.
 ASHLEY CARTER }
 S. J. ASTBURY, Secretary.

7th May, 1942.

THE INSTITUTE
REVENUE ACCOUNT FOR THE

	£	s.	d.	£	s.	d.	1940 £
To Administration Expenses :—							
Staff Salaries	1650	4	9				1515
Printing and Stationery	164	19	7				182
General Postages	169	16	1				165
Telephone, Cables, and Telegrams	8	15	0				6
				1993	15	5	
„ Establishment Charges :—							
Rent, Rates, etc.	338	2	2				530
Cleaning and Lighting	34	9	6				33
Repairs and Renewals	5	18	6				7
				378	10	2	
„ Publications :—							
Journal Expenses	1313	13	5				1416
Abstractors' Fees	243	4	6				246
Postage on Journals	167	10	5				190
Cost of Other Publications	442	7	7				454
				2166	15	11	
„ Meetings :—							
Hire of Hall, Pre-prints, Reporting				171	2	2	119
„ Professional Fees :—							
Legal Expenses	28	0	3				50
Auditor's Fee	42	0	0				42
				70	0	3	
„ Students' Scholarships and Prizes				87	7	0	89
„ Library Expenditure				34	11	9	45
„ Branches and Sections :—							
Students Section	14	15	0				
Trinidad Branch	20	0	0				
				34	15	0	55
„ Sundry Expenses				196	10	9	150
„ War Damage Contribution and War Risks Insurance				76	10	0	—
„ Donation to R.A.F. Benevolent Fund				105	0	0	—
„ Transfer to War Contingencies Reserve				—			1250
„ Balance, being Surplus for Year, carried to Balance Sheet				210	14	1	121
				£5525	12	6	£6814

RESEARCH FUND INCOME AND EXPENDITURE

	£	s.	d.
To Grant Made During Year :—			
British Electrical and Allied Industries Research Association	15	0	0
„ Balance as at 31st December, 1941	137	17	10
	£152	17	10

OF PETROLEUM
YEAR ENDED 31ST DECEMBER, 1941

	£	s.	d.	£	s.	d.	1940 £
By Subscriptions for 1941 received	3199	8	6				3583
„ Special Subscription	20	0	0				20
„ Subscriptions in Arrear, received during year	130	7	0				72
„ Publications	1928	19	4				2400
„ Interest and Dividends (Gross)	246	17	8				238
„ Grant in Aid of Rent							500
„ Compensation Received from Ministry of Works and Buildings for 1941	1000	0	0				
„ Add Grant in Aid of Rent	692	10	7				
	<hr/>			<hr/>			
	1692	10	7				
Less Rent payable to the Adelphi for 1941	1692	10	7				
	<hr/>			<hr/>			

£5525 12 6 £6814

ACCOUNT FOR THE YEAR ENDED 31ST DECEMBER, 1941.

	£	s.	d.
By Balance as at 31st December, 1940	142	16	1
„ Interest Received During Year	10	1	9
	<hr/>		
	152	17	10
	<hr/>		

THE INSTITUTE
(A Company limited by Guarantee)
BALANCE SHEET AS

	£	s.	d.	£	s.	d.
Capital of the Institute under Bye-Law, Section 6,						
Paragraphs 14 and 15 :—						
<i>Life Membership Fund—</i>		£	s.	d.		
As at 31st December, 1940		817	14	0		
Additions during year		2	0	0		
		819	14	0		
<i>Entrance and Transfer Fees—</i>						
As at 31st December, 1940		3642	12	9		
Additions during year—						
Entrance Fees		69	16	0		
Transfer Fees		2	2	0		
		3714	10	9		
<i>Profit on Sale of Investments—</i>						
As at 31st December, 1940		351	10	11		
<i>Donations—</i>						
As at 31st December, 1940		326	5	0		
		5212	0	8		
Research Fund					137	17 10
T. C. J. Burgess Prize Fund :—						
As at 31st December, 1940		10	0	0		
Less Awards during year		5	0	0		
		5	0	0		
War Contingencies Reserve :—						
As at 31st December, 1940		1250	0	0		
Add Surplus on settlement of rent and compensation (1939-40) in respect of Adelphi premises		514	1	0		
		1764	1	0		
Members' Subscriptions Received in Advance					87	13 6
Journal Subscriptions Received in Advance					224	0 5
Sundry Creditors, General Account					1265	16 2
World Petroleum Congress					223	15 4
Revenue Account :—						
Balance as at 31st December, 1940		2524	9	1		
Add Surplus for year as per separate statement		210	14	1		
		2735	13	2		

C. DALLEY, President.
 ARTHUR W. EASTLAKE } Joint Honorary Secretaries.
 ASHLEY CARTER }

£11,655 8 1

AUDITORS'

We report to the Members of THE INSTITUTE OF PETROLEUM that we have obtained all the information and explanations we have required. We are of the correct view of the state of the Institute's affairs as at 31st December, 1941, according to the books of the Institute.

CAVENDISH HOUSE,
41, WATERLOO STREET, Birmingham 2.
4th May, 1942

OF PETROLEUM.

and not having a Share Capital.)

AT 31ST DECEMBER, 1941.

	£	s.	d.	£	s.	d.
Investments :—						
<i>On Account of Capital, at cost—</i>						
£461 12 0 3% Conversion Stock, 1948/53	491	12	6			
664 6 6 3% London County Consolidated Stock, 1920	481	10	6			
806 8 3 3% Manchester Corporation Redeemable Consolidated Stock, 1958	845	17	7			
867 8 6 2½% Bristol Corporation Redeemable Stock, 1955/65	845	17	7			
150 0 0 5% Wandsworth and District Gas Co. Debenture Stock	154	8	6			
400 0 0 3% Metropolitan Water Board "A" Stock, 1963	346	10	7			
125 0 0 5% Great Western Railway Co. Consolidated Preference Stock	105	4	9			
150 0 0 3% Luton Corporation Redeemable Stock, 1958	151	6	7			
150 0 0 3% Smethwick Corporation Redeemable Stock, 1956/58	151	4	9			
600 0 0 3% Bristol Corporation Redeemable Stock, 1958/63	597	7	3			
500 0 0 3% Defence Bonds	500	0	0			
525 0 0 3% Savings Bonds	525	0	0			
	5196	0	7			
(Market Value at 31st December, 1941, £5303 10s. 0d.)						
Cash awaiting Investment on Deposit with Post Office Savings Bank	16	0	1			
				5212	0	8
<i>On Account of Revenue, at cost—</i>						
£790 8 3 3% Conversion Stock, 1948/53	842	8	0			
500 0 0 3% Defence Bonds	500	0	0			
				1342	8	0
(Market Value at 31st December, 1941, £1311 3s. 1d.)						
<i>On Account of Research Fund, at cost—</i>						
£336 5 10 3% Conversion Stock, 1948/53				357	14	8
(Market Value at 31st December, 1941, £345 0s. 10d.)						
Office and Library Furniture (excluding Presentations) :—						
As at 31st December, 1940				1	0	0
Library Books (excluding Presentations) :—						
As at 31st December, 1940				—		
Subscriptions in Arrear :—						
Not Valued				—		
Sundry Debtors, less Reserve for Doubtful Debts				421	16	4
Cash at Bank on Current Account and in Hand				1320	1	7
Cash on Deposit with Post Office Savings Bank :—						
General Account	2776	11	6			
World Petroleum Congress Account	223	15	4			
				3000	6	10
				£11,655	8	1

REPORT.

examined the above Balance Sheet with the books of the Institute and have opinion that such Balance Sheet is properly drawn up so as to exhibit a true and to the best of our information and the explanations given to us, and as shown by

BENEVOLENT FUND.

RECEIPTS AND PAYMENTS ACCOUNT FOR YEAR ENDED 31ST DECEMBER, 1941.

RECEIPTS.

	£	s.	d.	£	s.	d.
Balance on 1st January, 1941				815	5	2
Receipts during 1941:—						
Subscriptions	50	1	6			
Donations	99	0	2			
Interest	15	13	6			
Income Tax recovered	7	13	0			
				172	8	2
				£987	13	4

PAYMENTS.

Benevolent Fund:—						
Grants in Aid				60	0	0
Balance on 31st December, 1941 *				927	13	4
				£987	13	4

* The Balance on 31st December, 1941, was held as follows:—

	£	s.	d.
Cash in hand			12 0
Cash at Bank on Current Account		48	4 4
3% Defence Bonds	350	0	0
£600 0 0 3% Local Loans at cost †	528	17	0
	£927	13	4

† (Market Value at 31st December, 1941, £574 10s. 0d.)

We have examined the above Receipts and Payments Account with the books and vouchers of the Fund and find it to be in accordance therewith. We have verified the Investments and the Balances with Bankers comprising the Balance on 31st December, 1941.

CAVDISH HOUSE, 41, WATERLOO STREET,
BIRMINGHAM, 2.PRICE, WATERHOUSE & Co.
4th May, 1942.A. E. DUNSTAN, Chairman, Benevolent Fund Committee.
CHRISTOPHER DALLEY, President.

LIST OF DONORS AND SUBSCRIBERS DURING 1941.

Adams, A. C.	Dunstan, A. E.	Jones, H. F.	Robathan, T.
Ailcard, H. G.	Edcleanu, I.	Kenyon, H.	Roger, A.
Auld, S. J. M.	Ellis, J.	Knights, J. W.	Ruthven-Murray, A. J.
Austin, J. M.	Evans, A.	Kidd, T. G.	Sams, C. E. R.
Backhouse, S. R.	Evans, R. J.	Kugler, H. G.	Scott, G. H.
Bayliss, A. N.	Everist, G. E.	Lavington, H. V.	Scott, L. D.
Bell, O. A.	Farrant, V. M.	Lee, C. A.	Scott, T. R.
Blakiston, J. H.	Farthing, V. L.	Le Mesurier, L. J.	Smallwood, W.
Bolton, R. P.	Fay, E.	Macarthur, H.	Southwell, C. A. P.
Bowrey, S. E.	de Ferembre, R. G.	McCreath, T. T.	Spielmann, P.
Bressey, R. J.	Fletcher, H. D.	McCue, C. F.	Stevens, L. C.
Brodie, N. M.	Fox, D. A.	McCullum, I.	Tait, E. J. M.
Brown, C. B.	von Fuchs, G. H.	Mackilligan, R. S.	Tait, G. S.
Brown, R. G.	Garner, F. H.	Macniven, H. B.	Taylor, J. F. M.
Burwell, A. W.	Gent, E. L.	Martin, J. W.	Templeton, J. C. L.
Busch, L. A.	de Golyer, E.	Maskell, L. O.	Thornley, G. H.
Cameron, I.	Gottesmann, M.	Masters, J. S. S.	Tijmstra, S.
Castle, A. F.	Gray, W.	Mayo, F.	Tullet, G. V.
Chadwick, A.	Griffiths, P. M.	Mayo, H. T.	Tweed, R. R.
Charlton, H. E.	Hall, F. C.	Mitchell, R. G.	Underwood, A. J. V.
Chrisman, A. E.	Hall, J. H.	Moon, C. A.	de Waele, J. P. A.
Clapp, F. G.	Heaton, W. B.	Moore, L. F.	Walker, L. H. T.
Clement, L.	Henderson, W. R. S.	Nash, A. W.	Walsh, D. M.
Cole, F. A. J.	Henson, F. R. S.	Owen, R. M. S.	Walter, G.
Cox, A. W.	Hersch, L. H.	Perks, A. J.	Watling, R. A.
Coxon, G. H.	Hirst, W. P.	Porter, P. N. D.	Webb, J. F. N.
Crichton, R.	Hotham, E.	Pracey, H. E. F.	Westbury, J.
Dalley, C.	Howard, G. P. E.	Preston, R.	Wigney, W. J.
Darley, H. C. H.	Hubbard, W. A.	Purves, A. R.	Wilkes, A. C. R.
Davson, C. W.	Hunter, F. E.	Redgrove, E. R.	Wood, C. W.
Dawhurst, J. D.	Hunting, E. A.	Reid, H. W.	Young, R. H.
Downs, W. W.	James, J. E.	Richard, A. H.	Staff of Shell Central Laboratories.
Duck, A. E.	Jameson, J.	Richards, G. A.	
Dunkley, G. W.	Jennings, J. C.		

TRINIDAD BRANCH.

REPORT OF THE COMMITTEE ON THE WORKING OF
THE BRANCH DURING THE SESSION 1940-41.

FIVE meetings were held during the Session, at which the following papers were read :—

1941

- 29th January. 13th *Annual General Meeting*. "Notes on the Sealing Effect of Fault Surfaces," by G. STEWART TAITT.
- 30th April. 64th *General Meeting*. "Countercurrent Flow," by D. GORDON BAGG.
- 8th May. 65th *General Meeting*. "The Oil Industry and the War Effort," by DR. G. EGLOFF.
- 28th May. 66th *General Meeting*. "Hardening Times for Casing Cementation," by N. HEALEY and S. L. PEASE.
- 27th June. 67th *General Meeting*. "Well Completion Methods in Trinidad," by P. E. T. O'CONNOR.

Mr. L. A. Bushe was elected Chairman, and Mr. A. F. Castle Hon. Secretary and Treasurer.

The average attendance of members and guests at meetings was forty-four, but it was brought up to this high figure by the large attendance at Dr. Egloff's lecture, otherwise the figure would have been twenty-two, compared with twenty-five for the previous year.

There were seventy-eight members on the roll at the end of the year, compared with seventy-three for the previous year.

On account of the War, the Annual Dinner was not held.

The sum of \$103.00 was contributed to the Benevolent Fund by members of the Branch and forwarded to the parent body. The sum contributed the previous year was \$67.90.

An extract from a letter from the Secretary of the parent body states :—

"The Committee has always appreciated the substantial help for the Fund which comes from the Trinidad Branch. Once again I have to thank you for the generosity of the members."

A revised List of Members resident in Trinidad was made and issued during the Session.

The parent body wrote requesting the Branch to accept half the usual Annual Grant—*i.e.*, £20 instead of £40—owing to the need for conserving resources during the war. In view of the satisfactory financial condition of the Branch, the Committee willingly agreed.

Great difficulty was experienced by the Committee in securing papers by members to be read before the Branch, and the thanks of the Committee are due to those members who gave much time and effort towards keeping the Branch in a live and useful state.

TRINIDAD BRANCH.

BALANCE SHEET AS AT 31ST OCTOBER, 1941.

LIABILITIES.		ASSETS.	
Subscriptions to Benevolent Fund :		Cash at Bank	\$431.49
As per last Balance Sheet	\$140.80	Cash in hand	2.69
Received during the year	130.40		
	271.20		
Remitted to London during year	256.30		
	\$14.90		
To be remitted to London			
Income and Expenditure Account :			
As at 31st October, 1940	439.92		
Excess Expenditure over Income for year ended			
31st October, 1941	20.64		
	419.28		
	\$434.18		\$434.18

INCOME AND EXPENDITURE ACCOUNT FOR YEAR ENDED 31ST OCTOBER, 1941.

EXPENDITURE.		INCOME.	
Filing Cabinet	\$11.86	Grant from Institute of Petroleum, London	\$48.00
Clerical assistance	25.00	Excess Expenditure over Income	20.64
Stationery, etc.	17.98		
Postages	11.16		
Telephone	2.64		
	\$68.64		
	\$68.64		\$68.64

(Signed) L. A. BUSHE,
Chairman.

A. F. CASTLE,
Hon. Sec. and Treasurer.

F. E. HUNTER }
H. A. HARRIS } Auditors.

MINUTES OF 14TH ANNUAL GENERAL MEETING, HELD AT APEX
CLUBHOUSE ON 26TH NOVEMBER, 1941.

Mr. L. A. Bushe in the Chair.

1. The Acting Hon. Secretary read the Minutes of the 13th Annual General Meeting, and their confirmation, being proposed by M. J. D. Fullerton, and seconded by Mr. J. Burslem, was carried unanimously.

The Minutes of the 67th Ordinary General Meeting, at which the Auditors for the current year had been elected, were also read, their confirmation being proposed by Mr. H. W. Reid, seconded by Mr. G. S. Taitt, and carried unanimously.

2. The accounts for the year having been circulated, the Chairman pointed out that expenditure exceeded income by \$20.64, but that the parent body owed them \$48 for the year. They had written to the parent body suggesting that the Trinidad Branch might vote some of the funds received from the parent body to some war charity; but the parent body had thought they might accept a smaller grant, to which the Committee had agreed, and the grant was cut in half, being now \$96 a year. They had received \$48, and had therefore \$48 to come, which would give them something in the neighbourhood of \$20 income over expenditure for the year.

The adoption of the Accounts for the year was proposed by Mr. H. C. H. Thomas, seconded by Mr. F. H. L. Tindall, and carried unanimously.

3. The Committee's Report on the working of the Branch for the year 1940-41 was read. The Chairman observed that with regard to the list of members, apparently it did not agree with the parent body's list, and the Secretary would be glad if anyone who had any amendment to make would advise him. Some members might think that apologies were due to them because they had not received notices of papers or meetings, but this was entirely due to the fact that their list of members was apparently not complete. There were some members who were really members of the parent body, but whose names they had not received, and, conversely, there were some whose membership had ceased, but whose names were still on the list.

The "hardy annual" question again came up about the difficulty of obtaining papers, and he was sure the new Chairman would be very pleased to hear from any gentleman who would like to read a paper during the coming year.

The adoption of the Committee's Report was proposed by Commander H. V. Lavington, seconded by Mr. G. H. Scott, and carried unanimously.

4. *Election of Officers.*—The Chairman said it was not necessary to hold a ballot, as there were two retiring members of the Committee and two new names had been received—namely Mr. L. K. White, who had already served on the Committee previously for some years, and Mr. F. W. Penny, who had served the Institute for many years in Roumania.

The thanks of the Committee were due to the retiring members, Messrs. F. H. L. Tindall and C. C. Wilson.

Mr. G. H. Scott had also been nominated, but asked to have his name withdrawn, and thus obviate the necessity of holding a ballot at the meeting.

The new Committee was therefore: Messrs. L. K. White, F. W. Penny, H. W. Reid, A. F. Castle, H. C. H. Thomas, and L. A. Bushe.

5. *Auditors.*—A vote of thanks to the retiring Auditors, Messrs. H. A. Harris and F. E. Hunter, was proposed by Mr. H. C. H. Thomas, seconded by Mr. G. H. Scott, and carried unanimously.

The meeting terminated at 9 p.m.

ANNUAL GENERAL MEETING.

FRIDAY, 29TH MAY, 1942.

THE TWENTY-NINTH ANNUAL GENERAL MEETING of the Institute was held at the Connaught Rooms, London, W.C.2, on Friday, 29th May, 1942. There were fifty members of the Institute present.

At the commencement of the Meeting, DR. A. E. DUNSTAN, Past President, occupied the Chair.

DR. DUNSTAN said that he had two duties to perform, one a sad one and the other a very pleasant one. From the earliest days of the Institute it had been the custom for the retiring President to introduce his successor. On the present occasion their retiring President was no longer with them. Professor Nash had died in March, after occupying the Presidential Chair for nearly three years. They had lost a man whom they all loved, one who had been a personal friend for more than twenty years. He was a man in the prime of life, and they were all saddened by his untimely death. As this was the first meeting of the Institute to be held after Professor Nash's decease, he would ask the members to stand for a few moments in silent tribute.

(The members then stood in silence.)

Continuing, DR. DUNSTAN said it was appropriate that he should have the privilege of inducting their new President, both as the senior Past President present and as Mr. Dalley's oldest friend.

INDUCTION OF MR. C. DALLEY.

DR. DUNSTAN had known Mr. Dalley for more than twenty-five years. Mr. Dalley's connection with the Institute went back to its early days. He had been trained as an electrical engineer, and his early work was concerned with the installation of large generating plants in electric traction schemes, including the electrification of the L.C.C. tramways and London's underground railways.

Mr. Dalley had subsequently specialized in the application of electricity to the industries of coal, iron and steel, and petroleum. He had been chief engineer to the Anglo-Persian Oil Company during its great development period of 1914-1926. In 1926 he had left the Company to become joint managing director of Trinidad Petroleum Development Co., Ltd. Dr. Dunstan believed that Mr. Dalley was the first engineer to install on a large scale high-lift centrifugal pumps in pipe-line boosting-stations operating in series. One pump delivered oil into the suction of the next pump many miles distant, and so on. He was also one of the first to utilize in refinery practice the principle of pass-out or reducing turbines for the economic and simultaneous production of high-pressure and low-pressure steam and electricity.

All this was typical of Mr. Dalley. He had always been a pioneer. He had pushed new ideas, and was never content with the *status quo*. Dr.

Dunstan well remembered a day when, as a humble chemist, he had evolved a new reaction. Like all chemists, he had done his experiments in a test-tube, which, after shaking for so long, allowed the reaction to proceed to completion. He had put the suggestion up to Mr. Dalley, whose comment had been: "All right. How long do I shake this up in a 20,000-gallon washer?" That was typical of the man, always taking the broad, practical point of view.

Finally, DR. DUNSTAN could not omit to say a word about the personal qualities of their new President. Many of the members present knew him well, as the genial, hard-working President of the Oil Industries Club. Mr. Dalley was a good mixer, what their American friends called a "good scout." It was fitting that they should have as their President one who was both a man of affairs, an eminent engineer, and a good fellow. He had the greatest pleasure in asking Mr. Dalley to take the Presidential chair. (*Applause.*)

MR. DALLEY then took the Chair.

• Replying MR. DALLEY said that he wished to thank the members for the honour they had done him, as well as Dr. Dunstan for his very flattering remarks. In electing him President they had set him a difficult task in having to follow such a long line of distinguished men. But he would do his best to see that their confidence had not been misplaced.

MR. DALLEY very much regretted that he had to ask them to excuse him on this first occasion, as he was at present under the doctor's orders. He would have to leave the meeting in the capable hands of his old friend Dr. Dunstan.

DR. A. E. DUNSTAN then resumed the Chair.

The Secretary, MR. S. J. ASTBURY, read the notice convening the meeting and the report of the Auditors. The Minutes of the Twenty-eighth Annual General Meeting were read and signed.

NEW MEMBERS.

It was agreed that the list of Fellows, Members, Associate Members, and Students elected and transferred during 1941 be laid on the table.

ELECTION OF MEMBERS OF COUNCIL.

On the proposal of MR. VINEALL, seconded by MR. WARD it was unanimously agreed that the following members of Council, retiring and offering themselves for re-election, be duly elected members of Council: Messrs. E. A. EVANS, J. S. JACKSON, H. C. TETT, and A. WADE.

In reply to a question, the Chairman stated that Dr. Wade was at present in Australia.

ANNUAL REPORT.

The Chairman then moved:—

"That the Annual Report of the Council for the year 1941, together with the Accounts and Balance Sheet as at 31st December, 1941, be and are hereby adopted.

MR. ASHLEY CARTER, seconding the motion, said that income and expenditure were now both about 75 per cent. of their pre-war level. He would

like to direct attention to the fact that the assets of the Institute were, at the end of 1941, over £10,000, the highest they had been in the history of the Institute.

Other features of the accounts were dealt with in the Report. The long negotiations over the Adelphi had reached a settlement of sorts at the end of 1941, but he hoped that recent legislation would enable the Institute to be relieved altogether of its liabilities for the Adelphi premises. He was pleased to report that arrangements had been made for an early return of the Institute's offices to London.

The Chairman then put the motion to the meeting, and it was carried unanimously.

ELECTION OF A JOINT HONORARY SECRETARY.

Referring to the occasion as a very pleasant one in the history of the Institute, the Chairman said that their friend Mr. Ashley Carter, who had from the first been a tower of strength in their deliberations, was now put forward as a Joint Honorary Secretary of the Institute.

MR. T. DEWHURST, formally proposing the election of Mr. Carter, said that Mr. Carter's qualifications for the post were so obvious, indeed so striking, and his election was so desirable, that it was with much pleasure he commended the proposal for unanimous acceptance.

COL. S. J. M. AULD, seconding the proposal, said that the Institute was extremely fortunate in having secured the services of this most estimable man and this most loyal supporter of the Institute's activities.

The motion was unanimously adopted.

MR. ASHLEY CARTER, in responding, said that a word of explanation was necessary. Since the inception of the Institute, Mr. Arthur W. Eastlake, long associated with their first President, Sir Boverton Redwood, had been their Honorary Secretary. The years were now telling on Mr. Eastlake's health and, unfortunately, he was no longer able to attend the meetings of the Institute, nor the meetings of the Council and committees. It was felt that it might be advisable to appoint somebody to be a joint honorary secretary with Mr. Eastlake. There was no intention that his position should be usurped, and no implication that he no longer retained his interest in the Institute. It was simply that someone, acting jointly with Mr. Eastlake, should be able to attend the meetings. Therefore, in thanking the members for the honour they were conferring upon him, Mr. Carter said he was assuming its responsibilities in the earnest hope he would carry them out to their satisfaction. (*Applause.*)

APPOINTMENT OF AUDITORS.

On the proposal of MR. G. J. C. VINEALL, seconded by MR. R. J. WARD, it was unanimously agreed that Messrs. Price, Waterhouse & Co., be re-elected auditors for the ensuing year.

There being no further business, the proceedings of the Annual General Meeting then terminated, and the Chairman declared the meeting closed.

OBITUARY.

ALFRED WILLIAM NASH.

It is with the deepest regret that we have to announce the death of Professor A. W. Nash, whilst holding office as President of the Institute. He died peacefully in his home at Solihull, Warwickshire, on Saturday, 14th March, in his fifty-sixth year.

Born in 1886 at Ongar, Essex, he was educated at the East London Technical College. After serving an apprenticeship with Messrs. Hunter & English he became Assistant Engineer at Chatham Dockyard. In 1906 he joined the Staff of the Taikoo Dockyard and Engineering Company in Hong Kong as Engineer, going from there to the Port of London Authority in 1908. A year later he went to Persia as Fields Engineer and Surveyor for the Anglo-Persian Oil Company, Ltd. During this period he was engaged on refinery construction work at Abadan. Here his first task was the erection of storage tanks on the island of Abadan and he relates how when the floods came up the tanks were washed away and they had to chase them for many miles out to sea.

