CETANE NUMBERS AND PHYSICAL PROPERTIES OF NORMAL ALKYL BENZENES AND OTHER HYDROCARBONS.

Part III. Evaluation of *n*-Alkyl Benzenes and Certain Related Hydrocarbons as Diesel Fuels.

By T. Y. Ju, B.Sc., Stud.Inst.Pet., C. E. Wood, M.Sc., F.Inst.Pet., and F. H. Garner, Ph.D., M.I.A.E., F.Inst.Pet.

Synopsis.

The cetane numbers of *n*-dodecyl benzene and *n*-tetradodecyl benzene were found to be 68 and 72, respectively. The blending curves for these two *n*-alkylated benzenes with low-standard-reference fuel are straight lines.

The blending cetane numbers of three diphenyl homologues were obtained by interpolation or extrapolation from blends with high-standard diesel reference fuel: the blending curves are not linear.

The cetane number of *m*-di*iso*propyl benzene is too low to be run straight in the engine. The blending cetane number as calculated from 50 per cent. blend is −3, and the cetane number of the unblended hydrocarbon as obtained by extrapolation is −12.

A summary is given of blending cetane numbers obtained in the present work and of those previously published in the literature, and, while the data are incomplete, they indicate that the hydrocarbons with a compact or highly branched structure tend to have low cetane numbers. There is thus a general similarity existing between octane number and cetane number, in that the type of structure which gives a high octane number also gives a low cetane number.

In a previous paper (*J. Inst. Petrol*, 1939, **25**, 695–703) the cetane numbers and blending cetane numbers of four mono-*n*-alkylated benzenes—namely, amyl, hexyl, heptyl, and nonyl benzenes—were described. In the present investigation two additional *n*-alkylated benzenes (alkyl group: C_{12} and C_{14}) have been investigated. The boiling points of these two hydrocarbons correspond to the highest-boiling fractions normally present in automotive diesel fuels, and thus, together with the other normal alkylated benzenes previously tested, comprise most of the particular hydrocarbons of this series which may be present in diesel fuels.

Biphenyl and two hydrocarbons derived from it—namely, diphenyl dimethane and dibenzyl—have also been investigated, and as these boil at normal atmospheric pressure at 254–284° C., they are within the diesel fuel range. Two other hydrocarbons have been investigated, *meta*-di*iso*propyl benzene (an isomer of the *n*-hexylbenzene tested in the previous series of hydrocarbons), and di*cyclo*hexyl, a fully-saturated, two-ring compound boiling at 238° C.

Mono-Alkylated Benzenes, *n*-dodecyl- and *n*-tetradecyl-benzene.

The table below gives the principal physical properties of the two *n*-alkyl benzenes under consideration.

Properties.	*n*-Dodecylbenzene.	*n*-Tetradecylbenzene.
Boiling point, ° C.	172–3/9 mm.	195–6/9 mm.
Density, $d_4^{15.5}$	0·8607	0·8605
Viscosity, in centistokes	4·2095 (100° F.) 1·5656 (210° F.)	5·6099 (100° F.) 1·9584 (210° F.)
Aniline point, ° C.	13·5	27·1
S.I.T. Moore apparatus in oxygen, ° C.	244	242

The engine tests were carried out on the C.F.R. Diesel Fuel Testing Unit in the Esso European Laboratories at Vauxhall, London, by Mr. A. Prizeman. The method adopted for the measurement of cetane number was the " Coincident-Flash Fixed Delay " method, using neon lights which are located on the periphery of the flywheel, and are operated by contact points on the combustion and injection indicators (A.S.T.M. Standards on Petroleum Products and Lubricants, issued October 1938, p. 8; *J. Soc. aut. Engrs*, 1938, **43**, 453). The combustion and injection indicators are of the bouncing-pin type, suitable provisions having been made for adjustment of the contact points. The operating conditions specified in this method are as follows :—

1. Engine speed	Constant, 900 ± 9 r.p.m.
2. Jacket temperature	Constant within ± 1° F. and at a temperature between 209° F. and 215° F.
3. Cooling liquid	Distilled water, or rain-water, or ethylene-glycol if necessary.
4. Crank case lub. oil	S.A.E. 30.
5. Oil pressure	25–30 psi.
6. Oil temperature	120–125° F.
7. Valve clearances, cold	Intake, 0·008 in. Exhaust, 0·010 in.
8. Injection advance	13° b.t.d.c. for rating. 5° b.t.d.c. for combustion contact setting.
9. Injection pressure (opening pressure)	1500 ± 50 psi.
10. Injection quantity	13·0 ± 0·5 ml./min.
11. Injector cooling water-jacket temperature	100 ± 5° F.
12. Air inlet temperature	150 ± 2° F.

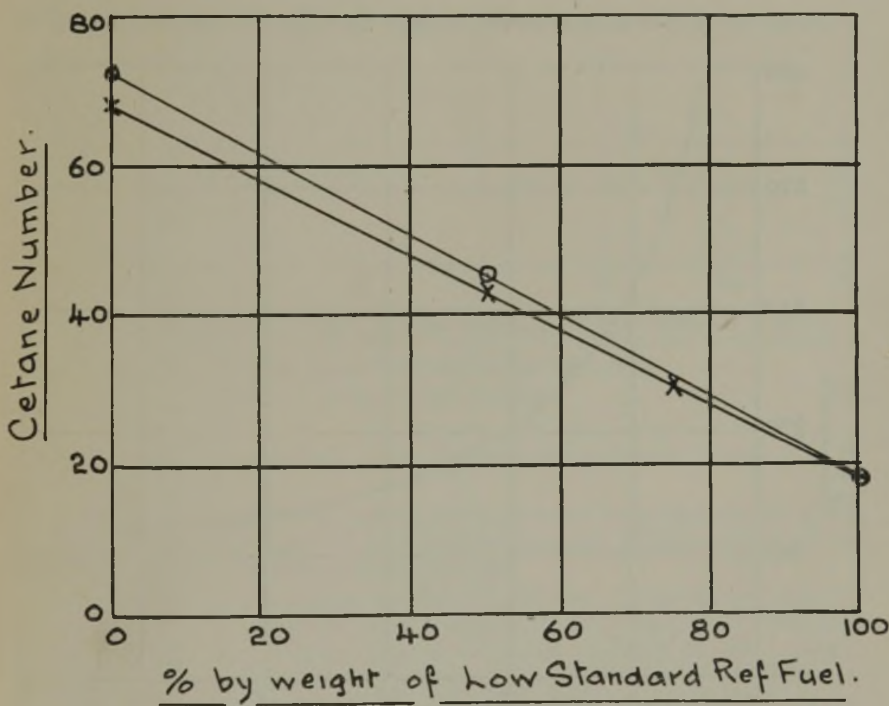
The cetane number of the unknown sample is estimated, and two reference-fuel blends, one of which has a longer delay period and the other a shorter delay period than the sample, are selected, differing by not more than eight cetane numbers. The cetane number of the fuel under test is calculated by interpolation from the required compression ratio, giving coincidence of the two neon flashes for each of the two reference fuels.

Two reference fuels, the I.P.T. high-ignition-quality and I.P.T. low-ignition-quality secondary reference fuels, were used to match the sample. The high standard fuel has a cetane number of 70·5, and the low standard a cetane number of 18. Fuels of any cetane number between 70·5 and 18 can be matched by mixing these two reference fuels. In the case of *n*-tetradecyl benzene, the cetane number was higher than that of the high-standard-reference fuel, so a blend of primary reference fuel of cetane and α-methylnaphthalene was used in matching the cetane number of the sample. In general, by careful operation, results are reproducible to within ±1 cetane number.

The following table shows the cetane numbers of the pure hydrocarbons and blends of the hydrocarbons with low-standard-reference fuel.

Hydrocarbons.	Cetane number, % by weight of hydrocarbon in blends with low-standard-reference fuel.			
	100%.	50%.	25%.	0%.
n-Dodecyl benzene . . .	68	43	31	18
n-Tetradecyl benzene . .	72	45	—	18

These experimental results are shown in Fig. 1, which gives the relationship between the cetane numbers of blends of low-standard-reference fuel and of the pure hydrocarbons against the percentage by weight of low-standard-reference fuel in the blends. Here the relationship is linear in both cases, the blending cetane numbers being the same as when the hydrocarbons are run straight in the engine.



× *n*-Dodecyl benzene.
⊙ *n*-Tetradecyl benzene.

Fig. 1.

BLENDING CURVES OF *n*-ALKYL BENZENES WITH LOW STANDARD REFERENCE FUEL.

The following table summarizes the results of the six alkylated benzenes so far investigated.

(Cf. *J. Inst. Petrol.*, 1939, **25**, 695–703).

	n-Amyl benzene.	*n*-Hexyl benzene.	*n*-Heptyl benzene.	*n*-Nonyl benzene.	*n*-Dodecyl benzene.	*n*-Tetra-decyl benzene.
S.I.T., ° C. (Moore's apparatus in oxygen . . .	276	261	255	247	244	242
V.G.C.[1] (Moore and Kaye) .	0·9933	0·8795	0·8725	0·8623	0·8464	0·8402
Cetane number from V.G.C.[1] .	7·3	43·8	47·5	50·8	56·3	58·3
Cetene number from ring analysis[2]	30·3	35·1	38·0	45·4	52·2	55·5
Aniline point, ° C. . .	<−12	<−12	<−12	−12·3	13·5	27·1
Diesel index[3]	—	—	—	3·2	18·6	26·7
Cetane (cetene) number by A.S.T.M.–C.F.R. method[4] .	8 (10)	26 (30)	35 (40)	50 (57)	68 (78)	72 (82)
Blending cetane number from 50% blend . . .	18	32	39	51	68	72

[1] G = 1·082A − 0·0887 + (0·776 − 0·72A) log log (KV-4). A = 1·015 − 0·003N. Cf. Moore and Kaye, *Oil Gas J.*, 15.11.34, **33** (26), 108.

[2] Cetene number = −0·2A + 0·1N + 0·85P. Cf. Kreulen, *J. Inst. Petrol. Tech.*, 1937, **23**, 253.

[3] Diesel index = $\frac{\text{Aniline point, °F.} \times \text{A.P.I.°}}{100}$. Cf. Becker and Fischer, *J. Soc. aut. Engrs*, 1934, **35**, 376–380.

[4] *Loc. cit.*

From the above comparison it is clear that for this particular class of

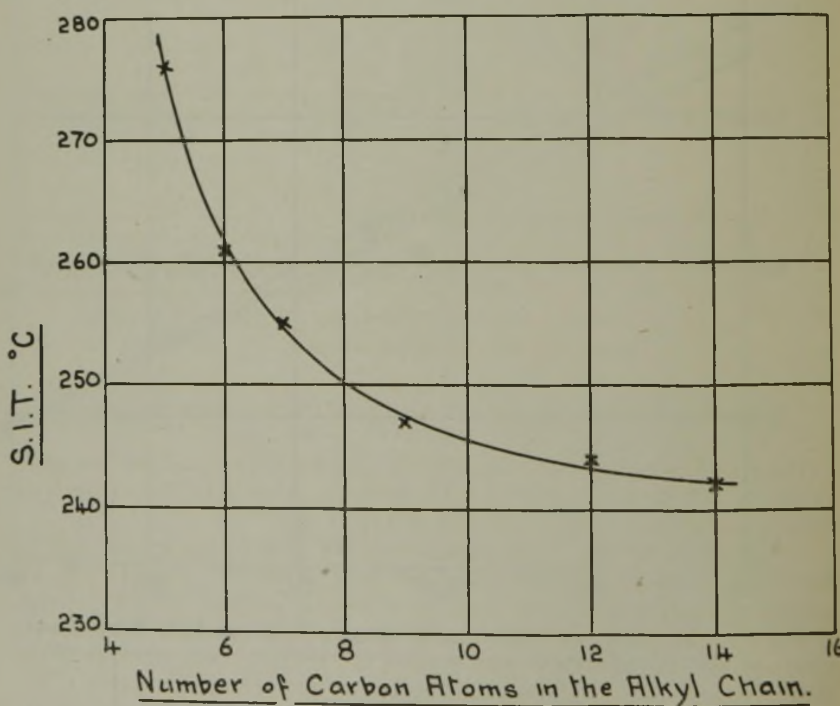
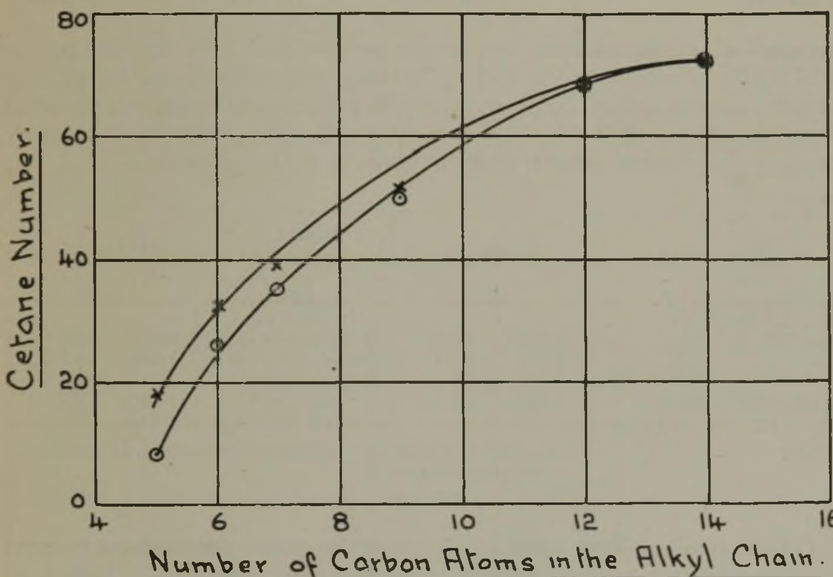


FIG. 2.

SPONTANEOUS IGNITION TEMPERATURES OF *n*-ALKYL BENZENES AGAINST CHAIN LENGTH.

hydrocarbon, the cetene numbers obtained by engine tests differ considerably from those calculated from the formulæ of V.G.C. and ring analysis. Aniline points and diesel indices are available for only three of the hydrocarbons, and these increase regularly with increasing cetane number. The relationship between aniline point and cetane number is, however, quite different from that found for gas oils from petroleum, for which diesel index and cetane number are of about the same numerical order. S.I.T. data are in corresponding order (the lower the S.I.T. the higher the cetane number) to the results of the engine tests, but, as will be seen later, the relationship between S.I.T. and cetane numbers varies for hydrocarbons of different series.



× Blending cetane number from the 50% point.
⊙ Cetane of unblended hydrocarbons.

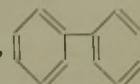
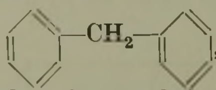
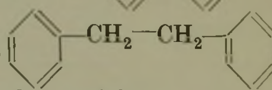
FIG. 3.

CETANE NUMBERS OF *n*-ALKYL BENZENES AGAINST CHAIN LENGTH.

The spontaneous ignition temperatures of these hydrocarbons are given in Fig. 2. With increase of chain length the curve flattens and tends to become asymptotic to the chain length axis.

Fig. 3 shows (*a*) the cetane numbers of the pure hydrocarbons, and (*b*) the blending cetane numbers calculated from 50 per cent. points which are plotted against chain lengths (number of carbon atoms in the alkyl chain). It is seen from the graph that the blending cetane numbers of the lowest members are, in every case, higher than the actual cetane numbers of the pure hydrocarbon. The difference, however, diminishes with ascent of the series, and for *n*-dodecyl and *n*-tetradecyl benzenes the two values are identical. It will be noted that the blending curves for the first four hydrocarbons were determined on blends with low-reference-standard fuel and for the last two with high-reference-standard fuel: it is not known whether this has any bearing on the results, although the first four appear to lie on different curve for the last two points.

Biphenyl and Homologues of Biphenyl.

Only the blending cetane numbers of biphenyl, , diphenyl methane, , and dibenzyl, , were determined, owing to their low cetane number and high melting points. The hydrocarbons were purified by heating with sodium and by vacuum distillation over sodium (diphenyl methane) or recrystallizing several times from absolute alcohol (biphenyl and dibenzyl). The following table summarizes the physical properties as determined in the laboratory.

Properties.	Biphenyl.	Diphenyl methane.	Dibenzyl.
Melting point, ° C.	69·1	24·8	53·0
Boiling point, ° C.	—	117–8/9 mm.	—
Density, d^t_4	0·9861 (80° C.)	1·0002 (26° C.)	0·9590 (60° C.)
Viscosity, in centistokes	1·302 (80° C.)	2·238 (100° F.)	1·998 (60° C.)
	1·078 (200° F.)	1·087 (200° F.)	1·218 (200° F.)
Refractive index	1·5870 (75° C.)	1·5739 (25° C.)	1·5476 (60° C.)
n^t_D	—	1·5713 (30° C.)	1·5455 (65° C.)
S.I.T.	The S.I.T. of biphenyl, diphenyl methane, and dibenzyl are all over 440° C.		

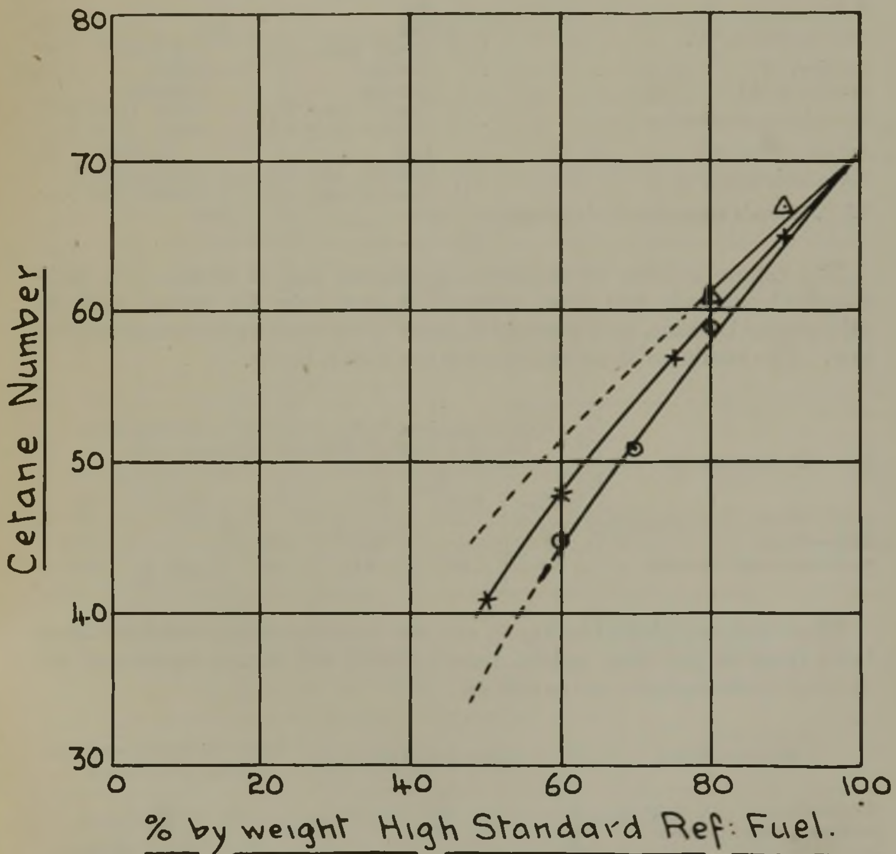
Cetane numbers were made on blends of the pure hydrocarbons in high-ignition-quality secondary reference fuel (cetane number 70·5). Only low-concentration blends of biphenyl could be investigated, owing to the low solubility in the secondary reference fuels. The results obtained are given below:—

Hydrocarbons.	Cetane numbers, % by weight of hydrocarbon in blends with high-standard-reference fuel.						
	50%.	40%.	30%.	25%.	20%.	10%.	0%.
Biphenyl	—	—	—	—	61	67	70·5
Diphenyl methane	41	48	—	57	—	65	70·5
Dibenzyl	—	45	51	—	59	—	70·5

Fig. 4 shows cetane numbers of blends plotted against the percentage by weight of high-standard-reference fuel in the blends. There appears to be a slight curvature for all the three blending curves, which makes it difficult to estimate what is the actual cetane number of the unblended hydrocarbons. The following blending cetane numbers are calculated from the curves either by interpolation or by extrapolation.

Hydrocarbons.	Blending cetane numbers.	
	From 25% blend.	From 50% blend.
Biphenyl	47*	21*
Diphenyl methane	43	11
Dibenzyl	39	1*

* Extrapolated, see Fig. 4.

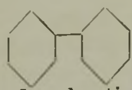
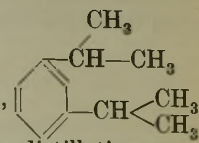


△ Biphenyl.
× Diphenyl methane.
⊙ Dibenzyl.

FIG. 4.

BLENDING CURVES OF DIPHENYL HOMOLOGUES WITH HIGH STANDARD REFERENCE FUEL.

Dicyclohexyl and m-*Diisopropylbenzene.*

Dicyclohexyl, , and *m*-di*iso*propyl benzene,  were purified (after heating with sodium) by vacuum distillation over sodium. The following table gives the determined principal physical properties of the two hydrocarbons.

Properties.	Dicyclohexyl.	*m*-Di*iso*propyl benzene.
Melting point, ° C.	4·2	—
Boiling points, ° C.	238·5 95–6/9 mm.	204 75–6/9 mm.
Density, d_4^{20}	0·8865	0·8596
Sp. Gr. 60/60	0·8906	0·8638
Viscosity in centistokes	3·057 (100° F.) 1·235 (210° F.)	1·250 (100° F.) 0·644 (210° F.)
Aniline point, ° C.	48·2	miscible
Refractive index, n_D^t	1·4795 (20° C.) 1·4745 (30° C.)	1·4890 (20° C.) 1·4850 (30° C.)
S.I.T. Moore's apparatus in oxygen, ° C.	257	416

The cetane number of di*cyclo*hexyl benzene and of blends with high-standard-reference fuel were determined, but only for blends with *m*-di*iso*propyl benzene, as the cetane number of the pure hydrocarbon was too low. The results of these engine tests are shown below.

Hydrocarbons.	Cetane number, % by weight of hydrocarbon in blends with high-standard-reference fuel.					
	100%.	65%.	50%.	25%.	10%.	0%.
Di*cyclo*hexyl	53	—	61	66	—	70·5
m-Di*iso*propyl benzene	—	21	34	53	64	70·5

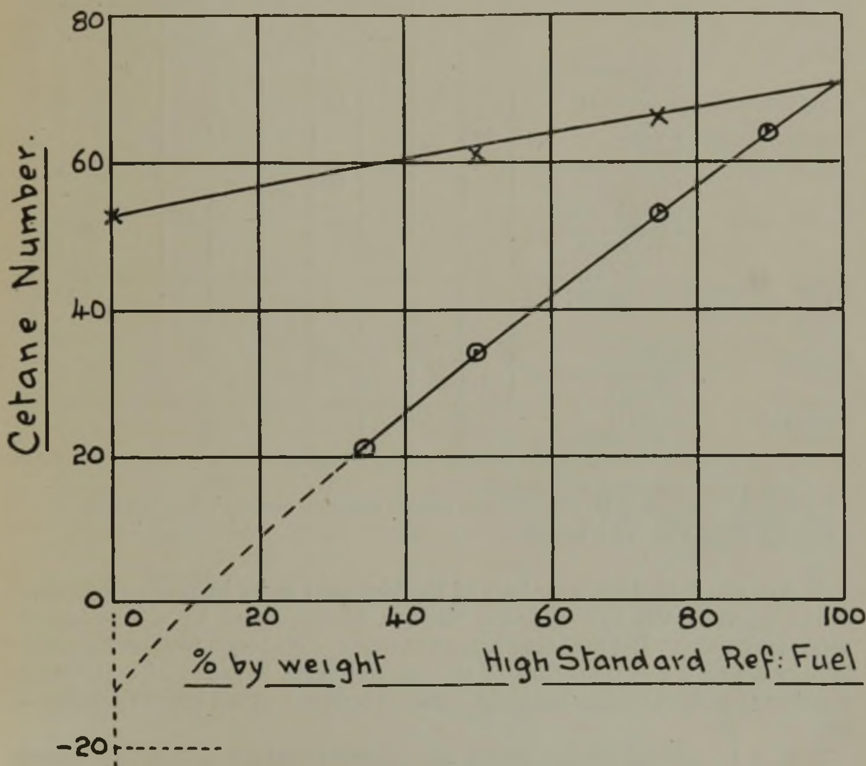
These data are plotted in Fig. 5, and the blending cetane numbers calculated from 50 per cent. points, together with the cetane number of unblended hydrocarbons, are as follows :

Hydrocarbons.	Cetane number.	Blending cetane number from 50% blend.
Di*cyclo*hexyl	53	53
m-Di*iso*propyl benzene	−12*	− 3

* Extrapolated, see Fig. 5.

Since di*cyclo*hexyl consists of two naphthenic rings, the cetene number calculated from Kreulen's formula (*loc. cit.*) of ring analysis should be 10, which deviates greatly from the experimentally determined figure. The following table shows the evaluation based on laboratory methods.

	Di*cyclo*hexyl.	*m*-Di*iso*propyl benzene.
S.I.T., ° C. (Moore's apparatus in oxygen) .	257	416
V.G.C. (Moore and Kaye)	0·8854	0·8843
Cetene number from V.G.C.	43·2	43·6
Cetene number from ring analysis . . .	10	—
Diesel index	33·7	—



× Di*cyclo*hexyl.
⊙ *m*-Di*iso*propyl benzene.

Fig. 5.

BLENDING CURVES OF DI*cyclo*HEXYL AND *m*-DI*iso*PROPYL BENZENE WITH HIGH STANDARD REFERENCE FUEL.

A summary of the available data on cetane numbers and pure hydrocarbons is given in the following table and Fig. 6. The cetane numbers given are mainly blending cetane numbers based on 50 per cent. blends for the various series of hydrocarbons, and in Fig. 6 the cetane numbers are plotted against the total number of carbon atoms present.

1. The cetane number of benzene substituted by normal alkyl group of progressively increasing lengths of chain show a minimum in the curve beyond toluene, and tends to approach the maximum as the number of

carbon atoms approaches 20. Thus the initial substitution of paraffin groups actually results in lower cetane number, but with increasing length of chain paraffin substitution becomes more effective and the cetane number rises.

Blending Cetane Numbers (based on 50 per cent. blend).

Type of hydrocarbon.	Hydrocarbon.	C_6.	C_7.	C_{11}.	C_{12}.	C_{13}.	C_{14}.	C_{15}.	C_{16}.	C_{18}.	C_{20}.
Paraffin	Cetane								100		
Olefine	Cetene								88[a]		
	Tetra*iso*butylene								5[b]		
Dicyclic naphthene	Di*cyclo*hexyl				53[c]						
Benzene, substituent—a straight chain	Benzene	−10[c]									
	Toluene		−21[c]								
	n-Amyl benzene			18[d]							
	n-Hexyl benzene				32[d]						
	n-Heptyl benzene					39[d]					
	n-Nonyl benzene							51[d]			
	n-Dodecyl benzene									68[c]	
	n-Tetradecyl benzene										72[c]
Benzene, substituent—a branched chain	*m*-Di*iso*propyl benzene				−3[c]						
Biphenyl	Biphenyl				21[c]						
	Diphenyl methane					11[c]					
	Dibenzyl						1[c]				
Naphthalene series	α-Methyl-naphthalene			0							

[a] *J. Inst. Petrol. Tech.*, 1938, **24**, 170–175.
[b] *J. Soc. aut. Engrs*, 1932, **31**, 283–293 (figure given is actual not blending cetane number).
[c] Present paper, Figs. 7 and 8.
[d] *J. Inst. Petrol. Tech.*, 1939, **25**, 695.

2. For the first three members of the biphenyl series increasing length of chain between the two benzene rings is accompanied by a decrease in cetane number. The blending cetane number of biphenyl itself is 20, which is only slightly less than that of the normal alkyl benzene with the same number of carbon atoms—namely, dodecyl benzene with a cetane number of 32.

