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RELATION BETWEEN MELTING POINT AND MOLECULAR WEIGHT IN THE *N*-PARAFFIN SERIES.*

By A. H. Etessam, B.Sc. (Student Member), and M. F. Sawyer, B.Sc. (Associate Member).

The relation between the melting point and number of carbon atoms in the molecule in a homologous series provides an interesting study, and it is therefore not surprising that attempts have been made to derive a formula expressing the melting point in terms of the number of carbon atoms in the molecule. The *n*-paraffin hydrocarbons, by reason of their many syntheses and the consequent accumulation of data, are particularly suitable for such a study, and some attention has been given to this series, which is of special interest to the Petroleum Industry.

The need for some relation which involved directly the melting point and molecular weight was mentioned by Austin[1] who, from certain theoretical concepts, deduced that for all homologous series these two properties are connected by the equation :—

$$\log M = A + \frac{4}{10^3} T,$$

where M = molecular weight, T = melting point in ° K. (Kelvin), and A is a constant, the value of which depends on the series. The relation, however, holds only roughly over a limited temperature range (250–330° K.).

From a knowledge of the heat of crystallization and setting point of the α-forms of four *n*-paraffins of comparatively high molecular weight (C_{22}, C_{26}, C_{30}, C_{34}), Garner, van Bibber and King[2] deduced the relation :—

$$T = \frac{(0{\cdot}6085n - 1{\cdot}75)}{(0{\cdot}001491n + 0{\cdot}00404)}$$

between the setting point T (in ° K.) and n, the number of carbon atoms in the chain. This equation, which gives a convergence temperature of 408° K., was used to calculate the setting point of the *n*-paraffin hydrocarbons from C_5H_{12} to $C_{70}H_{142}$. Agreement between experimental and calculated values is good for members above $C_{20}H_{42}$, but for *n*-paraffins of shorter chains the experimental value is always higher than the calculated value. The alternation in melting points between the odd and even paraffins of low molecular weight (see Fig. 1) was recognized by these authors, who suggested that the melting point of the members of this series cannot be represented by one equation, a suggestion confirmed by the alternation in the heats of crystallization of *n*-paraffins containing 5, 6, 7, and 8 carbon atoms.[3]

An attempt to find a more accurate relation has been made by Merckel,[4] who considers the odd and even members separately. For the odd series

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he finds that a linear relation exists between log T (melting point in ° K.) and the number $(n - 1)$ in the series such that

$$\log T = -\frac{2{\cdot}091}{n-1} + 2{\cdot}6018,$$

the two constants being calculated from the average of two known melting points. The difference between the experimental and calculated melting points for n-paraffins from C_{11} to C_{35} is not greater than 1° C. in any case, but considerable deviation is shown by the lower members of the series.

The even members fall into three groups :—

(*a*) Those above C_{22} which conform to the relation

$$\log T = -\frac{2{\cdot}284}{n-1} + 2{\cdot}6136,$$

good agreement being shown in the examples given to $C_{36}H_{74}$.

(*b*) Those from C_{10} to C_{22} (inclusive) which are in substantial agreement with the equation

$$\log T = -\frac{1{\cdot}870}{n-1} + 2{\cdot}5896,$$

the maximum deviation between observed and calculated values in this range being 1·8° K., and

(*c*) The members below C_{10} which deviate from this equation.

The convergence temperatures as given by the appropriate Merckel equations are 399·8° and 410·8° K. for the odd and even series, respectively.

Moullin,[5] by plotting $\log_{10}(n - 2)$ against the melting point (in ° C.) for $n = 9$–31 and 3–27, respectively, finds in each case that the points lie almost on a straight line, and concludes that the melting point T (in ° C.) and the number of carbon atoms, n, in the molecule are related by the equation :—

$$\log (n - 2) = 1{\cdot}065 + \frac{5{\cdot}29}{10^3} T.$$

The agreement between the actual and the calculated melting points is, however, not very satisfactory.

This paper deals with an interesting and fundamental relationship between melting point and molecular weight in the n-paraffin series. In Fig. 1, curves *A* and *B* show, for the odd and even members, respectively, the melting point of the n-paraffin plotted against its molecular weight. Considerable choice in melting point is afforded by the literature for many members of the series, but the values used have been selected after careful consideration and, in the opinion of the authors, represent the most reliable figures.