After his marriage in 1912, he became Oilfields Manager to Messrs. Bewick Moeing & Co. at Maikop in South Russia. He remained in Russia until the revolution, when he returned home with his wife and young family. He relates how during the revolution all work on the oil-fields ceased until a Local Soviet had been set up, and how he was elected a member of this Soviet by his Russian workmen. He did not, however, take an active part in this enterprise.

After his return to this country he obtained a commission in the Royal Naval Air Service. Nash always had a strong leaning towards the Senior Service and his family had many naval connections, one of his ancestors being writer on the "Victory" at the battle of Trafalgar. After the war Nash returned to his old firm but he left them in 1922 and joined the staff of the University as lecturer under Professor R. R. Thompson in the then newly formed Oil Engineering and Refining Department. In 1924 he succeeded Professor Thompson as Head of the Department.

Many notable researches have been carried out in the Department under Nash's direction. His early work was concerned with the cracking of petroleum oils. Following the conclusion of this work he devoted his time to dealing with the production of fuels and lubricants from coal, shale, and allied materials.

In 1924 he and his colleagues commenced work on the high-pressure hydrogenation of cellulose, lignin, and coal, some of the work being carried out in part collaboration with the Mining Research laboratory of the British Colliery Owners' Research Association. In 1926 published results of this work proved nickel oxide to be effective as a catalyst in the high-pressure hydrogenation of cellulose. This was the first conclusive work to be published in which the hydrogenation reaction was recognized as catalytic. This was confirmed later in the same year by a publication showing alumina

and nickel oxide to be catalysts in the high-pressure hydrogenation of lignin and cellulose.

In 1928, in collaboration with Dr. A. M. Stanley, Nash succeeded in showing that liquid hydrocarbon could be obtained from methane by thermal treatment, in this way confirming similar results published by Fischer earlier in the same year. A little later in 1928 Wheeler announced that he had succeeded in obtaining commercial yields of benzene from methane in 1926. Professor Nash and Dr. Stanley must be considered pioneers in this important work.

In 1929 Nash was publishing some of the first work on the knock ratings of pure hydrocarbons. This work attracted a good deal of attention and once again we find him to be one of the pioneers in a new field which subsequently led to vast and important developments. This line of work was continued in the Department for many years and noteworthy contributions on the knock rating of olefine and acetylene hydrocarbons were published in 1932 and 1933. In more recent years with the development of the diesel engine he commenced a similar project dealing with the diesel rating of pure hydrocarbons.

Nash was always interested in the production of fuels and lubricating oils from indigenous sources and research work carried out in his Department on these subjects continued from 1925 to 1940. The early work dealt with the production of fuel from carbon monoxide and hydrogen and was followed by work on the synthesis of lubricating oils by the polymerization of ethylene. This attracted much attention, especially the isolation of organo-metallic compounds of aluminium formed during the reaction by the aluminium halide condensing agent. Later researches in this field succeeded in preparing high-grade lubricants from chlorinated paraffin wax and benzene.

The work of the last five or six years in which Nash was engaged, has dealt largely with the fundamentals of solvent extraction and the results of this research have been widely applied by the petroleum industry in all parts of the world.

Nash possessed the gift of leadership, and in the many research investigations carried out in the Department under his direction was a source of inspiration to his junior colleagues and collaborators. Nearly 160 research papers were published by members of the Department during the period of his direction. Of these he was sole or senior author of more than eighty. In addition to his teaching and research he found time to produce several important text-books. The first of these was "The Principles and Practice of Lubrication" with Dr. A. R. Bowen, published by Chapman & Hall. The second was written in collaboration with Dr. D. A. Howes of the Anglo-Iranian Oil Company, entitled "The Principles of Motor Fuel Preparation and Application," and was also published by Chapman & Hall in 1935 in two volumes. This text-book had an immediate success and went into its second edition in 1938. It is an accepted authority on the manufacture of gasoline and has received very high praise from all petroleum technologists. Nash was one of the editors of the monumental "Science of Petroleum," published in 1937 by the Oxford University Press. In preparing this work he was associated with Dr. Dunstan of the Anglo-Iranian Oil Company, Sir Henry Tizard of

the Department of Scientific and Industrial Research, and with Dr. Brooks, the well-known American technologist. The exhaustive character of this publication and the care with which it was prepared was largely due to Nash's work as editor of contributions.

Professor Nash was an Original Member of the Institution of Petroleum Technologists in 1914, and later became a Life Member. He was elected a member of Council in 1925, a Vice-President in 1934, and became President in April 1939. In the first months of his Presidency he made arrangements for the summer meeting of the Institute in Birmingham, held in June 1939. In his dual capacity of President and the holder of a professorial chair at the University, he spared no effort to make this meeting both useful and pleasurable to visitors. The main topic of the meeting, "Fuels and Lubricants for Internal Combustion Engines," was one with which he was particularly qualified to deal and of the greatest importance to the Midlands motor industry.

Shortly after the outbreak of hostilities in September 1939 the Institute's offices at The Adelphi, London, were requisitioned at short notice by H.M. Government. Professor Nash immediately offered accommodation at the Department of Oil Engineering and Refining at Birmingham, a happy solution of the Institute's housing difficulties during the first two and a half years of war.

Nash was a member of the Institution of Chemical Engineers and a member of its Council since 1939. He was elected a full Member of the Institution of Mechanical Engineers in 1916. He was also a Fellow of the Institution of Fuel and of the Chemical Society.

By his death the Institute is bereft of a lovable personality and a man of sound judgment in counsel. To his widow and the members of his family, the sympathies of members of the Institute all over the world will go out.

DR. A. E. DUNSTAN writes :

Professor Nash followed in the footsteps of that great pioneer, the late Lord Cadman, who had founded the first school of petroleum technology in Great Britain under his charge as professor of mining. When Cadman left, the chair was divided and a separate professorship of oil technology was established, and in 1924 Nash was appointed to the post. A very substantial endowment of £125,000 had been raised by the great British oil companies, and Nash's first task was to erect a block of laboratories, offices, museum, and library to house his school. This was opened in 1926 and remains his chief monument.

During his whole career at Birmingham, Nash was responsible for a constant stream of scientific contributions to oil technology. He was a man of ideas and well able to stimulate his staff and students. With his ample background of first-hand experience in oilfields and refineries, he was well equipped to sense the relative importance of both practical and academic problems, and to direct a vigorous and progressive school of research, while in the course of his many visits to centres of oil activity in America, Europe, and the East he made innumerable contacts with the men on the spot, and thus realized the need for investigation on this or that project.

His researches and publications have been referred to in the account of his career given above. I should like to add a special tribute to his Presidential Address to the Institute of Petroleum on "Petroleum as a Raw Material." This showed a real insight into the ever-growing utilization of oil and its gaseous by-products as raw materials for chemical syntheses.

This brief note would be incomplete did I not pay a personal tribute to my old and valued friend and collaborator. Nash had a most lovable nature, and those of us who enjoyed his close friendship for many years must feel his passing acutely. Especially will he be missed by his old students who, working in all parts of the world, always kept in touch with him, and were always delighted to visit him on their return home.

PROFESSOR D. HANSON (Dean of the Faculty of Science in the University of Birmingham) writes :

For the past eighteen years Nash directed, with success and distinction, the Department of Petroleum Technology at the University. He possessed all the qualities required in such a post. Quick of thought, clear and logical in reasoning and expression, he was naturally a good lecturer; and when to these qualities are added a wide knowledge of men and life, a sound common sense, and an intense love of his work it is clear why he was a great professor.

Though he worked hard Nash was no recluse. When he played, he played as he worked, and enjoyed it as much. He was essentially a man's man and liked the open-air sports that men like—riding, hunting, shooting, fishing, and golf. And if through pressure of work he did not get as much relaxation as he would have liked, he made the quality of his enjoyment atone for any lack of quantity. He had travelled much and had a vast store of interesting knowledge, yarn, and anecdote—the result, no doubt, of an acute mind, good powers of observation, coupled with a retentive memory—which made him most interesting company.

Professor Nash was a world figure in his profession, and his influence was profound and world-wide. Such a man may cease to live, and we may mourn him; but his work goes on through his students in all parts of the world and his writings, and who shall say that he is dead?

DR. T. G. HUNTER writes :

During the eighteen years in which Professor Nash directed the Oil Engineering and Refining Department at Birmingham University, over one hundred students have graduated under his genial guidance. The sound training he has imparted together with the help he has so freely given with their careers, has contributed in no small measure to the success of these graduates in the Industry. Within the Department he expounded the principle that the success and welfare of the students was the first essential duty of the Staff, and both graduates and undergraduates requiring advice and assistance received this wholeheartedly from him. No trouble was too great for him in such matters and he leaves behind him an example and tradition which will endure.

In 1924 he began the first of a long series of noteworthy research in-

vestigations and he has, since then, built up and directed with distinction a vigorous and enterprising research School. He possessed the rare gift of inspiring enthusiasm in his collaborators and the present status of petroleum science owes much to his leadership and initiative.

In twelve years' intimate association with Professor Nash I have been privileged during this period to enjoy his friendship and I should like to take this opportunity of paying a personal and grateful tribute to him. Among his Staff at the Department and his old students his passing is deeply regretted. We have been deprived of a great and much-loved friend.

MR. R. R. DAVIDSON writes :

In Nash's younger days and particularly during that arduous period in his career from 1910 to 1914 there were few, if any, of his contemporaries who possessed to anything like the same degree his friendliness. What a medley of happy memories the mention of his name recalls! He was a great artist and his talent for entertaining found expression in song and story. His stories of the Fields were inspiring. They left us marvelling at his audacity and wondering what manner of man had come amongst us.

If ever the story of those early days in Persia receives the publicity it merits, Nash's name will figure prominently among the famous old-timers who laid the foundations of the Anglo-Persian.

DR. D. A. HOWES writes :

The memory of Nash will be cherished by all his students. To everyone of them he was well known, not only as a Professor and a teacher, but as a man whose sterling personal qualities claimed their highest esteem and regard. Their welfare was his constant concern and his interest in them continued long after they had left his care.

He maintained contact with all his students so generously and so naturally that some, recollecting years of unflinching friendship and practical help, must now find it hard to believe that they were perhaps officially in his charge for no more than a few months of post-graduate work. He was a great Professor and an almost prophetic leader, but to his students he will be remembered, not so much as the author of many research papers or even as one of the editors of the "Science of Petroleum," but as the conversationalist whose company was never dull, the man of infinite resource and sagacity, and most of all as the best of good friends whose advice and guidance could always be relied upon. He will be sadly missed by them all.

SIR WILLIAM BRAGG, O.M. (*Hon. Mem.*)

ON 12th March last, at the flat above the Royal Institution in Albemarle Street in which Faraday lived and died, there passed away at the age of seventy-nine a man respected by men of science in every land, and loved by all those who had the privilege of his friendship.

He was brought up on a farm in Cumberland and attended the village school. Later he went to King William's College, in the Isle of Man, from which he won a scholarship to Trinity College, Cambridge, and was subsequently Third Wrangler in the Mathematical Tripos.

He was then appointed to the Chair of Mathematics and Physics at the University of Adelaide, where he remained for twenty-two years. It is a very surprising fact that he did no research work until he was over forty. He then became interested in radio-activity. In 1909 he returned to England to take the Cavendish Chair of Physics at Leeds, and six years later became Quain Professor of Physics at University College, London. In 1923 he became Director of the Royal Institution, and of the Davy-Faraday Research Laboratory. He never lost his love of the countryside, and for many years spent his week-ends in his house near Chiddingfold, where he made many friends. To help one of these he devised an apparatus which is now well known as the iron lung.

The work by which he will be best known is that of the development of the technique of elucidating the arrangement of the atoms in crystalline substances by means of the X-ray spectrometer, which he invented. With this, together with his son, now Sir Lawrence Bragg, Cavendish Professor of Physics at Cambridge, he carried out much brilliant work which in 1915 earned for father and son the coveted Nobel Prize.

The results of Bragg's work are very far-reaching. The method was eagerly adopted by numerous workers and resulted in the accumulation of an enormous amount of data which has thrown much light on the constitution of the most complex chemical bodies. As a result of this work, we now can understand why the diamond is hard, why certain minerals can soften water and be regenerated, why flannel shrinks when it is boiled in water, why certain chemical substances polymerize to plastics, and even an inkling of the chemical constitution of those very complex chemical molecules, the proteins, on which life itself depends.

His admiration for his great predecessor, Michael Faraday, amounted almost to worship. He took a great delight in repeating the early experiments at his lectures, using the actual apparatus which Faraday had made. He studied Faraday's works from his written notes, which have all been preserved and recently published, and he took a great delight in understanding the workings of that great man's mind, and explaining them to his interested audiences in the many lectures which he gave.

In the best sense of the word he was a deeply religious man. In his Riddel memorial lecture, delivered in Durham in 1941, he pointed out that "each man can try the Christian way and discover for himself and acquire his own convictions. He tests his faith. He has ever in front of him the hope that he will by doing his service play his part in binding the community together. That is his hope. As to the actual mode of the experiment, I will say nothing. We know it well already: it has been

enshrined in a thousand testimonies; it is all included in the lovely words of St. Paul, simple though they are: 'And the greatest of these is charity.'"

J. KEWLEY.

NORMAN MITCHELL.

It is with regret that we received the announcement of the death of Norman Mitchell on 10th May. Mr. Mitchell was in charge of the Asiatic Petroleum Company's Engine Fuel Department, and had been associated with the Company for a period of twenty-one years. Prior to this he served during the last war with the Royal Naval Air Service and the Royal Naval Volunteer Reserve. He served on the Institute's Knock Rating Committee, and also represented the Institute on various occasions in America where he joined in the work of the C.F.R. Committee. In this he was singularly successful, as his personality made him extremely welcome to all his friends in America whenever he visited them. He made frequent visits there both in connection with his work on the C.F.R. Committee and as a foreign member of the S.A.E. He had been a Member of the Institute since 1936.

His work took him to many parts of the world where his staff carried on the work of testing I.C. engine fuels and advising the sales areas of the company with which he was associated. It is of interest to record that Mitchell was very closely connected with much of the early work on fuels done by Messrs. Richardo & Co., and continued this association until quite recently.

To those who knew him intimately it is not surprising that Mitchell had close friends in every part of the globe. A man of great charm and with a genuine friendly spirit such as his could not help making friends wherever he went. Perhaps one of his most engaging features was his extreme simplicity. He managed to retain a very young attitude of mind throughout his life, and had a keen sense of humour which one might perhaps associate with his Irish origin, for he was born in Ireland and lived there in the early part of his life.

Mr. Mitchell was 55 years of age and leaves a widow and one son, who has chosen the Navy as a career, and is now making rapid strides in his profession.

R. I. LEWIS.

A TECHNICAL STUDY OF TRANSVAAL TORBANITE.

By S. L. NEPPE, B.Sc. (Eng.), A.I.C., A.M.Inst.Pet.

The following results are an Addendum to the author's previous Paper on this subject (*J. Inst. Pet.*, February 1941, 27, No. 208, 31).

SECTION B.—EXPERIMENTAL.

1. PHYSICAL EXAMINATION.

(f) *Pressure Extraction Tests on Transvaal Torbanite.*

In order to ascertain the optimum conditions for pressure extraction of torbanite, it was decided in different tests to vary temperature, pressure, size of material extracted, and time of heating.

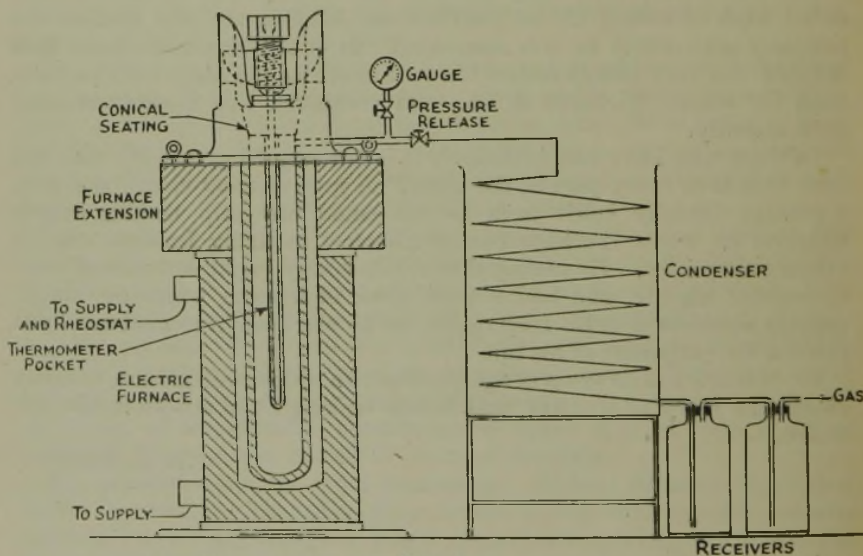


FIG. 7.

5-LITRE STEEL AUTOCLAVE.

Owing to lack of suitable facilities at the time this particular work was carried out, the solvent used in the following series of tests was Shell Petrol, although pure dry benzene would undoubtedly have been preferable and more advantageous.

The apparatus used for these experiments was a 5-litre steel autoclave or high-pressure bomb, shown in Fig. 7. Heating was carried out by an electric muffle (Wild Barfield type, 200–220 v., 3020 watts), and the furnace temperature could be controlled fairly accurately by an external

resistance of 16.5 ohms carrying 11 amps. The temperature during a test was recorded by inserting a thermocouple or thermometer into the central pocket of the bomb.

A wire gauze cage was specially constructed to hold the ground torbanite, and fitted inside the bomb. This arrangement was found to be most convenient in facilitating fairly complete removal of the solid matter from the bomb at the completion of an extraction experiment.

A particularly rich deposit of torbanite (Sample No. 4c) was purposely selected for these experiments.

A blank determination was first carried out to study the effect, if any, of heating the torbanite alone in the autoclave for a period of 2 hours at 250° C. Very little decomposition of the torbanite, beyond a very slight residual pressure in the bomb after cooling, was observed. Proximate analyses of the material before and after the experiment showed practically the same results.

All tests were carried out on 400 gm. of torbanite with 1500 ml. of solvent. Unfortunately, no arrangements could be made for carrying out the experiments in an inert atmosphere, which would have been preferable for this type of work. The volume of air present in the apparatus at the beginning of each extraction was 2800 c.c. It is probable that besides having an oxidizing effect on the petrol, the air may have retarded the actual solvent action of the torbanite by the petrol.

In this work, only one extraction was carried out for each particular test, although successive extractions would undoubtedly have given increased yields.

After extraction had been maintained under certain conditions of pressure and temperature for a definite period of time, the current was switched off, and the bomb allowed to cool slowly in the furnace, generally overnight.

Any residual pressure in the autoclave due to gas formation was first released slowly through the valve, and the gas passed through a meter at atmospheric pressure and sampled for analysis.

The bomb was then opened up, and the gauze cage, containing the bulk of the extracted torbanite, removed. The solution and remainder of the material were then tipped out and the bulk of the solution separated off by filtration. The combined extracted material at this stage, however, contained a high proportion of the solution by absorption (*e.g.*, in Test 2, after filtration, 36 per cent. of the total extract remained behind with the extracted torbanite). It was thus necessary to complete the extraction in every case under atmospheric conditions to remove all the extract adhering mechanically to the torbanite, this process being continued until the solvent in the flask containing the torbanite was only pale in colour.

The solutions obtained from the autoclave by filtration and from final extraction at atmospheric pressure were then combined, and the petrol solvent distilled off. A proof that no heavy petrol remained behind in the extract was that for all the tests the combined weight of torbanite residue and extract totalled the original weight to within 0.5 per cent. maximum and 0.2 per cent. average.

In all cases the solutions from extraction were orange-coloured with a green fluorescence, and the final residue in the distillation flask—*i.e.*, the

TABLE IVA.

Pressure Extraction of Transvaal Torbanite.

Solvent used : Shell Petrol.

Sample No. 4c (Prox. Analysis : Vols. 61-39, Ash 25-64, Fix. Carb. 12-97, Carb.-Ash Ratio 0-50. Assay Value 104 gals. per ton, *i.e.*, 45-7% oil).

Test No. :	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
Size of material (I.M.M. mesh)	-20	-20	-20	-20	-20	-20	-20	-20	-60	-60	-60	-60
Max. temp. (° C.)	—	220	245	240	260	270	310	320	295	320	325	335
Max. gauge press. (lb. per sq. inch)	Atmo- spheric	270	275	340	440	390	640	800	640	840	1,050	1,250
Total time of heating (hours)	8	8	2-5	7	8	16	16	4	16	8	8	8
Total extract (wt. %)	0-58	1-78	3-92	2-0	1-78	3-1	6-25	4-75	17-5	19-65	15-0	17-7
Total extract on D.A.F. basis (wt. %)	0-78	2-40	5-27	2-69	2-40	4-17	8-41	6-39	23-54	26-42	20-20	23-80
Total extract as % of retorting yield	1-3	3-9	8-6	4-4	3-9	6-8	13-7	10-4	38-4	43-0	32-8	38-8
Specific gravity of extract (at 15-5° C.)	—	—	—	—	—	—	—	—	0-935	0-927	0-910	0-922
Gas of evolution (cu. ft. per short ton at N.T.P.)	—	—	—	—	—	—	109	78	422	563	767	1,057
Composition of gas of evolution (vol. %) : H ₂ S + CO ₂	—	—	—	—	—	—	5-2	8-2	8-1	13-1	15-9	13-3
Unsaturates C _n H _m :	—	—	—	—	—	—	13-6	22-2	6-6	5-6	11-4	9-2
O ₂	—	—	—	—	—	—	2-1	1-1	1-5	2-5	2-6	2-9
CO	—	—	—	—	—	—	16-0	10-1	11-2	11-3	1-0	0-3
H ₂	—	—	—	—	—	—	14-5	10-1	2-1	9-6	7-3	6-3
N ₂	—	—	—	—	—	—	48-6	48-3	49-8	32-6	30-3	32-8
Saturates C ₂ H ₄	—	—	—	—	—	—	Nil	Nil	20-7	25-3	31-5	35-8
Value of x in C ₂ H ₄	—	—	—	—	—	—	3-05	4-51	1-9	4-1	3-1	3-2
Carb.-Ash ratio of residue	—	—	0-53	0-55	—	—	—	—	0-56	0-55	0-54	0-53

extract obtained from torbanite at high pressure but relatively low temperature—was a moderately viscous black bituminous oil, free from light distillate. Beyond the fact that the specific gravities of the extracts in Tests 9–12 (Table IV_A) have been recorded, no further information was obtained about the nature of the extracts, owing to lack of available facilities.

Test No. 1, on 400 gm. of torbanite dried previously at 120° C., was carried out under atmospheric conditions alone for comparative purposes.

As recommended by Bone¹ and his associates in their classic researches on coal. Tests 1–8 were carried out on –20 mesh material dried at 120° C., but, owing to the relatively unsatisfactory yields, it was decided to use a finer-grade material (–60 mesh) for subsequent tests 9–12. This size corresponded more closely to the size of the kerogen gels determined previously.

The considerable improvement in yield shown, for example, by Test 9 over Test 7 by using material of increased fineness, is marked. Conditions of maximum pressure and time of heating in these two tests were identical, and, if anything, the higher temperature of Test 7 should have been conducive to a higher percentage of extraction. These tests emphasize the importance, stressed earlier, of using material the size of kerogen gels for recovering the oily portion of the mineral.

The general effect of maximum temperature, pressure, and time of heating is immediately apparent from the table, although Test 3 gave a yield slightly higher than would be expected from the other tests. Similarly, Test 10 appears to give a higher yield than Tests 11 and 12, although the latter were carried out under more strenuous conditions. This may be explained by the enormous difficulty generally experienced in this type of work for obtaining exactly concordant results under comparable working conditions.

The tests carried out for 16 hours were all 2-day runs of 8 hours each. In Tests 10, 11, and 12 the maximum temperature and pressure conditions were maintained for 3 hours, the maximum conditions in Test 9, however, being maintained for about 4 hours on each day.

The effect of time can be seen by a comparison, for example, of Tests 5 and 6 or Tests 7 and 8, which show that although Test 8 was carried out at a higher pressure and temperature than 7, a lower extract was obtained and also less total gas, indicating that insufficient time was given for 8 to reach the same state of completion as 7.

With increasing temperature and pressure there is apparently increasing decomposition of the torbanite, as shown also by the increasing yields of gas.

Since the ratio of nitrogen to total oxygen (combined and uncombined) in the residual gas after extraction was different from that in the original air, part of this gas must have been due to thermal decomposition of the torbanite, but since the total quantity of gas evolved including petrol vapour was relatively small—compare the yield on low-temperature carbonization tests described in the original paper—it can be concluded that the actual pressure thermal decomposition of torbanite is negligible below 300° C.

The gas analyses reported in Table IV_A are not exactly as determined, as the latter included the air originally present in the bomb (2800 c.c.),

the oxygen content being assumed to be converted into carbon dioxide by oxidation of the petrol. An allowance has therefore been made for such air, the values given (in cu. ft. per ton at N.T.P.) being thus due only to gas of formation from torbanite decomposition, together with vapours derived from the petrol solvent.

The presence of the large quantity of saturated and unsaturated hydrocarbons in the residual gas is indicative of the high proportion of petrol vaporized during extraction. An interesting feature is the high proportion of nitrogen evolved under the more heavy conditions of temperature and pressure; this can come only from the decomposition of the torbanite.

Reference.

- ¹ Bone, Pearson, and Quarendon, "Researches on the Chemistry of Coal. Part III. The Extraction of Coals by Benzene under Pressure," *Proc. Roy. Soc.*, 1924, 105, A, 68.

NOTE ON THE SEALING EFFECT OF FAULT SURFACES.*

By G. STEWART TAITT, A.M.I.Mech.E., F.G.S. (Fellow).†

A PAPER on the above subject was read by the author at a meeting of the Trinidad Branch on 29th January, 1941, and was followed by a discussion.

The following is a summary of the most important points in the paper.

The effect of subsidiary faulting in controlling oil accumulation conditions in local tectonic blocks within a structural unit is now generally recognized.

It has only recently become apparent, however, that the separation effected by such faults is not always maintained in the later stages of exploitation, and that migration across the fault surfaces may bring about complicated producing conditions calling for the closest study if water-flooding or unsatisfactory drainage is to be avoided.