3. For 11 and 12 carbon atoms the cetane numbers of 3 hydrocarbons with 2 rings are available. Of these, saturated di*cyclo*hexyl has the highest cetane number—namely, 53—biphenyl 21 and the condensed two-ring—α-methylnaphthalene—by definition has a cetane number of 0.

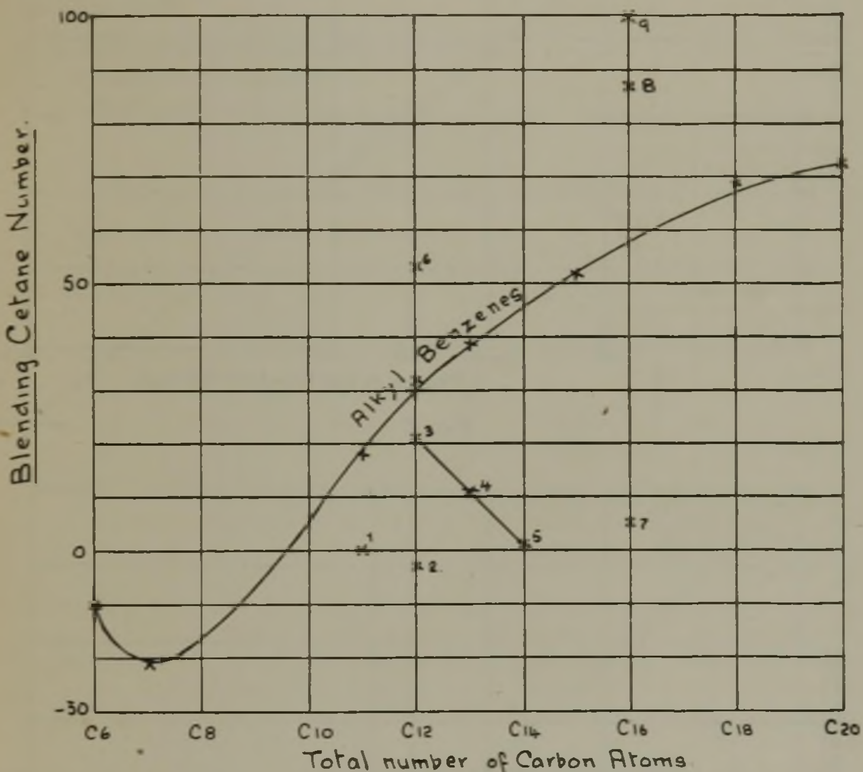
4. The effect of branched chain is shown by the very low cetane number of *m*-di*iso*propyl benzene—namely, − 3—as compared with 32 for the straight-chain hydrocarbon normal dodecyl benzene.

5. For the hydrocarbons containing 16 carbon atoms the paraffin hexadecane is highest, the olefine hexadecene slightly lower, the corresponding *n*-alkyl benzene can be assumed to be about 56, and the highly branched olefine tetra*iso*butylene is much the lowest—namely, only 5.

6. While the data so far available are relatively incomplete, the indications are that hydrocarbons of highly branched structure, or of compact structures such as closely connected rings, have a very low cetane number. There appears to be a general similarity between cetane numbers and octane numbers from the point of structure, in that the type of structure

which produces high octane numbers gives correspondingly low octane numbers.

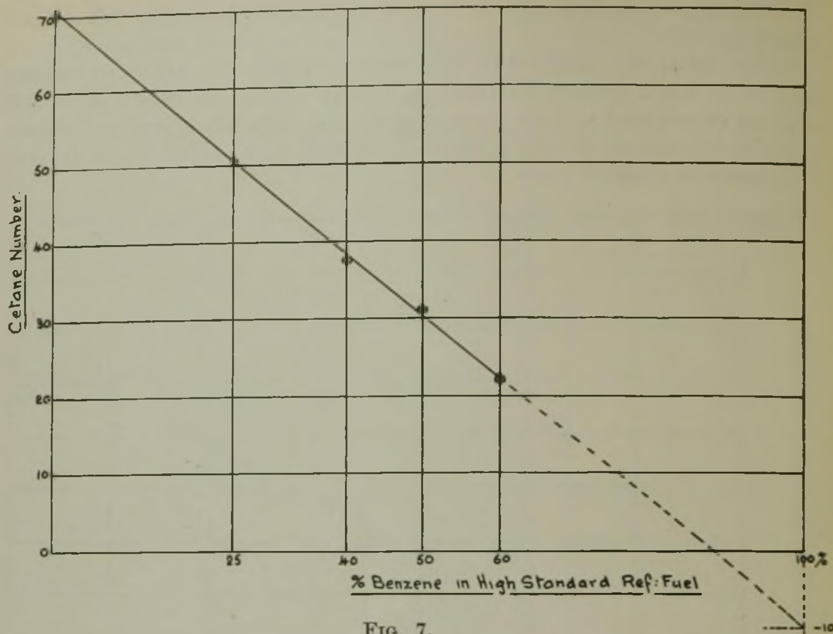
Wilke (*Aut. Z.*, 1940, 148–149) has proposed the equation octane number = 120–2 (cetane number). This was based on blends of octane heptane cetane and α-methylnaphthalene, but does not appear to hold for other hydrocarbons, of which both cetane and octane numbers are known, although it is a useful guide.



1. α-Methyl naphthalene.
2. *m*-Di*iso*propyl benzene.
3, 4 & 5. Diphenyl homologues.
6. Di*cyclo*hexyl.
7. Tetra-*iso*butylene.
8. $C_{16}H_{32}$ Cetene.
9. $C_{16}H_{34}$ Cetane.

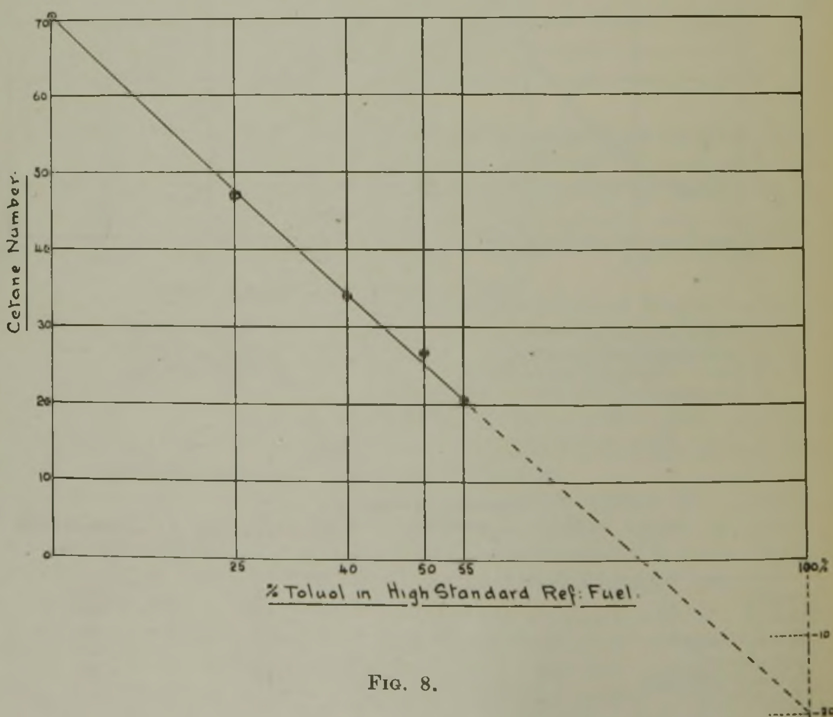
FIG. 6.

	Blending cetane number.	Octane number.	
		As determined.	Calculated from formula.
Benzene	−10	87	140
Toluene	−21	90	162
n-Amyl benzene . .	18	101	84
Di*cyclo*hexyl . . .	53	− 7·5	14
Diphenyl methane . .	11	128	98



Cetane Number.
70
60
50
40
30
20
10
0
25
40
50
60
100%
-10
% Benzene in High Standard Ref: Fuel

FIG. 7.



Cetane Number.
70
60
50
40
30
20
10
0
25
40
50
55
100%
-10
-20
% Toluol in High Standard Ref: Fuel.

FIG. 8.

7. Blends of gas oils derived from petroleum usually give straight-line blending curves, and certain of the hydrocarbons investigated in this work have given straight-line blending curves. Thus the lower alkyl benzene have blending cetane numbers higher than the actual cetane numbers, whereas for two highest members investigated blending and actual cetane numbers are the same. Similarly there is an indication that biphenyl gives curved blending lines, and it would appear that further work should be done on this subject.

Department of Oil Engineering and Refining,
Birmingham University,
Edgbaston.

GAMMA-RAY WELL-LOGGING IN TRINIDAD.

THE following illustrations to "Gamma-Ray Well-Logging in Trinidad," by Glenn M. Conklin, were received after publication of the paper in the July, 1942, issue of the *Journal* (*J. Inst. Petrol.*, 1942, **28**, 141–145).

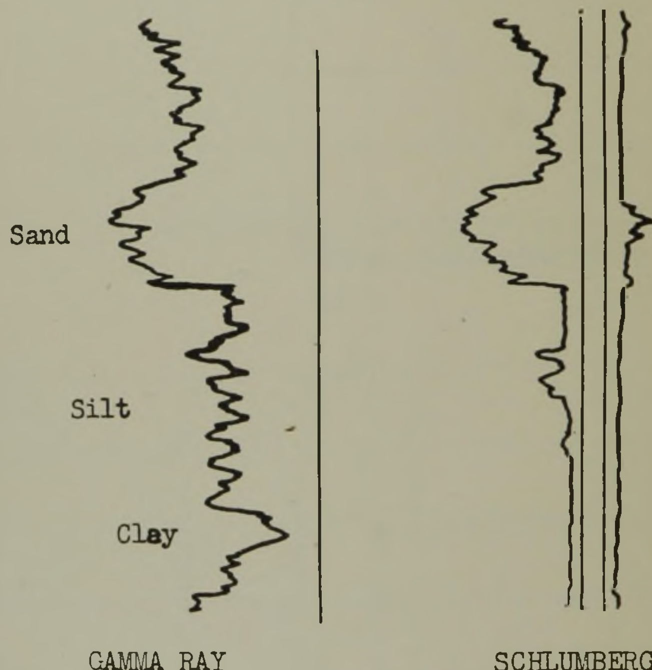


FIG. 1.

COMPARISON OF A SCHLUMBERGER LOG AND A GAMMA-RAY LOG MADE IN THE SAME HOLE.

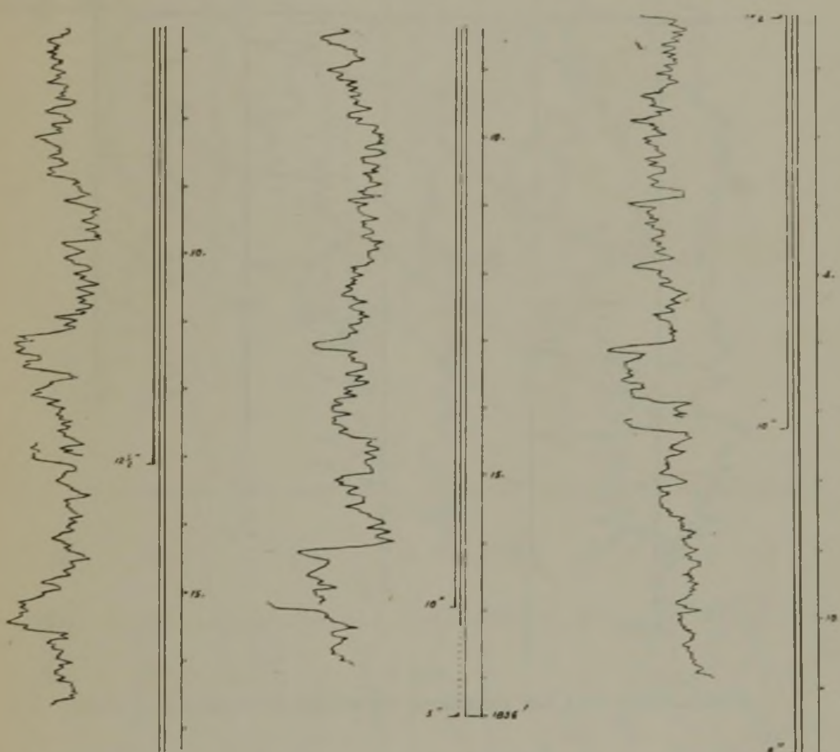


FIG. 2.

LOGS SHOWING EFFECT OF ADDITIONAL STRING OF CASING ON ABSORPTION OF GAMMA-RAYS.

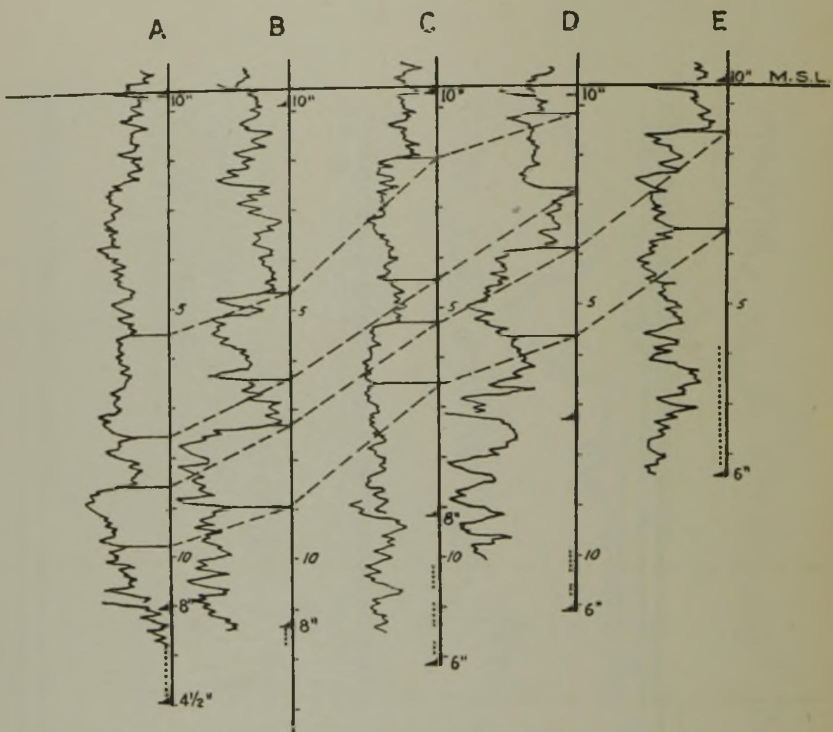


FIG. 3.

CORRELATION IN A DIP DIRECTION BY MEANS OF GAMMA-RAY LOGS.

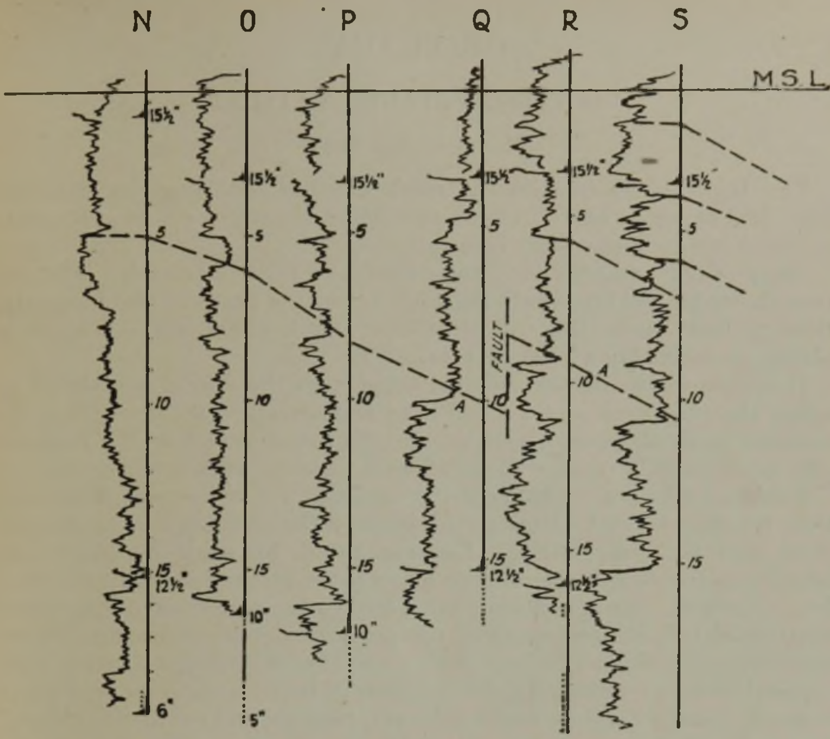


FIG. 4.

SERIES OF GAMMA-RAY LOGS SHOWING LOCATION OF A FAULT BY CORRELATION OF THE LOGS.

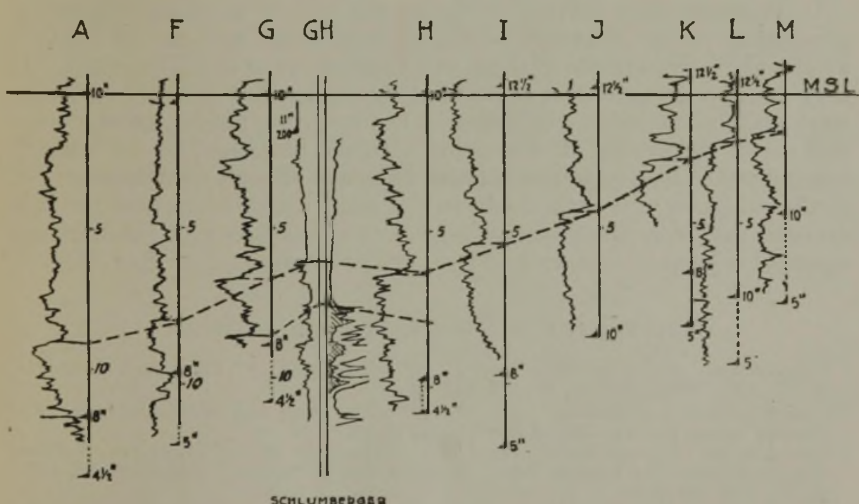


FIG. 5.

GAMMA-RAY LOGS FOR A SERIES OF WELLS ADJACENT TO AN ELECTRICALLY LOGGED WELL. THE LOGS WERE STUDIED FOR CORRELATION AND POSSIBLE PERFORATION.

OBITUARY.

PROFESSOR STANISLAS PILAT.

(Member 1925–1941).

The Institute learns with the greatest regret that Professor Stanislas Pilat died at enemy hands in Lvow recently. He was sacrificed at the altar of Polish science and culture by a ruthless foe.

Many of our senior Fellows knew Professor Pilat intimately. The last time the writer met him was in Delft just before the war, and, unfortunately, there is little news these days of our Dutch colleagues—all equal in ability, scientific knowledge, and humanity.

It is grievous to all right-minded people that the dogs of war should so afflict the very men whose whole lives and activities are devoted to the common good, and surely a grievous retribution must fall on the assassins who are responsible for the blood of these innocent scientists.

Professor Pilat was a prolific writer, and a survey of his researches shows that he studied with characteristic energy the chemistry of naphthenic acids and their derivatives. Looking ahead, his work on gases and selective solvents will clearly give him a place in the hierarchy of petroleum chemists. He was always interested in the synthesis of compounds that simulated, or even excelled, the properties of natural hydrocarbons. Had he lived to the full fruition of his acute mental activities he would have rejoiced in the overwhelming development of better and better products—aviation spirit, fuels, lubricants, solvents, plastics, and synthetic rubbers.

Our thoughts go out to his widow, Madame Newman-Pilat, formerly his brilliant pupil. Their last joint paper was dated 1940 and appeared in the *Journal of Applied Chemistry* (*U.S.S.R.*) A. E. D.

In Professor Pilat German barbarity has robbed us of an outstanding personality in the world of petroleum technology and one who was a loyal and generous friend of those who could claim to be his intimates. It may be hoped that when opportunity occurs a full account of Pilat's work may be prepared or a memorial lecture given, for his investigations and career are worthy of close study. In the meantime we can but pay our tribute to him. He was a great Pole, and though no details are yet forthcoming, there is little doubt in my mind that his imprisonment and assassination were the result of refusal to co-operate with the Germans against his beloved country and its friends and allies. S. J. M. A.

Bibliography of Professor Pilat's Works.

"Sulphonation of Naphthenic Acids." W. Kisielewicz, S. Pilat, and J. Sereda. *2nd Congres Mond. Petrole*, 1938, **2**, 435–439.

"Constitution of Lubricating Oils." J. Müller, S. Pilat, and W. Szankowski. *2nd Congres Mond. Petrole*, 1937, **2** (Sect. 2), 123–125.

"Detection of Phenosulphonic Acids in the Products of the Interaction between Sulphuric Acid and Mineral Oils." S. Pilat and J. Sereda. *Przem. Chem.*, 1938, **22** (11–12), 459–463.

"Fractionation of Heavy Oils by Solutions of Gases at Ordinary Temperature." M. M. Godlewitz and S. Pilat. *2nd Congres Mond. Petrole*, **2** (Sect. 2), 883–886.

"Preparation of Naphthene–Sulphonic Acids from Petroleum." S. v. Pilat and N. Turkiewicz. *Petrol Z.*, 23.2.38, **34** (8), 5.
"Naphthene Hydrocarbons of High Molecular Weight." J. Müller and S. v. Pilat. *Brennst.-Chemie*, 1936, **17**, 461–465.
"Sulphonated Naphthenic Acids." S. v. Pilat and M. Turkiewicz. *Petrol. Z.*, 13.10.37, **33** (41), 1.
"Fractionation of Petroleum Residues with Natural Gas under Pressure." S. v. Pilat. *Oil Gas J.*, 23.7.36, **35** (10), 54.
"Solutions of Gases as Selective Solvents." M. Goddewicz and S. Pilat. *Przem. Chem.*, 1934 (10–12), 376–385.
"Mineral Oil Sulphonic Acids IV." S. v. Pilat and W. Szankowski. *Petrol. Z.*, 6.3.35, **31** (10), 1–6.
"Fractionation of Residues, etc., by Means of Natural Gas." S. v. Pilat. *Oel und Kohle*, 1935, **11**, 655–658.
"Cyclic Constituents of Petroleum Ceresin." J. Müller and S. v. Pilat. *J. Inst. Petrol. Tech.*, 1935, **21**, 887–894.
"Sulphonic Acids from Petroleum." E. N. Newman and S. Pilat. *Industr. Engng Chem.*, 1934, **26**, 395–396.
"Seventh Meeting of Polish Oilmen." S. Pilat. *J. Inst. Petrol. Tech.*, 1934, **20**, 821–828.
"Cyclic Components of Paraffin Wax." J. Müller and S. v. Pilat. *Nature*, 1934, **134**, 459.
"Wax in Petroleum Asphalts." J. Müller and S. v. Pilat. *Asphalt u. Teer*, 1934, **34**, 649–654.

SINCE THE WAR.

"Petroleum Sulphonic Acids." S. Pilat and J. Sereda. *Refiner*, February 1940, **19** (2), 50–52.
"Properties of Synthetic Lubricating Oils. Synthesis and Properties of 11-normal-decyldocosane." S. Klos, E. Newman-Pilat, and S. Pilat. *J. Appl. Chem. U.S.S.R.*, 1940, **13** (a), 1369–1374. Translated by A. A. Boehtlingk for *Petrol. Tech.*, November–December, 1940, **8** (11–12), 438.

DR. LEOPOLD SINGER.

DR. LEOPOLD SINGER, a native of Vienna, who died in London on 10th June, in his 73rd year, came of a petroleum-minded family. His father, Wilhelm, was one of the foremost pioneers of the Austro-Hungarian-Rumanian petroleum industry, and owned a refinery in Orsova (Rumania, formerly Hungary).

After matriculating in Vienna in 1887, Dr. Singer continued his studies at the Polytechnic at Zurich under Professor Lunge, and took the degree of "Technical Chemist." At Karlsruhe he prepared a thesis under Professor Engler, and in 1893 the University of Zurich conferred upon him the degree of Doctor of Philosophy.

He started his practical career at his father's refinery at Orsova, and began to replace the empirical methods ruling at that time by more scientific methods. Crude-oil distillation and cracking procedure were improved and the technique of fully refining paraffin waxes was developed. The sweetening of petrol, the use of fuller's earth, the recovery of low-boiling point petrol (0·625) from the distillation gas were the new inventions due to him.

In 1903 Dr. Singer took charge of the Fanto A.G. (Czechoslovakia, at that time Austria), which post he held until 1912. Under his management the refinery became perhaps the biggest and best equipped in Europe.

In 1914 Dr. Singer was entrusted with the completion and management of the lubricating-oil plant of the Rhenania Refinery in Duesseldorf. In 1918 he was appointed consultant to the Allgemeine Depositenbank in Vienna, and in 1926 he joined the Universal Oil Co. of Chicago as chemical consultant, a post he held until his death.

Dr. Singer took out numerous patents, especially on fractionating columns, high-vacuum distillation plants, lubricating-oil and paraffin-wax production, etc.

The literary activities of Dr. Singer were as extensive and successful as his industrial career, and particular reference should be made to his contributions to C. Engler and H. v. Hoefer's "Das Erdoel" (Vols. 3 and 4) and to his annual reports on progress in the petroleum industry published in *Petroleum* (Vienna).

Dr. Singer had been associated with the Institute of Petroleum since 1925, and in his last years he attended most lectures and meetings of the Institute.

L. IVANOVSZKY.

ABSTRACTS.

AUTHOR INDEX.

The numbers refer to the Abstract Number.

The original papers referred to in the abstracts marked with an asterisk may be borrowed by Members from the Institute Library.

Geology and Development.

650.* Rhythm of Permian Seas—A Paleogeographic Study. J. M. Hills. *Bull. Amer. Ass. Petrol. Geol.*, February 1942, **26** (2), 217–255.—In spite of some practical disadvantages inherent in the diastrophic method of correlation, J. M. Hills believes that a classification of the Permian must have a sound physical background. He summarizes the palæophysiography of this period in the southern Mid-Continent with especial reference to the West Texas Permian basin. Seven palæogeographical maps are presented, drawn on the following key horizons: latest Pennsylvanian (Thrifty), Wolfcamp (Coleman Junction), lower Leonard (Choza), San Andres (Blaine), middle Guadalupe (Grayburg), Castile and Salado, and Rustler. The regional correlations involved in making the maps are discussed, and several supporting cross-sections are illustrated.

From data on the areal extent of the Permian seas several curves are constructed. These emphasize the more salient characteristics of the period and disclose much of the basis of classification of the system. An account is given of the relation of this study to the standard Permian section for North America set up by Adams *et al.*

The Wolfcamp epoch was initiated at the close of the Marathon–Ouachita orogeny by the expansion of the normal marine seas, and was closed by a shrinkage of these seas. Leonard time began with a restriction of marine circulation, resulting in the deposition of the evaporites of the Wellington and Valera. This epoch was characterized by the great development of evaporites in the Yeso, Clear Fork, and Salt Plain, by the advance of largely saline and brackish water in the San Andres, and by the subsequent retreat of the seas into the Delaware basin. The Guadalupe epoch began with the sea confined to that basin. Moderate floodings are typical of it, and marginal reefs separated marine from more highly saline waters. The epoch closed with the sea again restricted to the basin, and a probable increase of salinity caused the extinction of its greatest reef, the Capitan. The Ochoa commenced with exclusively saline seas in the Delaware basin, and terminated with regional uplift and the deposition of uppermost Permian sandy shales. J. T.

651.* Subsurface Geology of the Sewell–Eddleman Area, Young County, Texas. P. L. Applin and R. F. Imbt. *Bull. Amer. Ass. Petrol., Geol.*, **26** (2), 204–216.—The Sewell–Eddleman area in Young County, Texas, was discovered in January 1937. Fifty-nine producing oil- and gas-wells have been completed within the area and six producing zones have been encountered at depths ranging from 2300 to 4500 ft. The principal producer so far developed is a porous zone in the lower part of the Caddo limestone (Pennsylvanian). All but the lowest producing zone, which is Mississippian, are in rocks of Lower Pennsylvanian age.

The structure and producing area of the Sewell field have been closely defined by wells on the north flank, but on the south and east sides, and in the Eddleman area, fewer wells have been drilled and structure and extent are less well known.