It is evident from Fig. 1 that the odd and even members of the series lie on different curves, and it is therefore obvious that no one equation connecting melting point and molecular weight will suffice to represent to any degree of accuracy both the odd and even members over the whole

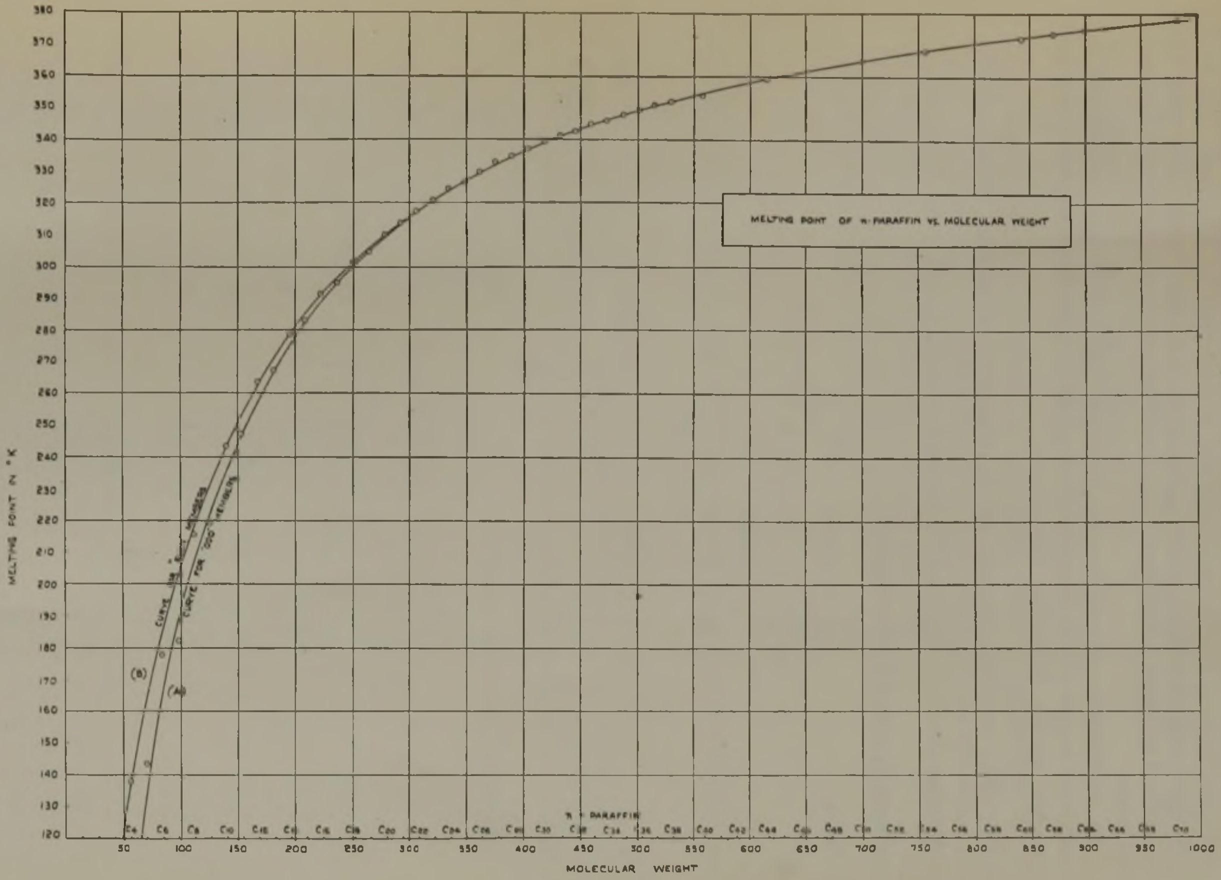
MELTING POINT OF n-PARAFFIN VS. MOLECULAR WEIGHT
MELTING POINT IN °K
380
370
360
350
340
330
320
310
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
120
CURVE FOR "EVEN" MEMBERS
CURVE FOR "ODD" MEMBERS
(B)
(A)
n - PARAFFIN
C4 C6 C8 C10 C12 C14 C16 C18 C20 C22 C24 C26 C28 C30 C32 C34 C36 C38 C40 C42 C44 C46 C48 C50 C52 C54 C56 C58 C60 C62 C64 C66 C68 C70
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
800
850
900
950
1000
MOLECULAR WEIGHT

FIG. 1.

series of n-paraffins. It is seen, however, that with increase in the number of carbon atoms in the molecule, the curves tend to converge, and the difference between them from C_{22} onwards is so small that they may be considered as being coincident—*i.e.*, a smooth curve may be drawn through the plots.