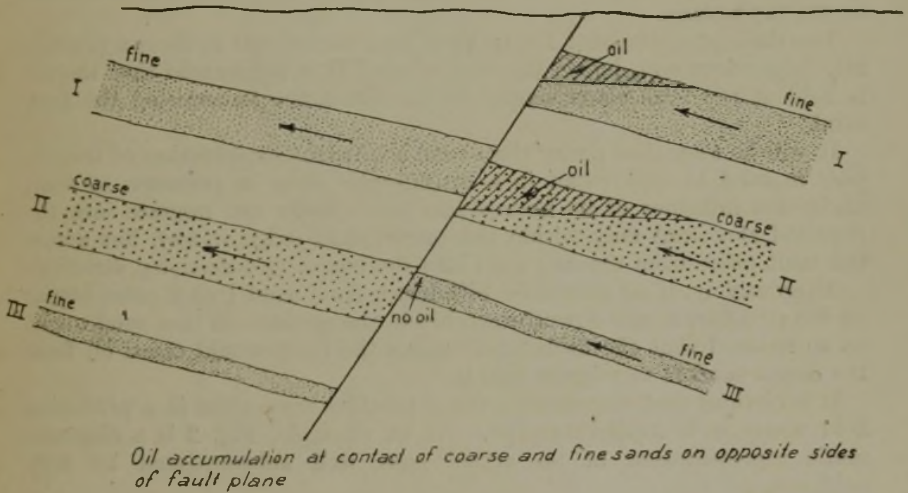


FIG. 1.

It is difficult to say whether the normal condition is represented by faults which provide permanent control, *e.g.* by the formation of an impervious zone due to the presence of plastic or pulverised material on the fault surface, or by faults in which the control is unstable and liable to

* Paper received 28th April, 1942.

† United British Oilfields of Trinidad, Ltd.

break down as a result of artificial changes of pressure on opposite sides of the fault.

In the latter case, which presumably would be more likely to occur, for example, in a series consisting of sands with relatively few clay breaks, the fault surface could be regarded ideally as having no thickness, being simply the contact surface of the formations on the opposite sides.

Control of accumulation would then be simply a question of retention of oil at the interfaces of sands of different texture, as postulated in the published works of Dr. Versluys,^{1,2} Professor Illing,^{3,4} and others, depending only on the "filtration pressure" resulting from the intermolecular forces between the oil and the circulating water.

An example of this condition is given in Fig. 1.

Professor Illing has shown that the filtration pressure may be of quite a low order,⁴ and that if the pressure differential between the coarse and fine sand is raised sufficiently, the seal may be broken down and the oil can then migrate into the finer sand.

In the hypothetical example shown in Fig. 1, the oil is assumed to have been brought to the fault plane by circulation of the underground waters across it in the direction shown by the arrows. In the upthrown block sand I is shown as having oil trapped in fine sand in contact with the still finer shale, sand II has oil trapped at the contact of coarse sand against fine sand, while the fine-grained sand III is water-bearing as the migrating oil has escaped into the coarser sand with which it is in contact at the fault-plane.

The shale opposite sand I may have been compacted to form a practically impervious seal, but in the case of sand II it is assumed that the oil is held at the fault-plane simply by its reluctance to entering the finer sand.

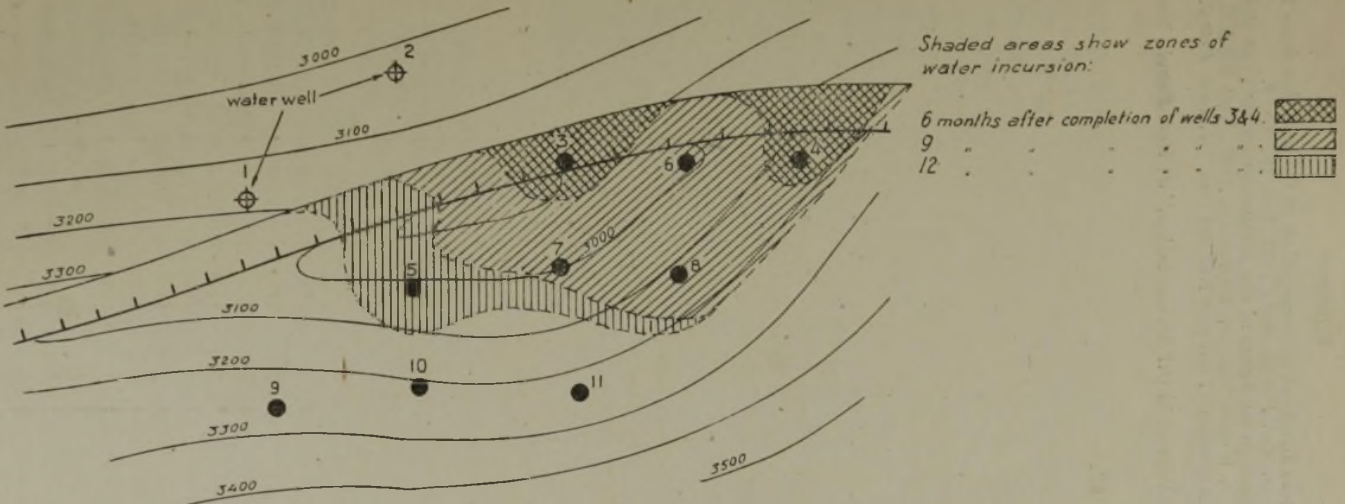
It will be seen that under the above conditions exploitation of the oil-pool in sand II may result in a considerable drop in pressure, so that, under the influence of its hydrostatic head, water can migrate into the depleted zone, not only within the coarse sand (edge water), but across the fault plane from the fine sand into the coarse in a *down-tip* direction.

Alternatively, if oil should be withdrawn from sand I at a point higher on the structure in the downthrown block, the pressure in that sand might be so reduced that the differential across the fault would cause oil from the coarse sand II to migrate into it.

It is obvious that complicated water troubles may occur in a producing field where such conditions exist. As an example, Fig. 2 is a diagrammatic representation of an actual case well substantiated by field evidence.

It is not known whether such conditions of water-flooding across fault-planes represent a very rare occurrence, or whether they are really more common but have usually escaped detection. It is evident, however, that when dealing with fields in which faulting plays an important part in control of accumulation, the possibility of fluid migration across the faults as a result of pressure changes should receive attention.

The author's thanks are due to the United British Oilfields of Trinidad, Ltd., for permission to publish this paper.



Flooding at top of structure due to water migration across fault plane.

FIG. 2.

References

- ¹ Versluys, J., "Factors Involved in Segregation of Oil and Gas from Subterranean Water," *Bull. Amer. Ass. Petrol. Geol.*, 1932, Vol. 16, No. 9.
- ² Versluys, J., "Compaction an Agent in the Accumulation of Oil at the Anticlines," *Proc. Kon. Acad. v. Wetenschappen, Amsterdam*, 1930, Vol. XXXIII, No. 9.
- ³ Illing, V. C., "The Migration of Oil and Natural Gas," *J. Inst. Petrol. Tech.*, 1933, No. 19, p. 229.
- ⁴ Illing, V. C., "Some Factors in Oil Accumulation," *J. Inst. Petrol.*, No. 186, p. 201.

Point Fortin,

7th April, 1942.

REID VAPOUR PRESSURE OF ALCOHOL BLENDS.*

By S. J. W. PLEETH, B.Sc. (Member).†

IN the standard method for the determination of the Vapour Pressure of Motor Spirits by the Reid method (I.P. Serial No. G37, A.S.T.M. Serial No. D323-32T) certain precautions and modifications are necessary when examining blends containing ethyl alcohol. The present note may be found useful to new workers in this field, in consequence of the growing importance of alcohol blends.

The first precaution is obvious: the sample cannot be obtained by water displacement, and the gasoline chamber may be filled either by direct immersion into the sample to be tested, or by pouring, if the temperature be low enough, or by siphon, the normal method for laboratory use.

The second precaution is less obvious, and may easily be overlooked. The standard method states that the air-chamber shall be rinsed with water before use and the temperature of the air within the chamber taken. When now the spirit is introduced, the bomb assembled, and the whole immersed in a bath at the standard temperature of 100° F., the rise in pressure is due to the increase in vapour pressure of the gasoline and the water (considered as saturated by providing excess) and by the normal pressure increase of air. To obtain the required vapour pressure of the gasoline, a correction is applied to the gauge reading corresponding to the two other factors introduced. This is given by the standard correction

$$\frac{(P_a - P_t)(t - 100)}{460 + t} - (P_{100} - P_t)$$

where t = initial air-chamber temperature, ° F.

P_t = vapour pressure of water in lb. per sq. in. at t ° F.

P_{100} = vapour pressure of water in lb. per sq. in. at 100° F.

P_a = normal barometric pressure in lb. per sq. in.

In the author's laboratory it has been observed that the amount of water left in the bomb after rinsing is usually sufficient to cause separation of the alcohol blend into the two phases: aqueous alcohol and petroleum spirit.

The standard correction no longer applies, for there is no free water in the bomb. In any case, the recorded vapour pressure is erroneous, for, by Raoult's Law, the total vapour pressure of immiscible liquids is the sum of their partial pressures, and would lie between the values for aqueous alcohol and petroleum spirit; whereas it is well known that alcohol and petroleum hydrocarbons give azeotropes of higher vapour pressure than either of their constituents.

We have therefore taken the liberty of modifying the standard method

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† Chief Chemist, Cleveland Petroleum Company, Ltd.

when testing alcohol blends by using a dry bomb, by rinsing with alcohol or acetone and blowing with air; an initial air temperature is obtained, the gasoline chamber filled by siphoning, and the method proceeds as before.

The correction factor to be applied in this case ignores the water-vapour factor, as we assume that the pressure of the water vapour in the air at the commencement of the test increases with temperature to the same extent as does the air. The factor now becomes

$$\frac{P_a(t - 100)}{460 + t}$$

or to a close approximation

$$0.03(t - 100) \text{ lb.}$$

Using this method, the true vapour pressure of alcohol blends is obtained, and the phenomenon of the enhanced vapour pressure of azeotropes of ethyl alcohol, benzole, and petroleum spirit readily observed.

One final point: it has often been stated, especially in the American journals, that alcohol motor-spirit blends cause greater vapour locking in an automobile than normal petroleum-spirit fuels of the same Reid Vapour Pressure. We have never found this difficulty to arise in practice on English roads, and this may be due to the less severe temperature conditions that apply here. An alternative explanation might be obtained in the light of the present paper.

Failure to observe the precautions outlined above would result in a depreciation of vapour pressure of alcohol motor spirits of several lb. per sq. in. Thus an alcohol motor spirit of true Reid Vapour Pressure of 10 lb. might be recorded as only 8 lb. This fuel would then be tested in an automobile against a petroleum motor spirit of only 8 lb. vapour pressure, and would, of course, reveal an enhanced tendency to vapour lock. Had it been tested against its equivalent—a petroleum motor spirit of 10 lb. vapour pressure—the opposite result would have been recorded, as our own road tests have shown, a result that confirms theoretical considerations.

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Geology and Development.

496.* Some Silurian Correlations in Lower Mississippi Drainage Basin. J. R. Ball. *Bull. Amer. Ass. Petrol. Geol.*, January 1942, 26 (1), 1-18.—The Niagaran (Middle Silurian) of Tennessee begins with the grey and red shaly Osgood limestone, 17 ft., of Clinton age, with crinoid roots, ostracods, and some orthoceratites of small diameter. The succeeding, well-bedded, greyish-pink or flesh-coloured Laurel limestone, 30 ft., forming the base of the Lockport, contains scattered calcite rhombs of deeper hue and clusters of crinoid roots and ossicles. The Waldron grey and green shales, 0-5 ft., have a considerable fauna, but above them the bluish-grey Lego limestone, 45 ft., is poor in fossils. The Dixon red shale and mottled limestone, 45 ft., near the top, has a thin but persistent horizon with large *Dalmanites*, and fistuliporoids are more

widely disseminated. At the top of the Niagaran, the Brownsport formation, 250 ft., comprises bluish-grey argillaceous layers and crystalline limestones, often grey or purple, with crinoids and some flattened nodules of black chert, and is notably fossiliferous.

The Bainbridge, 30-150 ft., of Missouri, includes the whole Niagaran. At Greither Hill, *Pisocrinus* shales of the Brownsport rest on either Laurel or Dixon, and there is a greenish-grey *Merista* bed corresponding with part of the Bob limestone, Middle Brownsport.

Only the bottom part, 40-50 ft., of the sequence is present in Illinois.

In Arkansas the grey to pink crinoidal St. Clair limestone, 0-100 ft., and the Lafferty red-mottled limestone, 0-85 ft., represent the whole Niagaran.

Under these beds in each of the four States lies the Brassfield limestone, 0-70 ft., often glauconitic and cherty, which forms the top of the Alexandrian Series (Lower Silurian).
A. L.

497.* Geochemistry of Natural Gas in Appalachian Province. P. H. Price and A. J. W. Headlee. *Bull. Amer. Ass. Petrol. Geol.*, January 1942, 26 (1), 19-35.—Investigation of the simpler hydrocarbons in natural gas is one geochemical method in the search for oil. The total heating value of a natural gas on an inert free basis depends on the proportions of hydrocarbons present, so that iso-Thv maps give a valuable indication of lateral changes of composition. In the Appalachian-Ontario area total heating value is highest—1250 to over 1450 B.T.U.—in a belt running from Charleston, West Virginia, passing west of Pittsburgh, and expanding in the north to include Cleveland, Ohio, and the south-eastern part of Lake Erie, beneath which both oil and gas may be present. Towards the eastern margin of the area gases decrease in Thv and approach pure methane, so that they have a low-carbon high-volatile composition where high-carbon low-volatile coals occur. Traced west from the axis of the Pittsburgh-Huntington basin, the carbon percentage in the coals steadily falls, and the same thing happens in the gases. It is clear that changes in natural gas conform with position in the basin, and not with degree of dynamic metamorphism, as in the case of coals. Towards the centre of the Michigan Basin Thv also rises.

In the Oriskany (Lower Devonian) of the Elk-Poca field, commercial oil may be found above the 1180 isometric Thv line—e.g., in the north-east where there is also a low nitrogen percentage and where the quantity of hexanes and higher-boiling hydrocarbons decreases. The Oriskany itself has less than 0.02% carbon dioxide, but strata below it show up to 45%, possibly owing to former bacterial action under stagnant conditions. Hydrogen sulphide, absent above the Oriskany, increases to 25% beneath it, and is attributed to bacteria acting on sulphates and sulphur-containing proteins probably on the deep floor of a quiet sea.

Similar data are given for the Villa Nova field, opened in 1940, which yields from the Webster Springs and Big Lime (Mississippian) formations, and a graph shows increase of heating value and likelihood of oil occurrence corresponding with decrease of methane. A quantitative relationship may also exist between frequency of different hydrocarbons in gas and the amount of oil associated with it in a reservoir.

Gas from very near coal-seams tends to be rich in methane, since coal absorbs the higher hydrocarbons; and if gas migrates to the surface through coal-seams, it loses the constituents which indicate oil possibilities. Near-surface gases have no ethane, propane, butane, pentane, etc., but much methane, and usually relatively high nitrogen. In course of time, reduced organic matter reacts with methane to give equilibrium mixtures of hydrocarbons.
A. L.

498.* Criteria for Subsurface Recognition of Unconformities. W. C. Krumbein. *Bull. Amer. Ass. Petrol. Geol.*, January 1942, 26 (1), 36-62.—The term *unconformity* includes (1) *non-conformity*, involving folding and erosion of the older strata, and (2) *disconformity*, due to erosion or non-deposition. *Diastem* is a minor gap of rank lower than a formation; and *ravinement* describes a disconformity produced by movement of masses of water. Unconformities may be associated with wind, stream, glacial, deltaic, beach, or marine deposits. A single unconformity may occur at more than one level in a stratigraphical column. A number of diastems may branch out from a principal unconformity.

The sedimentary, palaeontological, and structural criteria of unconformities may be

tabulated as follows (those that are less reliable and need confirmation from other lines of evidence are indicated by an asterisk):—

A. SEDIMENTARY.—(1) Basal conglomerate with residual or weathered pebbles of underlying formation, often thinning or becoming more finely grained to seaward; (2)* basal black shale where a transgressive sea has flooded a land surface with richly organic soil; (3)* desert varnish of iron and manganese oxides on pebbles; (4) lag gravels from which wind or water currents have removed fine material, and deposits with aeolian bedding or dreikanter; (5)* edgewise conglomerates usually marking diastems due to local erosion, shoaling, seismic sea-waves; (6) weathered cherts and silicified or flint-bearing layers at or below erosion surfaces; (7)* richly glauconitic layers; (8)* phosphatic nodules and phosphatized surfaces; (9) numerous nodules of iron-manganese carbonate; (10)* iron-oxide zones which may form under erosion surfaces; (11)* pyritiferous zones; (12)* caliche deposits of soluble salts and duricrust; (13)* corrosion surfaces on pebbles; (14)* interbedded conglomerates; (15)* abrupt appearance of clastic beds, like sandstones, in non-clastic sequences; (16) sudden changes in heavy-mineral assemblages which are often much richer above an unconformity than below it; (17)* beds with concentrations of radioactive minerals; (18)* porous zones in limestone, etc; (19)* sharp differences in lithology, especially abrupt change from marine to continental strata and change in chemical constitution; (20)* asphaltic residues or oil-staining; (21)* X-ray patterns from powdered cuttings which indicate presence of phosphate, glauconite, etc.; (22)* concretions and pisolites; (23) buried soil profiles—*e.g.*, humus layers in the Pleistocene, and lateritic beds in older formations.

B. PALAEOONTOLOGICAL.—(1) Sudden changes of fauna and omission of expected faunas; (2) gaps in the line of development of fossil species that show mutation in an orderly direction; (3) borings by littoral organisms; (4)* hiatuses which yield land-plants or animals in place; (5)* calcium-carbonate biscuits deposited by algae; (6) lateral spreading of coral-reefs which would be built steadily upwards if sedimentation were continuous; (7) bone and tooth conglomerates that show signs of having been re-worked; (8) beekite rings—*i.e.*, droplets of opaque to translucent quartz due to silicification of shelly fossils under surfaces of uplift or erosion.

C. STRUCTURAL.—(1) Discordance of dip; (2) undulatory surface of contact; (3) truncation of dykes, etc.; (4) larger number and greater throw of some faults in older of two superimposed formations.

Where two or more of the criteria are fulfilled, the possibility of unconformable relations is enhanced. In the future help may be obtained from increasing knowledge of soil-forming processes in terms of profiles that develop from given rock types under different climatic conditions, and from information about phenomena associated with submarine non-deposition. The lateral extension of known unconformities by judicious use of the less certain criteria is as important as the finding of new unconformities.

A. L.

499.* Basal Beds of Salado Formation in Fletcher Potash Core Test, Near Carlsbad, New Mexico. W. B. Lang. *Bull. Amer. Ass. Petrol. Geol.*, January 1942, 26 (1), 63-79.—East of Carlsbad, New Mexico, under 890 ft. of beds comprising Quaternary caliche, Triassic red beds of which the Pierce Canyon member reaches the exceptional thickness of 505 ft., and Rustler (Permian), 320 ft., lies the Salt or Salado formation (Permian), 490 ft., of mainly chemical sediments. The Salado is thinned by bevelling towards the south-west, so that in the core the sylvite-bearing upper section is missing. Knowledge of the position and exact character of anhydrite, polyhalite, and shale beds allows of stratigraphical correlation within the Salado, in which three distinctive members are the Cowden anhydrite, 18½ ft., the La Huerta siltstone, 15 ft., and the Fletcher anhydrite, 69 ft. The last rests after erosional unconformity on the Carlsbad reef limestone, normally less than 10 ml. wide, but surrounding the Delaware Basin, which is 100 ml. in diameter, like a distorted ring.

The Cowden begins with 2-in. grey magnesian shale forming the base of 2 ft. of fine, dense anhydrite. This grades up into 1½ ft. shaly magnesian anhydrite, followed by 2 ft. of glassy anhydrite with seams of white magnesite crumpled and disrupted by anhydrite pseudomorphs after gypsum crystals that grow from the upper surfaces of the seams. The upper 13 ft. are of massive graphic anhydrite with brown ferruginous blotches contributing to the marmorcal appearance. Secondary acicular

crystals of anhydrite are associated with whitish magnesite, and fractures are cemented with halite. At the very top there is gradation from banded anhydrite into less than 1 ft. of coarsely granular halite.

The La Huerta silt has a dark mahogany colour—deep Corinthian to dark Indian red. Although only 1.11% ferric iron oxide is present, saturation with halite produces a colour change akin to that caused by wetting of sediments. The constituents are sharp quartz grains coated with residual clay, and bottom currents are suggested by incorporated angular silt fragments of varied appearance.

The Fletcher is more warped than higher beds, and part of it has a lace-like aspect where tabular crystals of halite separated by anhydrite ribs replace a swarm of twinned gypsum crystals. Some wood-brown dolomite has been washed in near the junction with the Carlsbad reef. The top and front of the latter are marked by pisolites up to 2 in. diameter, and by fusulinids, both of which disappear towards the zone of interdigitating sandstones.

A. L.

500.* Lateral Gradation in the Seven Rivers Formation, Rocky Arroyo, Eddy County, New Mexico. R. L. Bates. *Bull. Amer. Ass. Petrol. Geol.*, January 1942, 26 (1), 80-99.—Measured exposures in Rocky Arroyo Canyon, 12 ml. north-west of Carlsbad, New Mexico, show that in the Seven Rivers formation (Permian), which was deposited in a shallow sea on the back-reef—lagoonal—side of the Capitan reef, there is lateral change of limestone and magnesian limestone into a 275-ft. section of gypsum with intercalated thin dolomitic layers. Illustration is provided of a 2½-ft. bed of porous calcitic limestone, containing reddish sediment, that passes into a considerably thicker bed of gypsum. The latter, presumably deposited as anhydrite, owes its superior thickness to the 40% increase in bulk following hydration. Precipitation of calcium sulphate took place nearest to the reef in early Seven Rivers time, and then progressively farther away from it.

Associated breccias of angular fragments that show no evidence of rolling or abrasion by waves, are regarded by R. L. Bates as occurring most prominently where drainage on the present land-surface is concentrated. They may be of modern origin, but Meinzer, Renick and Bryan think that the breccia at the top of the Seven Rivers gypsiferous member was of contemporaneous formation, possibly due to subsidence, and marks a disconformity.

A. L.

501.* Problem of Well Spacing. Houston Geological Study Group. *Bull. Amer. Ass. Petrol. Geol.*, January 1942, 26 (1), 100-122, with bibliography from 1931 to 1939 of 121 items.—In the development of oil-fields many factors cannot be controlled—for example, structure and porosity, permeability, initial temperature and pressure, composition of oil, gas, and water. Some degree of control, however, is possible over location and density of wells, and rate of production, and proper penetration of the productive section. The effect of water-drive and of free and dissolved gas should be conserved; and where both water-drive and free-gas cap are present, the wells should be completed so as to allow for expansion of the cap, but in such a way that the water, which is more effective in flushing out oil, will play the major part. If there is no water-drive, the wells should be completed in the lower part of the producing section in order to obtain maximum utilization of pressure from dissolved gas; and where there are interbedded bodies of shale, the lowermost parts of the pool should be depleted first. Generally speaking, properties most densely drilled have yielded the greatest relative share of total field recovery, but to some extent the densest drilling has been prompted in the most prolific parts of fields. Often the more rapidly fields are exploited, the less efficient are the processes of oil recovery. In a continuous reservoir, given sufficient time, there is no limit, apart from structure and other wells, to the area that may be drained by a single well. The number of wells drilled, therefore, should be determined according to the required rate of production and in keeping with the safe rate, so as to prevent coning and channelling of gas and water around the wells.

Gas-oil ratios tend to be kept down by slow production and by sealing of gas-bearing strata. With the latter purpose in view, determination of gas-oil contacts by analysis of mud returns is important. Bottom-hole pressure gauges, in use since 1930, give warning of rapid fall of pressure if withdrawal is in excess of encroachment by water-drive. Permeabilities of the producing formations, calculated from pressure and pro-

duction data on flow-tests are also significant; and productivity indices per pound pressure drop and specific productivities per foot of sand provide a sound basis on which the producing abilities of wells may be compared. Too great pressure reduction may result in distillate yields, since a hydrocarbon system existing as one phase may, owing to release of pressure, give rise to a two-phase system, in which case the liquid phase, with the most valuable constituents, may prove irrecoverable. Other points are that with low rates of flow, greater drainage radii are to be expected, while fine sands may possibly be flooded by encroaching water more quickly than coarse sands; and that after damage by coning prolonged shutdown sometimes leads to recovery.

The trend from 1931 to 1939 towards wider spacing and regulated production has been valuable from the points of view of conservation and total yield. At the beginning of the period J. R. Suman advocated that only wells sufficient to delineate a reservoir should be drilled, with addition only of wells necessary to complete the exhaustion. More recently L. L. Foley (1938) puts the same case, and emphasizes the desirability of producing slowly from a few initial wells, so as to determine the character of the water-drive. In the Salt Creek and Rock River fields of Wyoming, and at Cat Creek, Montana, expected total recovery was not augmented by additional drilling; and J. J. Zorichak has demonstrated that delayed drilling often furnishes a large proportion of dry holes, so indicating the efficiency of existing wells; this, of course, does not apply to lensing-sand reservoirs or to limestones with discontinuous porosity. In gas-drive fields M. Muskat (1939) concludes that little extra recovery from permeable sands would result from close-spacing; but that for very tight sands spacing should be close enough to obtain appreciable returns before well production drops below the economic limit. A. L.

502.* **Viola Well-core from South Dakota.** C. E. Decker. *Bull. Amer. Ass. Petrol. Geol.*, January 1942, 26 (1), 123-126.—North of the Black Hills, South Dakota, the base of a 487-ft. limestone, at a total depth of 7728 ft., yields *Amplexograptus amplexicaulis* (Hall), *Climacograptus typicalis crassimarginalis* Ruedeman and Decker, and *Callograptus* sp. This seems to be the exact equivalent of a horizon 150 ft. above the base of the Viola limestone (Ordovician) in its thickest development of 927 ft. on West Spring Creek, Arbuckle Mountains. A. L.