The structure is described as an anticlinal fold, approximately 6 ml. long and 2 ml. wide, the major axis of which trends nearly east and west. Closure increases with depth. In addition to east–west folding, in the Caddo limestone a series of secondary folds control to some extent the accumulation of oil and gas.

The average density of wells in the Sewell field is now about one well to 35 acres.

Under the Carboniferous there is Ellenburger dolomite (Ordovician) with some oil staining. J. T.

652.* New Interpretation of Some Laccolithic Mountains and its Possible Bearing on Structural Traps for Oil and Gas. C. B. Hunt. *Bull. Amer. Ass. Petrol. Geol.*, February 1942, **26** (2), 197–203.—In the Colorado Plateau of South-eastern Utah the domal structures averaging 6 ml. diameter of Mounts Pennell, Hillers, Holmes, and Ellsworth are attributed to the injection of stocks of diorite porphyry. In each case the space occupied by the intrusion would approximately be closed if the formations tilted up around the igneous cores were returned to horizontal. Allowance must also be made for stretching which accompanied the arching of the domes. This deformation should be measured in terms of area, and not along linear cross-sections, since the stretching was mainly circumferential, probably along shear-planes, and the upturned beds were compressed outwards from the stocks.

Anticlinal noses radiating from the centres of the larger domes are due to off-shoots in the form of irregular, tongue-shaped laccolites. These are of relatively small volume; and their emplacement caused much less thermal alteration than did that of the stocks. If the large domes were to be credibly attributed to symmetrical mushroom intrusions, the required laccolites would have to be of the order of twenty times as big as any that can be observed. Arching is, therefore, best explained by vertical push, as if by the stocks.

A comparable igneous core at Marysville Buttes, California, has been shown by drilling not to be a mushroom laccolite. Other cylindrical intrusions giving rise to domes may include those at Moccasin Mountain, Montana; Carrizo Mountain, Arizona; Bear Butte, Dakota; and those in the Piatigorsk region, north of the Caucasus. A more problematical case is the huge dome, without exposure of core, at Nordlingen, Germany.

Stocks in petroliferous regions may, it is suggested, act like salt domes, and oil and gas may collect in adjacent inclined strata. A. L.

653.* Upper Cretaceous Formations and Faunas of Southern California. W. P. Popenoe. *Bull. Amer. Ass. Petrol. Geol.*, February 1942, **26** (2), 162–187.—The Upper Cretaceous of the Santa Ana Mountains, 50–75 ml. south-east of Los Angeles, amounting to about 2600 ft. of conglomerates, shales, and sandstones, contains two main fossil assemblages : the older, *Glycymeris pacificus* fauna, with two sub-divisions, (*a*) *Trigonarca californica* and (*b*) *Cucullaea gravida* zones; and the younger, *G. veatchii* fauna, with three, (*a*) *Turritella chicoensis*, (*b*) *T. chicoensis perrini* and (*c*) *Metaplacenticeras pacificum* zones—in ascending order.

In the Santa Monica Mountains, 20 ml. west of Los Angeles, the top 300 ft., in a column of over 8000 ft. of coarse clastics, yield fossils of *Metaplacenticeras pacificum* age. The finer clastics, over 6000 ft., of the Simi Hills, 25 ml. north-west of Los Angeles, provide fossils in the lowermost 500 ft., which correspond with those of the two highest sub-divisions.

In the Santa Ana Mountains two major formations are distinguished, the Ladd and the Williams. The Ladd comprises : (1) the Baker Canyon conglomerate resting comformably on the reddened and poorly graded Trabuco (high Lower or basal Upper Cretaceous), from which it differs in being better sorted and in containing less deeply weathered boulders of andesites and schists; (2) the Holz shale, well exposed in Silverado Canyon, and showing local lenses of conglomerate, grit, or thin concretionary limestones.

It is within the Holz shale that the transition from the *Glycymeris pacificus* fauna to that of *G. veatchii* takes place.

The Williams formation of boulder-beds and light-coloured, felspathic sands is divided into : (1) the Schulz member with loosely cemented blocks of cherts, quartzite, and volcanic and plutonic rocks; (2) the Pleasants member, which has fine, ferruginous, and micaceous sandstones interbedded with thick, cross-laminated sands and sandy limestones.

The overlying Martinez conglomerate (Eocene) is marked near its base by the marine gastropod *Turritella pachecoensis*. It also contains clay and coal-beds.

A. L.

654.* Del Valle Oil-Field, Los Angeles County, California. L. A. Tarbet. *Bull. Amer. Ass. Petrol. Geol.*, February 1942, **26** (2), 188–196.—Oil is obtained from lenticular saturation in the Delmontian Stage of the Upper Modelo formation (Upper Miocene). Locally there is evidence of slight angular unconformity between Miocene and Pliocene, but this is not sufficient, in the Del Valle and Newhall–Portrero fields, to upset the deduction of structure from the Pico (Pliocene). The succeeding Saugus (Upper Pliocene and/or Pleistocene) is of coarse-grained, non-marine sediments, the junction of which with underlying marine beds, south but not north of the Santa Clara river, is an unconformity.

The Del Valle area occupies the east end of the Ventura basin of deposition; and oil concentration is on the Del Valle anticline, which trends east–west, and is bounded on the north by the Holser fault and on the south and east by downward plunge of the strata. Producing zones are 280 ft. and 900 ft. below the top of the Miocene, and are respectively 100–150 ft. and 200 ft. thick. The upper zone, with initial production of from 600 to 1500 brl./day of 32–36° gravity oil and 250,000 to 1 million cu. ft. gas, has water complications which also appear in what seems to be a continuation of the same zone in a western extension of the field. From the lower horizon initial production was estimated at 300 brl./day of 50° gravity oil with 10 million cu. ft. gas. When the gas zone was partly cased, production became about 900 brl./day of 33° gravity oil and 250,000 cu. ft. gas.

The two zones of the Del Valle oil-field may be equal to the second and third zones of the Newhall–Portrero field. This correlation is based on foraminiferal evidence, since faulting and much lenticularity make the exact use of electrical logs difficult.

A. L.

655.* Progress of Stratigraphic Studies in California. E. R. Atwill. *Bull. Amer. Ass. Petrol. Geol.*, February 1942, **26** (2), 153–161.—Superseding the maximum vogue of the reflection seismograph, which is still specially valuable for determining variation in the number of reflecting horizons in a sequence, attention is now being concentrated on stratigraphical investigation, since over 50% of Californian oil-fields prove to be of stratigraphical type. Electrical logging in wells and surface mapping of narrower lithological and palæontological units are localizing minor interruptions and giving fuller information about down-dip thickening and pre-depositional faulting.

Many parts of the Californina coast are natural laboratories where lagoon and sand-bar conditions can be observed with a view to interpretation of like features in oil-fields. The Gulf of California—a modern equivalent of the ancient sheltered embayments of San Joaquin and Salinas—is also being studied. One interesting result is that off-shore winds blowing down the Gulf drive silica-depleted waters out to sea, and a replenishment of silica-rich water from the ocean permits huge colonies of diatoms to flourish. In winter these die, so that pale layers, due to the silica of the diatoms, alternate with darker summer silts

13,000-ft. wells are penetrating the deeper portions of the geosyncline, and new ideas are arising about relations of sediments to the basement complex. The data of lateral changes can now be more fully illustrated by palæogeographical and isopach maps. A. L.

656.* Stratigraphy of Eocene between Laredo and Rio Grande City, Texas. J. M. Patterson. *Bull. Amer. Ass. Petrol. Geol.*, February 1942, **26** (2), 256–274.—A cross-section of the Eocene stratigraphical succession on the American side of the Rio Grande is in rather close agreement with results by Trowbridge, who failed, however, to classify the different members in the detail later worked out by Kane and Gierhart.

At the bottom of the succession, the Mount Selman consists of 700 ft. of Queen City sandstone and shales, overlain by 300 ft. of marine and non-marine shale and sandstone. Above this, the Cook Mountain formation is divided into three members : basal sandstone, 500 ft. thick ; middle shale and sandstone, 700 ft. ; upper sandstone, 500 ft. The subsurface top of the Cook Mountain formation, taken at the uppermost occurrence of *Ceratobulimina eximia,* is about 500 ft. below the top of the Cook Mountain as mapped at the surface.

Cycles of deposition in the succeeding Yegua are found to be very similar to those of the Fayette. The Mier and Loma Blanca sandstones in the Yegua ; and the Salineno, Roma, and Sanchez sandstones of the Fayette, have a marine facies where they cross the Rio Grande in Starr and Zapata Counties. These marine sands wedge out northwards, and the shale concomitants become increasingly non-marine. It is suggested that each sandstone wedge and its associated shales represent a cycle of transgression and retreat of the sea. J. T.

657.* Gas in Rockingham County, Virginia. P. H. Price. *Bull. Amer. Ass. Petrol. Geol.*, February 1942, **26** (2), 275.—In the strongly folded middle Appalachian region, near Bergton, a rock pressure of 1150 lb. and an open flow of over 60 M cu. ft. gas are recorded in a boring to 2992 ft. which just enters Oriskany sandstone (Devonian). Analysis shows methane 98·69%, ethane 0·12%, propane + 0·01%, nitrogen 1·18%, carbon dioxide nil ; Thv = 987. Large open structures between this locality and the producing areas 70 ml. to the west, suggest the likelihood of further similar discoveries. A. L.

658. Note on the Sealing Effect of Fault Surfaces. G. S. Taitt. *Journ. Inst. Pet.*, June 1942, **28** (222), 109–112.—A summary of a paper on the above subject, which was read at a meeting of the Trinidad Branch is presented. Possibilities of fluid migration and water-flooding across fault-planes are studied. A. H. N.

659. Typical Oil-Field Structures : Regular Anticlinal Fold : Kettleman Hills Field, California. Anon. *Oil Gas J.*, 4.6.42, **41** (4), 50.—Kettleman Hills is on the west side of the San Joaquin Valley, near the southern end. The basement of the Valley deposits is a pre-Cretaceous complex, which is faulted. On the eastern side of the valley the Eocene and Cretaceous wedge out between the basement and the Miocene. The Miocene beds extend completely round the southern part of the valley, and are overlain by Pliocene marine and non-marine beds with thick deposits of Pleistocene and Recent over much of the valley. Near the western edge of the valley there are about 25,000 ft. of beds. In the Kettleman Hills area movements were frequent from the Jurassic onwards, giving many wedge edges.

Kettleman Hills has two elongated domes, with only the North Dome giving important oil production. This dome has 2000 ft. of closure in the Temblor which is productive. The south-west flank has maximum dips of 45°, and the north-east flank 35°. The crest has a series of faults. The Avenal (Eocene) is also productive.

The Kreyenhagen below the Temblor is highly bituminous. Some consider this to be the source-rock. Other possible source-rocks are the brown shales above the Temblor and shale equivalents of the producing sands downdip.

Most of the fields of the Los Angeles basin are anticlinal. Anticlines are common in the Rocky Mountain area.

Some anticlines are obvious at the surface, but others are discovered by geophysical methods or subsurface geological work. G. D. H.

660. Typical Oil-Field Structures : Truncated Faulted Anticline—Oklahoma City Field, Oklahoma. Anon. *Oil Gas J.*, 7.5.42, **40** (52) 56.—The Oklahoma City field lies on the Nemaha granite ridge, and its main oil production is obtained from the Arbuckle lime. The structure shows evidence of uplift in Mississippian times, levelling, and then inundation by the Cherokee sea. The east flank of the anticline is downfaulted, some faulting persisting after Lower Pennsylvanian times. During the period of erosion the Arbuckle was exposed in the crest of the fold. Differential movements caused the structure to be reflected in the Permian beds.

The main oil-bearing horizons are in the Wilcox, Simpson, and Arbuckle, below the unconformity at the base of the Pennsylvanian. The Pennsylvanian yields gas mainly, with oil in small areas round the flanks of the structure. This oil differs from the lower oil. The fault forms the eastern boundary of the oil production, except for a few small local uplifts which give Wilcox production.

A post-unconformity source is postulated for the oil, since the Ordovician rocks carry oil only if they are exposed at the unconformity.

Garber, Crescent, Edmund, and Moore are similar fields on the Nemaha granite ridge, and other " bald-headed " fields occur on the Central Kansas Uplift. The Texas Panhandle is of this type.

Many of these deeply buried truncated folds are shown at the surface by a gentle fold or terrace. Subsurface geology is difficult as a means of detection, but if the conditions are favourable, seismic or gravimetric methods may be applied. The crest of these structures is not always the most promising part. Although many of these structures are faulted, faulting rarely seems to provide the trap. G. D. H.

661. Geology and Development of the Paloma Field, Kern County, California. J. T. Wood. *Petrol. Tech.*, May 1942, A.I.M.M.E. Tech. Pub. No. 1471, 1–7.—The Paloma field lies 17 ml. south-west of Bakersfield, in the San Joaquin valley. The first condensate producer was completed in August 1939 at a depth of 10,178 ft., and gave condensate at the rate of 2280 brl./day and gas at the rate of 14,750,000 cu. ft./day. In 1934 a small gas pool had been developed at about 5200 ft. in the San Joaquin clays. This was known as the Buena Vista gas-field. It was renamed Paloma, and the Paloma gas-field is productive from six wells in several zones in the interval from 4177–5548 ft.

The Paloma distillate wells penetrate Recent to Upper Miocene beds. The Paloma producing zone (Stevens sand zone, Upper Miocene) is at 9950–10,300 ft. The massive, hard sand, interbedded with siliceous shales, frequently contains material resembling Grahamite. The effective thickness of the producing zone is 200–250 ft., with porosity averaging 20% and permeability under 100 millidarcys. The underlying Lower Stevens zone is chiefly shale. There are indications that the Paloma producing zone is thinner and less permeable south-west of the axis of the structure, which is believed to be a large faulted dome. The Stevens sands may grade into richly organic shale towards the centre of the Buena Vista–Kern Lake basin to the south. The fold, discovered entirely by geophysics, is 9 ml. long, and may have 500 ft. of closure. The ultimate productive area is estimated at 3000 to over 5000 acres, but the field is not yet fully defined. G. D. H.

662. Gulf Coast Region is Ready for Expanded Exploration to Meet Increased Needs of Nation's War Effort. F. L. Singleton and N. Williams. *Oil Gas J.*, 25.6.42, **41** (7), 52–54).—Transport difficulties and drilling restrictions have caused a slackening of development on the Gulf Coast. The area is rich in crudes suitable for special fuels and products, and there has been an increase in exploration and leasing in spite of the restrictions. Twenty fields were discovered in the first five months of 1942, and major extensions and new sand discoveries have also been made. Six wildcats being completed on 1st June have showings of oil and gas, indicating probable new fields.

846 wells were completed during the first five months of 1942, 348 on the upper Texas Gulf Coast, 262 on the lower Gulf Coast, and 236 on the Louisiana Gulf Coast.

The largest decline in drilling has been on the Louisiana Gulf Coast, largely due to the 40-acre rule restricting salt dome exploitation. Nine new discoveries are on the Upper Texas Gulf Coast, eight on the Lower Gulf Coast, and three on the Louisiana Gulf Coast.

The most active area is in Jackson County, where Frio sand discoveries continue to be made. Wildcat operations are expected to be concentrated along the Wilcox trend. Six Wilcox fields have been found this year. The Wilcox production now ranges 1900–11,775 ft. in depth.

Prolific oil production has been found down dip in the sands which yield gas-distillate at Agua Dulce-Stratton. At South Caesar the first commercial oil production has been found in the Carrizo–Wilcox at 6500 ft. and 6600 ft. Gas-distillate has been obtained at 11,660 ft. in the Hayes field. The Bay De Chene gas-field has proved to be associated with a salt dome, and oil has been found at 7470–7500 ft.

Tables summarize the completions and drilling operations by districts on 1st June, 1942, and 1st June, 1941. G. D. H.

663. More but Smaller Discoveries is Trend along Gulf Coast. W. V. Howard. *Oil Gas J.*, 25.6.42, **41** (7), 104.—In the areas bordering the Gulf of Mexico from Mississippi to the Rio Grande area 7,515,160,000 brl. of oil have been found, and of this 2,748,151,000 brl. have been produced.

The first two ten-year periods from 1901 had discovery rates averaging about one and a half fields per year. In the 1922–26 period, which saw the introduction of geophysics, the average was 3·6 per year. The rate was 10·4 per year in the 1927–32 period, 20·6 in the 1932–37 period, and 44·6 for the 1937–42 period. The average size of the fields was greatest in the 1901–11 period (50,000,000 brl.). After a decline it rose to 34,500,000 brl. in 1922–27, and then declined again.

At present fields are being found by a combination of geology and geophysics, and while the trend is still upwards, the rate of discovery may be expected to decline in the near future.

In South Texas production follows certain trends where structural axes cross wedging out oil-bearing beds. The fields are usually smaller than in the other districts. Early production in the Lower Gulf Coast area was from shallow Miocene beds. Later large reserves were found in the Frio. Discoveries in the Upper Gulf Coast area were entirely due to geology until 1925. A similar state of affairs obtained in South-west Louisiana, but in South-east Louisiana all the discoveries are due to geophysics.

Random drilling has found 6% of the coastal fields with 1·5% of the reserves; geology, shows, and core-drilling 37% of the fields (37·5% of reserves), and geophysics 57% of discoveries (61% of oil).

Tables show the number of discoveries and amount of reserves found in the different sectors over certain periods, and the production, amount of reserves, and modes of discovery for each year by districts. G. D. H.

664. Complete Report of Gulf Coast Field Development. Anon. *Oil Gas J.*, 25.6.42, **41** (7), 94.—Tables give the fields alphabetically according to districts, with discovery year, number of producing wells, daily average and cumulative production, producing formation and depth, sand thickness, type of structure, oil gravity, and outlet. A series of maps is included. G. D. H.

665. East Texas Wildcat Campaign only Moderately Successful. R. Ingram. *Oil Gas J.*, 28.5.42, **41** (3), 82.—Of 2,325,000,000 brl. of oil produced in East Texas, 1,911,000,000 brl. have come from fields in the East Texas basin, and all but 1,000,000 brl. of this is from the Woodbine sand. Much of the Mexia fault-zone production is from the Woodbine. Among a number of minor pools, such important Woodbine pools as Cayuga and Hawkins have been brought in during the past decade. These are mainly in anticlinal traps in the deeper part of the basin. East Texas is a shore-line stratigraphic trap, Boggy Creek is a piercement type salt dome, and Van is probably a deep-seated salt dome.

The entire floor of the basin is covered by 35–150 ft. of Woodbine sand.

Below the Woodbine, Lower Trinity and Marine pays have been increasingly explored since 1939, and while no major fields have been opened, a number of gas-distillate pools have been found.

Concord is the only important discovery in this area this year.

Since 1920 291,920,000 brl. of oil have been produced from the Mexia fault zone fields, mostly from the Woodbine. Last year Pettit production and a gas-distillate pay in the Glen Rose were found. The Lower Trinity and Marine pays are considered favourable prospects. West of the fault zone, the Smackover appears to have possibilities in view of recent developments in Southern Arkansas.

Along the flank of the Sabine uplift a number of pools, mainly small, give oil from the Lower Trinity and Marine group. On the uplift production is chiefly from the Glen Rose and older Lower Cretaceous.

The East Texas fields are listed, with the date of discovery, number of wells, daily average and cumulative production, depth, oil gravity, etc. A map is included.

G. D. H.

666. West Texas Development, Production, and Reserve Data by Fields. Anon. *Oil Wkly*, 4.5.42, **105** (9), 32.—The discovery data, producing depth and formation age, developed acreage, number of oil and gas wells, daily allowance in January 1942, cumulative production, estimated reserve, oil gravity, and the depth of the deepest test, with the formation reached, are given for each field, the fields being arranged alphabetically under alphabetically arranged counties. G. D. H.

667. West Texas–New Mexico Permian Basin Presents Largest and Most Prolific Proven Undrilled Oil Reserve in the United States. H. H. King and G. M. Wilson. *Oil Wkly*, 4.5.42, **105** (9), 29–31.—The Permian basin has more proven and undrilled locations than any other geological province in U.S.A. Up to the end of 1941 1,499,351,000 brl. of oil had been produced, 1,195,073,000 brl. from the West Texas sector, which is credited with 2,564,831,000 brl. of the 3,000,000,000 brl. estimated reserve. Production is obtained from the Lower Permian and the Ordovician, and highs which are non-productive in the Permian remain prospects until explored down to the Ellenburger. Except at Big Lake, Ordovician production has been slow in attaining prominence. In 1936 Ordovician oil was discovered at Sand Hills on a series of highs within the Permian area, and in 1939 Ordovician production was found in Pecos County, where the Simpson and Ellenburger yield oil. Ellenburger production was found on the Barnhart structure in 1941.

Crinoidal and Silurian limestones also are productive in the Permian basin.

Yates has given 260,079,187 brl. of oil from 20,000 acres, and is estimated to have a reserve of 407,944,000 brl. Wasson, covering 58,000 acres, has a reserve of 414,950,000 brl., and Slaughter, which covers 52,000 acres, has reserves estimated at 279,532,000 brl. Goldsmith, North Cowden, Foster, and McElroy have estimated reserves of 311,000,000, 135,693,000, 109,978,000, and 127,280,000 brl., respectively.

Lea County has three distinct producing trends. Maljamar, Philmex, Corbin, and Vacuum are on one trend, Jal, Cooper Lynn, Eunice, and Monoment on a second. The third line lies east of the second.

Hobbs will pass the 100,000,000 brl. mark this year, and although most of its wells are ten years old, 89% of them still flow naturally. G. D. H.

668. Wilcox Trend Play may Extend into South Central Texas. F. L. Singleton. *Oil Gas J.*, 4.6.42, **41** (4), 72.—Since 1922 the trend of development has followed the same pattern, with the Edwards lime production important and possibilities of shallower production in the Taylor–Navarro series and Austin chalk. This fails to open new reserves, and so the search will be deeper or along new trends.

The Glen Rose is to be tested below 7000 ft. in Dimmit County, 4 ml. north-east of Atherton, and if this is unproductive, the Trinity may be tested. The first Glen Rose production was found on the Chittim anticline in 1929, and consisted of wet gas at 5600 ft. Recently a small producer was completed in this area in the Georgetown lime at 2966–3030 ft.

Wilcox production is now being sought over a large part of the Balcones fault-line as a sequel to the discovery of Wilcox sand production in the Washburn area. A discovery seems to have been made in Wilson County near Poth.

Few tests have been drilled on the Edwards Plateau, but some have logged encouraging shows in the Pennsylvanian and Ordovician.

South-west of Pearsall a small discovery seems to have been made in the Austin Chalk or Edwards lime.

A table shows the fields, discovery date, number of producers, cumulative and daily average output, type of structure, depth, and oil gravity. G. D. H.

669. West Texas–New Mexico Oil and Gas Fields; Geological Data and Development History. Anon. *Oil Wkly*, 4.5.42, **105** (9), 43.—The oil-fields of West Texas and New Mexico are arranged alphabetically under alphabetically arranged counties, with brief notes on the discovery data, structure, producing formations, acreage, production at the beginning of 1942, cumulative production, number of producing wells, oil gravity, outlet, deepest test, principal leaseholders, etc. G. D. H.

670. Bottom-hole Contours Show Deeper Possibilities on Gulf. W. V. Howard. *Oil Gas J.*, 25.6.42, **41** (7), 125.—Contour maps with the bottoms of the deepest wells drilled as a datum can provide clues as to the possibilities of deeper production in many areas on the Gulf Coast. A series of maps show the greatest depths reached at different points, and the distribution of the deepest formations encountered on structure. Structural highs are revealed by the relatively shallower depth at which older beds are reached in areas where the wells are generally bottomed in a younger formation. The age of the oldest bed penetrated generally increases away from the coast, and also in going westwards along the coast, although the rate of the latter change is much smaller than that of the former. G. D. H.

671. Illinois Basin Discovery Rate Shows Drop this Year. H. E. David. *Oil Gas J.*, 14.5.42, **41** (1), 100.—When the known oil deposits are mapped with regard to the producing formations, the resulting picture of the Illinois basin displays definite trends or areas, in which the majority of pools produce from the same sand or series of sands. In this way the entire State falls into six areas, with a few outlying fields.

The Centralia–Salem area was opened by the discovery of Bartelso in 1936. Centralia, Salem, and Patoka followed quickly. Extensive exploration has continued to the present, Woodlawn being the latest discovery. Prior to the discovery of Devonian oil at Sandoval in 1938, all the development was in Pennsylvanian and Upper Mississippian sands, chiefly the latter. Many of the fields have Devonian production, and some have Lower Mississippian production. A small amount of Trenton oil has been found at Salem and Centralia. Most of the fields are on the Louden axis in a line with the Duquoin flexure. The structures are mainly anticlines and domes.

The Louden area has relatively few pools, and most of them are small. Important production occurs on the Louden–Salem axis, chiefly from Upper Chester sands. There is some Devonian production.

There was little production in the Dale–Hoodville area before 1939. Upper and Lower Chester sands give most oil. No sands have been tested below the McClosky.

Except for three recently discovered fields, all the fields of the Clay City area (Dundas, Noble, Johnsonville, etc.) produce from the McClosky. Tests have been made below the McClosky.

The Wabash River area has a 60-mile string of fields, and is the most recently developed area. The main pools are on a N.N.E.–S.S.W. trend parallel to the Wabash River. The principal pays are of Pennsylvanian and Upper Mississippian age. The sands are erratic in properties and distribution.

Almost all the fields in the La Salle anticline area were discovered between 1906 and 1912. The Pennsylvanian sands give the main production. There is also Chester, Devonian, and Trenton oil.

Data about the fields are tabulated and a map is included. G. D. H.

672. New Illinois Spacing Rules to Bring only Slight Drilling Gain. Anon. *Oil Wkly*, 1.6.42, **105** (13), 15.—Partial relaxation of well-spacing regulations in Illinois may cause a small gain in production. Since the beginning of the year output has fallen by 100,000 brl./day, but the change may check this fall. The increase in drilling may amount to 20%.

With few exceptions, the best Illinois producing horizons are between 2800 and 3500 ft. The Bethel, Aux Vases, and McClosky, which give much of the output, are below 2500 ft. in most areas. The Cypress is frequently over 2500 ft. deep.

The new rule permits 20-acre spacing for wells less than 2500 ft. deep; 10-acre spacing if they are not more than 1500 ft. deep; 5-acre spacing if not more than 500 ft. deep. Hence the 40-acre spacing will operate in the most prolific horizons and in many of the new developments.

The Boulder field is giving 250–400 brl. wells in the Benoist at 1200 ft., and Griffin finds the Cypress at about 2400 ft.

Eight new fields were found in May, one of the discoveries being a McClosky lime well which gave 700 brl. in 12 hr. from 3333–3348 ft. A 200-brl. Trenton producer was completed in Madison County. Most of the strikes are below 2500 ft.

Tables give the completions by months since October 1941 and the fields with the spacing pattern which will be effective. G. D. H.

673. Condensate Field Spurs Texas Wilcox Activity. G. B. Nicholson. *Oil Wkly*, 8.6.42, **106** (1), 14–16.—The Wilcox yields gas with a high saturation of high-octane gasoline from several sands at Lake Creek. The deepest horizon is at 11,775–11,815 ft., some 3300 ft. of Wilcox having been penetrated. At least 5000 ft. of Wilcox is known to exist. Three main sands yield condensate.

The gentle elongated anticline was located by reflection work. The present producing area covers about 2000 acres. The discovery well, completed early in 1941, came in at 1,380,000 cu. ft. of gas and 170 brl. of 62·5-gravity distillate per day through a 17/64-in. choke at 9314 ft. Eight producing wells have been completed, with the sands at 9200, 9800, and 11,800 ft., while several other sands have appeared favourable in drill-stem tests.

Few cores are taken in drilling, but electrical logs are run before setting pipe. Gas/fluid ratios range 5000–10,000 to 1, approximately 7 gal. of distillate being obtained per 1000 cu. ft. The gas has 43·4% of hexane and 24·31% of methane.

Injection of gas is difficult, due to the high pressure and low permeability of the receiving sand. The two shallower sands have bottom-hole pressures of 3690 and 4280 lb./in.^{2}. G. D. H.