An expression connecting the melting point with the corresponding molecular weight which is applicable especially to this smooth curve may be obtained in the following manner :—

Let M = molecular weight of an n-paraffin of melting point = T° K.

Assume $$\frac{dM}{dT} = k\phi^2, \text{ where } \phi = f(M) = aM + b$$

where k, a and b are constants.

Then $$\frac{dM}{dT} = k\,(aM + b)^2$$

$$\therefore \quad dT = \frac{1}{k}\,\frac{dM}{(aM + b)^2}$$

$$\therefore \quad \int dT = \int \frac{1}{k} \cdot \frac{dM}{(aM + b)^2}$$

i.e., $$T = -\frac{1}{ak} \cdot \frac{1}{(aM + b)} + \text{const.} \qquad \cdots \qquad (1)$$

When $T = 0$, $M = 0$, $\therefore$ const. $= \dfrac{1}{akb}$

Equation (1) now becomes

$$T = \frac{1}{akb} - \frac{1}{ak} \cdot \frac{1}{(aM + b)}$$

$$= \frac{1}{akb}\left\{1 - \frac{1}{\dfrac{aM}{b} + 1}\right\}$$

$$= \frac{1}{akb} \cdot \frac{\dfrac{a}{b}M}{\dfrac{aM}{b} + 1}$$

$$= \frac{1}{akb} \cdot \frac{1}{1 + \dfrac{b}{aM}}$$

i.e., $$T = T \cdot \frac{1}{\left(1 + \dfrac{c}{M}\right)} \qquad \cdots \qquad (2)$$

where T_f and c are both constant, being equal to $\dfrac{1}{akb}$ and $\dfrac{b}{a}$, respectively.

Equation (2) may be expressed in the form :—

$$T_f = T\left(1 + \frac{c}{M}\right) = T_{(x)}\left(1 + \frac{c}{M_{(x)}}\right) = T_{(y)}\left(1 + \frac{c}{M_{(y)}}\right)$$

from which
$$c = \frac{T_{(y)} - T_{(x)}}{\dfrac{T_{(x)}}{M_{(x)}} - \dfrac{T_{(y)}}{M_{(y)}}}$$

The constant c may therefore be calculated from a knowledge of the melting points and molecular weights of any two n-paraffins. The average figure of $c = 94{\cdot}4$ was obtained from a number of such calculations. By substituting this value of c in equation (2), T_f (which obviously represents the convergence temperature) is found to be 414·5° K.

Equation (1) connecting the melting point (T° K.) and molecular weight (M) of the n-paraffin then becomes :—

$$T = \frac{414{\cdot}5}{\left(1 + \dfrac{94{\cdot}4}{M}\right)} \text{ or } \frac{414{\cdot}5\,M}{(M + 94{\cdot}4)} \quad . \quad . \quad . \quad . \quad (3)$$

In Table I below are tabulated for the known n-paraffins, between C_{22} and

TABLE I.

Member of Series.	Molecular Weight.	Melting Point, ° K. (from Literature).	Melting Point, ° K. (from relation $T = \frac{414{\cdot}5M}{94{\cdot}4 + M}$).	Experimental — Calculated Melting Point.
C_{22}	310·4	317·5	317·9	−0·4
C_{23}	324·4	320·4	321·0	−0·6
C_{24}	338·4	324·1	324·1	±0·0
C_{25}	352·4	326·3	326·9	−0·6
C_{26}	366·4	329·6	329·6	±0·0
C_{27}	380·4	332·5	332·1	+0·4
C_{28}	394·4	334·6	334·5	+0·1
C_{29}	408·5	336·9	336·7	+0·2
C_{30}	422·5	339·0	338·8	+0·2
C_{31}	436·5	340·8	340·8	±0·0
C_{32}	450·5	342·6	342·7	−0·1
C_{33}	464·5	344·5	344·5	±0·0
C_{34}	478·5	345·8	346·2	−0·4
C_{35}	492·6	347·6	347·9	−0·3
C_{36}	506·6	348·8	349·3	−0·5
C_{37}	520·6	350·4	350·9	−0·5
C_{38}	534·6	352·2	352·3	−0·1
C_{39}	548·6	—	353·6	—
C_{40}	562·6	353·75 (±0·25)	354·9	−0·9
C_{44}	619·7	359·4	359·6	−0·2
C_{50}	702·8	365·1 (±0·2)	365·3	±0·0
C_{54}	758·9	368·0	368·7	−0·7
C_{60}	842·9	371·9 (±0·4)	372·8	−0·5
C_{62}	871·0	373·5	374·0	−0·5
C_{64}	899·0	375	375·1	−0·1
C_{70}	983·1	378·25 (±0·25)	378·2	±0·0