503.* **"Ortiz Sandstone" and "Guarumen Sandstone Group" of North-Central Venezuela.** M. Kamen-Kaye. *Bull. Amer. Ass. Petrol. Geol.*, January 1942, 26 (1), 126-133.—It is concluded that the Ortiz sandstone, dated by R. A. Liddle as Lower and Middle Eocene, is either within the Upper Cretaceous-Paleocene division on account of its association with Upper Cretaceous dark shales containing ammonites, etc., or of post-Paleocene age and unconformable upon, alternatively downthrown among beds of the earlier series.

South of the steeply folded area, with thrusting from the north, in which the Ortiz occurs, there lies on either side of the Rio Guarumen—a strike-stream—a broad zone of sandstones with silts and clays, of great thickness and simple structure, for which the name of "Guarumen Sandstone" is designated. Outcrops often show cliffs a few feet high and surfaces with ripple-marks which have up to as much as 10 cm. between crests. The sand is of pure quartz, with quartz cement and limonitic stain; and any feldspar is altered to kaolin. Plant remains include leaves probably of *Cassia* and *Longifolia*, and sometimes give rise to lignites. Some of the clays yield marine molluscs apparently belonging to the families Arcidae, Tellinidae, and Ledidae, while Foraminifera are restricted to the arenaceous genera *Ammobaculites*, *Trochammina*, *Haplophragmoides* and a miliolid. There seem to be marine limestones near the base of the Guarumen with Orbitoididae of *Lepidocyclina* type, possibly belonging to the Upper Eocene-Lower Oligocene transition. If so, the Guarumen group may continue to a high Oligocene or Lower Miocene horizon.

The Guarumen sandstone provides a restricted suite of heavy minerals—zircon, rutile, tourmaline, garnet, none of which is abundant, along with occasional anatase and very rare chloritoid. The scarcity of these suggests that the beds were derived from a sedimentary source. For this Kamen-Kaye looks southwards to the ferruginous quartzite of the Rio Orinoco, lightly metamorphosed possibly under thermal rather than hydrothermal conditions, which might have supplied small consistent

amounts of garnet. In the north it is thought that the coastal schistose massifs were not uplifted to any important degree until Middle Miocene time. A. L.

504.* McLouth Gas- and Oil-field, Jefferson and Leavenworth Counties, Kansas. W. Lee. *Bull. Amer. Ass. Petrol. Geol.*, January 1942, 26 (1), 133-135.—Closure of the McLouth anticline, in the Forest City basin, North-east Kansas, increases with depth, and the structural crest shifts south. Most gas is obtained from the McLouth sand at the bottom of the Pennsylvanian, and five wells also produce oil from this zone. Production extends far outside the area of closure, except where the sand contains clay. The weathered top of the Mississippian yields gas, and is locally saturated with oil, although none has yet been recovered. Porous dolomite in the undifferentiated Burlington-Keokuk limestone provides oil from four wells.

On 31st November, 1941, thirty-nine gas-wells had been drilled, with productions of a quarter of a million to 19 million cu. ft./day, whilst the total aggregate initial production of the oil-wells did not exceed 450 brl./day of oil of 24-25° Be.

Oil-saturated dolomite has been struck in the Hunton (Upper Devonian), and this suggests that the oil-source may lie below the top of the Devonian. The basal Devonian is water-bearing, resting on Maquoketa shale. A. L.

505. Geology of Avoyelles and Rapides Parishes [Central Louisiana]. H. N. Fisk. *Louisiana Geol. Surv., Bull.*, 13 (1940), 1-240.—Deposition on levees and lowlands by flood-waters of the Mississippi and Red rivers is described, and also the crevassing of the levees, and changes of course whereby great stretches of the rivers may be abandoned by the main stream, although kept open in part by tributary drainage entering the arcuate channels. Mississippi levees have a backslope of 6 ft./ml., and average about 3 ml. wide. Red River levees reach about a mile wide, and slope at about 10 ft./ml. Meander loops of the Mississippi have a maximum diameter of 7-9 ml., while for the Red river this is 2-3 ml.

In the Pleistocene, alluvial terraces taken as interglacial are separated by glacial epochs of entrenchment, the fourth and last of which carried incision to a depth well below the base of the recent alluvium. The Pliocene is missing, but the earlier Cainozoic history is also of fluvial deposits, under the accumulation of which from the shifting mouth of the Mississippi the crust was down-warped. Strangely enough, there seems to be a limit of crustal bending in each depositional cycle—of about 3000 ft. In Central Louisiana this applies to (1) Midway and Sabine (Lower Eocene) deltas; (2) Claibourne to Vicksburg (Middle Eocene-Oligocene) and (3) Catahoula (Lower Miocene) up to *Heterostegina* marls. In Southern Louisiana Middle and Upper Miocene also aggregate 3000 ft., each; and both the Pleistocene and Recent deposits, where fully developed, have roughly the same thickness. Each 3000 ft. unit is built seaward along the monoclinial flexure of the preceding section. Principal marine advances took place in the Upper Catahoula, prior to the abundant incoming of *Rotalia beccarii*, which survives well in brackish water, and in the Fleming formation (Miocene), which contains, in the Lena member, pyroclastic material floated from a distance. Outcrops of the latter are either sulphur-yellow, or leached to a white colour with accompanying precipitation of siliceous caliche nodules from the ground-water. Common brackish molluscs from the *Potamides matsoni* Zone of the Fleming are illustrated.

Under the alluvial plain of the Red river, the Cheneyville oil-field, Rapides Parish, is localized over a piercement type of salt dome, above which there are major radiating faults, and secondary faults subparallel with the margin of the plug. All the faults cut the *Heterostegina* Zone of the Catahoula, but are pre-Quaternary. Production is from the Eocene, as in the larger, but closely comparable Eola field, in Avoyelles Parish, 3 ml. south of Bunkie, where oil-sands have been logged in the Cockfield, Sparta, and Wilcox. A. L.

506.* Eastern Venezuelan Fields Contribute to Record Yield. J. P. O'Donnell. *Oil Gas J.*, 12.3.42, 40 (44), 34.—During 1941 Venezuela's oil production amounted to 228,131,000 brl.—more than 10% of the world total. In 1939 the new eastern fields within a radius of 75 ml. in Monagas and Anzoategui gave 1.5% of the country's output, but in 1941 they gave 16%. Only one of the fields (Oficina) was of importance

in 1938. Jusepin, San Joaquin and Santa Ana were added to the producing list in 1939, and the rest—Guario, El Roble, Leona, Santa Ana (Texas), Santa Rosa and Santa Barbara—subsequently. Improved outlets for the crude are expected to improve the region's output.

Lagunillas and Tia Juana gave more than half of Venezuela's oil in 1941.

Tables show the crude-oil production of Venezuela by years since 1917, with the percentages it has contributed to the world totals, and the total and daily production by fields in 1940 and 1941, with the status of the wells at the end of 1941. G. D. H.

507.* Eastern Venezuelan Fields Raise Production; Lake Area Declines. Anon. *Oil Gas J.*, 26.3.42, **40** (46), 75.—During January 1942 the daily output in Eastern Venezuela rose 6000 brl., while that of the Lake fields fell by 42,119 brl./day. Tia Juana took first place with a monthly total of 5,584,625 brl., and altogether the Lake fields produced at the rate of 439,139 brl./day. In the east Santa Rosa's output was three times the December 1941 figure. Increases in January took place also at La Paz, Mene Grande, Mara, Quiriquire, Oficina, Jusepin, El Roble, Leona, and Guario. Shipping of oil began in the Mulata field.

A table gives the production by fields and companies in January and December 1941, and January 1942. G. D. H.

508.* Arkansas Smackover Lime Pools have Large Sour-gas Reserves. Anon. *Oil Gas J.*, 26.3.42, **40** (46), 250.—Development of the Smackover lime-fields in Southern Arkansas began in 1937 at Schuler. Soon discoveries were made at Magnolia, Village, Buckner, Atlanta, Dorcheat, McKamie, and Macedonia, the last three being mainly gas-distillate fields. All lie south of a major fault system which runs south-west to Rodessa. Early in 1942 a field was found north of the fault at Midway, in which area the Smackover had previously been considered tight and barren.

All the fields are on elongated domes, generally trending north-west to south-east and tending to be *en echelon*.

The McKamie field now covers 3000 acres and gives mainly distillate, although there is a little oil in the bottom of the pay. The original pressure was 4365 lb./in. The pay is at 8750–9070 ft., averaging 105 ft. thick, with an estimated possible recovery of 225,000 million cu. ft. of gas and 18 million brl. of oil. Dorcheat, covering 2000 acres, has reserves of 70,200 million cu. ft. of gas, 17 million brl. of oil and 4,050,000 brl. of distillate. Macedonia covers a similar area, and has rather larger reserves of gas and distillate.

The Smackover lime-pools are believed to be under water drive. G. D. H.

509.* Strategic Location of Wells in Flank Sands on Piercement-Type Salt Domes. Anon. *Oil Wkly*, 4.2.42, **104** (10), 17.—The wells around a salt dome are generally located in a narrow band, 300–500 ft. wide, although the productive zone is occasionally three-quarters of a mile or more in width. Usually one flank is more prolific than the other. Individual sands range 10–100 ft. or more in thickness, and there may be as many as twenty sands, which often dip at 20–60°. They may end at the salt or at fault gouge, while some may end a short distance from the salt. Irregular radiating faults frequently affect the beds, the fault-planes being at times 25–50 ft. wide and giving rise to separate reservoirs. The oil-sands are usually highly porous and permeable, with a low gas-oil ratio. Hydrostatic head is the common driving force for the oil.

The various possible ways of testing the flanks of salt-domes satisfactorily are briefly discussed, and as regards wild-cattling it is suggested that wells may be deepened to new sands, or directionally drilled towards or away from the salt in search of new sands; wells may be drilled to test a new segment, or on domes without previous flank production. The aim should be to pierce as many sands as possible so that oil may be produced from the sands one at a time by small workover jobs. G. D. H.

510.* San Jacinto Strike Encourages Coast Wilcox Drilling. R. Reaves. *Oil Wkly*, 9.2.42, **104** (10), 22.—Recently a producer was completed in the Wilcox of the Mercy area of the southern tip of San Jacinto County. Previously a number of wells, mainly Cockfield tests, had found oil and gas shows, but no commercial production in this county.

The Mercy area has been seismographed, and the structure, probably a faulted anticline, is believed to run north-east to south-west for several miles.

The well was drilled to 8321 ft. and perforated at 8273-8279 ft. A 24-hr. test gave 583 bbl. of 38-gravity oil through a $\frac{1}{4}$ -in. choke with a gas-oil ratio of 771. The find is on the same line as Shepherd, Segno, Ace and Joe's Lake to the east.

G. D. H.

511.* Prospecting Tactics in a Total-War Economy. E. E. Rosaire. *Oil Wkly*, 9.3.42, 105 (1), 13-18, 32.—Nine steps seem to be involved in a co-ordinated prospecting programme: (1) The collection of all pertinent prospecting data, and information regarding the accessibility of markets, communications, leasing, and the prospecting history. (2) Geochemical reconnaissance, possibly on a mesh of one half mile. (3) Consideration of the results of geochemical reconnaissance, and the selection of favourable anomalies for detailed work, having regard to the geology and areal extent. (4) Detailed geochemical work using a grid less than one-quarter or even less than one-eighth of a mile. (5) Consideration of the detailed geochemical work, and selection of the most suitable anomalies. (6) Use of the reflection seismograph to obtain structural information down to depths well below probable drilling depth. (7) Examination of reflection data for closure, wedging, faulting, and variation of structure with depth. (8) Slim-hole drilling to obtain lithological, hydrocarbon, micropalaeontological, and electrical logs. (9) Examination of the exploratory hole data to select sites for production tests and to predict points for coring, production, etc.

G. D. H.

512.* Wells Drilling off 40% since January 1st. Anon. *Oil Wkly*, 9.3.42, 105 (1), 33.—On 1st March, as a consequence of lack of materials in January and February, only 2063 wells were actually drilling. On 1st January there were 3453 wells, and on 1st February there were 2,659 wells drilling. The outstanding curtailment was in Illinois, where there were seventy-one on 1st March and 298 on 1st January.

Tables give by states and districts the numbers of rigs in operation on 1st February and 1st March, 1942, and on 1st March 1941, details of the activity on 1st March, 1942; the monthly completions for January and February 1942, and for February 1941; and the types of completions in January and February 1942.

G. D. H.

513.* Second Well Completed in Guarico State. Anon. *Oil Wkly*, 9.3.42, 105 (1), 48.—Mercedes 2 has been completed at a depth of 5586 ft., giving on test, 363 bbl. of 35° A.P.I. oil/day through a $\frac{1}{2}$ -in. choke. It lies about 130 ml. west of the El Roble field, and $\frac{1}{2}$ ml. south of Mercedes 1, which was abandoned last summer as non-commercial.

G. D. H.

514. Cephalopods from the Drummuck Group of the Girvan District. C. Teichert, *Trans. Geol. Soc. Glasgow*, 1940, 20 (1), 103-115.—The description of *Zitteloceras costatum* and *Neumatoceras drummuckense* from the Ashgillian (Upper Ordovician) of Scotland constitutes the first record of these well-known American genera from Europe. *N. drummuckense* is closest to *N. milleri* Foerste from the probably pre-Richmond base of the Bighorn formation in Wyoming. Another Girvan species, *Diestoceras lamonti*, does not have close affinities with any American member of the genus, which ranges from Black River to Richmond, but is most nearly related to *D. acuminatum* Strand from Etage 5a of Oslo. Teichert's *D. scoticum* resembles *D. isotelorum* Strand from horizon 4dy and certain species from Percé, Quebec, and Anticosti. A fragment described as *Cyrtorizoceras?* sp. ind. from Girvan may even belong to *Manitoulinoceras* or *Richardsonoceras*, at present well known from the Ordovician of North America.

A. L.

515. Subsurface Geology and Oil and Gas Resources of Osage County, Oklahoma. Part 6. Townships 28 North, Ranges 10 and 11 East, and Township 29 North, Ranges 9 to 11 East. H. B. Goodrich, L. E. Kennedy, and O. Leatherrock. *U.S. Dept. Inter., Geol. Surv. Bull.*, 900-F, 1940, 209-236.—Over 1000 wells have been drilled in this part of North-eastern Osage County, and production is from eight zones at depths of from 475 ft. to about 2000 ft. These are in Siliceous lime (Ordovician), at the Missis-

issippi lime-Burgess sand unconformity, and in six Pennsylvanian sands, among which the Wayside, Weiser, and Peru are the most important. The regional dip, as observed from the Oswego lime (Pennsylvanian), is westward at 25 ft./ml., interrupted by domes that become more pronounced at depth and that have crests offset from their positions in the surface structures. Deepening and extension of existing fields are indicated, but few entirely new localities deserve to be tested. In some localities repressuring is being proceeded with.

A. L.

Drilling.

516.* Drilling Methods at Chapel Hill. T. P. Sanders. *Oil Gas J.*, 12.3.42, 40 (44), 37. —Universal difficulties have been found in drilling the Chapel Hill field of Smith County, East Texas. A surprisingly large number of the wells, ranging in depth from 5700 to 8500 ft., have experienced very costly fishing jobs, despite the fact that all ordinary precautions have been taken to guard against sticking of the drill-pipe. Experience gained in the 3½ years since the first well was completed has led to the introduction of remedies that appear to be successful in overcoming the most serious problems, but as yet there is no general acceptance of the innovations, and comparatively little uniformity in the practices of the drilling firms participating.

Principal trouble is credited to key seating of the hole by the drill-pipe, particularly in the alternating lime and shale sections. To solve this problem one company followed the practice of increasing the size of the hole drilled down to the Austin Chalk. Thus, the new programme requires no additional casing, gives the same protection to the fresh-water sands, and provides a much larger hole through the troublesome portion of the strata.

There are several ways in which a larger hole serves to eliminate key seating. First, the greater clearance minimizes the effect of small direction changes if the general course of the hole is vertical, and the result is that lateral forces tending to force the drill-pipe against the walls of the hole may be eliminated. Second, the reduction of fluid velocity due to greater area helps to prevent enlargement of the hole in the soft-shale intervals. Third, if a key seat is formed, there will be less likelihood that the drill assembly will be forced into it while the pipe is being pulled. The practice seems to be a success.

Some operators in the Chapel Hill field have successfully avoided stuck drill-pipe without resorting to the method described above. As a rule these individuals depend on careful pulling of the pipe to avoid getting stuck. All holes drilled in the field appear to have tight places where the pipe will become stuck if pulled rapidly. The fact that it can be worked through these places if care is taken in pulling supports the belief that key seating is the cause of the trouble.

Practically all wells in the field have been drilled with carefully controlled mud; hence it appears unlikely that stuck pipe has been caused by thick filter-cake on the walls in any great number of cases. Water-loss tests are performed regularly at most rigs, the mud is kept alkaline, and the weight is maintained at approximately 10.2 lb./gal., with viscosity usually in the neighbourhood of 24. One operator reports good results from use of common baking-soda in treating mud that has become cement contaminated. It is stated that cement bubbles are quickly knocked out by addition of the soda.

The number of bits required for an 8300-ft. well indicates the hardness of the lower formations. Even when the 12½-in. hole was drilled to 2800 ft., the record of a typical well shows that two 12½-in. rock-bits were required for drilling that interval, as compared with thirty-six 8½-in. rock-bits from 2800 ft. to the total depth. However, one operator at present drilling expects to complete his well with a total of twenty-eight bits, which would represent a considerable reduction in rock-bit costs. Dual slim-hole completion is discussed.

A. H. N.

517.* High Gas Pressure Controlled. N. Williams. *Oil Gas J.*, 26.3.42. 40 (46), 229.—Abnormal gas pressures, among the highest yet recorded in the lower Texas Gulf Coast district, and caving shales combined to create unusually difficult conditions for a company in the drilling of its 2 Stillwell, recently completed as the discovery well of Yegua production in the Alice field, Jim Wells County. On several occasions operators were threatened with serious blow-outs and loss of hole, and in the completion

of the well, the drill-pipe, stuck by bridging and caving of the shales, was left in the hole because of the hazards involved in attempting to recover it under existing high pressures.

The operations involved in drilling and controlling the well are briefly described.

A. H. N.

518.* Caliper Logging. C. P. Parsons. *Oil Wkly*, 2.3.42, 104 (13), 23. *Paper Presented before American Petroleum Institute.*—Caliper logging is a practice of measuring the variations in diameter of the open hole. The number of cases where caliper logging is of service is great, and the paper details some of them. Starting with the grass roots in a well to be drilled in the Gulf Coast, for instance, the first problem in which the diameter of the hole is involved is where to set surface casing. The physical measurement obtained by caliper logging not only assists in determining the proper depth for setting surface casing, but is the only way of determining how much cement will be required to fill the space behind the casing. It may not be necessary to run a caliper log in every well for this purpose, but enough of them could be run to establish a casing and cementing programme in the early development of a field.

Another problem is the failure of tool-joints due to excessive wobble of the drill-string. This has a definite relation to the size of the open hole. Future progress in deeper drilling is partly dependent on solving this problem. So far the problem has been studied from the standpoint of materials and design used in the drill-string. Caliper logging now makes it possible to study the relation of the varying sizes of open hole to the wobble of the drill-string, and to study results of various drilling techniques. Other problems are connected with completion, gravel packing, plugging back, etc.

The caliper is run into a well with the arms in closed position, and when it reaches the bottom of the well or some other level where caliper logging is to begin, the arms are released by an electrical means and opened by spring tension. The four arms are mechanically independent of each other. The caliper is run into a well on an electric cable. When it is pulled upward through the open hole, the four arms ride gently against the wall of the open hole. The variations in diameter of the well are measured by electrical means connected to the upper ends of the arms, and the recording is made directly in inches at the surface. Measurements are obtained at rates up to 100 ft./minute, depending on conditions in a well. It is not necessary to remove the drilling mud, oil, or water from the open hole, as they do not affect the operation.

Several typical caliper logs are given as illustrations. An interesting case is one of a 10,000-ft. well made before running in casing. The purpose of running this log was to determine the volumetric capacity of the space which would be behind the casing, so that the proper amount of cement could be used to cover the Haas sand and Tate sand located upward in the hole, and which later may be produced by perforating the casing. According to calculations based on the size of the bit which drilled the hole and the O.D. of the casing, it would require only 400 sacks to fill the annular space up to the proper level. According to caliper measurement, it required 1250 sacks. Previous wells drilled in the same field failed to get proper fill-up, and several squeeze jobs were necessary to repair a condition which was attributed to channelling. The caliper log shows that the 525 sacks plus the usual amount donated to the hole would scarcely reach the upper sands. A thermal log taken after the casing was cemented with the 1250 sacks calculated from the caliper log, showed that the cement reached its intended height.

A. H. N.

519.* Abandoned Wells Can Be Reclaimed. F. R. Cozens. *Oil Wkly*, 6.4.42, 105 (5), 34.—Methods of plugging abandoned wells, to prevent the entry of water to the pay, with a view to their reclamation later, are described. After the final section of casing has been removed from the hole, a block of wood about 4 ft. in length, circular in shape, and with a diameter slightly larger than that of the bore-hole is brought to the job. Lengthwise, through the centre of this block or core, a short piece of pipe is driven (3 ft. is the average length). The core, with pipe extending upward, is then pressed into the mouth of the salvaged well, and driven down until the top of the pipe is about 3 ft. below the surface of the ground. Earth is firmly tamped down upon this core, which now becomes a bridge, until the hole is filled level with the surface, and the abandonment job is completed.

Later, when, in the course of months or years, it is decided to reopen this abandoned

well, the recovery operator locates the spot, and by digging away the tamping, uncovers the pipe. A plumb-bob and line inserted in the pipe-top reveals the exact centre of the old well, and drilling equipment is rigged accordingly. The wood plug or core is easily broken up by the drill, and from thence on, the hole is usually found remarkably free of spoil. In a test reopening of thirty-three abandoned wells in South-eastern Ohio, the amount of cavings or spoil averaged less than 40 ft./1000 ft. of hole. Ten of these wells had been abandoned for five years and longer. Where pieces of former pumping equipment are known to be in the hole, the reopening problem is more difficult; but if a record of the well, with accurate measurements, has been kept, it is usually possible to force the obstruction into the walls with the drill, and after so doing use casing of smaller diameter. Some operators equip such wells with heavy-weight 2-inch tubing, bedded in cement at the top of the pay-sand. A. H. N.

520.* Central Mud Plant Provides Drilling Fluid for Marine Locations. G. B. Nicholson, *Oil Wkly*, 13.4.42, 105 (6), 15-18.—In marine locations, often isolated, and where procuring fresh water is costly and inconvenient, mud requirements are effectively supplied for the Texas Company by output from a mud plant and storage system located in a central site, and furnishing incidental mud requirements of rigs drilling in waters of the bays and inlets of the region. Special barges deliver mud of specified weight and viscosity to rigs, relieving drilling crews of mixing, as well as eliminating expense of providing fresh water supplies and special mud-storing installations on drilling barges.

Products of the plant consist of lighter muds or clays, used in drilling shallow or low-pressure wells. Chemical and specialized muds are mixed on drilling barges as conditions warrant, and all barges are equipped for mixing and storing such muds when needed. Light drilling fluids made of native clays and having characteristics adaptable for ordinary conditions, however, are stored in the terminal, and have a widespread use. Mobility of mud-delivery barges allows rapid movement to rigs where mud is shipped, and appropriate pumps for emptying tanks, moving mud to barges, and transferring it to drilling barges are provided. Excavation for, and conveying of, mud by a 400-ft. belt conveyor are described, with details of mud processing and storage.

When the plant is in full operation, six men are employed to dig and mix mud. Four men work in the excavation pit near the belt, shovelling mud and placing large lumps on the conveyor for carrying to the cutting machine; one man operates the engine governing the cutting and the pumps, whilst the sixth is stationed at the strainers to keep the meshes clean and uncongested and to test the fluid prior to its storage. When operating at full capacity, the plant produces about 350 brls. of 10½ lb. mud daily.

Cost of the mud is low, in recent production amounting to only 9½ cents./brl., although it is estimated that present cost has increased to 11 or 12 cents./brl. Initial investment was small, and upkeep is kept at a minimum by operating the plant only at intervals sufficient to keep the tanks filled. Mobility of barges permits rapid and economical distribution of mud to rigs, relieving drilling crews of mixing light mud, leaving them only the task of preparing special muds for extreme drilling conditions. A. H. N.

521.* Directional Drilling Deflects Hole into Productive Zone. C. C. Pryor. *Petrol. Engr*, March 1942, 13 (6), 31-32.—Failure to find production on a lease in an East Texas field recently led one operator to resort to directional drilling to find a productive zone. Although deflection of the hole from an unproductive to a productive portion of a lease is common practice in these days of modern scientific drilling, the cost of an abandoned hole, which may include casing lost in the hole, besides the cost of drilling machinery and materials and the scarcity of labour, is entirely prohibitive in the present national emergency.

As a result of deflecting the direction of the well, there was no lost casing, drilling time, or machinery. There was an increase in drilling time of approximately 14 days, plus the cost of directional drilling service; but final completion of the well as a producer at a cost of approximately one-third more than a vertically-drilled well was regarded as ample compensation.

The procedure and results are given in some detail, and are illustrated. A. H. N.

522.* Orientation of Conventionally Recovered Cores. W. A. Sawdon. *Petrol. Engr.* March 1942, 13 (6), 46.—Polar core orientation is a magnetic method based on the fact that a certain amount of polarity from the earth's magnetic field has been acquired and retained by many formations. This phenomenon is especially true of formations such as sand and shale, the materials becoming oriented when settling into beds, and probably becoming further magnetized during the long period extending from the time they were laid down to the present. Utilizing this polarity of cores that have been taken in formations of this kind, the magnetic north and south of the core is determined with reference to the dip and strike, as shown by the bedding planes of the core, and the true direction of the dip and strike then computed.

There are, however, many cores from formations such as pure limestones, diatomites, anhydrites, and dolomites that show no polarity. Cores taken exclusively from such formations cannot, of course, be oriented by the polar method. In some cases, however, limestones will have shale-breaks, and cores containing such shale partings will frequently have sufficient polarity to be oriented.