674. Important Midway Field Increases Steadily. Anon. *Oil Gas J.*, 4.6.42, **41** (4), 74.—The Midway structure seems to trend north-west–south-east, but it is not long and narrow, as was supposed earlier. There may be a fault limiting the structure to the south. The structure may trend east–west in the south.

A map shows the stratum contours on the top of the Smackover porosity. The crest of the producing zone seems to be at − 6023 ft. G. D. H.

675. Completions Climbing from Low Reached in March. Anon. *Oil Wkly*, 8.6.42, **106** (1), 33.—Since March the U.S.A. average daily completions have been increasing, and on 1st June about fifty more wells were drilling than on 1st May when 1999 wells were drilling. Increased activity is shown in California, Eastern States, Michigan, Illinois, and Kansas. 1538 wells were completed in the four weeks ending 23rd May. 9101 wells were completed during the first five months of 1942, 19·2% less than in the corresponding period of 1941.

Details of the well completions are tabulated. G. D. H.

676. Lea County, New Mexico, Development and Production Data by Fields. Anon. *Oil Wkly*, 4.5.42, **105** (9), 36.—The same series of data are tabulated as for the West Texas area. G. D. H.

677. Complete Third Well on Yondo Concession. Anon. *Oil Wkly*, 4.5.42, **105** (9), 93.—Casabe No. 3 on the Yondo concession in the middle Magdalena valley is reported to be giving 800 brl./day on test, with much gas. This is the third Yondo producer.

Tres Bocas 2-A, 12 ml. north-west of the Petrolea North Dome field, has been finished as a producer. G. D. H.

678. Reserves Show Slight Increase in 1941. M. T. Halbouty. *World Petrol.*, January 1942, **13** (1), 36.—31,356 wells were completed in U.S.A. in 1941, compared with 30,041 in 1940. 21,733 were oil-wells, 2840 were gas-wells, and 6783 were dry holes. During 1941 there was more geophysical activity than in 1940, and the number of parties may be comparable to the peak in 1939. Texas led in the number of new fields discovered, with California, Louisiana, and Oklahoma second, third, and fourth, respectively. The Texas lead in reserves was mainly through new sands and old field extensions. On the Gulf Coast new reserves have been obtained from the development of old piercement-type domes.

In California the greatest activity was in the San Joaquin Valley, but there were also discoveries in the Los Angeles Basin and in the Coastal districts. The Louisiana discoveries were greater than in any previous year, with the greatest activity on the coastal area. Drilling is proceeding in Mississippi, while geophysical surveying and leasing are going on in Alabama, Georgia, and Florida. Activity in the Mid-continent area is at about former levels. Shows have been found in the Hunton in Nebraska. Illinois had more discoveries than in 1940.

Except for Illinois, the new oil-field discoveries were not as great as before, although there is a slight increase in reserves, mainly from developments in semi-proven acreage, new sand discoveries, and extensions. At the end of 1941 the reserves were calculated to be 19,622,227,000 brl., 3·14% more than at the end of 1940. 1,402,288,000 brl. were produced in 1941. At the end of August 1941 the daily output exceeded 4,000,000 brl./day for the first time, and a peak of 4,336,850 brl./day was reached in November. G. D. H.

679. Increased Wildcatting Required to Maintain U.S. Reserves. F. H. Lahee. *World Petrol.*, March 1942, **13** (3), 54–57.—Statistics are presented regarding U.S. wildcats in eleven states during the years 1937–40. These include the numbers and footage, and the successes and failures are separated into groups according as the wells were located on a technical or on a non-technical basis. Whether the new reserves discovered in any year per wildcat or per foot of wildcat drilling, or the total new proved reserves per wildcat or per foot of wildcat drilling is considered, there are indications of a regular drop in the rate of discovery from 1937 onwards. This drop seems to be due mainly to increased difficulty in finding new traps. The remaining undiscovered reserves are largely either in regions not explored, deeper than the reservoirs exploited on known structures often unconformably related to the strata with the known reserves, or they are in stratigraphic traps. Hence, to maintain a satisfactory discovery rate calls for a more vigorous wildcatting campaign, with an increase both in numbers of wells drilled and in average depths. G. D. H.

Geophysics.

680. Geological Application of Nuclear Physics. C. Goodman. *J. appl. Phys.*, May 1942, **13** (5), 276–289.—Although this paper is written for the geology reader in general, there is sufficient in it to interest oil geologists in particular. The primordial source of all rocks appears to be a substratum of basaltic material lying a few tens of kilometres below the surface of the earth. The radioactive elements are presumably distributed fairly uniformly throughout this layer, but at concentrations substantially lower than are found in acidic surface rocks. This decrease of radioactive content with depth and increasing basicity is the result of differentiation from the source material. On cooling of any molten mass, crystallization begins, and chemical separation takes place in accordance with the existing pressure, temperature, and composition conditions. Certain mineral species, such as allanite, zircon, and sphene, seem to have crystal structure admitting a greater number of the large uranium and thorium atoms. Accordingly, if conditions are favourable to the formation of these minerals, which are usually only minor constituents in igneous rocks, the resulting rock may show localized concentrations of the radioactive elements. On the other hand, the more common rock-forming minerals, such as quartz, feldspar, pyrozene, amphibole, micas, and magnetite, are less tolerant of foreign radioactive atoms. During crystallization only relatively few uranium or thorium atoms are admitted, and these are found randomly distributed throughout the structures of the crystals.

The properties of the radioactive elements are briefly reviewed. This is followed by a study of geochronology. The helium and lead methods of measuring geological times are described. Geophysics, well logging, earth heat measurements, and geochemistry are briefly studied. Mineralization is reviewed, together with isotopic variations.

A new era in petroleum prospecting should result from an understanding of the origin of oil. Nuclear physics may well be of aid in solving this complex problem. Unless the present emergency makes it impossible, a systematic study of the genesis of petroleum will begin this year under the sponsorship of the American Petroleum Institute.

The calibration of γ-ray logs would make available a wealth of geochemical and geophysical data on sedimentary rocks. While terrestrial radioactivity measurements appear incapable of casting further light on the thermal state of the earth at depths, many important local and near-surface problems depend on this information. Hence, further geothermal radioactivity measurements would be of value, particularly if these were correlated directly with diffusivity and geothermal gradient measurements. The future should also see an extension of the application of neutrons in geophysics. Already the relative scattering coefficients of neutrons appear to be useful in well-logging. The results of this type of survey reveal the relative hydrogen content (largely in the form of water) in the formations. By extending the neutron-induced activity method to rocks, an indication of their mineral and fluid contents could be obtained. This application awaits the development of compact, intense neutron sources.

An extended bibliography is appended to the paper. A. H. N.

681. Theoretical and Economic Significance of Geodynamic Prospecting. S. J. Pirson. *World Petrol.*, April 1942, **13** (4), 38–41.—Since the start of the U.S.A. oil industry one out of twenty-five wildcats has opened a new field, and up to 1937, 6·5% of the wells drilled were wildcats. Wildcat statistics show that the resolving power of geophysics has decreased during the past five years, whereas the resolving power of geology or of geology and geophysics combined has remained essentially constant. Geology and geophysics combined were more successful than geophysics or geology separately, and the actual probability of success agrees with that predicted from the degrees of success of the individual methods when allowance is made for random discoveries.

During a period of ten months three commercial producers have been obtained out of five wells located by geodynamic prospecting, and one found good impregnation. Thus the resolving power of geodynamic prospecting is much greater than that of the other methods.

Examination of the resolving powers of the various methods and combinations of methods in conjunction with the cost per acre, leads to the conclusion that geodynamic prospecting, because of its cheapness and high resolving power, should be the first method applied, followed by geology and geophysics. G. D. H.

682. Radioactivity Logging Proves Help in Reworking Old Wells. Anon. *Oil Gas J.*, 25.6.42, **41** (7), 140.—Radioactivity logging has made possible a greater degree of precision in the location of possible oil-bearing formations which may be cemented off behind casing in old holes. The method tells nothing about the porosity, permeability, or fluid content of the porous formation. It merely shows the positions of sandstones or limestones and shales. Logs may be made in cased or uncased holes.

The gamma-rays emitted by elements in the formations are detected by use of an ionization chamber, the gas in which is a non-conductor, except when rendered conducting by the action of gamma-rays. The conductivity of the gas is a function of the intensity of the gamma-rays. The current passing through the gas is amplified and recorded continuously at the surface.

Sands and limestones generally have feeble radioactive properties, but shale-beds have stronger radioactive properties. Salt has low radioactivity, and anhydrite even less.

Radioactivity surveys have been used mainly for correlation and for the develop- of new production from cased-off sands. The surveys have also shown unknown faults, wedging beds, and that some wells have not been drilled deep enough. They are useful for checking depth measurements, in setting casing, and in detecting the position of cement if the cement contains a little radioactive material. G. D. H.

683. Locating Cased-off Productive Zones. W. A. Sawdon. *Petrol. Engr*, May 1942, **13** (8), 55.—There is much economically recoverable oil cased off in various fields in the U.S.A., and probably all of it can be made recoverable without the use of new casing. The cheapness of the recovery will depend on how readily the cased-off oil zones can be located. In some cases data obtained during drilling will facilitate the location of these cased-off horizons, but in many older wells there are no reliable logs, so that radioactivity logging is of value in locating these horizons.

Radioactivity logs provide general geological information, and they can be made in cased holes. The intensity of the rays is decreased by steel casing and cement, but logs have been made through five strings of cemented casing. An ionization chamber with an amplifier is run in the well, and a continuous record is made at the surface. The sensitivity is adjusted to meet the conditions encountered. A high amplitude log gives a sharper definition of minor changes in the character of the formations.

Electrical logs, when available, facilitate the interpretation of the radioactivity logs. In California the shales are generally much more radioactive than the sands, although there are difficult areas.

A number of radioactivity logs are included with electrical logs for comparison, and examples are given of the application of radioactivity surveys. G. D. H.

684. Micromagnetic Surveys in the Sparta–Wilcox Trend of Texas and Louisiana. W. P. Jenny. *Oil Wkly*, 15.6.42, **106** (2), 20–23.—Purely stratigraphic traps without any structural factor are extremely rare. Thus East Texas is not only on the flank of the Sabine uplift, but on a distinct anticlinal nosing off this uplift.

The more detailed information that there is concerning an uplift, and especially concerning its flanks, the easier it is to assess the possibilities of finding stratigraphic trap production, since the chances will generally be better on local highs along the flanks. Geophysics in conjunction with subsurface investigations should therefore be of great value in searching for stratigraphic traps. A combination of geophysical methods may be helpful, provided that the limitations of the methods are considered. Seismic reflection and micromagnetic methods might profitably be combined.

In the Joe's Lake–Fred area early magnetic isogams indicated uplifts which were later proved to be productive. Some of the early Cockfield wells along the Sparta–Wilcox trend were on magnetic highs, but were structurally about normal. Thus an unconformity between the deeper Wilcox and the Cockfield was shown magnetically, for if the Cockfield is normal, magnetic beds below must be uplifted in order to give the anomalies. The Eola field conforms with these conditions. Its reflection profile indicates only 100 ft. of closure, because wedging of the low-velocity beds tends to veil the reversal of the dip when examination is made by means of the reflection seismograph.

In Western Montgomery and Southern Walker counties the Lake Creek field seems to be indicated by a local magnetic high. G. D. H.

Drilling.

685. Proper Operation of Wire Rope Prolongs its Useful Life. Part I. H. F. Simons. *Oil Gas J.*, 21.5.42, **41** (2), 38–39.—The following rules are stressed for maintaining ropes in good condition. (1) Keep wire-rope-using equipment in good condition. Sheaves should be of proper size, design, material, and free from corrugations. Keep all sheaves properly lubricated and in line. Avoid excessive fleet angles. (2) Keep wire ropes thoroughly and correctly lubricated. (3) Avoid kinks and sudden jerks; also, avoid cross-winding on drums, and reverse bends if possible. (4) Make sure wire ropes operate with an adequate factor of safety. If there is not a proper ratio between the strength of the rope and the maximum load to be handled, the rope may be over-stressed—a condition no rope can long survive. (5) Use wire rope of the correct size, construction, type, and grade for particular conditions. (6) Purchase wire rope in sufficient length to allow for changes in position on drum.

Wire-line management can be used effectively to increase the service life of a rope. Contractors or oil companies having both deep and shallow operations can remove the lines from their deep-drilling equipment, when they are no longer safe, and put them in service immediately on the shallower wells. A line the safety factor of which has been reduced to three or two on a 10,000-ft. well would still have an adequate safety factor on a 4000- or 5000-ft. well.

Probably the greatest increase in wire service is available through more careful operation of the drilling rig. Running into the load (string of pipe) instead of picking it up smoothly puts an undue strain on the strands and individual wires. The point of application of this strain on a drilling rig is generally when the blocks are at their lowest or uppermost position. This will cause premature failure of a line, due to concentration of the wear.

In connection with lubrication and corrosion, it is pointed out that the application of any type of lubricant on top of a coating of hydrated rust does absolutely no good, and if it forms it is necessary that the rope be thoroughly dried before any lubricant will take effect. For field application, suggestions are : (*a*) Rope lubricant of a reputable manufacture. (*b*) Fifty–fifty mixture of red engine oil and boiled linseed oil. (*c*) Red engine oil. (*d*) Discarded crankcase oil. (*e*) The same lubricant as applied during manufacture. A. H. N.

686. Proper Operation of Wire Rope Prolongs its Useful Life. Part 2. H. F. Simons. *Oil Gas J.*, 28.5.42, **41** (3), 48.—The life of wire rope could be increased if a systematic inspection programme were developed which would detect troubles when they first develop and would not wait until they become obvious. A rotary-drilling line should give somewhere between 8000 and 30,000 ton-miles of service. This average could probably be substantially increased if all users adopted a suitable inspection programme.

Methods of inspecting wire rope can be fairly well standardized, although inspection practices on rigs must necessarily vary to allow for the peculiarities of the individual installation. Evidences of deterioration in wire rope will, within fairly wide limits, be the same, regardless of where and how the rope is used.

Deterioration of wire rope will be evidenced by : (1) broken wires ; (2) worn wires ; (3) pitted or corroded wires ; (4) drastic reduction in rope diameter and excessive lengthening of lay ; (5) marks of mechanical abuse, such as flattening and distortion.

Inspection should include : (1) A quick check of the number of broken wires by rope lays, so that the worst lay can be selected. (2) A check of the diameter of the rope throughout its length should disclose any drastic reduction from the catalogue diameter at any point. (3) Inspection of the degree of abrasion wear occurring on the wires. (4) Noting carefully, not only in the worst broken-up section of the rope, but throughout its entire length, whether any signs of rust are appearing. (6) Noting carefully the condition of the rope near attached fittings. Causes of damage are tabulated. The significance of the different items of inspection is explained.

In addition to the number of breaks, the amount of stretch in a line also indicates the approach of the end of useful life. Applying loads to a 6 by 19 rope up to about one-half the rated breaking strength of the rope will show a total stretch equal to 0·2–0·3%. For correctly preformed ropes this stretch will be from 30 to 50% less.

In actual service the history of rope-stretch is always a guide to indicate when ropes absolutely must be removed from service. In the initial stages of rope life, rapid stretch always occurs, then a long period of negligible but rather constant stretch occurs, and finally, when the core starts to deteriorate rapidly and the wires within the rope start to break rapidly, the rate of stretch again becomes very rapid. When this latter stage of stretch begins the rope should immediately be taken out of service.

Proper inspection of wire rope must necessarily include examination of the equipment on which it is being used. The principal items to be checked are: (1) Sheaves. (2) Drums. (3) Reeving. (4) General operating conditions. These are studied in this part of the paper, giving general directions. A. H. N.

687. Maximum Service from Well-Surveying Equipment. Anon. *Oil Gas J.*, 30.4.42, **40** (51), 185.—The Syfo instrument, having no moving parts or mechanism whatever, is probably the most rugged type of instrument of its kind. If properly assembled in its protective casing, no other precautions are necessary. The operation of the Syfo is dependent on the uniform and consistent flow of the recording fluid. To secure consistent operation, cleanliness is essential. It is suggested that after use the instrument chambers be flushed out with clean water to remove any foreign matter which might eventually get into the recording fluid and clog the orifice. The orifice chamber is protected by a fine-wire strainer. This strainer should be in good condition and should not be removed oftener than necessary. The recording fluid, as well as the interior of the Syfo, should be kept free from oil or grease, which might interfere with the flow of fluid through the orifice. A fresh supply of recording fluid should be made up frequently. Recording charts should be kept in the sealed container up to the time required for use. Hints are given on the proper use and maintenance of inclinometers.

The following hints are given for the case of the instrument of the go-devil type: (1) Do not handle the instrument or pneumatic shock absorber with gloves or dirty hands. If you do, grease, moisture, grit and dust may get into the precision mechanism and necessitate a factory cleaning or repair job. Instruments and pneumatic shock-absorbers are as precisely made as the finest watch, and the presence of any foreign material is very destructive to them. (2) Immediately after use, carefully wipe the instrument and pneumatic shock-absorber with a clean, dry rag. Place the rubber protective cap over the open end of the angle indicator tube and return it and the timing element to the wooden instrument box. Replace the pneumatic shock-absorber in the go-devil container tube. This will protect them from water, dirt, and damage. (3) Keep the wooden instrument box clean and closed. It is strongly made and felt lined and sealed to prevent damage to the instrument. Clean the inside of the box with a dry brush (never use water or solvent of any kind). (4) Never at any time use pliers or other tools on the instrument. Screw the timing element into the angle indicator tube, using only your fingers on the knurled surface, and bring it to a snug shoulder. If you do this, the joint can easily be taken apart after use. Remember these are finely made threads and the tube is made of thin, comparatively soft metal. While the instrument will give long, satisfactory service, it cannot stand abuse and rough handling. (5) Never tinker with, attempt to adjust, or lubricate the mechanical parts of the instrument or pneumatic shock-absorber. They are lubricated and sealed for life at the factory, and can be taken apart and serviced only by instrument men specially trained in this work. (6) The only lubrication required for the instrument and shock-absorber is (*a*) the coarse pin thread which connects the instrument to the shock-absorber, and (*b*) the fine thread between the timing element and the angle-indicator tube. Use only a very light oil, apply it very sparingly, and wipe any excess away immediately with a clean rag before screwing the parts together. (7) Never wash any part of the instrument or shock-absorber with water, solvent, or fluid of any kind.

Similar hints are given for go-devil and accessories. A. H. N.

688. Latest Type Piling Structure for Gulf Coast Marine Drilling. C. C. Pryor. *Petrol. Engr*, June 1942, **13** (9), 27.—Among the many serious obstacles to be overcome before a piling structure is ready for drilling operations is that of the formation into which the piling is driven, which may allow the structure to settle. At many locations soil-formation tests are made at piling structure locations.

One important practice adopted by engineers in construction of the structure is the method of scabbing used on each pile. In this instance, four 6 in. by 8 in. by 8 ft. scabbing were used to bolt the scabbing to the piling. The upper ends of the scabbing were tapered in an endeavour to facilitate removal of the piling after the well or wells had been completed. The lower ends were placed at varying distances from the end of the piling, depending on the depth to which the individual piling was to be driven. The bottom ends of the scabbing were driven into the most solid formation as a distinct aid in preventing settling of the structure. At some locations the formations through which the piling must be driven are so compacted that it is necessary to jet the piling to remove them. Removal of the piling other than that necessary around the well-head after completion is on compliance with Government regulations. Scabbing has been found to play a major rôle in preventing settling of the structure; however, another important practice adopted by engineers is the capping and bracing of piling. These are discussed and illustrated as used in this plant. Equipment and derrick sections are detailed and dimensions given.

One of the most economical features of the piling structure is the ease with which more than one well can be drilled. On a similar structure, ten wells were directionally drilled for production, besides a water well to supply the needs of the rig. In addition to the drilling of several wells, the ease with which the entire structure is salvaged adds much to its economy. Obviously, the entire amount of steel 8-beams used in the construction can be removed even more quickly than they were constructed. The piling need not be broken off, but may be pulled or jetted out.

Advantages of this system over sunken barge system are discussed. A. H. N.

689. Fibre Pipe Run for Casing in Shallow Illinois Oil Well. F. Squires. *Oil Gas J.*, 28.5.42, **41** (3), 61.—This method, utilizing a special Orangeburg fibre conduit material instead of regular steel casing, was developed by the Illinois State Geological Survey as a war emergency project to save steel and promote petroleum production.

The fibre casing, with a bottom length of steel casing, was lowered into the hole on a string of tubing, and supported at the bottom of the tubing string by a special shouldered shoe designed for the job. The shoe was toothed at the bottom to prevent the turning of the casing when the tubing was unscrewed. The anchorage is of importance, because the tubing connection with the shoe was made with left-hand threading. This threading design allowed the tubing to be rotated and free from the shoe after the cement was run, without loosening the shoe assembly, whch was also threaded to the end of the casing.

The fibre casing was supported by the shoe, to avoid the possibility of parting of casing joints, since the joints were of the bevelled friction or " shove " type, with corresponding collars. The greatest departure from standard practice is the design and function of the shoe. This is described in detail.

As a result of the testing of this fibre conduit in an actual well installation, certain refinements suggest themselves in regard to future applications of the method described in this paper. It is believed that the cement can be reinforced with better results, and that more positive centering of the fibre conduit can be accomplished. In addition, some improvements in the design of the shoe can doubtless be made.

A. H. N.

690. Maintenance of Rotary Rig is Continuous Operation. H. F. Simons. *Oil Gas J.*, 30.4.42, **40** (51), 86.—On a schematic drawing of a standard two-engine rig, sixty-three items of maintenance are listed, together with instructions. The paper discusses the more important items in detail. It is suggested that instead of evaluating progress on hole made on time, it must be judged in the light of the damage and wear on the drill collars, drill pipe, and tool joints.

If steel were the only scarcity, a partial solution would be available by the use of rubber protectors on the drill-pipe. These are used to prevent contact between the drill-pipe and the walls of the hole. Some operators are already reclaiming as many drill-pipe protectors as possible from old strings of pipe no longer suitable for use. Instead of destroying them by cutting them off the pipe with a hatchet, protectors can be pressed off without damage from the worn-out pipe.

There are two ways open to prolong the life of the drill-stem. The first is to use less speed and less weight while drilling, and the second is to take better care of the drill-stem.

The term less weight is used advisedly, as with a properly designed drill-string more weight can be applied to the bit without damage than can be exerted with the ordinary drill-string. The use of a heavy drill-collar section on the bottom of the string has been advised for a number of years, the object being to concentrate the weight at the bottom and obtain a plumb-bob effect on the pipe in the upper portion of the hole. This prevents the tool-joints from contacting the abrasive side-wall formations, which wears them rapidly.

Unfortunately, most drill-stems are not properly designed, and the driller obtains the necessary force on the bit by supplementing the drill-collars with the weight of the drill-pipe. This causes bending of the drill-pipe, which develops an eccentric motion and contact between the pipe and the formation. The solution is less weight and lower rate of penetration, but an increase in the life of the pipe. This increase in life is not one merely of days, but more vital; it is one of feet of hole made and oil-wells or dry holes completed. Details are given of other maintenance procedures to be taken with drill-pipe, joints, swivels, pumps, and weight indicators.

Other points which apply to practically all rigs, and which, if observed, would prolong their life, are: (1) Avoid shock loads. (2) Operate rig at speed below rated capacity. (3) Keep all bolts and nuts tightened. (4) Replace worn parts before they wear mating parts. (5) Avoid excessive acceleration and deceleration and preserve bearings and brake lining. (6) Keep suction lift as low as possible. (7) Keep elbows and restrictions in mud lines to minimum. (8) Do not lug engines. (9) Engage clutches as easily as possible. (10) Have a systematic checkover system. (11) Do not continue to operate rig when there is any trouble developing; shut down and repair it immediately. (12) Do not overload rig. (13) Do not tinker.

A. H. N.

691. Maintenance of Blowout Preventers. Anon. *Oil Gas J.*, 30.4.42, **40** (51), 176.—In order to obtain maximum service life and most efficient operation from a blow-out preventer, it should be cleaned and lubricated at regular intervals. Drilling mud enters the working parts, and unless it is removed it causes corrosion and generally contributes to wear and improper operation. Detailed hints are given for maintenance of each part of the preventer.

A. H. N.

692. Boiler Maintenance. Anon. *Oil Gas J.*, 30.4.42, **40** (51), 182.—Gas-burners are more often set too high than too low. A high burner leaves the bottom of the firebox cold and produces unequal strains in the metal, frequently causing staybolt leaks, besides reducing effective heating surface and combustion volume. A good rule is to have the top of the burner in line with the bottom row of staybolts. Still better results are obtained by setting the burners in a base below the firebox, with refractory protection for the mud-ring. This makes an excellent setting for stationary installations and will produce better combustion. Automatic dampers in the base are of advantage to regulate the flow of air or to shut off air when the burner is turned off. In any setting excessive cold air influx lowers the efficiency and may be harmful to the boiler by sudden cooling.

Oil-burners should be set in a well-constructed refractory "duck's nest," and flame impingement against metal surfaces must always be prevented. After new boilers are placed, they should be washed out thoroughly to remove all foreign matter and rust accumulations.

Firing up a new boiler is somewhat similar to a stress-relieving or normalizing process, adjusting the boiler parts to their normal heat-strains. It should be done very gradually, starting with a low fire for several hours and taking at least 18 hours more to build steam pressure gradually. Small leaks in a new boiler will often "take up" or tighten themselves after a short time, but if they persist they should be peened or caulked tight. Continuous leaking produces concentrated corrosion and may in time crystallize the adjoining metal. Seal-welding of leaks should never be resorted to unless the structure is sound, and then only if approved by an authorized boiler inspector. Seal-welding of leaks, or even tack-welding of attachments, on the newer type of "high tensile" steel must never be permitted. Any welding on this type of steel, without subsequent stress relieving, is harmful to the metal and may produce crystallized spots.

Scaling and dangers accompanied therewith, heat conservation, pitting by free oxygen, use of superheated steam are discussed. The power output of machinery on a drilling rig is in direct proportion to the volume of steam supplied; therefore the net increase of 18% in the volume of steam generated for only a 5·6% increase in heat added recommends the use of superheated steam as of unquestionable value.

Other notable operating improvements on a drilling rig result from the use of superheated steam. With saturated steam a noticeable amount of condensation and pressure loss occurs in the long steam line from the boiler plant to the rig. Under ordinary conditions such condensation is entirely eliminated and the pressure loss greatly reduced when superheat of 100° F. is used. The machinery operates more efficiently, lubrication is more effective, and the response to heavy demands is more prompt when dry or slightly superheated steam is used, because the mean effective pressure is increased.

The general use of superheated steam on drilling rigs and the modern equipment provided to make its use possible represent far-reaching economies and an increase in the capacity of the rig that no additional number of boilers can equal.

Use of insulation is discussed. The paper ends with a study of the correct use of steam-traps. A. H. N.

693. Cable-Tool Service Extended by Good Operating Practice. F. J. Spang. *Oil Gas J.*, 30.4.42, **40** (51), 103.—In the actual drilling operation much can be done to prevent wear on the exterior of drilling cables, rope sockets, tool-joint collars, and bit blades. The constant use of colloidal clays to condition the walls of the hole while drilling will close the face of sharp rock thus preventing a certain amount of wear. Such clays also tend to reduce both minor and major caving. Naturally, if caving is reduced it lessens the time consumed in pulverizing and mixing the cavings, as well as the amount of bailing needed.

In addition to these advantages, the use of colloidal clays tends to reduce the formation of mud balls and mud rings, and the consequent wear of the tools and drilling cable working them loose. Drilling sediment is more readily and consistently mixed thus lessening the amount of time consumed in pulverizing it and permitting a greater footage to be drilled with each run.

The proper care of joints is discussed. In mating joints they should first be set up without much stress and then separated and subsequently cleaned, at which time careful examination should be made for the formation of any wire or galled spots on either the threads or the face of the joint. If these have formed, they should be fully removed. The joints should then be set a second time, after which they should be recleaned. If this procedure results in proper joint action, the joints may be tightened and put into use. However, if the action is not proper, they should be separated and cleaned as often as is necessary so that a step-by-step mating of the joints takes place. Use of clean water is emphasized as well as the avoidance of overstresses.