Either old or new cores can be tested by polar core orientation, so long as the cores are in good condition. Fresh cores are, of course, preferable, but so long as a core has not been exposed to magnetic influences sufficient to distort or destroy the residual polarity, reliable orientation can be made. Cores several years old have been tested with good results. The core must disclose a clearly defined bedding plane, and should be not less than 1 in. diameter and 2½ in. long. It can be taken with any type of coring equipment, but its top should be marked as soon as recovered, to avoid mistakes. After marking the dip and strike on the smooth, cylindrical core, it is placed in the core-holder and, after being accurately centred in direct alignment with the magnetic system, is rotated by means of a driving-gear that revolves the core 360° in synchronism with a drum, on which sensitized paper records by reflected light the magnetic reaction caused by the polarity of the core. This record is shown by a solid line on a chart. The core is then reversed end for end in the core-holder and rotated in the opposite direction, during which the "reverse run" is recorded with a broken line. When the record curves are flat and show no resemblance to a sine curve, the core is weakly polarized, and will often have to be re-run with the core closer to the magnet, in order to pick-up the weak field.

To interpret the curves, an arbitrary reference line is used as the abscissa, and a "resultant curve" plotted by subtracting graphically the reverse curve from the forward run. The purpose of this subtraction is to cancel out the effect of susceptibility. The resultant curve is then read by locating a 180° segment between the slopes of the curve, this segment being taken parallel to the abscissa. Magnetic south is at the intersection of this segment with the down-slope of the curve, magnetic north being at the intersection with the up-slope. As the beginning of the curve corresponds with the zero line marked on the core, the magnetic south is the number of degrees measured from the left end of the curve to the point marked "South." A. H. N.

523.* Factors Influencing Electrical Resistivity of Drilling Fluids. J. E. Sherborne and W. M. Newton. *Petrol. Tech.*, March 1942, A.I.M.M.E. Tech. Pub. No. 1466, 1-17.—The resistivity of the drilling mud and its filtrate can appreciably affect the electrical logs. Thus the self potential curve for a given well showed negligible variation with depth, using a mud of 0.8 metre-ohm resistivity, but a second run using a 2.0 metre-ohm mud produced a much-improved log.

Tests on five muds commonly employed in California showed the following features: (1) The effect of raising the temperature from 80° F. to 180° F. is to decrease the resistivity of [the mud or filtrate by about 50%. The same is roughly true for chemically treated muds. (2) In most cases the resistivity of the mud approximates closely to that of its filtrate. (3) The change in mud resistivity caused by the addition of a given amount of a chemical is not the same for each mud. Electrolytes lower the resistivity, and so tend to reduce the sensitivity of the logs, whereas non-electrolytes have little effect. (4) The resistivity of a native mud is approximately that to be expected from its sodium chloride content. (5) Weighting materials such as barytes and limestone tend to raise the resistivity of drilling mud, while cement and the sodium bicarbonate used for treating the cement-contaminated mud reduce the resistivity.

G. D. H.

- 524. Patents on Drilling.** W. J. Travers, Jr. U.S.P. 2,274,756, 3.3.41. Appl. 23.9.40. Cementing tool on tubular members.
- A. D. Stoddard. U.S.P. 2,274,940, 3.3.42. Appl. 5.9.39. Squeeze cementing of wells device, including a packer.
- J. H. Schreiber. U.S.P. 2,274,271, 3.3.42. *Appl. 3.6.40. Joint breaker and cathed arrangement.
- A. Boynton. U.S.P. 2,275,418, 10.3.42. Appl. 17.7.39. Threadless drill-pipe.
- J. Neufeld. U.S.P. 2,275,456, 10.3.42. Appl. 7.6.39. Method and apparatus for radioactive investigation of drill-holes.
- D. Scaramucci. U.S.P. 2,275,473, 10.3.41. Appl. 11.7.39. Well-cementing apparatus, consisting of an electrical sounding device for use in liquids.
- D. Scaramucci. U.S.P. 2,275,474, 10.3.42. Appl. 13.7.39. Measuring apparatus for determining the depth of oil-wells or the like.
- H. B. Robbins. U.S.P. 2,275,655, 10.3.42. Appl. 16.11.40. Means for cementing wells using a retainer.
- R. T. Cloud. U.S.P. 2,275,736, 10.3.42. Appl. 14.2.40. Seismic wave velocity well logging.
- R. E. Fearon. U.S.P. 2,275,747, 10.3.42. Appl. 27.12.39. Well-survey method and apparatus using an ionization chamber.
- R. E. Fearon. U.S.P. 2,275,748, 10.3.42. Appl. 28.3.40. Well-surveying method and apparatus using α -particles.
- W. A. Abegg. U.S.P. 2,275,813, 10.3.42. Appl. 3.10.39. Bushing supporting means for oil-well rigs.
- J. A. Zublin. U.S.P. 2,275,832, 10.3.42. Appl. 29.1.41. Apparatus for rotary drilling consisting of a bit.
- S. C. Fietinghoff, A. R. Maier, C. F. V. Loozen. U.S.P. 2,275,895, 10.3.42. Appl. 11.1.40. Oil-bath rotary.
- F. L. Le Bus. U.S.P. 2,275,911, 10.3.42. Appl. 14.2.41. Retriever tool for oil-wells.
- R. C. Baker. U.S.P. 2,275,937, 10.3.42. Appl. 11.1.41. Cementing device for well casing.
- R. C. Baker. U.S.P. 2,275,938, 10.3.42. Appl. 11.1.41. Control-valve (for circulating joints).
- R. C. Baker. U.S.P. 2,275,939, 10.3.42. Appl. 4.3.41. Casing scraper with sliding blades.
- R. O. Childers. U.S.P. 2,275,946, 10.3.42. Appl. 16.5.41. Device for removing casing sections.
- E. F. Hannon, Jr. U.S.P. 2,275,960, 10.3.42. Appl. 17.6.40. Fishing apparatus for well tools.
- J. E. Brautly. U.S.P. 2,276,016, 10.3.42. Appl. 22.3.40. Hydraulic well-drilling apparatus for rotating, raising and lowering a drill-pipe.
- C. E. Werensch. U.S.P. 2,276,075, 10.3.42. Appl. 14.10.39. Drilling-fluid using comminuted magnetic solids.
- R. R. Bloss. U.S.P. 2,276, 561, 17.3.42. Appl. 5.6.39. Rotary drilling-machine.
- C. H. Johnson. U.S.P. 2,277,110, 24.3.42. Appl. 31.12.38. Method of determining where pipe is stuck in well.

C. E. V. Stone and A. E. Johnson. U.S.P. 2,277,188, 24.3.42. Appl. 12.8.39. Portable pipe-straightener.

A. M. Graham. U.S.P. 2,277,397, 24.3.42. Appl. 15.1.40. Hose and hose-connector construction.

P. F. Murray. U.S.P. 2,277,500, 24.3.42. Appl. 20.9.39. Casing or drill-pipe spinning rope.

P. F. Murray. U.S.P. 2,277,501, 24.3.42. Appl. 28.12.40. Slush-pump piston.

L. A. Courter. U.S.P. 2,277,510, 24.3.42. Appl. 2.1.41. Cementing head in combination with a well-casing.

W. F. Carothers. U.S.P. 2,277,580, 24.3.42. Appl. 28.7.41. Combination wash-over and cutting tool. A. H. N.

Production.

525.* Illinois Production Depends on High Discovery Rate. W. V. Howard. *Oil Gas J.*, 26.2.42, 40 (42), 42.—During five years 118 new fields have been found in Illinois, and the production rose almost to 15,000,000 bbl. in July 1940, with a decline to about 5,000,000 by the end of that year. A number of discoveries in 1941 raised the figure to over 12,000,000 bbl./month, but the production is now nearer 10,000,000 bbl.

Fifty-seven of the 118 fields have fewer than ten producing wells, and until the end of 1940 80% of the oil came from eleven major fields.

The first major discovery was Clay City, followed quickly by Noble. Centralia and Loudon also were discovered in 1937, although they were not of importance in that year. Centralia proved its potentialities in the middle of 1940, when, with Loudon and the other 1937 discoveries, it gave 5,700,000 bbl. of oil. The old fields were then giving about 3,000,000 bbl./month in December. Salem was the only major producer found in 1938, and almost immediately it became an important factor, at its peak topping the 6,000,000 bbl./month mark. It declined quickly to less than a third of its peak.

The 1939 discoveries were some months before becoming important—Tonti, Griffin, Keensburg and Dundas. These were developed slowly, and the same is true of New Harmony. As a consequence they have not declined markedly.

Hoodville developed rapidly in 1940. Benton, Rural Hill, Johnsonville, and Parkersburg had rapid rises, and were responsible for 25% of the Illinois output at the end of 1941.

Graphs show the Illinois production in the period 1937–1941, with the discovery date and production of the major fields. G. D. H.

526.* South Jennings Distillate Plant Features High-Pressure Control. N. Williams. *Oil Gas J.*, 19.3.42, 40 (45), 39.—Production of the field is obtained from three deep sands, one at 8600–8700 ft., the second at 8800 ft., and the third at 9500 ft. Gas is being returned only to the shallower horizon, in which pressure is from 3200 to 3250 lb. Pressure of the 9500 ft. sand is above 5200 lb., as recorded at well-head, and is one of the highest pressures yet encountered on the Gulf Coast. This sand is being drawn on at present to supply additional volume of gas above cycling needs that is required to meet gas sale demand. The 8800-ft. sand is not producing at present, but will be used later to supply gas-sales demand.

There are three producing wells for the 8600-ft. sand and two for the 9500-ft. sand. Separate 4-in. flow-lines for each lead directly from the wells to the plant. All production is controlled through a central choke and regulator installation at the plant inlet. Each well is equipped with a double-acting pressure-controlled valve installed on the flow-line at the christmas tree, which operates to close the well in the event of any increase or decrease in back pressure from fixed limits. To shut in any producer it is only necessary to close the control on that particular well at the central regulator station. A rupture in a flow-line, causing a decrease in the pressure on the line, would likewise automatically shut in the well.

All flow-lines discharge into a common header to the plant intake line. Reducing regulators on the 5200-lb. flow-lines from the two 9500-ft. sand wells ahead of the header effect an initial fall in pressure of this gas to equalise with the 3200-lb. gas from the 8600-ft. sand-wells. Mixing of the expanded high-pressure gas with the somewhat warmer normal 3200-lb. gas not only lessens the chance of freezing that might result in expansion of the high-pressure gas, but also cools the 3200 lb.-gas.

The working data of the plant, including pressures, temperatures, quantities of fluids, and features of design, are described and illustrated. Items of equipment such as pumps, control instruments, and prime movers are also described. Plant power is derived from steam, and cooling water is obtained from deep wells.

A. H. N.

527.* Thermal Logging of Producing Oil-Wells. C. R. Dale. *Oil Gas J.*, 19.3.42, 40 (45), 49. *Paper Presented before American Petroleum Institute.*—The geothermal gradient varies in different areas and, in fact, may vary in different parts of the same structure. Also there is evidence to show that the geothermal gradient may not remain throughout the producing life of a field.

The normal geothermal gradient of a producing well is subject to change from a variety of conditions which may exist at points in the well. The anomalies recorded in a thermal log are indicative of these conditions. An interpretation of the log in the light of all other available information concerning the well shows the nature of the conditions and suggests the remedy or manner of taking advantage of them.

A number of different temperature-recording instruments have been developed for use in oil-wells. In general, they are of two types: those which record the temperature at successive stations, the instrument being held stationary in the well during recording, and those which produce a continuous record while the instrument is being lowered or raised at a constant controlled speed. Requirements of such instruments are: minimum thermal lag, sensitivity to temperature change of 0.2° F., and accuracy to within 1° F. from actual temperature. A photographic instrument which can be run on a piano wire at a speed of 2000 ft./hr. utilizes the twisting moment of a bi-metallic helical coil, which, on change of temperature, winds or unwinds to a variable degree, and thus changes the length of a beam of light on a photographic plate. The image is later projected and magnified by a special projector.

In interpreting the data, each well must be considered as an individual problem, and all other information pertaining to it should be correlated with the temperature record in making interpretations. Well conditions under which the temperature record is taken are often as important as the accuracy of the recording instrument. Careful control of the well conditions must be exercised in order that the anomalies may be localized and developed in sufficient magnitude.

Where it is known, the normal geothermal gradient for the field can often be used as a basis for making an interpretation of the anomalies observed in the record. However, owing to the variations in geothermal gradient that may occur in various parts of the structure or during the producing life of the field, it may be necessary to make two traverses, one while the well is flowing, and the second after the well has been shut in for a period of 24 hrs. This practice has produced excellent results in locating the source of water, gas, and oil production, and in tracing the migration of fluids between zones. Each of these troubles is discussed separately.

A. H. N.

528.* Automatic Tank-Battery Control Simplifies Lease Operation. H. F. Simons. *Oil Gas J.*, 26.3.42, 40 (46), 227-228.—Use of a centrally located tank battery for the production from a large group of wells greatly increases the efficiency of the operation. Through the installation of automatic controls, the pumper on a lease in the Burbank, Oklahoma, field is allowed more time for duties away from the tank battery. The installation described includes ten tanks of 1000 brls. capacity each, and handles approximately 4600 brls. of oil/day.

Principal advantages of such an automatic system are that it fills the desired tank and automatically switches the production to the next empty tank, and so on, until all tanks have been filled. The cycle must then be automatically repeated, as some of the tanks will have been emptied into the pipe-line in the meantime. The system must also provide for the selection of a particular tank to be filled, and must have some reserve space for an emergency when all operating tanks happen to be full.

Through the installation of an electric control system, it is possible to fill and empty the tanks of a certain lease without any danger of overflowing the tank, or backing oil up into the separator, or losing any production. It is totally and completely automatic, and, so far as is known, is the only system of its kind in existence. Principal parts of the system are high- and low-limit automatic liquid-level control switches, electrically operated hydraulic valves and holding circuit relays, and a master control panel. These are described and illustrated.

A. H. N.

529.* Improvements in the Treatment of Crude Oil-Water Emulsions. R. C. Buchan. *Oil Wkly*, 2.3.42. 104 (13), 27. *Paper Presented before American Petroleum Institute.*—The theory of treating oil-field emulsions when reduced to its simplest concept shows that two things must be done, e.g., first, the water globules must be coalesced; and, second, the water and oil must be separated. The main factors that affect the first include: (1) the physico-chemical conditions, (2) the temperature, (3) time.

Assuming that coalescence is practically complete, the main factors that affect the second include: (1) the degree of agitation in the settling chamber, (2) the temperature, (3) time.

The companies which manufacture treating chemicals have maintained a vigorous research programme in recent years, and better chemicals are available than at any previous time. Some of this work is necessarily done in field laboratories, often housed in trailers, in order that fresh emulsions can be studied on the lease. These newer chemicals have been a help in several ways. It has become possible, in cases where it is desirable, to eliminate heating in several fields by using suitable treating compounds. They have generally reduced the time necessary for the completion of their action on emulsions, thereby reducing the size of settling tanks; or, in existing plants, they obtain a lowering of the impurities content of treated oil. There are some physical and mechanical problems in treating that can never be overcome by chemical means; but, on the other hand, it is thought that too often the chemical consumption is criticised while equipment design weaknesses that can be corrected are disregarded.

The author discusses the improvements made during the last several years in the art of handling and treating oil-field emulsions. These improvements include wider dissemination of knowledge of the subject, better chemicals, and new equipment, most of which was designed for this particular work. The definite but very limited present application of superdehydration and desalting in the field is summarized, the separation of gas in emulsion-treating plants is briefly discussed and the need for continuous study pointed out.

A. H. N.

530.* Multiple-Zone Completions. E. O. Bennett. *Oil Wkly*, 9.3.42, 105 (1), 22. *Paper Presented before American Petroleum Institute.*—Multiple-zone completions may be made with more than two zones producing simultaneously into the same well. In this discussion only two such formations have been considered, and the equipment discussed has been designed for and limited to dual completions. The same principles and practices developed for dual completions may be applied to triple-zone completions. After a brief discussion of the problem in general, pumping of multiple-zone wells is discussed in detail. Dual pumping wells may be placed in several classifications, as follows: (1) A single pump and packer installation where the formations above and below the packer are pumped intermittently by the same pump. (2) A double pump with single or double prime mover where two zones are pumped simultaneously. (3) A single pump in one of two zones with natural flow from the other. (4) The gas lifting of two zones simultaneously. (5) The gas lifting of either of two zones while pumping the other. (6) The pumping of one zone while injecting gas into the second. (7) The gas lifting of one zone while injecting gas into the other. Each of these systems is discussed.

The completion steps taken in multiple-zone wells are discussed and the equipment used described and illustrated. When producing a dually completed well, care should be used to see that rates of flow from an upper sand do not occur with velocity sufficient to cut the tubing by a jetting action of fluids through the upper zone perforations. The use of a synthetic rubber sleeve over the tubing opposite such entrance ports will protect it from cutting out.

A summary of the advantages of multiple-zone completions, properly carried out by qualified operators, is set out: (1) Dual completions save approximately 50%

of the steel required to drill two separate wells to the corresponding zones. During the war emergency this steel is needed. (2) Dual completions will, in certain strategic areas, permit the most oil to be recovered per ton of steel used, and will help to keep up allowable requirements, so badly needed at this time. (3) Two-zone completions will permit the draining of thin sands which would otherwise not produce enough oil to justify the drilling of a well. (4) An edge-well that would not be drilled in a single zone can often be completed in a two-zone area and produce large volumes of oil that would ordinarily be left irrecoverable. (5) The drilling time and wear and tear on drilling equipment are reduced by approximately one half by the use of dual completions. This effects a corresponding saving in the completion costs of the wells drilled. (6) Multiple-zone completions greatly reduce the cost of marine drilling where several zones may be reached from a single derrick location. (7) The pumping of multiple-zone completions has been successfully carried out, and will permit such wells to be operated in separated sands long after the flowing stage has passed. (8) In a field where pressure maintenance is carried out, the use of multiple-zone completions provides many more locations for gas injection than would otherwise be available.

A. H. N.

531.* Swabless Method Speeds Up Routine Well Completions. G. M. Wilson. *Oil Wkly*, 9.3.42, 105 (1), 30.—Bringing in 8500–11,500-ft. wells without the need for swabbing, and in an average total elapsed time of only 3–4 hrs. after the removal of the drilling mud to flowing of clean oil into tanks, is fast becoming an accepted method of completing wells by several companies operating in the San Joaquin Valley area of California.

The completion method or technique is essentially one wherein live oil and gas from a nearby, already completed high-pressure well is turned into a new well. The oil and gas displaces and lightens the fluid column in the hole to such an extent that the well will kick over and begin flowing. Final operations prior to completing the well are carried on in the usual manner. The liner is hung, tubing is run in, and the Christmas tree is set in place over the well. A line is then connected between the well-tubing and the mud-pumps.

The pumps are started, pumping water down the tubing and forcing the drilling mud out through the casing outlet. This operation serves the dual purpose of relieving the formation of the heavier weight of the mud column, and at the same time salvaging the hole full of specially treated mud which can be used on the next well to be drilled. The hole is washed until the returns are clear water.

At this point oil and gas, which had previously been piped over from a nearby high-pressure well, is run in with the water being pumped down the tubing. An initial proportion of 1/3 oil and 2/3 water has usually been found to yield the best results. If there is sufficient differential in pressure in the injection well, the oil is fed into the line downstream from the pumps forcing water into the tubing. Otherwise it is mixed in with the water and forced on down the well together. Care must, however, be taken not to put in too much gas and oil at the start, lest the pumps become gas locked. As the pressure on the formation is decreased due to replacing the mud by oil, the well kicks over after a comparatively short cleaning time.

A. H. N.

532.* Design of Oil-Field Tank Batteries for Conservation. R. M. Stuntz, Jr., *Oil Wkly*, 30.3.42, 105 (4), 19.—*Paper Presented before American Society of Mechanical Engineers.*—Average evaporation losses from tank batteries are discussed historically beginning with Wiggins' estimate of 6% some 20 years ago for losses from well to refinery. To-day only 1% is lost in the temporary storing of lease production.

Vaporization of a given crude oil depends on the following factors: (1) *Pressure.*—Vaporization is inversely dependent on the pressure maintained in the tanks—that is, the higher the pressure, the less the vaporization. (2) *Surface Exposed for Vaporization.*—Other factors being equal, nearly five times the vaporization would occur in a tank 22 ft. in diameter, as compared with one 10 ft. in diameter. (3) *Temperature.*—Vaporization of a given crude is directly dependent on the tank temperature; the higher the temperature, the greater is the molecular activity and the greater the vaporization. (4) *Agitation.*—Vaporization is increased by agitation. Methods of controlling these factors are briefly discussed. Agitation is usually prevented by one

of four methods: (1) By means of a pipe nipple and an elbow immediately below the oil-inlet opening, the stream of oil is deflected against the shell and permitted to slide down the shell in a wide thin stream. In this way, excess or free gas is allowed to escape and the stream quietly enters the body of the liquid in the tank. (2) By means of a sloping trough the oil is conveyed to the bottom of the tank without agitation. (3) The oil-inlet connection can be placed near the bottom of the tank. This method of entry forces all free gas to bubble up through liquid already in the tank, also causing a considerable amount of agitation. (4) A fourth method consists of a sloping pipe which conveys the oil from the deck to a point about 12 in. from the bottom of the tank. A standard tee is used on the lower end of the pipe to prevent a continued jetting action of the bottom sediment and water in the bottom of the tank. Two 1-in. holes are cut in the pipe immediately below the tank deck. These holes permit gas to leave at this point rather than travel to the bottom of the tank and agitate the oil as it rises.

Closed pressure storage systems are discussed, and aside from evaporation losses it is noted that: (1) There will be a reduction of the hazards attendant to gauging tanks in sour-gas areas. There will be no opportunity for the fatal, or near fatal, accidents which have been caused by breathing toxic vapours. (2) A completely closed pressure system will do much to prevent corrosion of the inner surfaces of metal tanks. There are many examples to be had in which there is no corrosion to be found in the wells, lead lines, or separators, yet the tankage is severely corroded. The tanks are the first place in which the produced fluids are exposed to the atmosphere. If oxygen is excluded from contact with the fluid in the tank, the rate of corrosion should be drastically reduced.

The design of thief hatches and other conservation devices are discussed.

A. H. N.

533.* Air Compressor Station Permits Lifting Economy in Old Field. G. B. Nicholson. *Oil Wkly*, 30.3.42, 105 (4), 25.—The paper describes an efficient and economical system of air-lift which has been working over many years for lifting oil from ageing wells. An examination of the performance of wells operating on air-lift unit shows a record of low lifting costs and negligible maintenance expenses, based on conclusions following a fourteen-year operational period. Despite large quantities of highly corrosive fluid handled, it is recorded that tubing in each well is pulled only twice a year, and then only for inspection purposes to check condition of jets. This efficiency enables the wells to flow at virtually all times, which is important to prevent flooding sands or loading casing with water, followed by a consequent reduction of overall volume of oil produced. Mechanical breakdowns are rare, most of the original equipment is still in use, and repairs have been almost non-existent.

The company concerned realizes a large saving in employing the air-lift method of producing wells in this field. Other types of lift in this area are not entirely satisfactory, due to the volume of fluid which must be handled, and because of quick corrosion caused by salt water. Steady operation of air-lift wells prevents accumulation of water which may otherwise injure the oil-sands, and simultaneously keeps daily production at a maximum. The operators of the air station, with the average air/fluid ratio now about 1400 to 1, calculate that lifting costs of the wells show a sizeable saving compared with those of other wells in the field. Early abandonment of these wells is indefinitely postponed, while both daily and ultimate production are increased.

A. H. N.

534.* Shop-Made Gauging Device Simplifies Salt-Water Handling. G. M. Wilson. *Oil Wkly*, 6.4.42, 105 (5), 15-16.—Inexpensive, simply constructed salt-water gauging units of a type and design that makes their use easily adapted to the production from any single well, group of wells, or an entire lease, are being used with consistently good results by a California oil company. Water, in passing through the unit, is not only accurately metered, but at any time the rate of production may be read from a float indicator on the side of the container, by the pumper, directly in terms of barrels/day production.

The water-gauging is essentially a tall tank provided with an orifice of carefully determined size at the bottom, through which the water escapes. Water entering the tank passes out through the orifice at a rate which is dependent on the height of the

column backed up in the tank. A float inside operates an indicator that moves up and down on a calibrated board on the outside of the tank.

The unit operates on the familiar principle of the orifice-plate meter, widely used on gas-flow lines to measure the volume of gas passing through the system. The operation of the unit and details of its construction are explained. A. H. N.

535.* Methods for Lifting Oil and Water in Large Volumes. S. F. Shaw. *Oil Wkly*, 6.4.42, 105 (5), 17.—The reasons for the necessity to lift comparatively large volumes of oil and water from oil-wells are explained. The methods that are employed for lifting oil at a high daily rate are as follows: (1) natural flow; (2) gas-lift in some form; (3) centrifugal pump; (4) hydraulic pump; (5) beam pump. As long as natural flow can be maintained and can lift whatever production is required, it is probable that this method will be employed. Natural flow is the least expensive lifting method that can be employed, since it requires only the opening of a valve to the point where the required production is obtained.

The two forms of gas-lift employed for capacity lifting are straight gas-lift and combination gas-lift. Straight gas-lift is the logical method to follow natural flow, and so far as the well is concerned, if a tubing string has already been run into the well during the work of well completion and while natural flow takes place. It is the simplest and least expensive method to install, since it consists merely of injecting gas through the tubing in sufficient quantity to maintain the desired rate of production. In many cases it is the only method that can be employed that will maintain capacity production, inasmuch as cessation of natural flow takes place at a time when there is considerable gas associated with the oil which interferes seriously with the use of any form of mechanical pump. Straight and combination gas-lift methods are further discussed, in connection with casing sizes and capacities.

In fields of depth of 6000 ft. or more, where the fluid levels are low—that is, where the reservoir pressures are on the order of 10–50 lb./sq. in.—and where there is a large production to be lifted—that is, on the order of perhaps 1000 brls./day, and where casing diameters are no greater than those in use, the straight centrifugal pump has many advantages. If there is but little gas present with the oil, and if sand or caving troubles are not serious, the centrifugal pump can handle this production at rather low cost; but if sand troubles are serious, the expense of pulling the pump and making repairs on the pump and motor may become excessive.