Precautions to be taken with bits are: (1) The forge furnace should be large enough and smooth enough inside so that it will not crowd the flame or divert it to strike the bit directly and thus burn it. (2) The forge furnace should be deep enough to mix thoroughly the fuel and air, but put it into good even combustion before coming into contact with the bit. (3) The fuel entrance should be well below the bit and preferably in front of the forge. (4) The bit blade should not be stopped or blocked off with mud or wet ashes. (5) The fuel mixture should be rich, never a thin or cutting one, as such a mixture both decarbonizes the bit and heats exposed corners of the bit too hot before the body is warm enough to stand the consequent expansion. (6) Water courses should be cut out in such a way as not to leave corner cuts or deep grooves in them. (7) The bit should be allowed to cool to a fully black colour after dressing, and then a short end of the point reheated slowly and uniformly to an even cherry red in a rich flame. (8) The bit should be quenched only to have the corners submerged in the water. (9) Soft water gives the best hardening results. (10) A really cold bit should not be put into a hot flame, but should be laid in the forge without any flame until slightly warmed. (11) All seams, cracks and cold shuts should be kept chipped out of the bit at all times. (12) After a bit has been heated to high temperature, or several times to cut off and stove up to dress, it should be allowed to cool to a black colour and then be reheated to a temperature slightly above a hardening heat and again allowed to cool to a black before heating to harden. (13) Where the drilling is in extremely hard or abrasive formations, demanding a frequent change of bits, it has been definitely proved that a great saving of steel can be made by using a set of three bits instead of the conventional set of two. A. H. N.

694. Preventing Chain-Drive Failure. Anon. *Oil Gas J.*, 30.4.42, **40** (51), 167.—It can safely be stated that from 90 to 95% of all chain failures in service must be attributed solely to causes beyond the control of the chain manufacturers. In other words, they are caused by incorrect application, installation or maintenance on the part of the user.

Improper lubrication is probably the greatest cause of premature failure. Causes important enough to be given consideration follow: (1) Entire absence of lubrication. (2) Operation in dirty conditions. (Dirt taking the form of a fine abrasive dust, a coarse obstruction to chain operation, or corrosive conditions.) (3) Imposition of overloads. (4) Misalignment of drive.

At slow speeds periodic lubrication with a good grade of medium mineral oil is usually adequate. This oil should be applied so that it will penetrate to the pin bearings or the chain belt will not be lubricated.

At moderate speeds, constant drip-feed lubrication should be provided. The drip should be directed to the upper edges of the side plates of the lower strand. At moderate speeds, fast-drip feed in enclosed casings, or oil-bath lubrication should be provided for chain-belt drives.

For high-speed heavy-duty drives, a pump-spray lubrication system represents the best, most economical and efficient system. Misalignment seriously abuses a chain belt. When misalignment is present, the loads imposed by the sprocket teeth are not located centrally on the chain roller. This results in uneven and hence more rapid pin-bearing wear. Also as the chain enters the sprocket, the side plates are struck. This results in wear on the plates, decreased efficiency and also destruction of the chain through loosening of the side plates.

These precautions will extend chain life : (1) Do not install chain on worn sprockets. (2) Do not run chain at excessive speeds. (3) See that locking devices and other parts are replaced as soon as their failure is noted. (4) Do not allow chain to slap or otherwise contact obstructions. (5) When replacing worn parts do so in the prescribed manner. Do not abuse chain at this time.

Notes are given on the design of roller chain drives. A. H. N.

695. Getting the Most Service Out of Transmission Belts. Anon. *Oil Gas J.*, 30.4.42, **40** (51), 170.—Most important provisions in designing the new drive may be summed up as follows : (1) Equip the drive with a sufficient number of the correct-sized belts to handle a maximum load. (2) Use sheaves that are over the accepted minimum diameters. (3) Provide sufficient take-up, so that belts do not have to be discarded until they are worn out. (4) Don't leave tools, bars, or other material where they might fall into the drive and break the belt as the material passes between the belt and the sheave-groove. (5) Don't expect the drive to pull heavy overloads (above designated rating) for long periods. (6) If possible, protect the belt from the direct line of the sun while the drive is in operation. (7) Use standard sizes. To-day it is more than ever desirable to design drives to fit standard belts and standard sheave sizes. Replacements will be easier to obtain, and in fact it may not be possible to secure belts for any drives except those using standard sizes.

The facts which must be known in order to design a V-belt drive are as follows : (1) Maximum horse-power to be transmitted. This may be obtained from the rating of the engines or motors to be used. (2) Maximum speed of the driving and driven machines. This also may be obtained from the engine or motor ratings, or from requirements of the driven machine. (3) Space limitations. (4) Type of load to be handled. The paper discusses the design of V-belts in some detail. Installation and maintenance of belts are next studied. The substitution of leather for rubber belts and the peculiarities of these bolts are outlined. Inspection of belts should answer : (1) Is the belting too dry? (2) Is it dirty? (3) Is it saturated with oil? (4) Is it too slack or too tight? (5) Are the pulleys in line? (6) What is the condition of laps and plies? (7) What is the condition of lacing and the ends of belts that are laced?

If belting is dirty, clean the surface. In extreme cases a blunt-edge scraper may be used : usually, however, the belt may be cleaned satisfactorily by washing with naphtha or gasoline. To avoid fire hazard, carbon tetrachloride may be substituted. When the belting has been cleaned, dressing should be applied sparingly : use of too much dressing will cause excessive slippage of belts. A small application will keep them from drying out or slipping. Some dressings penetrate the leather and act as lubricants, but have no beneficial effect on transmission qualities ; others contain free fatty acids which materially shorten belt life. In fact, many dressings have little to offer except their stickiness, which often causes damaged grain and shortened belt life. A. H. N.

696. Clinton Sand Drilling and Production in Central Ohio. H. N. Ross. *Oil Gas J.*, 7.5.42, **40** (52), 55–56. *Paper Presented before the Natural Gas Section, American*

Gas Association.—The geology of the field is given briefly. All drilling in the area is with cable tools. Standard-rig equipment is generally used; however, some drilling is done with National machines, and a few wells have recently been drilled with spudders. The standard rigs have a 22-ft. base and are 84 ft. in height, with an allowable crown-block load of 120,000–180,000 lb. Most operators are using steel crown-blocks with cast-steel sheaves, although some still use wood crown blocks with cast-iron sheaves. Details of the rig and casings used are given.

Drilling costs—that is, labour, fuel water, and tools for drilling—are approximately $1/ft. The over-all dry-hole cost is approximately $1.25/ft. Average drilling speed is 100 ft./24 hr. As the cost and speed of drilling indicate, there are few problems in drilling in Central Ohio. Fishing jobs are largely confined to failure of wire and joints. Some difficulty is experienced in the top of the hole with caving. This can be materially helped by the use of Aquagel. The shell immediately above the Clinton sand caves very badly unless drilled with salt water. The wells are usually shot and produced against a back-pressure of one-third to one-half the rock pressure.

A. H. N.

697. Casing Recovery at Old Wells Conserves Steel for War Effort. H. F. Simons. *Oil Gas J.*, 18.6.42, **41** (6), 33–34.—Conservation of high-grade steel casing is necessary to provide steel for more essential war duty. Pipe for new wells can be obtained by reclaiming it from abandoned or uneconomic wells. This article describes recovery methods for long strings at Oklahoma City.

The amount of pipe which can be recovered from a well is principally dependent on the height of the cement behind it. Where casing has been set on a shelf, or with only a few sacks of cement in wells at Oklahoma City, it has been possible to recover the entire string. Recently on a Gulf Coast well over 8000 ft. of pipe was recovered.

The method used in this case was slightly different, an inside cutting tool being run in on a drill-string and a section of the casing freed by cutting. This section was then pulled by running a spear, after which another cut was made and another section pulled. A. H. N.

698. Mud Control Saves Steel. Anon. *Oil Gas J.*, 14.5.42, **41** (1), 49.—In a very short paper is described how, with the present necessity for minimizing the use of steel in any form, mud engineers for some oil companies have accomplished remarkable results in eliminating long strings of casing by intelligent and skilful mud control, and by a willingness to spend an increased amount of money to carry out a suitable mud programme in order to effect a much greater saving. Examples are quoted. Such a case is: In one field in which wells are drilled to approximately 6500 ft., the following casing programme has been customary: 600 ft., 13⅜ in.; 5600 ft., 11¾-in.; 6500 ft., 9⅝-in. Native mud weighing approximately 82 lb./cu. ft. has regularly been used in these wells.

Recently in this field several holes have been drilled in which by using 98 instead of 82 lb./cu. ft. mud, about 5600 ft. of 11¾-in. casing has been eliminated. Careful mud control was maintained and a sufficient amount of colloidal clay added to keep the water loss and cake thickness at a minimum. Suitable chemicals were also used to further decrease water loss by keeping the colloidal material in dispersion, and to control viscosity and gel strength. The control resulted in saving approximately 140 tons of steel/hole, and, although the monetary saving effected was of less importance, the operator actually saved about $12,000. Not included in the above estimate of savings are costs which were also eliminated, such as for casing shoes, float-collars, cement, cement equipment, shut-off tests, extra rig time, and wear on wire line. Other examples are similar. A. H. N.

699. Cheap Mud Work Employed in Drilling Trinidad Wells. C. N. Smith. *Oil Gas J.*, 28.5.42, **41** (3), 52.—This article describes some of the accomplishments possible through the use of modern mud-testing equipment used on wells in Trinidad, British West Indies, by the author. A testing kit, the same as that employed by many operators on deep wells in the U.S.A., was the basis for the work. Use of this kit resulted in a reduction of $11,000 in the mud costs for drilling 80,000 ft. of hole.

Various muds were tested to determine which gave the most desired characteristics. While searching for a cheaper viscosity reducing agent, tests were run on mud treated with citrus juice. The author describes the method of preparing the citrus juice, its application, and the results. A solution of 10% of pure citric acid is not as effective as the equivalent amount of lime-juice. Quebracho gives a much better reaction than pure tannic acid, both of which results suggest that it is not the acid content of these reagents which is of primary importance, especially in view of the fact that these reagents are equally effective when completely neutralized with caustic soda.

A very important economic point has been established—*i.e.*, that any grade or type of citrus fruit is useful for the preparation of this reagent; it does not even matter if the fruit is rotten, it still yields a reagent definitely better than quebracho and, of course, cheaper. Grape-fruits, lemons, shaddocks, and limes all have value, and this would certainly provide an outlet for all the low-grade fruit produced in the island. The significance of *p*H values of the mud is explained.

A. H. N.

700. Mud Control of Vital Importance to Drilling Technique. W. A. Sawdon. *Petrol. Eng.*, June 1942, **13** (9), 52.—A portable mud-testing laboratory is described. The apparatus includes a filter-press for determination of wall-building qualities and water loss, a *p*H meter, mud-balance and hydrometers, screens for cuttings and sand content, electric mixer, Marsh funnel, triple balance beam-scales, a shearometer, and equipment for analyzing for salt content.

The electric stove affords a means of testing viscosity, weight, gel strength, and water loss under various temperatures. New mud is frequently tested at temperatures as high as 170° F., as mud that reacts normally at atmospheric temperature may give a different reaction at hole temperature. The reactions obtained at various temperatures used in preliminary tests indicate what may be expected, and further tests made when the fluid is in circulation are performed at actual return temperatures. The mud during circulation does not attain bottom-hole formation temperature, and although there may be some heat loss before it reaches the surface, the temperature at the return is usually very close to that of the fluid itself when it is at the bottom of the hole, making routine tests performed at return temperature sufficiently accurate.

The procedure followed at the well where the laboratory is now in service required the taking of samples at stated intervals for routine tests. When the test indicates that chemicals should be added, allowances are made from the test data before using, as many factors are encountered while drilling that may have an influence on the mud fluid. Approximately one-half the amount of chemical is added initially, and another sample is taken at the end of the circulating cycle to determine what the effect of the chemical has been under down-hole conditions.

Tests are also made on the treated mud as it goes into the hole. The sample for this is taken just above the pump suction, as it is important to know exactly what is going into the system. Upon return of the treated mud another sample is taken, and whatever further treatment is necessary is indicated by this test.

Details and significance of various tests are reviewed. Advantages are discussed. Such an advantage is conserving casing steel. In one field where production is from depths of 9000 to 10,000 ft., an 8200-ft. string of 9-in. casing was eliminated and more than 900 ft. of 6⅝-in. string (usually run to below 9000 ft.) was saved. The weight of the mud circulated during the drilling of this well was from 90 to 92 lb./cu. ft., which was approximately the same as employed in previously drilled wells. More colloidal material was used, however, and chemicals were introduced to reduce the water loss. Other instances in another field are also cited. A. H. N.

701. Portable Steel Mud Flumes. Anon. *Oil Wkly*, 4.5.42, **105** (9), 83.—A California company is using highly unitized and interchangeable steel mud flumes which have a number of construction features. In addition to being easily moved from location to location and providing for the use of as many sections as necessary to design varied length of circulating systems, the sets have means of being connected in straight lines or for 90° turns, standards for constructing inspection walkways, facilities for cleaning and other features.

As the dimensions of each section are identical with others, as many may be used as are necessary to provide the desired layout. The type of material used in constructing the flumes consists of 2-in. pipe and several sheets of salvaged tank steel. The flume sections are constructed by first forming a substantial frame from the 2-in. pipe that consists of legs, side members, and top rails. These supporting frames are made up in standard dimensions, to provide interchangeability with other units. The construction of the flume is described in some detail.

For inspecting the flowing stream of drilling mud passing through the flumes, to make observation of make-up or dilution more convenient, and to keep the feet of the operators off the ground, sidewalks are a desirable part of the assembly. The supporting frame for the walks is made by using more of the 2-in. pipe, with sectional length sufficient to extend the full length of the flume section plus connecting attachments. The surface of the sidewalks may be finished with common dimension lumber wide enough in the aggregate to promote safety and utility. A. H. N.

Production.

702. How may Decline in Discovery Rate be Checked? J. L. Adler. *World Petrol.*, March 1942, **13** (3), 58–61.—The large majority in the oil-exploration industry are not yet convinced that geochemical surveys have shown a degree of infallibility which justifies appropriations at the expense of methods of proved worth. The search for stratigraphic traps has been strongly recommended, but of the larger ones discovered only a few are in the U.S.A., although many small ones have been found there. Moreover, the distinction between stratigraphic and other traps is not always clear. Indeed, many of the structural traps are dominated by stratigraphic conditions. It would be wise to consider the local structure in selecting locations for testing stratigraphic traps.

It would seem that the best way of increasing discoveries quickly is to maintain surface and subsurface geology, core-drilling, gravimeter, and reflection seismograph surveys at their present level, and then to drill on the numerous untested or insufficiently tested prospects which have been located during the last decade of geological and geophysical exploration.

These prospects have not been tested because of an attitude resulting from the economic depression of the thirties. Additions to already ample reserves were not essential, and dry holes were to be avoided at all costs. This attitude involving the search for greater certainties has led to many prospects being passed over. There is a need to return to the practice of testing all reasonable geological and geophysical leads. G. D. H.

703. Adequate U.S. Reserves Await Stimulation of Incentive to Drill. A. I. Levorsen. *World Petrol.*, March 1942, **13** (3), 44–47.—Estimates of available known U.S. oil reserves range from 18,000 million to 20,000 million brl., but only a quarter or a fifth of this is available for use during the next few years; the rest can be produced only at a progressively slower rate over a long period of years. The rate of withdrawal should not be such as will unnecessarily reduce the ultimate quantity of the known reserve. If the rate of production is to be expanded it is essential to discover new reserves.

The bulk of the current discoveries, as well as the most available undiscovered reserves, lie in areas of current development and production. Important reserves may be expected in the partly explored regions fringing the areas of current development. A third group of possible producing areas is farther removed from current development, and less is known about the geology of such areas than of the first two groups.

Areas in these three groups have thick, unmetamorphosed sediments, chiefly marine, evidence of oil and gas, regional unconformities and regional wedge-belts of porosity, all conditions common to most known oil provinces.

There are many possible producing provinces in the countries adjacent to U.S.A.

So many factors are involved in the formation of an oil-pool that almost every field differs from every other field. The conditions involved in the discovery of new fields are becoming more complex, increasing the cost of exploration. The results of many types of observations are now available to the geologist or other scientific worker, but thought has not advanced sufficiently to make the fullest use of such results.

The small independent operator in U.S.A. has tended to discover the bulk of the new fields in the past few years, and the general absence of such operators in countries outside U.S.A. means that many areas in those countries which would be considered favourable in U.S.A. are unexplored.

A combination of liberal reasoning with the drilling of many slim-hole tests seems to be the best means of discovering new reserves. G. D. H.

704. Core Analysis—an Aid to Increasing the Recovery of Oil. J. A. Lewis. *Petrol. Tech.*, May 1942, A.I.M.M.E. Tech. Pub. No. 1487, 1–8.—In water-drive the homogeneous permeability of the sand and the thickness of the sand are the significant variables to be evaluated in order that the rate of intake of a given well may be determined. Rates of intake and rates of recovery calculated from core analyses for many different flooding operations agree well with the actual values from operating records.

It appears that the production of oil at economic rates by artificial water-drive takes place by positive displacement of the oil present in excess of the equilibrium saturation, substantially in accordance with the permeability of the sand to homogeneous fluid flow.

It is now possible to compute from core analyses the normal connate-water content of flushed cores from reservoirs under normal hydrostatic pressure to within 10–15% of the values obtained from tracer or oil-base mud cores.

From a knowledge of the reservoir fluid characteristics and the homogeneous fluid permeability of the sand, the productivity index of any point or zone in a sand-body may be calculated. The calculated and measured productivity indices agree closely. Since the permeability indicates the productive capacity, it becomes possible to compute the recovery to be expected from a volumetric or effective water-drive reservoir.

Field results and research show the existence of an equilibrium residual oil saturation after water-drive. By adjusting the production rates in potential water-drive fields so that a minimum drop in reservoir pressure results, or by artificially supplementing this water-drive by injection of extraneous water to maintain the reservoir pressure while obtaining profitable rates of production, it will be feasible economically to recover a larger portion of the original oil content. This technique, which would involve considerable water production in the final stages, should give two to two and a half times as much oil as would be obtained by normal gas expansion, and should be even better than the application of water-drive after the reservoir pressure has fallen to a low values. G. D. H.

705. Caliper Logging. C. P. Parsons. *Petrol Tech.*, May 1942, A.I.M.M.E. Tech. Pub. No. 1474, 1–8.—Caliper logging measures the variations in the diameter of the open hole in a well by means of four arms on apparatus which is drawn upwards in the well and gives a continuous record of the hole diameter. These caliper logs permit the calculation of the volume of cement needed in cementing operations, eliminating the uncertainty present when guesswork is necessary. They show that shales usually wash out considerably beyond the bit size, while oil-sands remain closer to the bit size. In gravel packing, a knowledge of the profile of the hole permits operations to be carried out which will make the placing of the gravel satisfactory. Caliper logs taken before and after acidizing show whether or not the acid is attacking some of the required places, and similarly the effects of shooting may be measured. In side-wall coring a caliper log will indicate the length of the mechanical core-takers which are needed. Seats for packers may be located by this form of logging, and the logs for several wells in an area provide stratigraphical information which can be correlated from well to well.

A number of caliper, electrical, temperature, and drilling time logs are included.
G. D. H.

706. A Plan for Operation of the Paloma Field. W. H. Geis. *Petrol. Tech.*, May 1942, A.I.M.M.E. Tech. Pub. No. 1472, 1–6.—Soon after the discovery of the Paloma field it was realized that all the hydrocarbons in the reservoir were in the gaseous phase, so that to obtain the greatest ultimate recovery of condensate the reservoir hydrocarbons must be produced in the single or gas phase. Consequently, the production engineers of the several companies concerned devised a plan for operating the field. It was contended that ordinary competitive production would give only 4000–5000 brl./acre against 21,000 brl./acre using pressure control. The plan proposed a central plant working at a predetermined practicable rate to give a 60° A.P.I. water-white product with 50% of aviation spirit, the residual gas being returned to the reservoir and finally extracted as dry gas. This plan would reduce costs and increase recoveries all round.

Some insisted that the specific relationship for each lease should be determined, a relationship involving area, sand thickness, porosity, permeability, saturation, structural position, and other factors, but the committee suggested participation on an acreage basis only. It was decided to put the operation of the plan under independent control, and the consulting engineers performed the technical work admirably, all efforts being made satisfactorily to fix the area for unitization. Nevertheless, the plan failed because a minority refused to accept the position of the boundary, and because of the possibility of a black oil-ring existing between the gas-cap and the edge-water.

An agreement was prepared, the details of which are briefly outlined, but it did not become effective because of difficulties on almost every point, with the lessors as much to blame as the operators. G. D. H.

707. Water Influx into a Reservoir and its Application to the Equation of Volumetric Balance. W. Hurst. *Petrol. Tech.*, May 1942, A.I.M.M.E. Tech. Pub. No. 1473, 1–16.—A method based on the classical diffusivity equation seems applicable to the calculation of water-drive relationships, and this theory has been successfully applied to the study of water movement at East Texas. The radial flow case of water-drive appears to be sufficiently accurate for most engineering purposes, but in the appendix the mathematical treatment is given of the linear, radial, and spherical cases of water influx into a reservoir.

In addition to establishing equations for the rate and total water influx, a method of solution is given for the case where the pressure–time curve may be represented by a series of straight lines. If the pressure–time curve is a smooth curve, there is no alternative but to resort to graphical integration.

An illustrative calculation is given, using the " broken-line " pressure variation, and the calculated relative water influx at various times agrees closely with the observed values.

None of the equations can establish the absolute water influx unless it is possible to fix the numerical coefficients associated with the integrals. In the determinations of the absolute water influx, the coefficients associated with the equations are established algebraically, together with the quantity of oil originally in place, by a solution of the volumetric balance equation for the fluids in the oil reservoir. G. D. H.

708. Development, Operation, and Valuation of Oil and Gas Properties. Part I. P. J. Jones. *Oil Gas J.*, 28,5.42, **41** (3), 45–47.—The first part of the paper deals with the porosity, specific permeability, and geometry of spacing of fields. Definitions of these and allied terms, together with the formulæ used in their calculations from test data, are given in short paragraphs. A method of getting the effective radii of wells in random spacing patterns is given. For this type of spacing the boundaries of the acreage from which a well is producing in the absence of fluid migration is a polygon formed by the intersection of the perpendicular lines through the midpoint of the lines radiating from a given well to the surrounding wells. The area of each polygon may be planimetred, or each polygon may be subdivided into triangles, and the area of each triangle computed from base and altitude measurements. Then the following equations may be used for determining the effective radius :

$$a = \frac{0{\cdot}866D^2}{43,560}$$

and

$$R = 0{\cdot}595D$$

where a = acreage allocated to a well; D = distance in ft. between wells in a row; and R = effective radius in ft. A. H. N.

709. Proper Production Methods. R. O. Garrett. *Oil Gas J.*, 7.5.42, **40** (52), 56–57. *Paper Presented before Natural Gas Section, American Gas Association.*—The paper deals with gas-production methods from prolific and high-pressure reservoirs from a depth of 5000–7000 ft., pressures ranging from 1500 to 3000 lb./sq. in. at the surface, the gas having a considerable fluid content of 5–20 brl./1 million cu. ft.

The general plan of operation after the well is properly completed is to test it for open-flow capacity, following in general the Bureau of Mines method of back-pressure testing as described in Monograph 7. Care is maintained at all times to ensure that each rate of flow is thoroughly stabilized. If stabilization is impossible, due to fluid content or other factors which render surface pressure unreliable, it is necessary to run a sub-surface pressure instrument into the well and obtain pressures by that method.

Such tests are repeated at quarterly or half-yearly intervals, so that availability and reserve studies may be made.

Wells which do not tend to freeze through the formation of hydrates are controlled through surface chokes, and wells showing a tendency to freeze up are controlled through the use of regulators.

Where wells are completed sufficiently far above the gas–water content to minimize the danger of coning and channelling of water, they are produced at a sufficiently high rate of flow to prevent freezing for a period of a few days, and are then closed in for the remainder of the month, while other wells are turned on in a similar manner, to provide a continual flow of gas to the pipe-line; this, of course, is possible only where well capacities greatly exceed pipe-line requirements.

Details of mainfolding are given. A. H. N.

710. Calculation of Back-Pressure Tests. J. W. Ferguson. *Oil Gas J.*, 7.5.42, **40** (52), 52.—Tables are given for use in calculating back-pressure tests on wells having GL values up to 7000 and equipped with any standard casing or tubing size, where G = gravity of gas and L = length of column. The formation pressure P_f may be obtained by the equation $P_f^2 = e^S Pc^2$, in which Pc is the shut-in rock pressure at the wellhead, lb./sq. in., absolute, and e is the base of natural logarithms, 2·728 . . . , S is a symbol to represent the value of $S = \frac{2GL}{53 \cdot 34 T}$, in which G is the specific gravity of the gas, L is the average depth of gas pay in feet, T is the absolute flowing temperature of the gas in the producing string.

Values of e^S corresponding to various values of GL may be found in a table given in the paper. Once obtained for a well, this factor remains constant, depending, as it does, only on the GL of the well and the flowing temperature, which is assumed to be constant.

Formulæ and a table are given for calculating sand-face pressure during flowing conditions, utilizing a simplified form of Weymouth's formula to calculate the frictional head. A. H. N.

711. Oil-Well Pumping Tests. H. E. Dralle and E. H. Lamberger. *Oil Gas J.*, 7.5.42, **40** (52), 43.—Describes some results of comprehensive and exhaustive tests on pumping wells undertaken by the Phillips Petroleum Co. The full results of the tests are so far-reaching and cover so many phases of oil-well pumping problems that their ultimate value cannot be immediately utilized. So far, the most obvious benefit seemed in the direction of proposing to the A.P.I. special subcommittee on well-load formulæ more accurate formulæ for calculating from known well conditions, peak polished-rod loads, pump plunger stroke, and peak crankshaft torques. Solutions seem possible for such other problems as predetermining prime-mover horse-power from the hydraulic horse-power, optimum counterbalancing, and the true relation between loads at the polished rod and at any other point in the mechanical system on the pumping well.

Figures given illustrate the locations and types of the many strain-gauges used and the type of results obtained. One figure shows oscillographic recording (two oscillographs, each with nine elements used) of the following: (1) Load in string immediately above the pump. (2) Load in rod-string at mid-point between pump and polished rod. (3) Load in polished rod (Jones dynamometer). (4) Displacement of polished rod. (5) Tubing load. (6) Deflection of walking beam forward from sampson post bearing. (7) Deflection of walking beam to rear of pitman bearing. (8) Load in pitman. (9) Torsion in low-speed shaft of speed reducer. (10) Rotational displacement of low-speed shaft of speed reducer. (11) Prime-mover speed. (12) Electric-motor voltage. (13) Electric-motor current. (14) Electric-motor power input. (15) Timing record.

Besides these fifteen simultaneous recordings, the following accurate readings, timed for a particular test, were obtained : (1) Motor-power consumption (watt-hour meter). (2) Pumping speed (s.p.m. obtained with stop-watch). (3) Volts, amperes, and power consumption (graphically recorded by voltmeter, ammeter, and wattmeter respectively).

The various types of instruments and other equipment are briefly described. Test procedure is similarly outlined. An attempt was made to hold the total time/test to a minimum—5–10 min.—so that fluid level in the well would not be appreciably affected. The various conditions under which tests were made include the following : (1) Three plunger conditions : $1\frac{1}{4}$-in. plunger, $1\frac{3}{4}$-in. plunger, and $1\frac{1}{4}$-in. plunger without travelling valve. (2) Two tubing sizes : $2\frac{1}{2}$-in. and 3-in. (3) Rod-strings with all standard couplings, with alternating spiral and standard couplings, and with all special couplings. All tests were made with $\frac{3}{4}$-in. rods. (4) Beam and rotary-type counterweights, separately and in combination. (5) Three prime movers : two electric motors and one engine. (6) After a few tests at 4500-ft. depth, the pump was set at 3500 ft. for the remainder of the programme. (7) Forward and reverse crank rotation. (8) Short tests of many normal operating conditions. (9) Long-period tests under normal operating conditions to compare performance of two types of electric motors. (10) Shock and friction tests to study and secure data for determining the over-all damping factor of the well.

Only a few results, however, are given. A. H. N.

712. Central Hydraulic Pumping Used in Hull-Silk Field. T. P. Sanders. *Oil Gas J.*, 7.5.42, **40** (52), 41–42.—The central hydraulic pumping systems at Hull-Silk are distinctive in that the wells are pumped with their casing-heads closed. All gas produced with the oil passes through the pump and up the tubing to reach the surface. Since expansion of gas in the tubing reduces the weight of the fluid column, there is a corresponding reduction in the power-fluid pressure that must be used in the pumping system.

Another unusual feature found in both the Hull-Silk and K.M.A. fields is the equipping of many of the wells with hydraulic pumping equipment before natural flow ceases. This is done for two reasons : (1) the early installation of subsurface pumping equipment avoids the possibility of losing production during the final stages of uncertain flow, and (2) the producing gas–oil ratio can usually be lowered sufficiently to avoid the production penalties applied in this area against inefficient use of gas.

The penalty for excessive gas–oil ratio takes effect on wells which produce more than 2000 cu. ft. of gas/brl. of oil. Throughout most of the average well's flowing life it is not difficult to regulate the production rate in such a manner that penalty will be avoided. However, during the last stages of flow it is not unusual for gas–oil ratios to rise to 4000 cu. ft./brl., in which case the excessive gas–oil ratio penalty involves one-half of the well's normal allotment.

With casing-head connection closed, Hull-Silk casing pressures are found to vary from 100 to nearly 800 lb. while the wells are being pumped. In some wells of the K.M.A. field it has been found necessary to install regulators on the casing-heads that will allow a small amount of gas to bleed off while the well is being pumped, thus providing enough differential to keep oil coming into the hole. It is believed that this practice will be found necessary at some of the Hull-Silk wells.

Details of mainfolding are given. A. H. N.

713. Development, Operation, and Valuation of Oil and Gas Properties. Part 4. *Oil Gas J.*, 18.6.42, **41** (6), 35.—This part of the paper deals with the flow of homogeneous fluids, and in particular of water in virgin oil and gas-pays. The water content of hydrophylic oil and gas-pays prior to any advancement of bottom water or edge-water may be classified as (1) trapped water, (2) absorbed water, and (3) capillary water.

The significance of these waters is explained. Physical properties of sands are discussed. Interfacial tension and its effects on the problems of water in sands are studied. Interstitial water and its effects on recovery are mentioned and briefly studied. A. H. N.

714. Proper Oil Prolongs Life of Pumping Unit Speed Reducer. K. N. Mills. *Oil Gas J.*, 30.4.42, **40** (51), 161.—Correct use of the proper oil prevents excessive wear, overheating, and protects the parts from rust. In performing these duties the oil used must withstand high unit loads while continually subjected to oxidation by aeration, and perhaps also while exposed to atmospheric moisture and corrosive gases. Likewise, it is called on to give effective lubrication within extreme temperature ranges.

As the oil in a reducer is very thoroughly aerated, it is reasonable to expect the oil in a reducer operating in a sour-gas area to absorb some of this corrosive gas. This corrosive gas will act on the bright metal parts of the reducer, and will form a metallic oxide on the bearing parts. If the contamination of the oil by the sour gas is sufficiently high, it will cause the bearings to fail by abrasive wear. The author has had several oil samples from reducers which are operating in sour-gas areas analyzed to determine their acid content. Some of these samples were found to contain about seventeen times the maximum allowable amount of acid for a satisfactory roller-bearing lubricant.

Corrosion can also be produced by water in the oil, and water will enter the reducer with the air drawn into the reducer during its breathing action. This moisture condenses on the inside of the reducer, and mixed with the oil when the reducer is in operation. In damp sections of the country a surprisingly large amount of water enters the reducer in this manner. As water causes rust, and rust is an abrasive, this water may also cause excessive bearing wear. The corrosion resulting from this condition is probably the most destructive, because of its dual nature. The rust that it produces flakes off the parts on which it forms and is suspended in the oil. As this rust enters the oil, it is circulated through the bearings and causes abrasive wear. This action not only exposes the bearing to wear from abrasives formed on the bearing parts, but also from the abrasives formed on the other steel parts of the reducer.

Use of mineral oils and the care to be taken are discussed in detail. A. H. N.

715. Value of Sound Pump Practices Increased by Emergency. Anon. *Oil Gas J.*, 30.4.42, **40** (51), 136.—Oil producers will be obliged to use pumps made of less steel in order to produce more oil for the all-out war effort. Here are some of the specifications thought to be contributory: (1) One-piece alloy steel barrel. This will reduce bulk and can be rehoned repeatedly for long wearing life. (2) Special "heat treatment" applied to barrel. This step hardens the steel so that the barrels give two to five times the ordinary wear. (3) Precision-aligned barrel. Straight barrels will reduce pump wear. (4) Mirror-finish honing of wearing surfaces of barrel. Precision honing provides for smooth plunger operation. (5) Hard-metal plungers. Hardened and honed barrels must be fitted with metal plungers, equal in abrasion and corrosion qualities to the barrels. Such a combination results in minimum wear. (6) Uniformity of standards and measurements. Barrels, plungers, fittings, and even the elements which make up these items will require precision measuring instruments for control of every detail in the pump's design and construction. (7) Stroking through barrel. By arranging the stroke so that the plunger can stroke through the entire barrel, projecting at both ends, the barrel can be made to wear evenly so that an oversize plunger can be run without first rehoning the barrel.

Different types of pumps and their components are described. Care in transportation is discussed. Stroke lengths and frequency should be adjusted to the maximum desired recovery without "pumping off." The latter not only tends to bring sand into the well, but between heads permits the sand in the oil in the tubing to settle back on the plunger, and may cause scoring and sticking of the plunger. Pumping wells too fast often increases gas–oil ratio and causes water-coning of the sand. The rate of pumping should be adjusted to the ability of the sand to produce under the pressure of a uniform edge-water drive. Long, slow strokes best provide this condition when viscous oils are pumped, and also reduce the tendency for viscous oils to emulsify.

The pumping stroke should be adjusted to space the working and standing valves as closely as possible, without actual contact. This is particularly important for wells where gas is a factor.

In metal-to-metal pumps, the plunger fit is highly important. This must be balanced to suit all conditions, for maximum efficiency. If too tight, there may be excessive friction due to lack of space for proper lubrication, and the plunger may not drop freely enough to keep pace with the stroke. If too loose, excessive slippage may occur, particularly in higher gravity fluids. Fine sand is better handled with plungers which are not too loose. No specific rules for establishing proper plunger fits can be stated. Usually, nothing tighter than minus 1 is desirable, except under extraordinary conditions. By the same token, specific well conditions, particularly with fluid of extremely low gravity, may occasionally require the use of fits such as minus 11. Minus 1 to minus 5 may be said to represent the average range.

Dismantling, inspecting, and reassembling pumps are discussed. Stainless steel, with its 17% chromium content, requires special precautions to avoid undue wear and to make reclamation possible. Use of a neoprene packer is the only major difference between casing pumps and tubing pumps. The following precautions should be taken against tearing up the packer when the casing pump is being removed from a well: (*a*) Use only enough pulling force on the rod-string to remove the mandrel from the packer, then allow the well to stand idle for a few minutes until the back-suction has stopped, indicating that the column of fluid above the pump has equalized with the fluid pressure below the pump. Next, reseat and unseat the mandrel in the packer several times with a pumping motion. This will jar the packer, freeing the packing element from the walls of the casing and allowing fluid to pass down around the pump. The pump can then be pulled without having the packer act as a swab. (*b*) Casing pumps are usually set on slips. When this is the case it is recommended that the pump be moved up or down the hole a few feet whenever the pump is unseated for any reason. This prevents the slips from setting to the casing because of corrosion. A. H. N.

716. Suggestions for the Saving of Steel for the National Effort. Anon. *Oil Gas J.*, 30.4.42, **40** (51), 146.—Using the 1¼-in. hemp centre-grade " J " line in a 136-ft. derrick, it is possible to get approximately 10 ton miles/ft. of rope purchased, or 27,500 ton miles for a 2750-ft. length and, excluding unusual conditions, should be considered the average rather than the exception. This is accomplished by moving the line off the standby to the hoisting drum in 10–15-ft. increments every three to five round trips, depending on the weight of pipe used, and cutting off the accumulation on 100 ft. pieces. When rope becomes too short for further movement, it should be run to destruction. Studies are given of the wear rate of chains.

Saving in steel can be made through the maintenance of equipment larger than formerly, even though it be beyond the economical limits. It is common practice to re-sleeve drill-pipe tool-joints to extend their life, and, in the case of the integral joint, the pipe itself. Drill-pipe life may be further extended by replacing worn-out integral joints by the welding method. Also short wear collars may be installed on the middle body of the pipe. Drill-collar ends may be repaired in the same manner and, when the body becomes worn from formation, half-circle segments about 18 in. long may be welded together to form a new case.

In many deep California fields much drill-pipe is discarded prematurely because of failures due to slip-wear. Investigations are now being conducted as to the possibility of utilizing elevator-type slips to offset this condition. The life of drill-pipe can doubtless be greatly extended in this manner. Some companies have an arbitrary figure of $\frac{1}{16}$ in. which the wear of a fluid piston rod shall not exceed. Since the rod is ample in strength, it should be run until " bottle-necked " to such an extent that it will no longer hold packing, which on a 2½-in. rod will be found to be about ⅛ in. A. H. N.

717. Abuse Shortens Life of Rods and Couplings. Anon. *Oil Gas J.*, 30.4.42, **40** (51), 132.—In the case of a relatively deep well, where corrosion may be encountered, it is not practical to select a rod without exceedingly high physical properties and which is designed for these corrosive conditions. In a shallow well where exceedingly large bore-pumps are operated on short, fast strokes (with consequently heavy shock loads), it is not practical to install a rod that does not have the greatest ductility and impact resistance. On the other hand, it is not practical to use high-strength, alloyed rods for shallow stripper wells where very little impact is occasioned or where no corrosion is in evidence.

Size of rod is governed by highest peak load under which it is expected to operate, and also what portion of that load is released on the downstroke. In the deeper wells a combination string of rods may be required. This combination string may consist of two or three steps in rod sizes, of which there are 1-in, $\frac{7}{8}$-in., $\frac{3}{4}$-in., and $\frac{5}{8}$-in. rod diameters.

Where this combination string is used it is extremely important that the proper proportions are used to obtain the best service life. These proportions will vary with each bore of pump, regardless of the depth at which they are operating. For a well-balanced string the maximum stress in lb./sq. in. should be practically the same on all sizes in the combination. However, the allowable stress in lb./sq. in. will vary somewhat on each rod size, inasmuch as it is necessary to consider the fluctuating stress (or stress range) to arrive at the maximum allowable stress on each size.

Examples of, and precautions against, mishandling sucker rods in transportation, storage, and installation are given. After the installation is made, it is advisable to weigh the well in order to determine proper amount of counterbalance. At the same time it is possible to regulate the length of the stroke and strokes/minute to that point where the smoothest operation and most economical production may be maintained.

Where a pump has become sanded up, or when it is necessary to pull the pump for any other reason, it is highly important that too much pull is not put on the rods in an attempt to dislodge the pump from the sand or from the hold-down. In the event of the rods being stressed over the yield point irreparable damage may be caused to that particular string, and the company still has a difficult problem.

As the rods are removed from the well and the joints are broken, under no condition should the couplings be hit with a hammer or any metal object, in order to help free the tight joints. This results in fracturing the hard case on the couplings and, consequently, when the rods are run back into the well, fatigue failures occur in the couplings due to the concentration of stress in these fractured areas.

Suitable hangers should be used. A. H. N.

718. Proper Practices Extend Useful Life of Sucker Rods. Anon. *Oil Gas J.*, 30.4.42, **40** (51), 126.—The most important factors to consider in obtaining the maximum service from sucker rods may be roughly divided into three groups: (1) Proper selection of type and size. (2) Proper methods of transportation, warehousing, and installation. (3) Proper mechanical operating conditions both in surface and sub-surface well equipment. These are explained. Proper transportation and handling of sucker rods are detailed.

A pump which is not filling properly or which is too large for the rods and pumping unit will overtax these other pieces of equipment, and trouble will develop. Conversely, a string of sucker rods that is too small for the pump and unit will cause trouble and reduce the amount of effective work done by the other two. Consequently it is well to see that the various parts of the entire beam-pumping installation are in balance with each other.

Two of the most common causes of sucker-rod trouble are overload and low pump efficiencies. Overload usually makes itself apparent by sucker-rod failures in the top section of the string of sucker rods. The remedy lies in reducing the speed of operation or length of stroke, or both, reduction in the pump plunger size, or increase in the size of the sucker rods. Productive capacity of well, state proration laws and the economics of the case should indicate the action to take in reduction or elimination of this condition.

Low pump efficiencies and sucker-rod trouble usually go hand in hand, and this is one of the most common sources of grief to the sucker-rod user. With many wells it is not possible, with present equipment and well hook-up, to take an individual production gauge, and it has frequently been found that a well is being produced with a pump several sizes too large for the amount of fluid. It is impossible to calculate the efficiency of the pump unless total production figures are known. Where individual well tankage is not permanently installed on the lease, a wise procedure is the use of a portable test tank for the taking of individual well-producton gauges at frequent intervals.

A useful piece of equipment for the production engineer is a polished-rod dyanmometer or well-weighing instrument. Frequent use of this instrument on beam-pumping wells will reveal most of the common causes of sucker-rod failure, and preventive measures can be taken in advance of the actual trouble. Keeping accurate sucker-rod service records is an absolute necessity if the best performance is to be obtained from beam-pumping installations. Through a careful day-by-day study of such records a number of producing companies are effecting annual economies running into thousands of dollars through sectional replacements of sucker rod-strings alone—in other words, replacing only those portions of the rod string where trouble is being experienced rather than replacing the whole string. A. H. N.

719. Chemicals Play Important Rôle in Maintaining Equipment. Anon. *Oil Gas J.*, 30.4.42, **40** (51), 106.—Chemical effects in acid treating of water-disposal wells is illustrated graphically. Scale solvents, which contain appreciable amounts of inhibited hydrochloric acid, are used extensively for the purpose of removing nearly every kind of scale accumulation from the cooling systems of internal-combustion engines and compressors. This method of improving the efficiency and lengthening the life of the equipment is economical, easy to apply, and effective in every part of the equipment where the scale accumulates.

Ordinarily, the inhibited acid is merely circulated through the system until the scale is removed. Shutdown times are thereby reduced to a minimum, because it is not necessary to dismantle the equipment in order to remove the scale deposits by this method.

These solvents, the composition and concentration of which are frequently changed by the addition of various agents, for the purpose of securing maximum scale-dissolving properties, are also being widely used by refiners for the removal of acid-soluble chemical deposits found in condensers, heat exchangers, absorbers, evaporators, vacuum towers, and steam boilers. In the past the standard scale-removal practice has been by mechanical methods. However, due to improvements in chemical treating and rapid analysis of the scale by X-ray methods and the compounding of chemical mixtures based on the chemical analysis, serious delays in production schedules, costly shutdowns for repairs, and subnormal efficiency with its resultant higher operating costs have been largely obviated by chemical removal of the scale in refinery equipment, natural-gasoline plants, booster stations, and miscellaneous pumping and cooling equipment. A. H. N.

720. A Note on Conservation. E. L. DeGolyer. *Petrol. Engr*, June 1942, **13** (9), 58–59. *Paper Presented before American Petroleum Institute.*—A plea is made for conservation methods and the avoidance of waste both below and above ground. As an example, the author quotes the production practices in two fields—Hobbs, New Mexico, and Tinsley, Mississippi. Each field extends over about the same area, approximately 10,000 acres; although, owing to differences in the thickness of the producing zone, Hobbs was estimated to have about twice the recoverable reserve of Tinsley, with both fields produced under good practice. Each field had substantial water drive. Hobbs was produced slowly enough to allow it to be effective, and Tinsley at much too rapid a rate to allow the water drive to be effective.

Hobbs had an original bottom-hole pressure of 1550 lb./sq. in., approximately 263 producing wells, and after approximately 13 years had produced half its reserve with a loss of less than 400 lb./sq. in. bottom-hole pressure, and 85% of its wells were still flowing. Tinsley had a higher bottom-hole pressure, some 1850–1900 lb./sq. in., approximately 327 wells, and after less than 2½ years had produced a probable third of its ultimate recoverable reserves with a loss of more than 1000 lb./sq. in. bottom-hole pressure and with none of the wells in the main sand still flowing.

The conclusion is reached that in spite of the fact that no two oil-fields are comparable, the disparity in the performance of the two fields is so great that much of the difference is due to the different production practices. Stress is laid on the excessive production of gas in present-day practices. A. H. N.

721. Repairing Casing Leaks. F. J. Spang. *Petrol. Engr*, June 1942, **13** (9), 35.—The paper deals mainly with problems encountered in old fields, and deals with several methods used for removing and replacing a leaky joint by a joint of good casing. The first step in preparing the job for casing repair is to set a removable bridge either in the casing below the leak or, preferably, in a solid, hard-walled portion of the open hole below the casing seat, in a spot that would not expose a formation likely to cave during the repair job. The bridge may be started by using a small forked tree or bush centre. Sufficient burlap sacks to make a temporary support are placed on top of the bush, and sand pumpings and clay are then dumped above it in sufficient amount to prevent leakage through the bridge; or the bridge may be of a mechanical design.

When the bridge is set and the hole made tight by sand pumpings and clay, the hole should be baled out and a casing tester run to find the leak and determine its volume. A casing tester may be made of 1-in. or 1½-in. pipe 2 or 3 ft. long. The top of the pipe should be threaded about 4 in. A casing size leather, rubber disc, or diaphragm is fitted between two metal washers slightly smaller than the casing and held in place on the pipe by means of two pipe-size lock-nuts. A tee with the opening at the side is screwed on to the thread above the diaphragm, and a bail screwed into it. The lower end of the pipe is capped. The casing tester is run on the measuring line. The leak is found by running to different depths until found. Unless previously known, the volume, if rather large, is measured by gauging the fill-up time in the hole or bailers/hr. If rather small it can be gauged by the tester.

After testing, the hole is filled to the level of the leak, or a little above it, before removing the casing. Several methods are described.

The use of a trip-spear to free casing by successive jarring and tripping is described in detail. This method of establishing the free point of the casing and setting the spear for action just below it in a tight or frozen area lessens the likelihood of damaging the casing or couplings by excessive jarring at a point below where the casing is tight. Obviously, if considerable jarring were done at a point where the casing were free, and this point was below the tight point, there would be danger of injuring the casing at the point where the trip spear had its hole, or loosening or damaging the couplings above it.

By following this procedure, the casing will be loosened through each tight point, and the jarring action, even though moderate, will tend to loosen the sediment behind it. Thus, the stress taken at the surface may pass downward through the casing to a lower point each time an upper point is freed, thus aiding in greater degree as greater depths are reached.

Once the free point is found and the spear lowered each time the casing report is felt at the surface, some additional stress may be imposed on the casing at the surface. In other words, if 100 ft. of casing has been freed from the wall sediment, then 100 ft. of casing is ready to absorb its share of surface stress. This procedure, if carefully followed, will generally free any string of casing. A. H. N.

722. Lower Production Costs Through Advance Lease Planning. G. M. Wilson. *Oil Wkly*, 11.5.42, **105** (10), 22–25.—The planning for lease development of a California company is described. Long before drilling was started, the lease was laid out in a row pattern, and the gathering-line system, following the same pattern, has greatly aided in lowering both drilling and the subsequent production installations and maintenace costs.

While the drilling programme is not yet completed, and, in view of restriction being place on drilling, might not be completed for several years, the production facilities have been exceptionally well planned and laid out, and centrally located with a view to efficiently handling all the wells when they are finally drilled, with little work or enlarging of the present facilities.

In addition to the efficient gathering system, which incidentally does not include any small gauge-tanks, the company has installed a centrally located three-unit hydraulic-pumping plant that pumps fourteen wells. Low-cost maintenance and ffiecient operation of this plant are due in great measure to a specially designed combination power-oil and head-exchanger storage tank that utilizes engine-water heat to heat the oil, and at the same time, in so doing, cools the engine circulating water. The system is provided with means whereby any degree of heating or cooling is possible merely by turning of valves to divert the flow of engine-water through various parts of the system.

Production is from three zones. The development pattern was arranged as nearly as possible in north–south rows, approximately 400–500 ft. apart, and with each row containing from six to eight locations. Each location consists of from one to three single-zone wells spaced anywhere from 100 to 200 ft. apart. No two wells in a given zone are closer than 450 ft. The pattern is discussed. Engineering details of the gathering system are given.

Smooth, trouble-free functioning of the centralized hydraulic-pumping plant is a factor contributed in a large degree by a fully automatic heat-exchanger system that uses hot engine-water to heat the hydraulic power oil, and simultaneously causes the circulating water to become cooler by reason of its having given up its heat to the oil.

The hydraulic-pumping plant consists of three multi-cylinder gas-engine-driven triplex power units, housed in a 20- by 35-ft. sheet-iron building. As more wells go on the pump, plans long since worked out will permit the building to be expanded to accommodate four more units. Present piping, power-oil, and cooling facilities are designed for an ultimate of seven units. Each unit can handle six wells without danger of overloading. The system is discussed in some detail. A. H. N.

723. **Return of Surplus Gasoline to Sands Being Considered.** Anon. *Oil Wkly*, 4.5.42, **105** (9), 81.—Due to war-time demand for special products while normal civilian consumption declines, use of depleted oil reservoirs as storage basins for large stocks of finished low-grade gasoline piling up in California and Texas is being studied. Storage facilities for low-grade gasoline are being jammed, and within a few months the surplus may become so great that the product will either have to be destroyed or some revolutionary storage means developed. Priorities on steel for tanks are out of the question.

Therefore, many foresee the possibility of meeting this threatened crisis by pumping the gasoline back into depleted zones in old fields. Due to the great demand for fuel oil, some refiners may start burning gasoline under their boilers so as to dispose of it and save fuel oil at the same time. The situation is of grave concern, for refiners must continue operating to provide the necessary war products, and in doing so necessarily manufacture considerable quantities of low-grade gasoline for which there is a reduced need.

Previous experiments and experiences are given. If the period of low-grade gasoline over-supply is to be extended, it would appear that a number of economies could be effected by the use of old fields as storage basins for the surplus products. Several necessary items of expense incurred in surface storage could be eliminated. These would include insurance, taxes—both on the product and any surface facility in which it would otherwise be contained—and elimination of evaporation losses and losses from leakage.

Opposed to these advantages are also some disadvantages. A primary disadvantage lies in the fact that it costs money to put oil or gasoline into the formation, and would cost more to pump it out again. There is also a possibility that the product returned to the sub-surface reservoir may never be recovered, although Union Oil Co. engineers can see no reason why it cannot all be pumped out again—with the added prospect that a considerable volume of the original oil in place of heavier gravity may be subject to recovery when broken down by lighter fluids.

Important factors in estimating cost per brl. for such storage would be decided both by the volume of fluid for which storage is needed and the length of time such fluid is left in the storage basin. In the matter of taxes alone, for example, if it is left on the surface, the tax charges would eventually equal the original value of the products. Evaporation and leakage are also important considerations in surface storage over long periods. A. H. N.

724. **Arkansas Contributes Much to Sound Conservation Methods.** G. B. Nicholson. *Oil Wkly*, 11.5.42, **105** (10), 15–19.—With the development of knowledge of conserva-

tion methods, Arkansas stands among the most prominent advocates of practices for receiving greatest benefit from natural resources. At present the State, together with its valuable contribution to the oil and gas and condensate reserves of the U.S.A., also sets an example by furnishing outstanding methods of conserving these vital petroleum products. Well-regulated schedules of allowables for oil- and gas-wells are determined by engineers of the Arkansas Oil and Gas Commission after detailed field engineering tests are made, and enforcement of rules assigned to fields and wells is a foregone conclusion. Complete and detailed records are available in the commission offices, giving up-to-date reports on all fields in the State, and variations in these reports, which are frequently compiled, furnish specific knowledge of field and reservoir trends.

The oil industry in Arkansas represents minimum waste of natural resources. Proration and allowable schedules are designed to provide the greatest ultimate recovery of oil and gas, and there is little waste of these products in the drilling, completion, and producing of wells, or in the manufacture of by-products. While in many other oil-producing States venting to the atmosphere of casing-head gas containing hydrogen sulphide is not regarded as waste, it is in Arkansas, and for that reason a new industry is coming to life, consisting of removing hydrogen sulphide from gases produced in Southern Arkansas, fitting the sweetened gas for domestic or industrial services, and separating the sulphur for industrial use.

One of the most interesting procedures, and one on which considerable emphasis is being place in Arkansas, is installation and operation of repressuring projects. The large Schuler plant has now been completed long enough to show decisive benefits. This plant, a million-dollar project including pressure-maintenance and gasoline extraction units, was placed in operation in the early part of 1941, injecting gas into the Jones sand, one of three producing formations in the big field.

With virtually all gas produced from the Jones sand now being returned to the formation, the early rapid decline in bottom-hole pressure has virtually ceased. Besides the gas actually removed from the producing horizon, additional gas is being brought in from the Village, Atlanta, and Magnolia fields, and is injected into the Jones sand as part of the pressure-maintenance system. The pool continues to produce 13,500 brl. daily from this sand, according to the latest Oil and Gas Commission reports. Plans for launching a second project are being made. Sour gas conservation is also practised. Desulphurization plants are designed to separate hydrogen sulphide in a liquid form, and it is planned that this by-product will be utilized by the chemical industry. Carbon dioxide will also be removed from the gas, and it, too, will find its place in industry. The manufacture of butane and propane to supply the consumer with gas beyond the ends of gas line has become commonplace, with several gasoline and butane plants already operating, one of the finest and largest field plants operated by Shell Oil Co. in the Magnolia field.

The paper includes development and production data for Arkansas. A. H. N.

725. Petroleum Engineering. Part 4. L. C. Uren. *Petrol. Engr*, April 1942, **13** (7), 76.—In this part of the paper various colleges, universities, and institutions which give courses in petroleum engineering in the U.S.A. are studied, together with the requirements of such institutions to be efficient and effective in imparting the necessary training to engineers. A. H. N.

726. Petroleum Engineering. Part 6. L. C. Uren. *Petrol. Engr*, June 1942, **13** (9), 86.—In this part several more American universities and colleges which cater for petroleum science are described. A. H. N.

Transport and Storage.

727. Soil-corrosion Studies, 1939. Coatings for the Protection of Metals Underground. K. H. Logan. *Bur. Stand. J. Res., Wash.*, 1942, **28** (1), 57–71.—The condition of specimens of metallic and non-metallic coatings after exposure to soils for periods ranging from 2 to 16 years is reported in this paper. Specimens of metallic coatings applied to both sheet and pipe were exposed to soil corrosion at forty-seven sites in 1923 and 1924, while further series of tests were installed in 1932 and 1937 at an additional fifteen sites. Ten specimens of each coating were buried at each site, two samples being removed at each inspection.

The non-metallic coatings started in 1924 were applied to steel pipe, and five specimens of each coating were buried at each test site.

Conclusions previously reached regarding the protective value of zinc and lead coatings have been generally confirmed by the latest inspections.

The protection afforded by zinc coatings depends on the thickness of the coating and it has been found that uniformity of coating is important.

Lead coatings applied to iron and steel have not proved adequate for protection underground. The potential of lead is cathodic to iron, so that this metal cannot protect in a manner similar to zinc.

Tin coated copper is corroded in soils which corrode copper.

As regards non-metallic coatings, after 15 years' exposure to soils two hot-dipped asphalt and coal tar coatings have failed. A group of experimental vitreous enamel coatings and two hard rubber coatings exposed 7 years have so far afforded complete protection.