The hydraulic pump possesses considerable capacity, especially where large tubing sizes can be employed. Some difficulty is experienced from the entrance of considerable quantities of sand and also the presence of paraffin in large quantity. However, the lifting expense is lower when using the hydraulic pump than many of the other methods of lifting oil.

The beam-pump is capable of lifting considerable quantities of oil in shallow wells, but becomes reduced in capacity as the wells increase in depth. The casing pump offers a means of reducing the fluid friction that takes place through a small tubing string, especially when pumping from fairly deep wells. Crooked holes are a source of much trouble in wells producing on the beam-pump, especially in wells of considerable depth. A. H. N.

536.* Pressure Maintenance in the K-M-A Field. W. H. Rouzer, Jr., *Oil Wkly*, 6.4.42, 105 (5), 22.—*Paper Presented before American Petroleum Institute.*—The K-M-A Pool is an outstanding example of a number of oil operators initiating a programme to conserve a natural resource, and by efficient methods of recovery and gas re-injection ultimately produce millions of barrels of additional oil and save billions of feet of natural gas.

In November 1939 the K-M-A Pressure Maintenance Association was formed to co-ordinate the efforts of over 150 companies operating 375 leases and over \$3,000,000 in gasoline plants. A study of the engineering records of these 1591 3800-ft. wells emphasizes the theoretical predictions pertaining to increased gas-oil ratio and declining productivity in a depletion-type reservoir. Gas injection has resulted in lower producing gas-oil ratios and increased productivities.

Results from pressure maintenance in K-M-A have as a rule been quite satisfactory. The ultimate result will be an enormous increase in total oil recovered. But selection

and connection of an input well are but the beginning of the job. The first stages after initial gas injection are the easy stages. Gas-oil ratios will probably decline, due to the assistance given to the natural reservoir moving forces. After a period which, of course, recovers considerable fluid, gas saturation will begin to assert its characteristics by causing high producing ratios. Then again it is the problem of keeping gas production to a minimum so that recovery will be as efficient as possible.

There are frequent complaints of gas channelling. Often, true channelling is confused with coning, a result of too little input gas rather than too much. In either case the remedy is retarded production, which will allow the forces of capilarity, surface tension, and gravity to become effective. The principles of back pressure should always be applied when producing a depletion-type or gas-drive reservoir. Too high a flow-rate or excessive bleeding will result in channelling, whether natural or from gas input, and will cut ultimate recovery to an extremely low figure. It should be remembered that once gas is released from solution in the reservoir, no appreciable amount can be put back. For all practical purposes, it is concluded that no injection gas goes back into solution with the oil. Whether or not pressure maintenance or repressuring is practised or anticipated, all production should be closely watched for unnecessary escape of solution gas. A. H. N.

537.* Water Flooding Efficiency Aided by Laboratory Flooding Tests. R. C. Earlougher. *Oil Wkly*, 13.4.42, 105 (6), 21.—After an examination of several hundred cores from the shallow sand in nearly every part of the Mid-Continent area, together with many cores from the Bradford and Richburg sands of Pennsylvania, it has been found that a relatively close determination of the oil content of the sands can be secured from cores taken with either rotary or cable-tool equipment. Furthermore, probably in 95% of cases the oil content can be secured directly from the core without applying illusory factor in the known ranges of: (1) formation pressure of 0-70 lb./sq. in.; (2) gravity 28-36° API; and (3) permeability from 1 to 350 millidarcys. At this time this statement is limited to these conditions, inasmuch as that is the range covered by the data at hand. It is acknowledged that in some cores there may be a reduction in the oil content of the core because of slight flushing; however, it has been found that for the most part the values obtained from a core are quite reliable in so far as that core is representative of the field.

Detailed description is given of the precautions and methods used to take and test cores so that field conditions are reproduced and data correlatable with actual practice obtained. It is concluded that the use of extensive laboratory flooding tests on core samples, fresh from the field, is proving extremely important as an aid in the interpretation of core data for the purpose of evaluating a stripper property for water-flooding operations. It is a long way from that first method which considered only total oil remaining in place and a recovery factor of 40%; and if applied to its full extent it is ahead of the method which considers mainly the factors of initial oil saturation in place and an intelligent guess at what the final oil saturation should be. Data secured from such tests should reflect two very important results: (1) they indicate the ultimate volume of recoverable oil present in the sand if 100% efficient recovery were to be obtained from the entire sand section; (2) they serve as an extremely useful guide as to what rate of water-flow should be used in order to obtain as nearly as possible 100% recovery efficiency within the economic limit.

In conclusion it is pointed out that other factors, such as range in permeability, also play a vital part in the ultimate oil recovery which can be economically obtained. However, even this factor can be compensated for by certain development and operating methods. A. H. N.

538.* Well Spacing and Lease Allowable Based on Rates of Recovery and Unitized Pressure. P. J. Jones. *Oil Wkly*, 13.4.42, 105 (6), 28.—*Paper Presented before American Petroleum Institute.* If operating reservoir pressures are maintained in the neighbourhood of virgin bubble-point values, such operations recover as much oil as is possible, for the following reasons: (1) the effective viscosity is at its minimum value because gas remains in solution; (2) the effective permeability is at its maximum value because gas cannot evolve and occupy pore-spaces; (3) the displacing efficiency of the driving fluid is not reduced by virtue of shrinkage of the oil not produced; (4) the plugging resulting from deposition and accumulation of paraffin in the neighbour-

hood of well-bores does not occur because the cooling effect of gas expansion is eliminated; (5) the productivity of wells is maintained because the bottle-neck caused by free gas within the first 50-100 ft. of a well is eliminated, and (6) expansion of solution gas is confined to the upper region of fluid column, where it lightens them and flows wells in some fields to abandonment. The increase in volume of oil produced by such operations may range from 125 up to 200% of the oil otherwise producible—that is, from 1/4 brl. up to 1 brl. more for each barrel otherwise producible. The magnitude of the increase depends primarily on virgin bubble-point pressures and economic limits.

Operating reservoir pressures can be maintained in the neighbourhood of virgin bubble-point values (1) by not letting the rate of volumetric withdrawal exceed the rate of water encroachment, (2) by injecting gas or water at a rate equal to that of volumetric withdrawal on reservoirs having no water encroachment, and (3) by a combination of the two methods.

It is argued that allocation of allowables based on equal opportunities to produce oil is necessary but not sufficient. An incentive in the form of higher allowables for producing oil efficiently is needed. Such an incentive is the relative producing efficiency which stems from, and can be applied readily under, the concept of unitized pressure. It appears that unitized pressure can achieve what is claimed for unitized acreage, without involving the difficulties inherent in the latter. Voluntary unitization of certain acreage and of small tracts would probably be the rule rather than the exception. It is submitted that, if lease allowables were made proportional to rates of recovery and relative producing efficiency, avoidable underground waste, production costs, and steel consumption would be minimized. The discussion is intended primarily for newly discovered reservoirs; however, parts of it may be applied to reservoirs already developed. Inferentially, it is also submitted that if field allowables were made proportional to rates of recovery and producing efficiency, it would, in addition, (1) provide uniform pay-outs as between fields, insofar as it is physically and economically possible to do so by absorbing differences through spacing, (2) provide a reliable method for determining optimum rates of recovery, and (3) provide a scientific basis for pricing crude oil.

The long paper is well illustrated by cost graphs.

A. H. N.

539.* Question of Petroleum Reserves. P. T. Moore. *Petrol. Engr*, March 1942, 13 (6), 33-36.—The question involved is formulated as: Is the U.S. at last approaching that time when its oil-drills might not be able to find petroleum as rapidly as it is eaten up by a consumption still increasing?

Pertinent questions involved are those connected with a prolonged war, with the consumer, and with national economy. A long discussion shows that reserves are falling, and a possible solution advocated is "Pay the drill enough," which ended the prolonged period of shortage from 1915 through 1920; a period when gasolineless Sundays in 1918 were due to actual shortage of crude oil instead of transportation bottle-necks, and when, in the summer of 1920, California was rationed for gasoline. By raising prices of crude oil sharply in 1919 and 1920, enough additional drills were finally enticed into discovery work to produce plenty of oil.

A. H. N.

540.* Use of Meters for Measuring Production from Individual Wells. W. A. Sawdon. *Petrol. Engr*, March 1942, 13 (6), 60.—Metering in California in particular is studied. Construction and use of piston-type, disc-type, and gravimetric meters are briefly discussed. It is concluded that metering of well production has been done successfully in California and installations have met the demands of both accuracy and economy. Actual percentages of errors vary, and the allowable errors are governed by the purpose of metering. For low-pressure installations, under average conditions, the measurements are frequently kept below 0.5%. Whether metering under conditions adaptable to the use of meters is more nearly accurate than tank gauging is still a question, but, as meters can readily be checked from time to time, there appears to be no reason why they cannot be relied upon.

In high-pressure installations there is still the correction factor to be considered, because of the dissolved and entrained gas being measured with the oil, and an accuracy of from 1 to 1½% is probably as much as can be expected. Yet the economies resulting

from the use of meters on high-pressure production have been found sufficiently great to justify their use.
A. H. N.

541.* Gathering System Designed for Gravity Flow in New Michigan Field. J. C. Albright. *Petrol. Engr*, March 1942, **13** (6), 152.—To prevent the unnecessary using up of equipment that might be classified as National Defence materials, and at the same time to lower the cost of operation appreciably, a company recently constructed a gravity-gathering system and an oil pipe-line at Reed City, Michigan. The new field north-west of Reed City compares favourably with many of the larger pools of high flowing potential, the largest gauging approximately 12,000 brls. daily. Instead of producing these wells to capacity, an allowable has been established that permits only 480 brls. of production/day, and drilling is done on a 20-acre spacing, instead of 10 acres or smaller as in other areas.

The major portion of the most productive area of this new field is in Osceola County, in a somewhat hilly country that provides a natural elevation, in some instances approximately 135 ft. higher than the loading rack at the railroad. After the discovery well was completed, which indicated a field of some prominence, the company made an exhaustive survey of the topography, and decided from the results obtained that the oil could be moved from the tank batteries in the field to the loading rack with a minimum of pumping. The trunk and main gathering lines are 6-in. all-welded pipe, and the laterals from the flow-tanks to the main lines range from 3 to 4 in. The operators in the field readily agreed to place their flow-tanks on the highest part of the leases, thus providing as much head as possible for gravity flow in the gathering system so that use of pumping units could be avoided. The system is detailed.

A. H. N.

542.* Petroleum Engineering. Part 3. L. C. Uren. *Petrol. Engr*, March 1942, **13** (6), 156.—This part of the paper describes engineering courses for petroleum students in American colleges.
A. H. N.

543.* Pressure Prediction for Oil Reservoirs. W. A. Bruce. *Petrol. Tech.*, March 1942, A.I.M.M.E. Tech. Pub. No. 1454, 1-13.—The essentials of a mathematical method of studying the pressure behaviour of an oil reservoir as the fluids are withdrawn are outlined, and methods are noted whereby the behaviour of a reservoir can be used to predict the future relationships between withdrawals and pressure.

The oil reservoir is considered as a small part of a large porous continuum which contains water for the most part. The expansion of this water, resulting from a decrease of pressure in the oil zone, causes a movement of water that is an important factor in the relationship between fluid withdrawals and reservoir pressure.

Examples are given to illustrate the methods of pressure prediction for a circular reservoir containing under-saturated crude, the pressure distribution over a field having a uniform production rate, the effect of a fault line near a field, the mutual interference of nearby fields and the disturbing influence of a gas-cap. The analysis is also applied to well-spacing problems.
G. D. H.

544.* Completion Practices Related to Well Productivity. W. J. Travers. *Petrol. Tech.*, March 1942, A.I.M.M.E. Tech. Pub. No. 1465, 1-8.—Several new procedures for completing oil-wells have been developed in recent years. Each method, when used where properly applicable, promises to be a definite aid to operators in lowering development or operating costs or in developing the full potentialities of the oil-well. Multiple-zone completions are now frequently used in contrast with the older practice of setting a solid water-string over each zone to be produced. Gravel packing in unconsolidated formations often prevents sand troubles formerly experienced where a conventional perforated liner was used. Light-weight bentonitic clay-muds and oil-base drilling fluids are definite steps towards eliminating mudding damage, which occurs when heavy rotary mud is used.

Since in each case the new procedure developed is an alternative to older conventional methods, there is a problem of making a selection. Data are presented concerning the relationship between the initial productivity index and the cumulative production and the effect of drilling-in time on the initial productivity index. In comparisons in one area it appeared that gravel packing and the conventional liner gave similar

results with wells of small potentials, but the former treatment had an adverse effect on wells with high potentials, and the suggestion is made that there will be compensation for this in the form of a flatter decline and more continuous operation, but this is not very well supported by facts. G. D. H.

545.* Productivity Index and Measurable Reservoir Characteristics. J. A. Lewis, W. L. Horner, and M. Stekoll. *Petrol. Tech.*, March 1942, A.I.M.M.E. Tech. Pub. No. 1467, 1-9.—Observation and theoretical considerations show that the productivity index is proportional to the average permeability and exposed thickness of the producing formation, and inversely proportional to the viscosity of the oil under reservoir conditions and to the formation volume of the oil. The applicable permeability factor must include the effect of connate water on the permeability to oil and allowance for the presence of gas.

The measured and calculated productivity indices are compared in a number of cases, with general good agreement. The methods are applied to the potentials of pumping wells and also to secondary recovery to predict the water intake, with seeming success in both instances. G. D. H.

546.* Soviet Oil in Relation to Military Campaign. Anon. *World Petrol.*, Dec. 1941, 12 (13), 30.—Some years ago Gubkin estimated the Soviet oil reserves at 20,000,000,000 bbl., 9,659,000,000 bbl. at Baku, 1,006,000,000 bbl. at Grozni, 598,000,000 bbl. in the Maikop-Kuban area and 9,477,000,000 bbl. east of the Urals. Later Gubkin doubled his total reserve figure, and independent experts have put the figure at least 11,700,000,000 bbl. of known reserves, some 16% of the world's total known reserves. The Soviet production has risen since 1932, and reached 222,600,000 bbl. in 1940. The rise was about 42%. 86% of the oil production is from the Caucasian region, 72% being from the Baku area. The Maikop-Kuban fields yield 7.5%, and are rising in importance, while the Grozni fields seem to be declining.

The Ural-Volga fields provide about 8% of the Soviet oil, and the Emba fields give 2%.

The refineries fall into four main groups, but only 1.78% of the capacity is in enemy hands, with a further 19.35% in imminent danger. The Ural region has a refining capacity of 83,200 bbl./day, or 7.98% of the total capacity.

About 13,000,000 tons of oil/year are moved by tank-cars, 11,000,000 tons by canal and river, and 6,000,000 tons by pipe-lines.

In the Baku area there are 7500-8000 wells, with thirty producing sands. Few of the wells flow, and most are 2500-3500 ft. deep, although a few are 8000-10,000 ft. deep. Grozni has 3200 wells, with the present production from depths of 5000-6000 ft. The Maikop-Kuban wells are mainly 1500-2500 ft. deep.

In the Emba region there are at least 200 salt domes. 400-500 wells have been drilled in the Ural-Volga area, where it has been estimated that on a 10-acre spacing at least 10,000 wells can be drilled. G. D. H.

547. Patents on Production. J. H. Reynolds. U.S.P. 2,274,740, 3.3.42. Appl. 1.12.37. Working barrel support in a well-casing.

H. H. Raulerson. U.S.P. 2,274,937, 3.3.42. Appl. 19.12.39. Resilient counterbalancing device for an oscillating beam.

T. E. Bryan. U.S.P. 2,275,345, 3.3.42. Appl. 21.2.38. Removable gas-lift apparatus in oil-wells.

T. E. Bryan. U.S.P. 2,275,346, 3.3.42. Appl. 9.2.39. Gas-lift valve and surface-operating mechanism.

T. S. Harris. U.S.P. 2,275,364, 3.3.42. Appl. 29.5.39. Deep-well and cistern automatic pumping plant.

A. Boynton. U.S.P. 2,275,416, 10.3.42. Appl. 28.11.38. Bellows-type slugging foot valve for wells.

A. Boynton. U.S.P. 2,275,417, 10.3.42. Appl. 28.11.38. Foot-valve for wells to control the periodic discharge of slugs of liquid.

- E. H. Lamberger and B. F. Langer. U.S.P. 2,275,532, 10.3.42. Appl. 18.4.39. Oil-well strain gauge for use in pumping equipment.
- M. W. Hartmann. U.S.P. 2,275,627, 10.3.42. Appl. 3.4.39. Pumping system using a centrifugal pump.
- A. E. Wright. U.S.P. 2,275,668, 10.3.42. Appl. 19.2.40. Pipe-cleaning device.
- T. G. Myers and F. Mason. U.S.P. 2,275,679, 10.3.42. Appl. 27.2.32. Submersible pump and electric motor.
- T. G. Myers. U.S.P. 2,275,680, 10.3.42. Appl. 2.5.38. Sealing device to be used submerged in well liquid.
- E. W. Patterson. U.S.P. 2,275,919, 10.3.42. Appl. 27.11.40. Crank balanced unit in combination with a speed reduction unit.
- R. C. Baker. U.S.P. 2,275,935, 10.3.42. Appl. 6.5.40. Well-packer apparatus.
- R. C. Baker. U.S.P. 2,275,936, 10.3.42. Appl. 2.7.40. Casing bridging device.
- J. M. Courtney. U.S.P. 2,275,947, 10.3.42. Appl. 27.5.41. Gas-lift pumping device for wells.
- S. S. Smith. U.S.P. 2,275,109, 10.3.42. Appl. 1.3.41. Pipe-line cleaner for interna cleaning.
- C. C. Cole. U.S.P. 2,276,161, 10.3.42. Appl. 5.7.40. Gun-type casing perforator with a special projectile.
- H. W. Cardwell. U.S.P. 2,276,224, 10.3.42. Appl. 24.2.39. Well-servicing and drilling machine on a truck.
- R. O. Joslyn. U.S.P. 2,276,401, 17.3.42. Appl. 18.3.40. Well-cleaning apparatus using a tubing and screen.
- L. C. Miller. U.S.P. 2,276,544, 17.3.42. Appl. 6.2.39. Perforating device using explosive charges.
- G. Kennedy and C. C. Cole. U.S.P. 2,276,783, 17.3.42. Appl. 7.11.38. Fluid-operated motor for deep-well pumping equipment.
- * S. A. Germain. U.S.P. 2,276,833, 17.3.42. Appl. 6.5.39. Electric heater for oil-wells.
- J. W. MacClatchie. U.S.P. 2,277,002, 17.3.42. Appl. 19.8.38. Well-swab, including a tapered mandrel and packing.
- D. W. Zuck. U.S.P. 2,277,181, 24.3.42. Appl. 20.9.39. Apparatus for pumping deep-driven wells.
- E. E. Coffey. U.S.P. 2,277,306, 24.3.42. Appl. 12.12.40. Deep-well pump.
- J. R. Yaucey. U.S.P. 2,277,380, 24.3.42. Appl. 30.11.39. Apparatus for producing wells.
- P. S. Graver. U.S.P. 2,277,398, 24.3.42. Appl. 5.10.39. Expansion roof for fluid storage tanks.

A. H. N.

Crude Petroleum.

548.* **Crude Selection Important in 100-Octane Fuel Production.** W. L. Nelson. *Oil Gas J.*, 1.1.42, 40 (34), 14.—The task of rapidly increasing the output of 100 octane fuel from 40,000 to over 150,000 brls. a day is difficult, and it is suggested that consideration should be given to selection of straight-run base stocks of high octane number to supplement more effectively production of blending stocks produced by

alkylation and hydrogenation. A table has been compiled from the literature of naphthenic-base crude oils in the U.S. useful for the production of such straight-run base stocks, showing the field, county, A.P.I. gravity, yield of gasoline of E.P. 400° F., and properties of the gasolines. Crudes from recently discovered fields and those yielding gasoline of high sulphur content are not included. The production of naphthenic-base crude oils fell from 587,000 brls. a day in 1927 to 289,000 brls. a day in 1936. In 1941 and 1942 production will probably not exceed 350,000 brls. a day, but to a large extent the gasoline yield of recent production has been high and the sulphur content low. The new production is mainly from the Gulf Coast area, and one company is already constructing a plant for manufacture of base stock. The production of suitable aviation base stock having an expected octane range of 77-85 probably does not exceed 15,000-20,000 brls. a day. Careful investigation of new production and of naphthenic crude oils at present mixed with others on account of their low gasoline content or small production is advised. Reopening of certain wells shut down in past years for economic reasons may also prove advisable.

R. A. E.

549.* **20% of Texas Oil Labelled Aviation Base.** Anon. *Oil Gas J.*, 15.1.42, 40 (36), 26.—By order of the Railroad Commission, production from sixty-two fields in Texas has been segregated for processing in refineries equipped to produce the maximum amount of aviation-base stock. The allowable production from these fields is approximately 24% of the total for Texas. Names of the fields producing this segregated crude oil, together with production figures and data on gasoline properties and yields, are tabulated. Records of quantities processed and of yields of gasoline obtained must be kept by refineries operating on these crude oils. Methods for increasing the allowable production of these fields and of overcoming the difficulties facing refineries at present treating such oils, but which are not equipped for maximum production of aviation gasoline, are under consideration.

R. A. E.

Gas.

550.* **Liquefied Petroleum Gas Use Sets Record During 1941.** G. G. Oberfell. *Oil Gas J.*, 15.1.42, 40 (36), 42.—Although many factors operated against expansion, the sales of liquefied gases increased by 42% as compared with 1940 to a total of 445,000,000 gallons, excluding sales for motor-fuel blends, pipe-line deliveries in the gaseous state to chemical concerns near to the points of supply, and usage by producers. Distribution in millions of gallons to domestic users was 221.9, to gas manufacturers 29.6, and to industrial and miscellaneous users 193.5. Many industrial plants engaged on defence work have installed liquefied gas systems mainly as stand-by to ensure adequate fuel service during high peak-loads on the utility systems. Demand from gas-plants to meet rising peak-loads has also increased, especially in manufacturing centres. In the chemical field, large quantities of special grades of propane, *n*- and *iso*-butane, and butadiene were transported for use in manufacture of nitro-paraffins, plastics, and synthetic rubber, and propylene, butylene, *isobutylene*, and other special hydrocarbons are now available in pure and technical grades. The first large-scale installation of propane-fired heaters for removing ice and snow accumulations on switches in railroad yards was laid down during the year. Development of the isomerization process is expected to increase demand for *n*-butane for aviation-fuel manufacture, thus restricting the quantities available for the liquefied-gas industry.

R. A. E.

Synthetic Products.

551.* **\$400,000,000 Rubber Programme Presents Problems to Refiners.** W. L. Nelson. *Oil Gas J.*, 15.1.42, 40 (36), 19.—The projected increase in manufacture of synthetic rubber will increase the quantities of butane and other hydrocarbons which the petroleum industry will be required to supply. The extent of this increased requirement will depend on the quantities of the various types of rubber-like materials needed to give a balanced output, but may amount to 20,000-30,000 brls. of butane fractions

per day. Including requirements for production of 100-octane gasoline, the demand is expected to range from 43,000 to 80,000 brls. a day. It is estimated that at present one-third to one-half of recoverable butanes are not removed in natural gasoline plants and refinery gas-recovery systems. More complete removal of these fractions would probably enable requirements to be met for some time to come, and would involve only small additions to equipment at recovery plants.

R. A. E.

552.* Petroleum is Plentiful Source of Raw Materials for Chemicals. L. F. Hatch. *Oil Gas J.*, 29.1.42, 40 (38), 197.—The history of the synthetic production of chemicals from raw materials provided by the petroleum industry since 1922, when isopropyl alcohol was first produced commercially from propylene, is briefly outlined. The trend towards segregation of individual hydrocarbons from petroleum will tend to enlarge the field. Particular consideration is given to the production of glycerol from propylene, the manufacture of nitroparaffins, ammonia, and alcohols, and to the possibilities opened up in chemical manufacture not only from these materials, but also from the by-products produced during their manufacture.

R. A. E.

553.* Sufficient Butane can be Made Available for Synthetic Rubber. W. L. Nelson. *Oil Gas J.*, 29.1.42, 40 (38), 199.—The properties of some of the more important synthetic rubbers are compared with those of natural rubber, with particular reference to strength, elongation, chemical stability, and wear resistance.

Generally the synthetic products are superior to the natural product in respect of resistance to attack by chemicals and solvents, and resistance to oxidation, with consequent hardening and cracking, this superiority being most marked in the cases of butyl rubber and vistanex. The utilization of the synthetics will be selective, and dependent on their properties. As far as can be seen at present, it is considered that butyl and Buna S will be two of the most important types, so that the bulk will probably be made from butadiene, styrene, and butenes. There is probably an adequate supply of styrene available for Buna S requirements in the xylene fraction of coal-tar; if not it can be supplemented by manufacture from benzol and ethylene. Butanes from petroleum will probably prove the cheapest source for obtaining the required supplies of butenes and butadienes. The quantity of butadiene needed will probably range from 3000 to 8000 brls. a day. Yields obtainable from thermal or catalytic cracking processes are low, but by modification of operating conditions of plants manufacturing isobutene from isobutane for high-octane gasoline production, it may be possible to obtain a by-product from which the required quantity of butadiene can be separated, for example, by solution in cupric chloride. Should these methods prove inadequate, further supplies could be obtained by dehydrogenation of butane at 1100–1200° F. in the presence of chromium oxide catalyst supported on alumina, yielding 60–75% of butenes on recycling. By long-continued heating or repeating the operation on butenes, yields of 60–80% of butadiene are obtained, giving an overall yield of 36–60% butadiene from butane. If butyl rubber is made, a suitable feedstock mixture might be obtained in a single dehydrogenation operation, as separation of pure butadiene and isobutene may be unnecessary.

R. A. E.

554.* Preparation of Methyl Chloride from Natural Gas. Anon. *Oil Gas J.*, 12.2.42, 40 (40), 33 (translation from "Zhurnal Prikladnoi Khimii," Vol. 12, No. 12).—For these experiments natural gases from the Baku area, having a methane content of 99.7–99.8% by vol. and commercial chlorine, were used. Natural gas and chlorine, after passing through acid and calcium chloride, are mixed and delivered to a reaction vessel in an electrically heated furnace, the heated portion being filled with catalyst. The products are passed through ice-cooled water (to remove HCl), calcium chloride, and finally to a petroleum-ether bath cooled to –130 to –140° C. Distillation in a Podbielniak apparatus was found to provide the best method of analysis of the reaction products, and means employed for determining methyl chloride yield on consumed methane and chlorine are described. Experiments were carried out to determine effect on yield of methyl chloride of temperature of chlorination, rates of gas-flow, ratio of chlorine to methane, varying catalyst, and finally composition of natural gas used. The principal conclusions arrived at are: (1) With suitable catalysts and at reaction temperatures of 350–500° C. 80–85% of chlorine passed and of reacted methane are

consumed in the formation of methyl chloride, and 80–86% of the condensate consists of chemically pure methyl chloride, boiling within the range -25 to -23° C.; (2) of the catalysts investigated, cupric chloride on pumice, cupric chloride promoted by cerium chloride, iron shavings, and aluminium shavings were the most effective; at 450° C. and a ratio methane to chlorine of about 10 : 1 by vol. the condensate may contain 87% of methyl chloride; (3) variation of contact time between 0.5 and 40 sec. has little effect on methyl chloride yield or concentration; (4) a ratio of methane to chlorine of about 10 : 1 by vol. yields best results—on lowering the ratio the amount of polysubstituted derivatives of methane increases; (5) under established conditions of highest yield of methyl chloride, the residue gas is pure methane, which may be recirculated; (6) using a natural gas containing 91.3% methane, 4.2% ethane and higher, 4.5% air, and CO_2 as base material, it was found that the yield of methyl chloride calculated on the total volume of chlorine derivatives decreased appreciably when using a cupric chloride catalyst, and also that higher hydrocarbons are condensed simultaneously with methyl chloride, thus introducing separation difficulties. With iron shavings as catalyst, the yield of methyl chloride was even lower, and catalyst poisoning soon occurred. It is therefore recommended that higher hydrocarbons, if present, should be removed from natural gases before processing. R. A. E.

555. Natural Gas as a Raw Material in the Production of Synthetic Ammonia. F. H. Dotterweich. *Refiner*, March 1942, 21 (3), 63–67.—Synthetic ammonia production in the Axis-dominated countries is estimated at 2,775,000 tons, leaving but 1,135,000 tons of capacity for the rest of the world. The 1940 peace-time output of the United States is estimated at 260,000 tons, with total defence needs estimated at 550,000 tons.

At the present time, of the gases used in this synthesis, the most expensive and difficult to obtain is hydrogen. Hydrogen may be separated from coke-oven gas, obtained as a by-product in certain cracking processes, in the alkali-chlorine industry and certain fermentation processes, or quite pure as electrolyte hydrogen should cheap current be available. Three-fourths of the synthetic ammonia production is now made by the water-gas reaction, using coke or anthracite coal as raw material, this process yielding both the hydrogen and nitrogen required.

It is believed that although there are but few plants operating in the U.S.A. and Canada using natural gas as a source of hydrogen for this process, the future should bring a great number of them. The paper briefly reviews the water-gas process, the steam-conversion process, and products from synthetic ammonia relating to explosives, The chemistry and thermodynamics of processes are also obtained. A. H. N.

556. Synthetic Rubber. J. V. Hightower. *Refiner*, March 1942, 21 (3), 68–70.—It appears that at the present the programme for manufacturing synthetic rubbers is concentrated on producing Buna rubber. By concentrating on Buna production, the use of large quantities of chlorine, used in some other types of synthetics, could be avoided. Furthermore, the supply of the hydrocarbons used largely in the Buna rubbers is potentially great. A third consideration is that at least one variety of Buna rubbers has satisfactory qualities for tyre and tube production, which has been consuming 70% of the rubber supplies.

The Buna rubbers, notably Buna S and Buna N, consist largely of butadiene polymerized with (1) styrene in the case of Buna S and (2) acrylonitrile in the case of Buna N. These rubbers are vulcanizable. Buna S is reported well suited to tyre manufacture, more so than Buna N, although extensive road tests have been made with both types. High resistance to destructive action by gasoline, oils, and many organic solvents qualify Buna N for numerous speciality services.

Butyl rubber, like the Bunas, is basically composed of hydrocarbon gases obtainable in the oil industry. This is a product resulting from the polymerization of butylenes or other olefin gases with small amounts of butadiene. The product has the advantage of being made from olefins which are produced in greater volume in refineries than butadiene, but was recently declared as not yet developed as well as Buna as a material for tyres. This rubber is quite stable, chemically speaking, resistant to the passage of gases, is vulcanizable, and adapted to speciality uses, although is not resistant to the action of naphthas. Neoprene, a synthetic which last year led the others in production, utilizes acetylene gas as a raw material. The gas is polymerized to monovinylacetylene, which is treated with hydrochloric acid to produce chloroprene. In

turn, chloroprene is polymerized to form the synthetic rubber. It has been widely tested in tyres and the manufacture of specialty products. Neoprene is rated high in resistance to abrasion and to chemical action.

The questions of obtaining butadiene, and even styrene, from petroleum in sufficient quantities, of the equipment needed, and certain economical considerations are discussed. It is noted that even if with large-scale production it developed that the cost of synthetic rubbers remained higher than natural rubber, the fact that the synthetic products as a class have many qualities superior to those of natural rubber, including resistance to abrasion and sunlight, will favour such products and offset any price differential that may ultimately remain.

A. H. N.

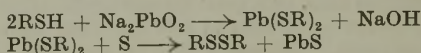
Refining and Refinery Plant.

557.* Psychrometry of Cooling Towers. E. Simons. *Chem. Met. Eng.*, April 1942, **49** (4), 82-86.—The paper is a review of some of the basic principles of psychrometry and a projection of the principles into the field of cooling-tower design and operation.

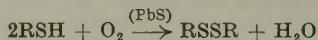
Using gas laws, principles of heat exchange, and of molecular diffusion, formulae are derived, and are given in conjunction with other data.

A. H. N.

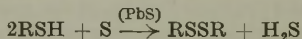
558.* Bender Lead Sulphide Treating Process Proves Economical. Le R. Eaby. *Oil Gas J.*, 1942, **40**, 37, 25.—The normal doctor treatment converts mercaptan sulphur into the less objectionable disulphide form. The reaction is usually explained on the following lines:



It is found in practice, however, that the quantity of mercaptan converted into disulphide per unit weight of plumbite is greater than can be accounted for on these grounds. Various investigations point to the conclusion that the PbS formed during the main reaction catalyses certain side reactions. Use has been made of the reaction:



The Bender system is designed to take maximum advantage of the reaction:



Sufficient aqueous NaOH is added to remove excess H₂S.

The main advantages claimed for the process are: (a) low running costs, (b) low stock losses, (c) chemicals used are relatively harmless and non-corrosive, (d) the system permits a compact lay-out and results in space-saving, (e) equipment required is simple, (f) operation is flexible and easy, (g) the process is applicable to any refinery product which requires mercaptan conversion.

Details of the preparation of a suitable catalyst are included. The article is illustrated with diagram and photographs of the units in service at the Sinclair plant in Marcus Hook, operational statistics of which are also shown.

C. G. G.

559. Fundamentals of Refinery Piping Design. Part II. A. Cibulka. *Refiner*, February 1942, **21** (2), 45-47.—The paper deals with the design of anchors and supports. For an overhead line the tie-rods anchored to the base of the pipe support themselves or to special deadmen provide an inexpensive anchorage.

For underground lines or lines close to the ground a concrete block is used for the purpose. The friction between concrete and the earth in the ultimate analysis is the only dependable factor for the transmission of forces, and therefore the friction surface should be made as large as possible. Short post-holes filled with concrete, reinforced with some scrap-rods, form a very effective, cheap friction pile.

For pipe support, structural steel sections, special thin-walled, pressed-steel sections, secondhand or new pipes, concrete or wooden poles may be used. Contrary to popular belief, wooden columns are far more fire-resistant than the unprotected steel sections, especially those made of thin pressed plates. Wooden columns will char on the surface, but do not lose strength, and will last for hours, where steel may collapse within a few minutes. Creosoted poles are cheaper, and do not require painting and protective

concrete foundations. They are easily installed, moved around, recovered, and are strong enough for any loads usually encountered in the practice. In dangerous locations the wooden top beams can be made reasonably fire resistant by thin sheets of galvanized iron nailed directly to them.

Charts are given for calculating the sag in pipes. The pitch of pipe-lines is usually expressed as so many inches in a certain number of feet. This expression is called the "average gradient" of the pipe-line. The formula given below indicates the maximum length of unsupported piping which can be permitted without allowing the deflection of each span to exceed the drop in elevation :

$$\text{Average Gradient} = \frac{144S^2y}{36S^2 - y^2}$$

where S = length of one span in feet, y = deflection of one span in inches.

A. H. N.

560. Fundamentals of Refinery Piping Design. Part III. A. Cibulka. *Refiner*, March 1942, 21 (3), 84-94.—This part of the paper deals with the dimensions and strengths of piping, and for the convenience of designers and detailers the scattered information most frequently needed has been concentrated in a few pages. Tabulations and figures give more than fifty separate and useful items for steel pipe from $\frac{1}{4}$ in. to 16 in. in diameter. Detailed dimensions for piping layouts, areas of metal, moments of inertia, radii of gyration for structural designers, volumes and surfaces for hydraulics or heat exchange problems—all essential information can be read directly from the table.

For sizes larger than 16 in. in diameter, not often encountered in practice, the catalogues must be consulted until some manufacturer compiles a continuation of these tables.

Details for brass, copper, lead, and transite pipe dimensions and specifications are given. Critical external pressures for pipe or cylindrical shells from 12 to 168 in. in diameter are also given. Internal pressures are also given in a separate figure. At temperatures higher than 800° F. the metal subjected to stress begins to flow or creep. It elongates permanently, and will not spring back to its original length when the load is removed, as is the case with the elongation produced within the elastic limit.

After a certain time this elongation due to the creep reaches an unsafe limit, and the tubes must be taken out of service. But the stress and time elements are not directly proportional. Doubling the stress may shorten the time factor by ten to thirty times; therefore the safe creep stress should be determined by experiments on the material in question, duplicating as nearly as possible the working conditions expected in the actual service. Time is a very important factor in design based on creep. There is no advantage in designing an apparatus for 100,000 hr. (11 years) creep stress when the economical life expected is only 1 or 2 years. 1-3% elongation is used by engineers as safe limits for creep, depending on the importance and dangers of the process. Figures give creep properties of some metals frequently used in refining processes.

A. H. N.

561. Fundamentals of Refinery Piping Design. Part IV. A. Cibulka. *Refiner*, April 1942, 21 (4), 123-124.—Flow problems for refining plants are studied. Selection of the proper pipe size is an engineering as well as economical problem. The pipe serves a certain purpose, and should do so properly. A steam-line must deliver so many pounds of steam/hr., at a certain pressure and a certain temperature (superheat), to a turbine or to a pump. Otherwise, if all the conditions are not met, the operation will suffer. Correct size and good insulation are essential. Water, oil, steam, air, vapour lines, all carry fluids. Flow causes friction, pressure drops, loss of energy, which must be paid for. Pumping cost has to be taken into account. These factors are briefly discussed.

A. H. N.

562. Heat Exchanger Tube Sheet Temperatures. K. A. Gardner. *Refiner*, March 1942, 21 (3), 71-77.—Since the permissible stress intensity of non-ferrous metals decreases rapidly with increasing temperatures, considerable valuable material may

be wasted by unduly cautious estimates of metal temperatures in heat-exchanger tube-sheets for design purposes. To provide a sound basis for reasonably accurate estimates, the author presents equations for calculating the metal temperatures in the unpierced and pierced portions of tube-sheets. The derivation for the latter case is given in some detail. Examples of the use of these equations are given, using as a basis the expression $f_{\max.} = PR^2/L^2$; it is suggested that, if this expression is approximately correct, it is reasonable to assume that this maximum stress intensity occurs in the pierced portion of the tube-sheet.

The assumptions made in deriving the equations are: (1) The tube-sheet ligament between adjacent tubes is thin enough, compared to its length, to result in a negligible temperature gradient over any cross-section normal to its length. (2) The thermal conductivities of the tube wall and tube-sheet metals are the same. (3) The heat-transfer coefficient at the tube side-face of the tube-sheet is the same as the coefficient through the tubes. (4) The area through which heat flows at the shell side of the tube-sheet includes the cross-sectional area of the tube walls.

After discussing the examples in detail, a rule for approximation is derived. Since one example was deliberately chosen to give the largest difference to be expected in practice between the maximum metal temperature and the tube-fluid in a water-cooled exchanger, it may be used as the basis for a rough rule of thumb, which may be stated as follows: The maximum metal temperature in the pierced portion of the tube-sheet of a water-cooled exchanger will not exceed the sum of the tube side design temperature plus 15% of the difference between the two design temperatures.

A. H. N.

563. Butadiene Calls for Few Departures in Equipment or Processing. J. V. Hightower. *Refiner*, April 1942, 21 (4), 101.—Equipment for the preparation of feed-stock for a butadiene unit largely consists of fractionators, and such equipment may already be available. Some natural-gasoline plants are fractionating butane cuts which are probably capable of being used as feed-stocks without further fractionation; the same is true of numerous refining units which are fractionating butane cuts from either crude or refinery gases. Fractionation is also required to produce liquid feed-stocks if these, rather than butanes, are to be converted into butadiene. In either case the equipment consists of conventional fractionator towers and such subsidiary equipment as charge-pumps, reflux pumps, drums, heat-exchangers and perhaps absorbers and compressors.

In the butadiene plant proper, the first processing step consists of cracking the feed-stock, or heating it (if a catalytic process is used) to the temperature where catalytic conversion of the material into butadiene will occur. The pressure involved is low, being, it is understood, around 150 lb./sq. in., or lower. A high temperature, ranging between 1000° and 1300° F., is necessary. Furnace coils of alloy steels are required at points where these high temperatures are encountered, although carbon steel might be used in the cooler sections of the furnace. Valves, instrument connections, and other fittings subjected to the high temperatures would also be of alloy steel. The furnace box would require such familiar equipment as oil- or gas-burners, refractories and tube hangers.

Low temperatures of -60° F. are involved in certain parts, and for these special alloy steels are used in valves, etc. Otherwise the equipment is conventional.

A. H. N.

564. Mercaptans Removed Prior to Doctor Treating. Anon. *Refiner*, April 1942, 21 (4), 103-106.—Gasoline treatment in the plant described is accomplished in three successive stages: a precaustic wash for the removal of hydrogen sulphide, caustic scrubbing for reduction of mercaptan content, and doctor-sweetening to a finished product. The three are phases of a continuous system whereby a blend of cracked distillate and plant-recovery vapours moves in uninterrupted flow through the three treating phases. The plant and its operation, together with the regeneration of caustic and disposal of mercaptans, are described in some length. Savings effected by the plant are discussed.

Important features of this system, which allows of economical sweetening of full-range Mid-Continent cracked gasoline with available chemicals, and without lowering of the TEL response, may be outlined as follows: (1) main hydrogen sulphide removal

by debutanization; (2) low Be. caustic soda prewash for partial acid-oil removal; (3) 80% mercaptan removal through packed tower regenerative caustic system; (4) temperature- and time-controlled doctor and sulphur contact; (5) meter-controlled and recorded sulphur addition, checked against butyl mercaptan and other tests; (6) continuous doctor treatment with carefully adjusted alkalinity, sodium plumbite, and lead sulphide conditions in gum-free treating solution.

A summary of the operating procedure shows that it is essential to keep the caustic well regenerated, to keep air from entering the system along with the caustic, and to maintain an even, unbroken flow of gasoline to the scrubber. The gravity of the caustic should not fluctuate, and the concentration of the phenols in the mercaptan-scrubbing caustic should be controlled by charging fresh caustic to the system as frequently as tests determine that this should be done.

A. H. N.

565. Conditioning Raw Natural Gasoline in the Field. Anon. *Refiner*, April 1942, 21 (4), 112-114.—A description is given of a plant used by one company to provide a source of isobutane.

Details are given of fractionators and similar equipment in the plant. A. H. N.

566. Making the Refinery Weld. W. L. Archer, *Refiner*, April 1942, 21 (4), 119-121.—The fundamentals of good welding practice for refinery purposes are discussed.

A. H. N.

Fire Prevention.

567.* Control of Oil Fires. A. F. Dabell. *Petrol. Times*, 2.5.42, 46 (1168), 207.—The principles involved in an oil-fire are briefly outlined. It is felt that the fire precautions for oil-storage installations which have proved efficient in the past cannot be deemed capable of coping with the present-day hazards of unusual and unforeseen nature, in particular those arising from the destruction of pipe-lines. Action must, therefore, at times be restricted to precautionary control of fire, rather than its immediate extinction.

It is suggested that by collection and disposal of burning gas and the provision of natural drainage, the liquid can be collected at distant points, with risk to life reduced and maximum salvage obtainable.

The author feels that in the case of large installations, the modern practice of eliminating auxiliary pumps and of concentrating plant calls for revision, and recommends that increased facilities for the release of vapours from oil tanks now be provided.

Storage tanks, pipe-lines, and oil in rivers and canals are discussed separately. Water is, contrary to public opinion, the most valuable asset for oil-fire fighting; but other agents are also discussed—*e.g.*, foam. The paper is then summarized under general and special conclusions.

A. H. N.

Analysis and Testing.

568. Note on Temperature Correction Methods in Calorimetry. R. S. Jessup. *J. Appl. Phys.*, February 1942, 13 (2), 128-137.—The problem of correcting calorimetric data for thermal leakage has been discussed by King and Grover in a recent paper in the *Journal of Applied Physics*. From their analysis of the problem these authors have concluded that large errors are involved in the usual methods of correcting the data of bomb-calorimetric measurements, and of experiments by the method of mixtures. In the present note it is shown, in agreement with W. P. White's treatment of calorimetric lag, that in the case of bomb-calorimetric measurements the errors in question are practically completely eliminated by calibrating the calorimeter experimentally. Since experimental calibration of the calorimeter is the usual practice in modern bomb-calorimetric measurements, the results of such measurements are not affected by the errors discussed by King and Grover. In case of measurements by the method of mixtures, these errors can be avoided by so conducting the experiment that the final temperature of the calorimeter will be very near the convergence temperature.

A. H. N.

569.* **Application of Spectroscopy in the Petroleum Industry.** J. R. Nielsen. *Oil Gas J.*, 1942, **40**, 37, 34.—A lecture review of published work on emission, absorption and Raman spectroscopy as applied to hydrocarbons and other products of interest to the petroleum industry. Illustrated with tables and diagrams. 13 references.

C. G. G.

570.* **Convenient Graphical Method for the Valuation of Lubricating Oil Crudes.** H. Moore, *Petrol. Times*, 1942, **46**, 1162, 68.—The valuation of a crude oil which is to be worked up for lubricating oils is frequently carried out by fractional distillation in vacuo, a number of narrow cuts being separated. The viscosity of each fraction is determined, and the composition of the oils which will ultimately be produced in the refinery is found by experimental blending of these cuts to the predetermined viscosity figures.

This procedure can be simplified by isolating a few narrow cuts during the distillation, and plotting their absolute viscosities on a log. scale against their mean composition, expressed as the percentage range of the lube-oil residue. The curve is then drawn. In the portion corresponding to the lower viscosities the graph is nearly straight and shows average composition for a given viscosity. In the higher portions some allowance must be made for slight curvature.

By choosing suitable scales, other characteristics, such as flash point, sp. gr., cold test, and coke test, may be plotted on useful blending diagrams. The article is illustrated with diagrams of the type discussed, and examples of their uses are given.

C. G. G.

571. **Investigation of the Aromatic Portion of Light Oil Fractions.** E. A. Robinson. *Zhurnal Prikladnoi Khimii*, **13** (12), 1852–1868. Translated by J. G. Tolpin. *Refiner*, March 1942, **21** (3), 78–83.—Since the differences between the properties of aromatics and other classes of hydrocarbons are not very pronounced in the higher-boiling oil fractions, no reliable methods of determining them in lubricating oils are available. The methods proposed for this purpose, including the use of selective solvents, hydrogenation of aromatics to naphthenes, and treatment with sulphuric acid, were evaluated in an experimental study under consideration of the available literature material. In the case of the lubricating fractions of two oils, a paraffin-base and a naphthene-base oil, it was shown that the types of aromatic compounds can be determined with a reasonable degree of probability by removing the aromatics from the oil, adding known aromatics, and comparing the properties of the obtained mixtures with those of the original oil fractions. On the average, the same type of aromatic compounds were found to be present in both oils.

Notwithstanding literature references that paraffin-base oils contain aromatics with long paraffin chains, these two oils were found to contain no compounds of this type of the composition $C_{16}H_{33}$ or $C_{18}H_{37}$, in the fraction boiling at 160–200° C. and 1 mm. pressure, although one of them (Karachukkur oil) was found to contain from 12 to 14% aromatics, and the other (Balakhany oil) 30–32% aromatics. The average composition of the aromatics in the fraction boiling at 130–160° C. and 1 mm. pressure corresponds either to dicyclic aromatics with an aliphatic chain, or monocyclic aromatics containing naphthene rings in the side-chain. The conclusions reached for the fraction boiling at 190–220° C. and 1 mm. indicate the probable presence in it of either tricyclic aromatics with a paraffin chain, or of dicyclic aromatics with a paraffin side-chain, containing one or two naphthenic rings, the total number of rings in the molecule being not less than three.

Considering the constants of the hydrocarbons isolated by Rossini from Mid-Continent oil, the composition of the fraction 205–210° C. and 0.5–1.0 mm. of the two oils are also thought to be subject to the above conclusions concerning the type of aromatics present in them. Published data for other oils of different types are held to point to a similar composition.

All data given in the original are included in the translated article. A. H. N.

Chemistry and Physics.

572. **Some Applications of the Kinetic Theory to the Behaviour of Long Chain Compounds.** H. Mark. *J. Appl. Phys.*, January 1942, **12** (1), 41–45.—If long-chain

molecules pass from the extended into the contracted state, a certain amount of curling energy and curling entropy may be developed. In recent years several authors have discussed these energy and entropy changes in connection with the elastic properties of long-chain high polymers. In this paper the melting points of long-chain compounds, their swelling tendencies, and their viscosities in dilute solutions are discussed mathematically.

A. H. N.

573. Structure and Dynamics of Liquids. W. E. Roseveare, R. E. Powell and H. Eyring. *J. Appl. Phys.*, September 1941, **12** (9), 669-679.—By co-ordinating information on viscosity, diffusion, melting, and other rate and thermodynamic properties, a detailed picture of liquid structure is built up. Thus it is found that a liquid is best thought of as a solid, to which a large number of empty equilibrium positions are added. In fact, the expansion on melting, as well as the expansion with a rise in temperature, arises almost entirely from this introduction of new equilibrium positions, and only to a minor extent from lattice expansion. Information is then obtained as to the number, size, and energy of formation of these empty lattice points.

A. H. N.

574. Correlation Between Elastic Moduli and Viscosity of Liquids and Plastics. A. Gemant. *J. Appl. Phys.*, September 1941, **12** (9), 680-685.—The chief purpose of this presentation is a practical one. The correlation appears to be valid also for plastic materials or for a series of materials ranging from the liquid to the plastic state. It is often required to know viscosity values of plastics where direct measurements are difficult or even impossible, yet the measurement of an elastic modulus is easy. On the other hand, it is often required to know the velocity of propagation of acoustical waves (*i.e.*, compressibility) of liquids for which viscosity measurements can be carried out much more easily and quickly.

By means of a simple theory, an equation, establishing a connection between elastic moduli of liquids and plastics and their viscosity, is derived. The equation, which contains two constants only, can be used either for a given substance in a range of varying temperature and pressure, or for a series of chemically related materials. The usefulness of the equation is shown on simple hydrocarbons, petroleum fractions, plasticized polyvinyl chlorides, and glasses.

A. H. N.

575. Frictional Phenomena. Part II. A. Gemant, *J. Appl. Phys.*, August 1941, **12** (8), 626-633.—On the basis of the kinetic theory, an explanation is given both of the viscous forces within a gas and of those external frictional forces operative between a gas and a wall. The extent to which the theory is able to reproduce the existing experimental data on the viscosity of different gases, and the variation of viscosity with pressure and temperature are shown.

A. H. N.

576. Frictional Phenomena. Part III. A. Gemant. *J. Appl. Phys.*, October 1941, **12** (10), 718-724.—The extent to which viscous processes can account for the absorption of freely travelling acoustical waves in gases is shown. Considerable divergence between theory and experimental data is found for polyatomic gases, and an explanation of this divergence on the basis of intramolecular vibrations is presented.

A. H. N.

577. Frictional Phenomena. Part V. A. Gemant. *J. Appl. Phys.*, December 1941, **12** (12), 827-836.—This paper presents theories of liquid viscosity, particularly those of van der Waals, Andrade, Prandtl, and Eyring. Whereas the viscosity of gases is based on the collisions of molecules, that of liquids is dominated chiefly by molecular attraction forces. Experimental material is presented on the effect of chemical constitution, temperature, pressure, and mixture ratio on viscosity, which effect is explained on the basis of existing theories. A brief outline of turbulent flow closes the paper.

A. H. N.

578. Frictional Phenomena. Part VI. A. Gemant. *J. Appl. Phys.*, February 1942, **13** (2), 90-96.—Colloidal particles present in solutions and suspensions increase the effective viscosity of the solvent. Einstein has presented the theory of this effect valid for spherical particles, and given an equation, deviations between which and experiments being due to either solvation or electric charge of the particles. Elongated

particles require a further modification of the formula. The theory is being successfully applied to the study of synthetic fibre molecules, and valuable information as to the shape of the latter can be derived by viscometric measurements on colloidal solutions of such polymers. A. H. N.