In a 2-years' exposure test a Bakelite coating consisting of several coats of varnish, each coat being baked on, has afforded the most satisfactory protection. Air-dried Bakelite coatings blistered somewhat and allowed some rusting, but severe corrosion under these coatings occurred only in cinders. D. L. S.

728. Soil-corrosion Studies 1939. Ferrous and Non-ferrous Corrosion-resistant Materials. K. H. Logan. *Bur. Stand. J. Res., Wash.*, 1942, **28** (3), 379–400.—Corrosion data are presented for the third of a series of five inspections which are made at approximately 2-year intervals. The chief departure from earlier reports consists in the presentation of the data for loss of weight as well as for maximum penetration as total loss per unit area and total pit depth rather than as rates. Since the primary purpose of this investigation was to determine what metals and alloys are most corrosion-resistant in different corrosive environments, the corrosiveness of the soils was an important consideration in the selection of sites for the field tests.

A table indicates the nature of the soils, physical and chemical properties being given. The composition of the metal specimens, which included cast iron, wrought iron, carbon steels, alloy iron and steels, copper and copper alloys, zinc, and lead, are also shown.

Results obtained so far show little difference in the corrosion resistance of the wrought iron, low carbon steel Cu–Mo open-earth iron, or steel containing 4–6% chromium. By increasing the Cr and Ni contents, ferrous metals may be made highly resistant to soil corrosion.

Except in one type of soil, the corrosion rate of Cu–Zn alloys increased generally with the zinc content. As regards zinc and lead-alloy specimens, the former behaved similarly to the ferrous metals, whilst lead was attacked in acid organic soils.

However, since a large proportion of the soils to which the specimens were exposed were very corrosive, the failure of certain materials does not necessarily reflect on their usefulness for moderately corrosive soil conditions. D. L. S.

Cracking.

729. Patent on Cracking. R. F. Ruthruff. U.S.P. 2,278,590 7.4.42. Appl. 20.10.39. Conversion of higher-boiling hydrocarbons to hydrocarbons of lower boiling point by vaporizing the former and passing the vapours in contact at a cracking temperature with a magnesium silicate pseudomorph of calcium silicate. H. B. M.

Hydrogenation.

730. Patents on Hydrogenation. W. F. Huppke. U.S.P. 2,279,198, 7.4.42. Appl. 18.1.38. Catalytic conversion of hydrocarbons involving subjection of hydrocarbon gases and vapours to a conversion temperature in the presence of a catalyst produced by precipitating a difficultly reducible metal hydroxide gel, and while still wet depositing zinc oxide thereon and partially dehydrating the gel.

W. F. Huppke. U.S.P. 2,279,199, 7.4.42. Appl. 21.2.39. Method for the dehydrogenation of hydrocarbons which involves subjecting a hydrocarbon to a high temperature in the presence of a catalyst comprising an oxide from the class consisting of uranium and vanadium oxides. The oxide is distributed upon an oxide of the class consisting of aluminium, zirconium, and thorium hydrous oxide gels, and the catalyst contains a zinc oxide activator.

M. Pier. U.S.P. 2,280,258, 21.4.42. Appl. 1.3.39. Process for the destructive hydrogenation of hydrocarbon oils to produce gasoline and middle oil. The process includes the introduction of gaseous olefins into the reaction zone in an amount of at least 10% by weight of the oil treated, and at a point where the oil has already undergone considerable splitting. H. B. M.

Polymerization.

731. Shell Isomerization Process for Producing Isobutane. Anon. *Nat. Petrol. News*, 24.12.41, **33** (52), R403.—Normal butane in vapour phase is passed at relatively low temperature and pressure over aluminium chloride catalyst supported on an inert base. Anhydrous hydrogen chloride is added to the butane in controlled quantity for the purpose of improving the efficiency and life of the catalyst. The one-pass products are condensed by a refrigerant and freed from HCl in a stripping tower, the HCl being recycled. The theoretical yield of *iso*butane is about 68%, and the normal commercial yield 40–45%. The mixed *iso*butane and unconverted butane are passed via a NaOH wash to the alkylation unit, the butane, unaffected by alkylation, being returned to the isomerization unit. All materials are rigorously dehydrated to reduce corrosion, which is negligible except when contact with the air is unavoidable. Only at these points have special alloys to be used. Elsewhere carbon steels are suitable. H. G.

732. Patents on Polymerization and Alkylation. E. I. Du Pont de Nemours. E.P. 545,193, 14.5.42. Appl. 5.10.40. Polymerization of aliphatic open-chain conjugated diolefinic hydrocarbons, such as butadiene and its homologues, to form soluble viscous, oily polymers possessing drying properties.

Standard Oil Development Co. E.P. 545,441, 27.5.42. Appl. 14.5.40. Production of saturated, normally liquid hydrocarbons suitable for use as motor fuels by the catalytic alkylation of saturated paraffin hydrocarbons containing at least one tertiary carbon atom with a mono-olefin. The catalyst consists of a solution of boron fluoride in orthophosphoric acid.

C. M. Hull. U.S.P. 2,278,445, 7.4.42. Appl. 8.10.38. Production of lubricating oils by polymerizing olefin hydrocarbons contained in a hydrocarbon gas mixture. The mixture is subjected in liquid phase in a first polymerization stage to the action of an excess amount of boron fluoride catalyst. In this way the major portion of the olefin hydrocarbons is polymerized, and a substantial portion of the excess catalyst forms a complex compound with the hydrocarbons. Unreacted hydrocarbon gases are removed from the complex compound and polymerization products and the compound treated in a second stage with additional olefin gases in excess. In this way practically all the catalyst complex is decomposed and additional polymerization products are produced. The excess gases are introduced into the first polymerization stage, and the polymerization products are distilled to separate these from the desired lubricating-oil fraction.

D. H. Putney. U.S.P. 2,281,248, 28.4.42. Appl. 2.8.41. Method of alkylation in which *iso*paraffinic hydrocarbons are alkylated with olefinic hydrocarbons in the presence of a condensation catalyst. The improvement comprises selectively absorbing the olefinic hydrocarbons of the charge in the catalyst prior to alkylation and limiting the residence time period of contact of the catalyst and olefins in minutes to less than one tenth of the volumetric catalyst olefin hydrocarbon ratio. H. B. M.

Refining and Refinery Plant.

733. A Note on Refining Light Oils by Silica Gel. A. G. Arend. *Petrol. Times*, 18.4.42, **46** (1167) 184.—The highly non-reactive properties of silica-gel are among the material's most attractive features, and its use in substitution of sulphuric acid treatment offers advantages. Acid-washing may involve a through-put loss of as much as 35% valuable constituents often being lost. Its use on aromatic products is particularly appropriate, owing to the reactive nature of these bodies. Silica gel is now being produced as a by-product in sundry metallurgical processes, to the pecuniary advantage of both ore and oil refiner. H. G.

734. Patents on Refining and Refinery Plant. Standard Oil Development Co. E.P. 544,915, 4.5.42. Appl. 10.6.40. Improved method of effecting a separation of the products of a petroleum hydrocarbon conversion process into relatively clean, desirable products and relatively highly carbonaceous products. The total product is withdrawn from a cracking or reforming zone at a temperature of about 850° F., and a hydrocarbon boiling in the range 200–700° F. is added to it. The mixture is then conducted at a temperature between 600° and 800° F. to a separation zone maintained under the reaction pressure, where it separates into a clean layer and a tarry layer.

Standard Oil Development Co. E.P. 547,729, 10.6.42. Appl. 23.10.40. Process for the separation of ethyl chloride from a mixture comprising ethyl chloride and butane—*e.g.*, an azeotropic mixture of ethyl chloride and butane. The mixture is contacted with a solvent having a preferential selectivity for the ethyl chloride under conditions to form a raffinate phase and a solvent phase.

H. C. Paulsen. U.S.P. 2,278,665, 7.4.42. Appl. 14.9.39. Method of converting mercaptan compounds contained in petroleum oil into disulphide compounds. The oil is contacted in an initial stage with a sodium plumbite solution under conditions designed to convert the mercaptan compounds into soluble lead mercaptides. The spent sodium plumbite solution is separated from the oil, and the treated oil fraction is passed to a secondary stage, where it is contacted with hydrogen peroxide under conditions designed to convert the lead mercaptides to lead oxide and disulphide compounds. In this way a water layer is formed which is separated from the oil. The treated oil is then passed to a third stage, where it is contacted with the spent alkali-metal plumbite solution. In this way lead oxide is completely removed from the oil.

K. H. Engel. U.S.P. 2,279,778, 14.4.42. Appl. 15.5.40. Production of a hydrocarbon oil of high indene content from a hydrocarbon oil of relatively low indene content. The process includes distillation of the original oil in the presence of sufficient phenol to form an azeotrope with non-indene components.

K. H. Engel. U.S.P. 2,279,779, 14.4.42. Appl. 15.5.40. Production of hydrocarbon oil of high indene content from a hydrocarbon oil of relatively low indene content. The process includes distilling the original oil in the presence of a glycol compound capable of forming azeotropes with the non-indene oils contained in the hydrocarbon oil.

K. H. Engel. U.S.P. 2,279,780, 14.4.42. Appl. 15.5.40. Production of hydrocarbon oil of high indene content from a hydrocarbon oil of relatively low indene content. The process includes distillation of the hydrocarbon oil in the presence of an organic compound having a radical selected from the group consisting of the hydroxyl, the carboxyl, the amino, and the pyridinic nitrogen radicals, and capable of forming azeotropes with indene and with the non-indene oils contained in the original oil.

T. J. Brown. U.S.P. 2,279,937, 14.4.42. Appl. 8.5.40. Method of distilling crude petroleum oil which involves mixing *para*-cymene with the crude oil, and afterwards heating the mixture to a temperature sufficient to cause flocculent precipitation of the wax from the oil and the light ends to pass off.

A. R. Nevitt. U.S.P. 2,280,445, 21.4.42. Appl. 5.6.39. Method of treating hydrocarbon oils, which comprises subjecting a paraffin-base petroleum hydrocarbon and a chemically reactive aqueous solution of metallic chlorides and soluble metallic sulphates to a high temperature at superatmospheric pressure in an enclosure, for a sufficient period of time to effect partial decomposition of the hydrocarbon. The mixture is then flashed under controlled pressure conditions, and the spent chemical solution is separated out. The treated hydrocarbon is finally fractionated and cooled.

F. G. Straka. U.S.P. 2,281,338, 28.4.42. Appl. 18.8.39. Conversion process which involves fractionally distilling hydrocarbon oil of relatively wide boiling range to separate therefrom a heavy gasoline fraction and a fraction suitable as catalytic cracking stock. The latter fraction is catalytically cracked, and the resultant products are fractionated to separate gasoline from higher-boiling hydrocarbons. At least a portion of these higher-boiling hydrocarbons is combined with the heavy gasoline fraction and the resultant mixture thermally cracked. H. B. M.

Analysis and Testing.

735. The Correlation of Filter Plant Yields with Laboratory Results. G. C. Jones. *Nat. Petrol. News*, 18.2.42, **37** (7), R57. On the basis of considerable laboratory work which has been done in conjunction with refinery filter plants, an example of which is presented, it is concluded that by means of the laboratory method previously described (see abstract No. 341) plant yields can be checked within 5%, provided plant control and burning are efficient. Greater deviation has been experienced during warm and humid weather than during colder weather. This has been shown to be due to the greater absorption of water by the clay under the more humid conditions, with a consequent decline of efficiency. H. G.

736. Examination of Emulsions. L. Ivanovszky. *Petroleum*, January 1942, **5** (1), 13. —A new design of separating funnel combines a decomposition vessel, fitted with reflux condenser, with a separation funnel and a graduated cylinder. The funnel is in effect the standard type cut along the stem into two parts. Suitable fittings enable it to be placed horizontally in a water-bath, where the widened section acts as the decomposition vessel. Placed vertically, the instrument acts as a measuring cylinder and separating funnel. R. A. E.

737. Reid Vapour Pressure of Alcohol Blends. S. J. W. Pleeth. *J. Inst. Petrol.* June 1942, **28** (222), 113–114.—Two precautions are stressed. The sample cannot be obtained by water displacement. Secondly, rinsing with water has been found to result in the separation of the alcohol blend into two phases. A modified procedure is described. A. H. N.

Chemistry and Physics.

738. Patent on Chemistry and Physics of Hydrocarbons. W. C. Astbury and F. H. Garner. U.S.P. 2,278,684, 7.4.42. Appl. 29.3.40. Production of an aqueous emulsion of the oil-in-water type containing an alkali metal salt, the anion of which contains a metal selected from the group consisting of aluminium, tin, boron, chromium, molybdenum, vanadium, and zinc, in conjunction with aliphatic amines having at least one aliphatic substituent of at least 11 carbon atoms. H. B. M.

Motor Fuels.

739. New Specifications Issued by British Petroleum Mission. Anon. *Nat. Petrol. News*, 24.12.41, **33** (52), R408–R410, R416.—Revised specifications for twenty-one products, including four new ones, have been issued by the British Petroleum Mission in Washington governing requirements of the British Government under Lease-Lend arrangements. The four additions concern finished alkylate for blending into 100-octane aviation gasoline, low-cold test distillate or residuum for lubes, Columbian lube distillate, sodium-naphtha-sulphonate (soluble cutting-oil base). The specifications are given in full, together with a list of the official test methods. The following specifications are unchanged: Pool Motor gasoline, White spirit, gas oil, diesel oil, marine diesel, marine fuel, W/D gas oil, special refinery gas oil, and Admiralty fuel oil. H. G.

740. Patents on Motor Fuels. Texaco Development Corp. E.P. 545,183, 14.5.42. Appl. 8.12.39. Method of manufacture of high anti-knock motor fuel by stabilising cracked naphtha to remove substantially all hydrocarbons of less than five carbon atoms in the molecule. In this way a stabilized cracked naphtha is produced of lower volatility than commercial gasoline, also a normally gaseous hydrocarbon fraction containing *iso*butane, normal butane, and olefins. This fraction is subjected to alkylation in the presence of an excess of *iso*butane and an alkylation catalyst. High anti-knock, normally liquid hydrocarbons within the gasoline boiling range are thus produced. Excess *iso*butane, normally liquid hydrocarbons, and normal butane are separated from the reaction products, and the excess *iso*butane is then recycled to the alkylation operation. Finally the normal butane is combined with the stabilized cracked naphtha to impart volatility thereto.

Standard Oil Development Co. E.P. 545,464, 28.5.42. Appl. 24.10.40. Production of a motor fuel for high-compression ignition engines, consisting of a gasoline hydrocarbon blended with an unsaturated ether represented by the general formula $R–R–R'$, in which R is an aliphatic olefinic radical or a saturated hydrocarbon radical containing more than two carbon atoms.

G. B. Zimmerman. U.S.P. 2,279,547, 14.4.42. Appl. 9.6.39. Production of anti-knock motor fuel from crude petroleum by topping the crude to produce straight-run gasoline fractions and afterwards cracking portions of the crude heavier than gasoline to produce cracked gasoline. This is then combined with the straight-run gasoline fractions, and the resultant mixture is subject to aromatization in the presence of a dehydrocyclization catalyst. Finally the aromatized gasoline is recovered.

F. W. Leffer, U.S.P. 2,281,361, 28.4.42. Appl. 30.11.38. Production of anti-knock motor fuel from gasoline distillates of low anti-knock value. The distillate is separated into a light fraction and a heavier fraction, and the light fraction is cracked in a heating zone. From the resultant products there are separated a condensate containing heavy gasoline hydrocarbons and a lighter fraction containing normally gaseous olefines. The heavier distillate is re-formed, and at least part of the condensate is mixed with the heated products from the second heating zone. The resultant mixture is fractionated to separate a gasoline product from normally gaseous olefins. The latter are combined with the lighter fraction containing normally gaseous olefins, and the final mixture subjected to polymerization. H. B. M.

Gas, Diesel and Fuel Oils.

741. Patents on Gas, Diesel and Fuel Oils. Standard Oil Development Co. E.P. 545,125, 12.5.42. Appl. 8.10.40. Preparation of an improved Diesel fuel consisting of a hydrocarbon Diesel fuel oil blended with a minor proportion of a high-molecular-weight diacyl peroxide containing from sixteen to thirty carbon atoms per molecule, or with a minor proportion of a mixture of such peroxides.

G. H. Cloud. U.S.P. 2,280,217, 21.4.42. Appl. 30.11.38. Preparation of a compression ignition fuel of the Diesel type, and consisting of a hydrocarbon fuel having a flash point above 150° F. and a small amount of an alkyl nitrate having at least ten carbon atoms per molecule.

H. C. Paulsen. U.S.P. 2,280,716, 21.4.42. Appl. 28.10.39. Preparation of a compression ignition fuel consisting of a hydrocarbon Diesel fuel oil, 0·1–5% of nitrogen tetrasulphide, and an amount of 1-mercaptobenzothiazole effective to lessen the normal deterioration of the nitrogen tetrasulphide. H. B. M.

Lubricants and Lubrication.

742. Frictional Phenomena. Part IX. A. Gemant. *J. appl. Phys.*, May 1942, **13** (5), 290–299.—This part of the paper deals with the application of liquid viscosity to electrical insulating liquids, particularly in high-volatge cables. The subject is discussed under : (1) mechanical processes involving viscosity, particularly (*a*) impregnation, (b) breathing, (c) oil migration with respect to high-voltage cables; (2) chemical processes involving viscosity, such as (a) Voltol process, (b) wax formation in cables, (c) polymerization of styrene; (3) electrical conductivity. With regard to the latter, the fundamental quantities, besides viscosity, that determine the conductivity are discussed, together with the various experimental methods the interpretation of which allows the quantities in question to be computed. A. H. N.

743. Improving the Efficiency of Lubricating Oils. A. H. Stuart. *Petroleum*, Dec. 1941, **4** (8), 179.—The functions of various types of addition agents for use with mineral lubricating oils are outlined and examples given of the agents used for each specific purpose. Among the substances considered are fatty acids, colloidal graphite, anti-oxidation and anti-sludge agents, anti-corrosion agents, and pour-point depressants. R. A. E.

744. The Development of Ball Bearing and Roller Bearing Greases. H. M. Fraser. *Nat. Petrol. News*, 21.1.42, **34** (3) R22.—The properties of greases are discussed under six headings—viz. (1) oxidation stability, (2) mechanical stability, (3) oil separation, (4) starting torque at low temperatures, (5) melting point, and (6) texture. The appropriate control tests are dealt with, and the effect of the variation of particular properties on general characteristics is discussed. H. G.

745. Lubricated Plug-Valves. P. Meredith. *Petroleum*, Dec. 1941, **4** (8), 180.—The plug-cock is the only type of valve in which machined surfaces are not exposed to the direct action of line fluid, and therefore possesses inherent advantages over other types of valve from the standpoint of resisting corrosion and erosion. The old unlubricated type suffered from the disadvantages of liability to stick and to seize. By application of pressure lubrication of correct design and the use of a suitable lubricant these disadvantages can be overcome and the valve sealed against entry of line fluid between machined surfaces. The lubricant should be inert in the service handled, capable of withstanding the service temperature, and possess the requisite viscosity to make it effective as a sealing medium. Pressure lubrication has made possible the use of plug-valves on services calling for test pressures up to 1500 lb. per sq. in. and the building of valves up to 30 in. bore. The uniform dispersion of lubricant over the contact surfaces without distortion of the valve-body by reason of excessive lubricant pressures is of great importance. Dissipation of lubricant into the line should also be avoided. Lubricating systems and desirable properties of lubricants are discussed. R. A. E.

746. Patents on Lubricants and Lubrication. Texaco Development Corp. E.P. 544,914, 4.5.42. Appl. 30.3.40. Preparation of a lubricating oil adapted for crankcase lubrication in internal-combustion engines, and consisting of a mineral lubricating oil, 0·1–2·0% by weight of a phosphatide compound and 0·1–2·0% by weight of a stannous soap selected from the group consisting of stannous naphthenate and mineral-oil-soluble stannous sulphonates.

Standard Oil Development Co. E.P. 545,355, 21.5.42 Appl. 12.11.40. Preparation of a lubricant consisting of an oil-base stock, one or more compounds for increasing the load-carrying capacity of the base-stock, such compounds containing chlorine with or without both sulphur and phosphorus, and a minor proportion of an amine having attached to the nitrogen at least one aliphatic or hydroxy aliphatic group containing an isocyclic ring.

Standard Oil Development Co. E.P. 545,519, 1.6.42. Appl. 18.4.40. Production of lubricants consisting of a hydrocarbon lubricating oil and from 0·1 to 5% of an organo-phosphorus compound consisting of a substituted phosphine or diphosphine, in which one or more of the hydrogens is replaced by a carbon atom of an organic group.

D. E. Birgen. U.S.P. 2,278,762, 7.4.42. Appl. 11.1.41. Preparation of a lubricant consisting of a mineral lubricating oil and less than 2% of an acylated derivative of an amino-heterocyclic sulphur compound containing the sulphur in the ring and the amino-group as a side-chain.

E. S. Hillman. U.S.P. 2,278,851, 7.4.42. Appl. 9.9.39. Preparation of an anti-wear lubricant consisting of a mineral lubricating oil and small amounts of a free aliphatic unsaturated ketone having at least ten carbon atoms, and an anti-wear compound which is substantially non-corrosive under lubricating conditions. The anti-wear compound contains as its active ingredient a semi-metallic element capable of forming with bearing metals alloys having melting points substantially lower than the said metals.

R. F. Bergstrom. U.S.P. 2,279,086, 7.4.42. Appl. 23.9.40. Preparation of a lubricant suitable for internal-combustion engines which contains dissolved therein 0·25–5% of a sulphonate salt and 1–10% of a sulphurized ester having at least ten carbon atoms combining a monohydric alcohol with a monocarboxylic acid.

M. A. Dietrich. U.S.P. 2,279,560, 14.4.42. Appl. 8.5.40. Preparation of a lubricant consisting of a major proportion of a viscous hydrocarbon oil and a small proportion of an organic hydroxamic acid compound selected from the group consisting of organic sulphonhydroxamic acids, the carboxylic esters and ethers of these acids, and carboxylic acid esters and ethers of organic hydroxamic acids.

M. A. Dietrich. U.S.P. 2,279,561, 14.4.42. Appl. 15.5.40. Stabilization of a viscous petroleum oil by incorporating therein a small proportion of a condensation product of 1 mole of an aliphatic polyamine in which two amino-groups are primary amino-groups directly attached to different aliphatic carbon atoms with from 3 to 10 moles of an aliphatic aldehyde of at least three carbon atoms having at least one hydrogen atom on the carbon adjacent to the –CHO group.

D. R. Merrill. U.S.P. 2,280,338, 21.4.42. Appl. 23.12.38. Preparation of a liquid mineral lubricating oil composition containing about three fourths of 1–2·5% of an oil-soluble carboxylic acid soap to overcome the formation of gummy and resinous materials tending to ring-sticking in heavy service internal combustion engines. The oil also contains a small proportion of a chlorinated aromatic compound containing chlorine in the aromatic ring and boiling above 600° F., in quantity sufficient to overcome the deposition of hard carbon behind piston rings. The oil is free from appreciable increase in viscosity over the original oil.

C. E. Wilson. U.S.P. 2,280,419, 21.4.42. Appl. 16.7.40. Preparation of a lubricant consisting of a mineral lubricating oil, a small proportion of an oil-soluble petroleum sulphonate, and a small proportion of the salt of a weak non-carboxylic organic acidic material having an ionization constant not exceeding about 5×10^{-6}.

R. Reuter. U.S.P. 2,280,450, 21.4.42. Appl. 20.2.40. Preparation of a lubricant consisting of a relatively large proportion of a refined hydrocarbon oil and in intimate admixture therewith a relatively small amount of an oil-soluble, water-insoluble reaction product of tricresyl phosphite and octyl phenoxy-ethanol to prevent deterioration by oxidation.

G. D. Byrkit, U.S.P. 2,280,474, 21.4.42. Appl. 18.7.38. Manufacture of a lubricating composition comprising a major proportion of an oil having lubricating characteristics and a minor proportion of a metal salt of an organic acid containing an ester group elsewhere in the molecule.

G. D. Byrkit. U.S.P. 2,280,475, 21.4.42. Appl. 10.7.40. Preparation of a lubricant comprising in combination a major proportion of an oil having lubricating characteristics and a minor proportion of a metal salt of a hydroxy-acid the hydroxyl group of which is esterified.

E. W. Fuller. U.S.P. 2,281,520, 28.4.42. Appl. 18.2.39. Preparation of a lubricant consisting of a viscous mineral oil fraction and a small proportion of a paranitroso dialkyl aniline to inhibit deleterious effects of oxidation.

E. W. Fuller. U.S.P. 2,281,521, 28.4.42. Appl. 8.10.40. Preparation of a lubricant consisting of a viscous hydrocarbon oil and a small proportion of a reaction product obtainable by reacting substantially equal proportions of a mercaptan, an aromatic amine and formaldehyde.

H. B. M.

Asphalt and Bitumen.

747. Wartime Requirements for Asphalt. G. Abson. *Nat. Petrol. News*, 18.2.42, 34 (7) R60.—It is assumed that with at least a partial prohibition of the use of steel for the reinforcing of concrete for road foundations the war will increase the demand for asphalt. The demands for new military roads and for aerodrome run-ways and tracks bring their own extra demands. It is pointed out that the flexible nature of a bituminous carpet has a special appeal when the demand for speed may preclude the proper preparations of the sub-grade. Typical specifications for bituminous material used in air-field construction are given under the following headings—Hot mix, cut back asphalt, seal coat, bituminous emulsion, and road oil. H. G.

748. Patents on Asphalt and Bitumen. Standard Oil Development Co. E.P. 545,287, 19.5.42. Appl. 4.9.40. Method of preparing a paving composition by mixing a mineral aggregate in its natural state, or after drenching with water, with a bituminous binding agent containing oleylamine. The process is particularly useful in connexion with aggregates which are acidic and/or highly siliceous, and also when bituminous roads are laid in damp or wet places.

J. C. Roediger. U.S.P. 2,278,671, 7.4.42. Appl. 10.10.39. Method of producing a bituminous bonding agent by blending a high-softening-point cracking coil-tar with a relatively low viscosity cracking coil-tar produced from gas-oil and low-viscosity tars produced from the cracking of crude petroleum. H. B. M.

Special Products.

749. The Manufacture of Synthetic Rubber. G. B. Murphy. *Nat. Petrol. News*, **34** (7) 18.2.42, R51–R56.—The article deals in a very superficial manner with the manufacture of synthetic rubber from butadiene and styrene. The aim is to produce 400,000 tons p.a., and it is estimated that production will reach 90,000 tons p.a. by the end of 1942. The essential features of the process comprise the co-polymerization of butadiene and styrene in the presence of a peroxide catalyst to form an emulsion with water. The emulsion is coagulated with acid, water expressed, and the coagulum masticated by the method of normal rubber manufacturing technique. The present cost of synthetic rubber is much greater than that of the natural product, but larger-scale production is expected to reduce the cost very considerably. H. G.

750. Patents on Special Products. Standard Oil Development Co. E.P. 545,293, 22.5.42. Appl. 22.5.40. Process for the catalytic isomerization of normal to *iso*-heptane wherein the normal heptane is contacted with aluminium chloride or aluminium bromide. The conversion reaction is carried out in the liquid phase at pressures not above atmospheric.

Standard Oil Development Co. E.P. 545,412, 26.5.42. Appl. 1.7.40. Process involving contacting at least one normal paraffin containing at least four carbon atoms per molecule with an isomerization catalyst under isomerization conditions in a step-wire process. The reaction is carried out in at least two stages, and a temperature gradient maintained between the stages. H. B. M.

Engines.

751. Pre-exhaust Gas-pressure Measurements for Indicating Diesel Engine Performance. B. H. Jennings and T. E. Jackson. *Gas Oil Power*, Dec. 1941, **36** (435), 269.—The use of the release pressure for indicating load conditions in the cylinders of I.C. engines has been proposed, and an instrument devised that operated effectively on this principle.

In this paper the principle is explained and developed and the experimental programme and data corroborating the idea are presented.

The problem of experimentally measuring the pre-exhaust pressure is a relatively simple matter, and one arrangement is illustrated in a diagram relating to a two-stroke cycle Diesel engine. A series of tests were run, using three units: (*a*) a four-cylinder single-acting $8\frac{1}{2} \times 12$ in. two-stroke-cycle Diesel; (*b*) a two-cyclinder $12\frac{1}{2} \times 13$ in. single-acting crosshead type, two-stroke-cycle engine, and (*c*) a standard C.F.R. Diesel fuel-testing unit. All the tests indicated that there was a definite value of release pressure related to the brake and indicated M.E.P. being developed by an engine at a given time. With the multi-cylinder engines, using the release-pressure readings as indexes for balancing and adjusting the load between the various cylinders, was a simple yet effective method of control.

Although release pressure showed a definite relationship to B.M.E.P. for each particular engine, there was no relationship apparent between the three different engines. D. L. S.

Coal and Shale.

752. Shale Oil Production in Russia. Anon. *Petrol. Times*, 24.1.42, **46** (1161), 49.—The Gdov district is said to contain 5×10^9 metric tons of oil shale of oil content 18%. This district is at present in enemy hands. Two workings capable of producing 5×10^5 tons p.a. are in operation, but in the 1937–39 period they produced only half this quantity. The same district has the only low-temperature shale-oil plant. The petrol is said to contain 6% S, and has to be hydrogenated. H. G.

753. A Technical Study of Transvaal Torbanite. S. L. Neppe. *J. Inst. Pet.*, June 1942, **28** (222), 194–108.—As an addendum to the author's previous paper on this subject (*J. Inst. Pet.*, February 1941, **27** (208), 31) further experimental results are presented dealing with pressure extraction of the torbanite. A. H. N.

754. Peat as Fuel. Anon. *Petroleum*, January 1942, 5 (1), 11.—The possibility of domestic utilization of peat in this country as a fuel is under consideration. A brief review of the formation of peat bogs is given and the peat resources of various European countries are surveyed. In Denmark, Sweden, and Eire completely mechanized establishments for harvesting the peat and the manufacture of briquettes have been constructed. All operate on the Peco process. Ditches 4 ft. deep, about 2 ft. wide, and up to a mile in length are cut in the surface 50 ft. apart. A track-laying tractor equipped with a cutter 8 ft. in diameter, sunk about half its diameter into the surface, is used for this purpose. The ditches drain the bog moisture content from 92% to 88% and allow the surface to take heavier weights. The surface is then milled off to a depth of $\frac{1}{2}$ in. by a long drum of $2\frac{1}{2}$-ft. diameter carrying cutters revolving at about 800 r.p.m. The peat is thrown up by these cutters as a powder on the surface, where it is allowed to remain for some hours, depending on weather conditions, to dry. The powder (moisture content 50%) is gathered into ridges and then placed on a belt conveyer and loaded into trucks, which deliver it to the factory. The powder is screened to remove twigs and fibrous materials which are used for steam-raising. The screened powder is blown through hot-water or steam-heated pipes, variations in moisture content of feed being compensated by blending back with partly processed peat. The powder passes through five stages of drying, and then goes to the briquetting press. A pressure of about 5 tons per sq. in. is applied, and the press is water-cooled to maintain a temperature low enough to prevent damaging the briquette. As the harvesting season is not longer than 6 months in the year, the factory is designed to operate at a lower rate than the harvesting section. Stacking and blending of the surplus peat obtained during the harvesting require special care to avoid overheating and to obtain best results during subsequent treatment. The final moisture content of the briquette is 10–12%. The briquetted peat has a calorific value of 8000–9000 B.T.U. per cu. ft., but its radiation value in an open fire is given as 18% compared with coal at 10–12%. Economics of the process and purposes to which peat is applied abroad are discussed. R. A. E.

755. Producer Gas Developments in Continental Europe. Anon. *Petrol. Times*, **56** (1161), 24.1.42.—Germany has the largest number of generator gas operated vehicles, but progress in Sweden has been rapid owing to the favourable fuel supply. In the middle of 1941 60,000 such vehicles were registered in Sweden. The first producer-gas ship is reported, and Denmark is building a 3000-ton vessel to operate on gas from coal and coke. In Germany and occupied countries 180,000 lorries were running on generator gas last year. Dwindling supplies of wood have promoted the use of anthracite, peat, lignite, etc. The fuel supply, in general, has controlled the rate of development, which has been slow in Belgium, Holland, Finland, and Hungary. In France progress has been considerable, but again supplies of wood and sheet iron for the construction of kilns cause difficulties. H. G.

756. **The Future of Road Transport Fuels.** J. Devon. *Petroleum*, January 1942, **5** (1), 3.—Future possibilities of some alternative fuels and practicable applications in war-time to existing engines and vehicles are discussed. Conversion to electric battery operation of cars and vans having a daily mileage of 30–50 miles, replacing the engine and gear-box by an electric motor and controller, is feasible, and may result in economies. Charging of batteries could take place at night, when demand for current is low. The main application of producer-gas plants has been to transport vehicles and lorries. The power output obtainable from a given engine is appreciably lower than when gasoline fuel is used, and falls off during the run as the volatiles are driven off from the fuel in the generator. Plants designed to use charcoal as fuel were found unsatisfactory when running on anthracite or coke fuel; additional filtration of the gas was essential. Owners of large fleets operating gas producers are making revisions to plants as now manufactured in the light of their operating experience, so that improvements on present design may be expected. Correct maintenance of the generating and filtration plants is essential in order to avoid the possibility of damage to the engine. Unless used for light duty on flat roads, increase in compression ratio of the engine is necessary, and change in axle ratio may also be required.

Power output on town gas from a given engine is about 75–90% of that obtainable on gasoline, but the use of steel cylinders to store the gas under pressure is not practicable in war-time. A roof gas-bag contains sufficient gas for only a 15-mile run. Increase of compression ratio of the engine to give improved performance on town gas will adversely affect running on gasoline. Special sparking-plugs are sometimes required to avoid overheating of engines running on town gas.

Steam engines appear to offer possibilities if advantage is taken of developments in steam-driven electricity-generating stations.

The use of creosote, acetylene, or alcohol is impracticable in war-time, and the future application of these fuels is considered to be limited for various reasons. The use of methane appears to have promising possibilities in the future. Methane can be used in compressed or liquefied form and applied to existing engines with little or no modification, or, alternatively, greater power output could be obtained by increase in compression ratio of the engine. Certain sewage-disposal works provide a ready source of methane supply. A new proposal from America, where the system is already in operation, is to extract methane from coal deposits by horizontal drilling, insertion of pipe, and application of vacuum. Vertical pipes convey the gas to the surface, where it can be liquefied. On the average about 1000 cu. ft. of methane is contained in a ton of coal, so that a considerable output might be expected.

R. A. E.

757. **Conversion of Petroleum Oil-Burning Plants to Coal Tar Fuels.** Anon. *Petroleum*, December, 1941, **4** (8), 169.—In order to conserve tanker space the Petroleum Department, in conjunction with the Petroleum Board, has been pressing suitable consumers to utilize a mixture of 50% creosote, 50% pitch as fuel in substitution for petroleum fuel. Considerable stocks of pitch are available for such use owing to cessation of exports to the Continent and the need for maintaining tar distillation at the highest possible level. After using all available creosote there will be further supplies of pitch available for use tel quel. One of the biggest consumers of liquid fuel in the country has used the mixture for steam raising for a considerable period, and reports satisfactory results from the technical aspect and an economic advantage at present-day fuel prices. Properties of creosote, pitch, and the mixture are given and compared with those of petroleum oils and the method of production of the creosote/pitch blend described. Medium soft pitch and the mixture for use as liquid fuels are loaded at temperatures of 200° C. and about 120° C., respectively, into road and rail tank-waggons and in insulated tanks remain pumpable for 24 hr. or longer.

In storage tanks the common practice is to maintain a temperature between the flowable and burning temperatures—*i.e.*, temperatures at which the fuels have viscosities R.I. of 3000 secs. and 100 secs., respectively. For medium pitch these temperatures are 260° F. and 392° F., and for the mixture 80° F. and 200° F. Internal or external heating may be applied, and the storage tank and all pipe-work should be free from joints made with rubber. Duplicate pumps are recommended, and fuel lines throughout their entire length should be lagged with inclusion of either a steam tracer line or electric heating cable. The ideal arrangement is to circulate the fuels by pump through a ring-main past the burners and back to the storage tank, the pump capacity being at least double the burner output. This ensures correct oil temperature at burners and assists in maintaining uniform tank temperatures. Alternatively, a steam-jacketed gravity feed-pipe from tank to burner may be used. Both systems are illustrated. Steam atomizing burners are generally used, and a recommended type is described. With creosote–pitch mixture pressure jet and certain types of low-pressure air burners may also be used. It is important that the burners should not have small orifices, and burner capacities usually range from 7 to 80 gals. per hr.

The use of valves, filters, etc., made of iron or steel is recommended, as some tar fuels exert a slightly corrosive action on brass and similar non-ferrous metals. To avoid precipitation and attendant difficulties, admixture with petroleum fuels should be avoided, and all traces of such fuels should be removed from the system when changing over to tar oils. Special precautions required to avoid solidification troubles when using grade B creosote (high pour point) and sedimentation troubles with creosote-pitch mixtures are outlined. For controlling supply of pitch or creosote-pitch to burners, ordinary screw-down valves are liable to become choked with deposit around the seating, and the use of a valve in which flow is controlled through an orifice is recommended.

Further recommendations are made in connection with the utilization of medium soft pitch in the liquid state and of pulverized hard pitch. R. A. E.

Economics and Statistics.

758. Biennial Report of Petroleum and Natural-Gas Division. Fiscal Years 1940 and 1941. R. A. Cattell, G. B. Shea and Others. U.S. Bureau of Mines. Report of Investigations No. 3616. Feb. 1942.—This report summarizes progress made during the years 1940 and 1941 by the Petroleum and Natural Gas Division of the United States Bureau of Mines towards their objectives of increased conservation and better utilization of petroleum, natural gas, and related resources through a co-ordinated programme of research. Owing to the present emergency, many of the Bureau's long-time research activities have been curtailed and attention has necessarily been focussed as far as practicable on problems associated with the needs of national defence.

The report is divided into seven main sections, comprising oil and gas development and production research ; petroleum chemistry and refining ; pipe-line transportation ; chemical and engineering problems ; helium operations ; work for other Government departments ; and visual-education activities. Discussions of problems listed under these headings are based upon statements submitted from the five field headquarters of the division.

Production research during the years under review centred around methods for obtaining and interpreting data relating to subsurface pressures and temperatures and the properties of reservoir oil as a means of analyzing reservoir performance ; collection and analyses of cores ; relation between decline in reservoir pressure and cumulative production of oil ; factors influencing the productivity of wells ; function of water in obtaining maximum oil recovery ; and the effect of well-spacing on ultimate recovery.

Of particular interest in the chemistry and refining section is the development of a satisfactory method for separating asphalt into its components. The method involves : (1) precipitating the asphaltenes with hexane and separating them from the hexane-soluble material by centrifuging ; (2) distilling the hexane from the hexane-soluble material, dispersing the residue on asbestos fibre, and extracting with acetone to obtain an acetone-soluble fraction (oils plus waxes); (3) extraction of the residue from (2) with hexane to obtain a hexane-soluble fraction (resins); (4) extraction of the residues from (1) and (3) with benzene to give the benzene-soluble fraction (light asphaltenes); and (5) extraction of the residue from (4) to give the pyridine-soluble fraction (heavy asphaltenes).

Incorporated in the report is a bibliography of publications issued by the Petroleum and Natural-Gas Division during the years 1940 and 1941, together with a list of reports prepared by members of the Division outside the Bureau of Mines. H. B. M.

759. **Agricultural Petroleum Fuel Consumption.** K. N. Gess. *Petrol. Times*, 18.4.42, **46** (1167), 190.—Where the three main tractor fuels, gasoline, kerosine, and Diesel oil, can compete on an equal footing with regard to taxes, gasoline is the more popular fuel, but Diesel engines are rapidly gaining ground. In England the petrol taxes make the use of petrol-engined tractors prohibitive, and kerosine is the principal fuel. Crank-case oil dilution remains a big disadvantage attendant upon the use of kerosine. In U.S.A. and Canada, where taxes are refunded, in whole or in part, on gasoline used for agricultural purposes, distillate fuels represent only a small proportion of the total. It is concluded that there is a strong case for preferential treatment for agricultural tractor fuel in England, but that the greater fuel economy and improved performance of the Diesel engine warrant greater attention being paid to that form of traction. H. G.

BOOK REVIEW.

Source Beds of Petroleum. By P. D. Trask and H. W. Patnode. Pp. 566, 151 tables and 72 figures. American Association of Petroleum Geologists, Tulsa, Oklahoma, 1942. Price $4.50.

Although opinions have been expressed from time to time regarding the characteristics of petroleum source beds, no criteria appear to be known yet which can be applied definitely to demonstrate that a given bed has been the seat of oil formation. The discovery and application of such criteria are not merely of academic interest, even though large amounts of oil have been and are being found without this knowledge, for the finding of new oil fields is becoming increasingly difficult, and demands the use of all possible information about the conditions necessary to form an oil accumulation. The search for certain types of structure, a procedure which has tended to dominate the scene in the past, takes cognisance only of the fact that a commercial oil accumulation must have a suitable trapping feature: but favourable structure alone will not guarantee the presence of an oil accumulation unless there is also an oil source rock from which oil has been able to reach the trap.

In 1926 the American Petroleum Institute initiated a project for the study of petroleum source beds, and for a period of five years an investigation was made of the conditions of accumulation of organic matter in deposits of a type similar to those which are believed to have generated oil in the past. The results of this work were summarized in Trask's "Origin and Environment of Source Beds of Petroleum." A study of ancient sediments from the point of view of oil formation was begun in 1931, in conjunction with the Geological Survey of the U.S.A. "Source Beds of Petroleum" sets out the results of the ten years' work on ancient sediments.

The principal object of the investigation was to discover diagnostic criteria for recognizing oil source beds, but, as the authors admit, there is no certainty as to what is a source bed, and also it is difficult to be sure that beds which have acted as sources of petroleum will retain features distinguishing them from beds which have not performed such a function. Hence, the entire study has been based on the assumption "that sediments stratigraphically near known oil zones, in general, are better source beds than those far from oil zones. . . . The method of approach to the problem has been to determine several properties of individual samples of sediments from many oil fields in most of the oil-producing regions of the United States in order to ascertain whether or not any of these properties were related to the distance of the sediments from known oil zones. If consistent differences for individual properties were found for groups of sediments in several regions, the conclusion would be reached that such properties were related to the generation of oil."

Some 35,000 samples have been examined, 32,000 being well samples and the rest outcrop samples. 14,000 samples were from California, 6000 from the Rocky Mountain area, 6000 from the Mid-Continent, 3500 from East Texas, 3000 from the Appalachian area, 2000 from the Gulf Coast, and 500 from West Texas. The subsurface samples came from 434 wells distributed among 150 fields. 87 of the wells were at Santa Fe Springs, 49 at East Texas, and 22 at Burbank, with many of the remaining fields represented by only one well. The number of samples from a single well ranged from 2 to over 200. 36 of the fields were in Texas, 35 in California, 23 in Wyoming, and the rest in Colorado, Oklahoma, Pennsylvania, Kansas, West Virginia, Louisiana, Kentucky, New York, Ohio, Montana, Nebraska, New Mexico, and Mexico.

Cores, cable-tool, and rotary samples were employed, with their inherent differences as regards depth indications, degrees of mixing, and predominant lithological types. Generally the analyses were made on samples from individual horizons, but composite samples were used for certain purposes. At first samples were taken at 3–10 ft. intervals from several wells in a few selected areas, in order to find the general tenor of the organic matter and its vertical and lateral variations. Subsequently it was decided that a reliable determination of the general organic content and other constituents of the sediments could be obtained nearly as satisfactorily if samples were taken at greater intervals, and so in later work samples were taken at 20–50 ft. intervals.

Some or all of eight properties were examined in the samples : (1) organic carbon content; (2) reduction number, which is a measure of the quantity of chromic acid that the sediments can reduce under given conditions; (3) nitrogen content; (4) assay number, which is a rough measure of the volatility of the organic constituents; (5) texture; (6) the content of bituminous substances; (7) colour; and (8) the calcium carbonate content. The methods of making the above determinations are described in detail, together with the limitations of the methods and the results generally, as well as on a regional basis. The significance of the various statistical indications is discussed, for this is the basis of the final conclusions.

From the basic determinations other quantities have been derived and studied, such as the relative volatility—the ratio of the volatility to the reduction number; the ratio of carbon to nitrogen; the nitrogen-reduction ratio—the ratio of the nitrogen content to the reduction number; and the oxidation factor—the ratio of the carbon content to the reduction number.

In the regional studies the areal and vertical variations of the properties are given, and also the relationship of the properties to the occurrence of petroleum on a stratigraphical and on a distance basis. In the first classification each sedimentary unit was put into one of five classes : (1) productive—units in which most of the samples were within 200 ft. of producing zones; (2) probably productive—most of the samples within 200 ft. of zones which produce oil in nearby areas, but not in the area of the sample; (3) questionable—units 200–500 ft. from producing or probably producing zones, or which contain small shows of oil; (4) barren—most of the samples over 500 ft. from the producing zone; (5) gas—most of the samples within 200 ft. of producing gas horizons or strong gas-shows.

The preceding classification involves certain assumptions, even if transformational migration alone is considered. The local stratigraphy may provide an indication of the chances that it is valid. If 500 ft. of sediments without any interbedded horizon which could act as a reservoir rock occur adjacent to the producing horizon, it is by no means certain that oil is more likely to have been formed in the nearer 200 ft. than in the more distant beds. Furthermore, it would have been preferable to avoid the use of "productive" in the names of the classes, especially when in the succeeding distance classification the term and its variants are used for the oil-producing horizons.

The nitrogen-reduction ratio was also examined on a basis in which the samples were grouped into ten classes : (1) within the confines of the producing zones; (2) 1–50 ft. above an oil zone; (3) 51–200 ft. above an oil zone; (4) 201–500 ft. above an oil zone; (5) over 500 ft. above an oil zone; (6) 1–50 ft. below an oil zone; (7) 51–200 ft. below an oil zone; (8) 201–500 ft. below an oil zone; (9) over 500 ft. below an oil zone; (10) wells in barren territory. The producing zones were divided into five classes : (1) productive—actually produce oil; (2) probably productive—barren in well sampled, but productive within 50–100 ml.; (3) shows—well has shows, but is not commercially productive; (4) gas—well yields gas; (5) a composite of classes (1), (2), (3), and (4).

The authors' final summary shows that according to the statistical methods employed, only the nitrogen-reduction ratio shows any definite relationship with oil, but even that is not absolute. Studies based on the distance of the samples from oil zones show that the ratio is lower near oil zones than far from them, but the significance of a given nitrogen-reduction ratio depends on the area. Consequently, a considerable amount of work must be done before the ratio can be applied. The ratio appears to be affected by metamorphism, nearness to the source of detritus, and texture. It cannot be used to locate fields, being essentially the same whether on or off favourable oil structure, and it seems more suitable for regional interpretation in wildcat territory. The ratio is of significance only if applied to well samples, and so it is not applicable until a test has been drilled, and that will have had to be located by means of other criteria. If the test is a failure, but the values of the ratio are suggestive, more wells will be needed before the true significance of the values can be decided.

The general range of the values of the nitrogen-reduction ratio seems to be 3 to 8, below 5 being a good index, 6 encouraging, 7 not very hopeful, and over 8 unfavourable, with poor prospects within 10–50 ml. in that bed, but without condemning the beds above or below.

The reduction number and the nitrogen content have been used to estimate the organic content of the beds by multiplying these quantities by factors which depend to some extent on the area in question. Therefore, the variation in the nitrogen-reduction ratio is a function of the conditions which lead to inconstancy in the multiplying factors. Some discussion on this point would have been of interest.

The volatility (assay number) and carbon–nitrogen ratio tended to be higher in productive than in barren sediments (Athy's and Patnode's terms), but the relationships were not constant, and so are of little value for prospecting. The organic content and colour were not found to be related to oil occurrence, and so it is concluded that they are not valid criteria for recognizing source beds. The organic content, carbon content, reduction number, nitrogen content, and relative volatility tended to be slightly higher in sediments near oil, while the oxidation factor tended to be very slightly lower, but there were many exceptions to these statements. The colour varied directly with the organic content, but the relationship depended on the area and the coarseness. The estimated organic content ranged 0·2–10%, the bulk of the samples showing 0·4–5%. The Californian sediments were richest in organic matter, and the Appalachian sediments the poorest. The variation of the organic matter with distance seemed to depend on the activity of diastrophism.

In view of the somewhat restricted possibilities in connection with the obtaining of samples, it is extremely doubtful whether the method of attack and of interpretation of the observations adopted is capable of yielding a solution to the problem. When an oil company drills wells, the wells are in certain very limited areas which are believed to be structurally favourable for oil accumulation, and apart from those drilled purely for structural data or for special purposes in connection with production methods, the wells are drilled with the object of obtaining oil. However, many recognize that if the geology is suitable, the oil present in the trapping part of the reservoir rock has not necessarily come from the immediate vicinity of the existing accumulation. In certain cases the geology may point to oil formation nearby, either above or below the actual accumulation, but in other cases there is the possibility that the oil has migrated laterally through the reservoir rock to the point of accumulation, and hence the effective area of source bed may be found above or below the reservoir rock some distance laterally from the site of the accumulation. Samples obtained from wells as normally located will be from the beds above and below the oil accumulation. The preponderance of these rather specialized samples, and their consideration statistically without due regard to the geology of the individual fields can, therefore, hardly be expected to lead to a satisfactory result.

Admittedly, the position with regard to samples is somewhat difficult. The researchers have to accept the samples which are available, since there are no funds for the drilling of considerable numbers of wells off structure at points which are unlikely to yield oil, but where valuable data on source beds might be obtained in some instances. Fields which appear extremely favourable for study because a complete picture of the geology is known, may be already drilled up and may have no suitable samples available. In other fields beds which might provide interesting data on source beds may not be penetrated because they lie below the oil horizon sought.

In their final paragraph the authors note that in "future investigations . . . special attention could advantageously be given to sediments which, because of their stratigraphic relations to known oil zones, almost certainly are source beds," although they make no mention of re-interpreting the large amount of data already obtained, in accordance with this recommendation. Provided that certain types of fields are among those sampled, re-examination of the data in conjunction with the detailed geological possibilities regarding migration and accumulation might prove extremely valuable.

No indication is given of the type of oil concerned in the various zones studied, and having regard to the recent claims of the ability of geochemical well-logging to detect oil accumulations laterally or ahead of the drill, it would have been of considerable interest to have any possible relationships of these observations to those described in the present volume discussed fully.

The volume shows clearly the enormous effort which has been expended on the project of finding determinative criteria for source beds of petroleum, but the final result is disappointing, and undoubtedly the authors feel disappointed too.

There is, however, the distinct impression that had the data been examined in conjunction with the geology of the fields, the conclusions might have been more valuable. As the basic analytical data are presented for each sample in a 113-page table, readers with a flair for statistics, detailed information on the geology and other features of the fields available, and ample time to give to the study, may be able to obtain more definite information concerning the measurable characteristics of source rocks than has been deduced in " Source Beds of Petroleum."

G. D. Hobson.

INSTITUTE NOTES.

August, 1942.

STAFF.

During the month of July, Mr. S. J. Astbury tendered his resignation from the position of secretary. This was accepted. Mr. F. H. Coe was appointed Acting Secretary of the Institute, taking up duties on 1st August, 1942.

HONOURS.

The King has approved the award to Major Percy R. Clark, R.A.O.C., of the Greek Distinguished Service Medal, conferred upon him by the King of Greece.

FORTHCOMING MEETINGS.

An interesting and widely comprehensive series of meetings is being arranged of which due notice will be given. It is hoped the first will take place in September, and monthly thereafter.

CANDIDATES FOR ADMISSION.

The following have applied for admission to the Institute or transfer to another grade of membership, and in accordance with the By-laws the proposals will not be considered until the lapse of at least one month subsequent to the issue of this *Journal*, during which any Fellow, Member, or Associate Member may communicate by letter to the Secretary, for the confidential information of the Council, any particulars he may possess respecting the qualifications or suitability of any candidate.

The object of this information is to assist the Council in grading candidates according to the class of membership.

The names of the candidate's proposer and seconder are given in parentheses.

Battye, Arthur, Chairman, Messrs. D. Battye & Son, Ltd. (*N. L. Skilling ; E. E. Manning.*)

Bishop, Henry John, Petroleum Inspector, Messrs. B. & R. Redwood. (*W. F. Jelffs ; A. T. White.*)

Cragg, John Coles, Chemist, Messrs. C. C. Wakefield & Co., Ltd. (*E. A. Evans ; S. J. M. Auld.*)

Gottesmann, Manfred, Technical Salesman, Socony-Vacuum Oil Co. (*Transfer to Associate Member.*)

Mitchell, John, Chemist, Attock Oil Co., Ltd. (*T. T. McCreath ; J. G. Annan.*)

Pocock, Neville Richard, Assistant Oil Stocks Superintendent, Trinidad Leaseholds, Ltd. (*J. H. McLea ; B. G. Banks.*)
Ridler, Kenneth Edgar William, Engineer, R.A.F., Farnborough. (*Dr. F. H. Garner ; H. C. Tett.*)
Wilding, John Sherley, Chemist, R.A.S.C. (*R. J. Bressey ; J. S. Jackson.*)

PUBLICATION OF STANDARD METHODS.

Work in connection with " Standard Methods for testing Petroleum and its Products " is in the hands of the printers and is expected to be published about the beginning of November next.

ARTHUR W. EASTLAKE,
ASHLEY CARTER.
Joint Honorary Secretaries.

LIST OF ADVERTISERS.

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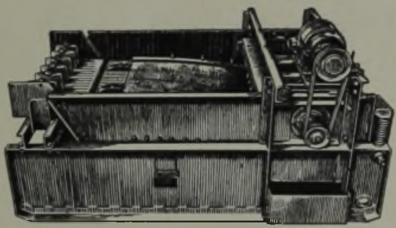

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Gentlemen:

We are glad to send this report on our "Cardwell" Model S twin-engine draw works.

First, let me say we are very pleased with the entire set-up, especially as the rig drilled this well to 7,006 feet. This is 2,000 feet beyond your recommended depth with Waukesha GAK engines.

The drillers liked the draw works from the start. It is light and compact, even with both engines assembled, making rigging up much easier. The air controls, even-step transmission and Hi-Speed drive saved them much time and effort.

In checking the round trip time, the following results were obtained: at 7,006 feet, we had 45 stands of 4-1/2" and 35 stands of 5-1/2" drill pipe in the hole. We pulled a stand every 2 minutes and 20 seconds in low gear; 2 minutes in second gear; 1 minute and 30 seconds in third; 1 minute and 15 seconds in fourth. Coming out at 7,006 feet we pulled 13 stands in second gear; 21 in third; 22 in fourth and 22 in fifth. We cannot give you the exact time as we had to stop at intervals to change tongs, etc., but as near as we could figure, it took 2 hours and 20 minutes to pull out from bottom, 7,006 feet.

Going in, we ran at the rate of one stand per minute average all the way, or 78 stands in 78 minutes. The drillers all agreed that the brakes are the best they have ever used, as they held the load nicely even at 7,006 feet.

We hope this report will be of value to you, and remain,

Yours very truly,

E. A. Bender

EAB:BB

TWIN ENGINE MODEL S FEATURES

"Cardwell" five-speed, even ratio transmission drives to the drum and rotary table through friction clutches.

Friction clutches are air-controlled.

Air-controlled Hi-Speed drive operates outside of transmission for quick "kick-up" of block.

Power take-off friction clutches are air-controlled.

Draw works can be moved complete without removing engines.

When rotating, the drum may be engaged and the drill pipe lifted without stopping the rotary table.

Dual safety, self-energizing brakes.

Heat-treated brake flanges have water-trough for quick cooling.

Sand line drum is available with rig or for field installation at later date.

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