579.* Ultraviolet Light and Gasoline Testing. J. De Ment. *Refiner*, April 1942, **21** (4), 125-126.—References are given to books and previous papers dealing with the subject. Ultra-violet light may be employed for testing the stability of gasoline and for determining gum-forming tendencies. As contrasted to fluorescence work, unfiltered, high-intensity light from a mercury-quartz arc is employed for stability testing. Ultra-violet light gives good results in stability testing, whereas tests with white light have resulted in unsatisfactory evidence. A sample is exposed in crystallizing dishes covered with Cellophane, and then in Pyrex dishes to the radiations from a quartz-mercury arc drawing 5.4 amperes with a 110-volt drop, placed 30 centimetres away from the gasoline surface. The results are decisive, and show a difference in the quality of two gasolines between which bomb tests had failed to exhibit a marked difference. The tests were completed by bomb tests following the exposure to ultra-violet rays. When the gum did not exceed 10 milligrams, reproducible values were obtained, but with greater values the accuracy varied as much as 10%. The experimenters believed optimum conditions to be ultra-violet irradiation for 1 hr. and heating to 100° C. for 3 hr. In ordinary gasoline the case is slightly different for ultra-violet irradiation for 30 mins. and heating for 2 hr. suffices.

Tests for other purposes are described briefly. Special patent literature of interest in cracking oils, removing "bloom", precipitation of objectionable substances, etc., are mentioned. An interesting fact is that a solution of gasoline in alcohol, when placed in a fine capillary tube and exposed to ultra-violet light from a mercury arc, moves appreciably when in a horizontal position. This means that the surface tension of the solution changes and the order of movement is from 1 to 2 millimetres/hr. Other solutions also exhibit this interesting property. A. H. N.

580.* Hydrocarbon Hydrates. I. C. Bechtold. *Refiner*, April 1942, **21** (4), 115-118. *Paper Presented before California Natural Gas Association.*—Historical development of the subject is briefly discussed. The chemical composition of these hydrates is difficult to determine. After a survey of the theories advanced is made, Villard's theorem is quoted: "Dissociable compounds, capable of existing only in the solid state, formed by water with various gases, are isomorphous between themselves, and crystallize in the cubic system, and their composition is expressed by the general formula: $M \cdot 6H_2O$, where M represents one molecule of the gas under consideration."

This viewpoint is in agreement with the conclusions reached by Nikitin, and is consistent with the general aspects of hydrate formation as they would be developed from Werner's co-ordination theory. Although it now appears that there is considerable doubt as to the exact composition of many hydrates of normally gaseous substances, it is assumed for purposes of discussion that all the hydrocarbon hydrates contain six molecules of water. Hydrates of ethane, propane, and the butanes have been reported in the literature, and data have been published to show the conditions necessary for their formation. There is considerable doubt as to whether normal butane forms any hydrate; Hammerschmidt could not produce this hydrate at pressures up to 800 psi. To date, it is definitely true that no hydrates of hydrocarbons heavier than butane have been reported.

The conditions necessary for the formation of hydrates are high pressures, certain limitations to temperature and composition. For a given temperature there must always be no less than the equilibrium pressure in order that hydrate may exist. In connection with composition, it may be added that it is always necessary that the gas be saturated with respect to water vapour at the equilibrium point before hydrate crystals will appear. Although the primary conditions may be proper for hydrate formation, it is not always true that the solid will immediately appear. These gas-water mixtures have a tendency to exist for long periods under measurable conditions. Certain secondary effects play a large part in determining whether these solids will appear under field conditions. For example, high velocities, turbulence, pulsations from compressors, sharp bends and similar conditions, which readily promote a mixing

action, will augment the formation of the solid phase. On the other hand, conditions which result in low velocities and little turbulence may allow gases to exist without the formation of a solid phase, even though the three primary conditions may be in proper relationship for hydrate formation. Once the solid has formed, or has started to form, it will proceed very rapidly under proper conditions because of the "seeding" effect of the crystals which have developed. Hydrate control is studied with these principles in mind. Prevention of hydrate formation is advocated as a better safeguard than methods alleviating its troubles.

A. H. N.

Lubricants and Lubrication.

581. Mineral Oils in Hot Tinning. Anon. *Chem. Tr. J.*, 5.12.41, 109, 282.—Compounded oils have been developed by the Tin Research Institute in collaboration with an oil company, to replace tallow for hot tinning and palm oil for tin-plate making. The oils are specially selected mineral oils containing active agents, and are superior to the glyceride oils generally used for tinning in respect of, e.g., stability at high temperatures over a prolonged period. Their use is likely to lead to an improvement in the technology of the process. Results from large-scale trials by the Institute have been confirmed in industrial plants.

C. L. G.

582. Studies in Lubrication. Part X. F. Morgan, M. Muskat and D. W. Reed. *J. Appl. Phys.*, October 1941, 12 (10), 743-752. Studies have been made of the stick-slip behaviour recently investigated by Bowden and collaborators. The friction apparatus consists essentially of a table which can be made to rotate at a very low velocity and a slider elastically supported at the centre of rotation of the moving surface. Examples are shown of the stick-slip process with several combinations of metals at various speeds and loads. Motion pictures of the slider and table have been made in order to study possible slipping during the stick phase. Temperature records of the stick-slip cycle indicate that the temperature flash is confined exclusively to the slip period and in no case studied exceeds 50° C. above ambient. Traces made of the slip phase with very high camera speeds permit an analysis of the variation of kinetic friction with velocity. Thus both static and kinetic friction data can be obtained from a single stick-slip cycle.

From the conclusions reached as a result of these experiments, it appears that Bowden and Leben have ascribed properties to kinetic friction that in reality belong to their particular apparatus. The temperature flashes which occur only during the slip are to be expected and are due to dissipation of energy at this time. Melting temperatures are ordinarily not reached although they may readily be attained if the rate of generation of heat is large, due to high speeds or high loads; if the melting point of one of the metals is very low, or if heat cannot be conducted away as fast as it is generated. Nor is melting necessary to establish the stick-slip behaviour. This is evident from the fact that the slider sticks to the moving plate in the beginning, that is, before the very first slip occurs and consequently before any temperature flash takes place.

A. H. N.

583.* Examination of Used Crankcase Oil. L. L. Davis. *Refiner*, April 1942, 21 (4), 107.—The depreciation of an oil in service results from contamination from two major sources: (1) From sources external to the lubricating system. These extrinsic contaminants (such as those from the combustion zone) depend on the mechanical conditions of the engine, and are not a consequence of the kind or quality of the lubricant. (2) From sources inherent to the lubricating system and to the oil. These intrinsic contaminants result from the changes in the oil, and therefore depend on the quality of the oil as well as on the operating conditions.

The various methods most commonly used for the estimation of the changes that have occurred in a used oil are: (1) dilution by the fuel; (2) water content; (3) viscosity; (4) carbon residue; (5) neutralization number; (6) ash; (7) metal content; (8) naphtha insolubles; (9) chloroform insolubles; (10) chloroform solubles; (11) oil insolubles; (12) resin content. Due to the infinite number of possible combinations of oils, engines and operating conditions, the interpretation of the results of used oil analysis depends on a knowledge of the oil used, the type or make of engine, the service conditions,

and the condition of the engine after use. Such interpretation includes an evaluation of the quantity and character of the various contaminants in the used oil. These are discussed as extrinsic and intrinsic contaminants. Discussions are further made of asphaltenes; carbon residue, the viscosity and neutralization number of an oil; and of corrosion. Correlations are attempted, and the conclusion is reached that engineers engaged in research may obtain considerable reliable information from a study of the detailed analysis of the used oil in relation to engine conditions. This relationship is too complex to be used for control of routine operation by either the individual or the fleet owner. The correct period between drains must be determined by practical experience with representative oils, in specific equipment, and under given operating conditions. It must primarily be based upon engine conditions, although detailed oil analysis will assist in developing optimum drainage periods. To insure protection of equipment, such drainage periods should be substantially shorter than the indicated maximum useful life of the oil.

In general the recommendations of the equipment manufacturer or the oil company are on the conservative side in order to protect the consumer from troubles which might arise under severe conditions. Certainly, if equipment must be kept in condition for maximum performance under severe conditions, a conservatively short crankcase drainage period is to be recommended.

After the correct drainage period has been determined from experience in service, a drainage schedule in hours or miles of operation should be established and rigidly enforced. The paper ends with a list of standard and other test methods for oils.

A. H. N.

Special Products.

584. Sugar-Cane Wax. Anon. *Chem. Tr. J.*, 26.12.41, 109, 322.—The U.S. Dept. of Agriculture have investigated the extraction of wax from sugar-cane, and are to set up a pilot plant at Houma, Louisiana. The industry was originally established in Natal during 1914-18, using the discarded mud press-cake (since it was not practicable to extract the wax from the cane before clarification). Some 12 million lb. are stated to have been exported in 1924, in spite of disadvantages such as stickiness, and dark colour difficult to improve owing to residual fatty matter, and in some cases an objectionable odour, due to the putrefactive decomposition to which it is subjected to reduce the fat content.

In Louisiana extractions of different mud press-cakes have been made, toluene being the recommended solvent. Fatty fractions can be removed by extraction in the cold with, *e.g.*, acetone to give a range of waxes, the solvent being removed by distillation and blowing the wax with steam or air.

C. L. G.

585. Peroxide from Propane. Anon. *Chem. Tr. J.*, 2.1.42, 110, 11.—English Patents 540,534 and 541,110 of 1941, taken out by the Bataafsche Petroleum Mij., cover the production of hydrogen peroxide and organic peroxides from gaseous saturated hydrocarbons with two or more carbon atoms and saturated alicyclic hydrocarbons by incomplete combustion at, *e.g.*, 400-500° C. at a volume ratio of hydrocarbon to oxygen of at least 4 : 1. The gas mixture is admitted with turbulence into the walls of the vessel, which is made of non-rusting metal, being eventually burnt in the centre of the vessel. The reaction product is then rapidly discharged and cooled at, *e.g.*, 40° C., so that a portion of the by-products formed (H·CHO and CH₃·CHO) remains in the vapour phase. Contact between the peroxide and the metal at high temperatures is avoided by cooling the reaction vessel to below 200° C. with, *e.g.*, ethylene glycol. An example is given of the combustion of 70 c. metres per hour of a mixture of 98% vol. C₃H₈ and 10% O₂, yielding 8 litres of an aqueous solution containing chiefly H₂O₂ (20 mgm. equivalent of oxygen per cc.). By recycling a portion of the reaction gases with more oxygen and propane, the yield may be increased to about 60 litres.

C. L. G.

586. Physical Characteristics of Synthetic Rubbers. J. N. Street and J. H. Dillon. *J. Appl. Phys.*, January 1942, 12 (1), 45-56.—A summary of the nature and special applications of the more important types of synthetic rubbers is given. Two series

of rubber and synthetic rubber stocks, compounded on the basis of comparable pigmentation, were selected for study. In addition to the conventional physical properties (tensile strength and elongation at rupture, modulus, ageing, etc.), a number of other mechanical properties, such as dynamic rigidity, hysteresis loss, "blow-out resistance," "running temperatures," and tensile strength at elevated temperature were measured. Swelling tests in various solvents were also made. Results are plotted in the form of correlation charts in an effort to select proper methods of measurement. Some observations on comparative service tests in tyres in the case of three synthetic rubbers, indicate them to be satisfactory, on a quality basis, for use in time of emergency. The importance of care in selecting the proper physical tests and methods of analysis is emphasized in the light of the results given. It is concluded that rubber testing techniques and interpretation must be modified in certain instances in evaluating synthetic rubber stocks.

A. H. N.

587.* Hydroforming Process Now Used on Commercial Scale. M. H. Arveson. *Oil Gas J.*, 15.1.42, 40 (36), 53.—In the course of the hydroforming process a certain amount of polymerization occurs as side reaction, resulting in the formation of 2% or so of a polymer of complex aromatic character. The general characteristics of the polymer are: A.P.I. grav. 11.0, spec. dispersion 264, A.S.T.M. distillation I.B.P. 448° F., 50% over at 490° F., 90% over at 620° F. Properties of 65% and 80% overhead cuts from the polymer are also quoted. A high content of polycyclic aromatics is indicated by the properties shown. The total quantities likely to be available from plants under construction and definitely planned in the U.S. is 10 million to 15 million gals. per annum. Various tests which have been carried out on the polymer and on distillates indicate that they will be of value as an improved high-boiling rubber solvent, as solvent for paints, lacquers, etc., as component of paint removers, as solvent or plasticizer in connection with natural and synthetic resins, rubber, bakelite compositions, etc., as solvent for asphalt and gilsonite impregnating compositions, as component of insulating and cable oils, as ingredient of preservative compositions for application to wood and other materials of construction and also wrappings, as preventive of deposition in gas-mains, as absorber oil, as heat-transfer medium, as a flushing oil, as stabilizer for fuels against sediment formation, as component of insecticide and printing inks, as high-octane blending agent for tractor fuels, etc. Both polymer and its distillates have octane ratings of about 90 motor method clear and blending octane numbers of 95-120. It is expected that the polymer will become a material of importance in the industry.

R. A. E.

Detonation and Engines.

588.* Ignition System as Influenced by Fuel Characteristics. J. T. Fitzsimmons. *Soc. Aut. Engrs. J. (Trans.)*, 1942, 50 (1), 15-19.—Fuels of the same A.S.T.M. octane rating may differ widely in detonation characteristics when used in an engine over a range of speeds, as has been shown by co-operative tests to determine the spark advance for borderline knock throughout the speed range. Modern high-compression engines have become more critical as regards the design of automatic advance mechanism to combine maximum power with freedom from detonation on a variety of marketed fuels. The author suggests means of utilizing borderline knock tests, on all fuels which are likely to be used in practice, so as to obtain substantially knock-free operation with the minimum sacrifice of power.

Manufacturers commonly hold automatic advance curves within a tolerance of 3 to 4 engine degrees. This seems reasonable, since fuels of the same A.S.T.M. knock rating differ as much as 20° in spark requirements over the complete speed range, whilst engines vary as much as 18° between cylinders as a result of variations in compression ratio, temperature, and mixture conditions. The widest commercial tolerance on synchronism of timing from one cylinder to another is 3°, with more than half the units showing only about 1.5°. However, in many engines a great deal of accuracy is lost through distributor drive backlash, end-play in spiral gears and torsional vibration.

K. A.

589.* Bearings for Heavy-Duty Automotive Engines. A. B. Willi. *Soc. Aut. Engrs. J. (Trans.)*, 1942, **50** (2), 62-72.—Tin-base babbitt has many advantages as a bearing material, but its strength and hardness decrease rapidly at high operating temperatures. The demand for higher-capacity bearing materials has been met by the development of certain cadmium alloys and copper-lead mixtures. The load capacity of babbitt has also been increased by developing methods of manufacturing steel-back bearings with a lining of babbitt as thin as 0.0025-in. Very thin linings require special precautions as regards efficient air-cleaners and oil-filters to guard against scoring by foreign particles in the oil-stream. Requirements of economy and availability necessitate the use of corresponding thicker linings in replacement bearings for undersize shafts.

In a discussion of replacement bearings, the unfavourable effects of the following conditions are emphasised: worn and out-of-round journals, bowed crankshaft, warped crankcase, oval bearing bores, dirt within the engine, displaced bearing caps and improper clearance. Correct grooving is important, and it is shown that the addition of a centrally located internal annular groove will improve the load capacity of bearings with a high L/D ratio.

Increased use of copper-lead bearings may be enforced by shortage of cadmium and tin. These are less tolerant than babbitt of misalignment, incompatible oils, etc. It is a normal characteristic for copper-lead bearings to acquire a surface deposit, which may be one of three types:

- (1) A hard orange, brown or black lacquer;
- (2) A soft, dull-black deposit, associated with the use of detergent oils.

There is little evidence that either of the above are harmful.

- (3) A *hard dull* black deposit, definitely associated with corrosion, and possibly accompanied by surface pitting.

Corrosion may be due to high-temperature operation (selective lead loss) or low-temperature operation (selective copper loss), *i.e.*, heavy flow-by, poor crankcase ventilation and excessive idling. Fifteen rules are given for the installation of copper-lead bearings. K. A.

Coal and Shale.

590.* Natural Gas from Coal. Anon. *J. Inst. Fuel*, 1941, **15**, 81, 67.—An account of an article by L. Ranney (*Eng. Expt. Station News, Ohio State Univ.*) in which the possibility of recovering methane from coal *in situ* before mining is examined.

Coal is stated to be as permeable to gas as is the ordinary gas-sand of the natural gas-fields of America. An evacuated bore-hole will drain the methane from the coal within a 400-ft. radius. The suggested scheme consists of drilling horizontal holes through the coal-seam from mine workings, the holes being up to a mile in length and spaced at 800-ft. intervals.

It is claimed that such a scheme would recover 800-2000 cu. ft. of gas per ton of coal and would reduce ventilation costs and explosion hazards in coal-mines. C. G. G.

Economics and Statistics

591. World Oil Consumption in 1941. V. F. Garfias, R. V. Whetsel, and J. W. Ristori. *Oil Gas J.*, 12.2.42, **40** (40), 13.—The total world consumption of petroleum and its substitutes in 1941, excluding that for military purposes except in the U.S., is estimated to have been 2067 million brls., which is greater than the consumption in any previous year. Demand for military purposes, including addition to stocks, is estimated to have been 304.5 million brls. in countries outside the U.S.A. Consumption in the U.S.A. totalled 1492 million brls., of which motor fuel accounts for 671 million, kerosine 70 million, gas and fuel-oil 560 million, and lubricants 32 million brls. In Japan, production is estimated to have been 8.2 million brls., and civil consumption, based on 20% of that in 1938, 5 million brls. In other Axis-controlled countries production is estimated to have been 89 million brls. and civil consumption at 20% of that in 1938, 37 million brls. A table shows consumption of various products by countries. R. A. E.



INSTITUTE NOTES.

JUNE, 1942.

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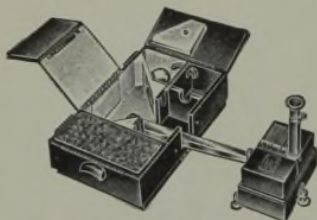
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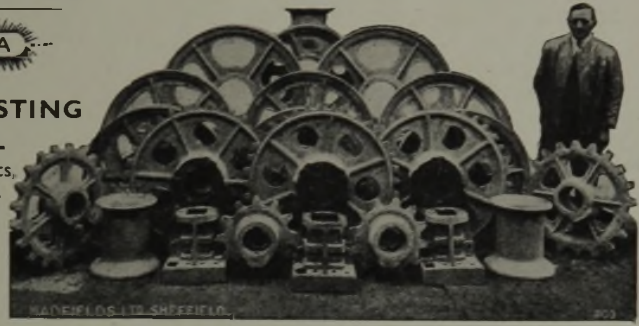


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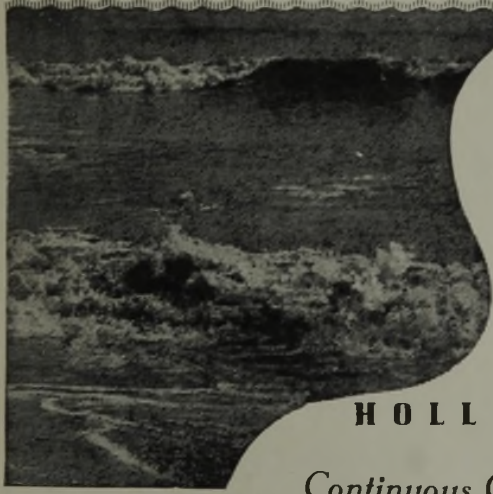
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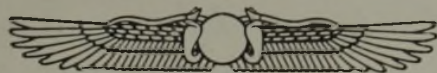
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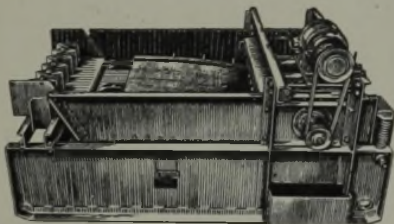
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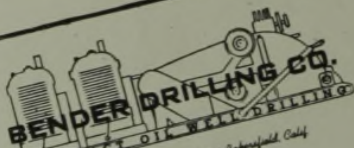
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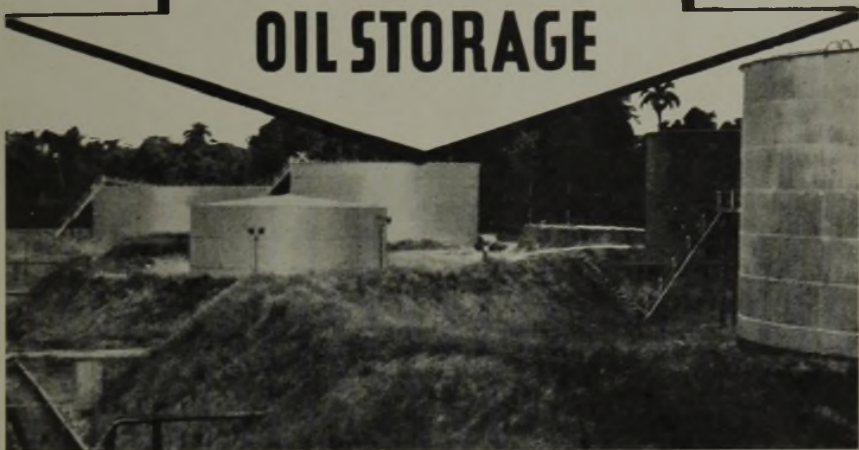
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The illustration shows a group of Oxley Arc-welded Tanks for oil storage, erected by us in Trinidad, B.W.I. We are specialists in the design, manufacture and erection of tanks for the storage of petroleum, oil, etc., and operators and plant are sent to any part of the world.

A recent contract in Trinidad included the cutting down of a Riveted Tank 114 ft. 6 in. dia. x 35 ft. 4 ins. deep, and re-erecting as a Welded Tank 30 miles from the original site, all seams being welded instead of riveted, allowing the depth of the tank to be increased to 38 ft. 6 ins.



TANKS ERECTED AND IN COURSE OF ERECTION IN TRINIDAD . . .

One tank, 114 ft. 6 ins. dia. x 38 ft. 6 ins. deep. Two tanks, 80 ft. dia. x 42 ft. deep. Four tanks, 50 ft. dia. x 40 ft. deep. Three tanks, 9 ft. dia. x 30 ft. long. Twenty tanks, 118 ft. dia. x 41 ft. 6 ins. deep. Five tanks, 70 ft. dia. x 37 ft. deep. Two tanks, 70 ft. dia. x 35 ft. deep.

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FOR OIL-FIRED FURNACES

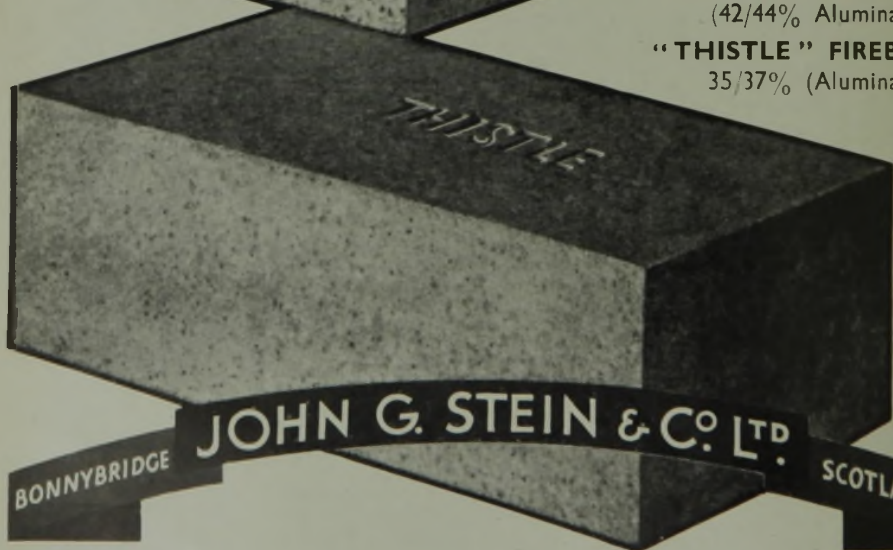
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(42/44% Alumina)

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Stabilisation

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Cracking

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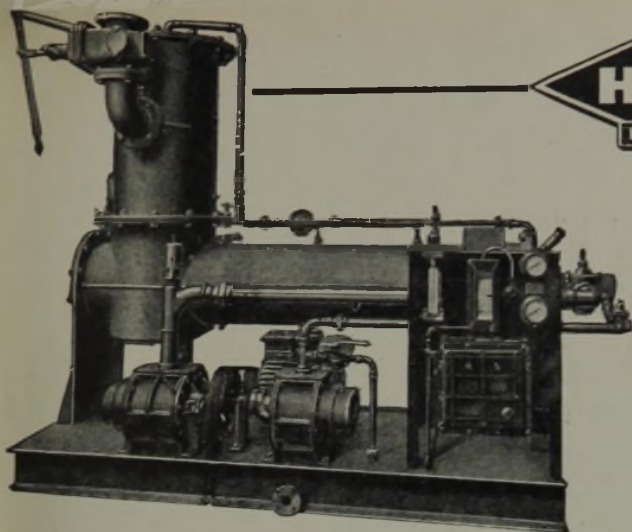
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Inert Gas from these machines is also extensively used for blanketing Oil Storage Tanks and Vacuum Filters in solvent de-waxing processes.

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deliver a positive reliable and oil free supply of Air or Gas economically and efficiently. Absence of internal contact ensures long life, low maintenance and continuous operation over long periods.

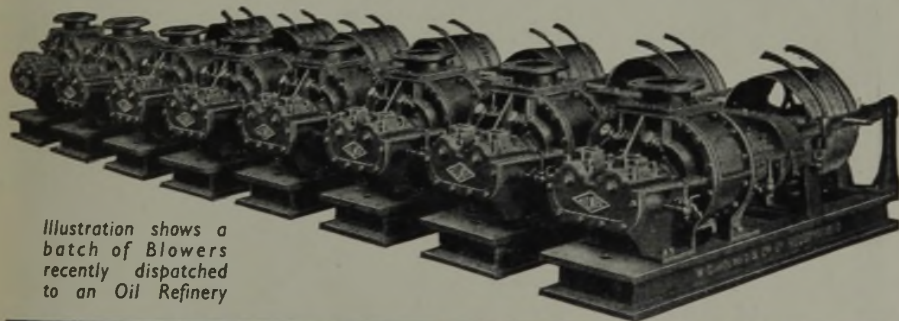


Illustration shows a batch of Blowers recently dispatched to an Oil Refinery

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