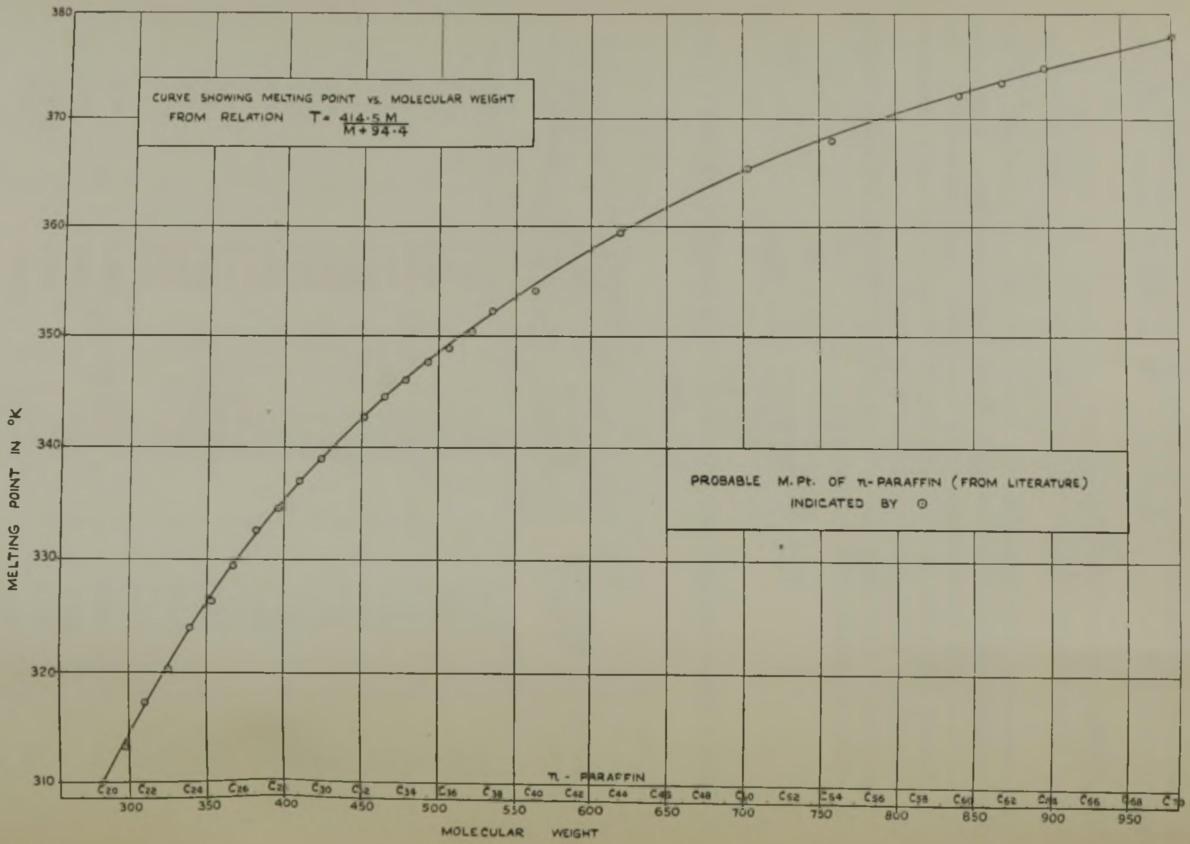
CURVE SHOWING MELTING POINT VS. MOLECULAR WEIGHT
FROM RELATION $T = \frac{414.5M}{M+94.4}$
PROBABLE M. Pt. OF n-PARAFFIN (FROM LITERATURE)
INDICATED BY ⊙
MELTING POINT IN °K
380
370
360
350
340
330
320
310
n - PARAFFIN
C20
C22
C24
C26
C28
C30
C32
C34
C36
C38
C40
C42
C44
C46
C48
C50
C52
C54
C56
C58
C60
C62
C64
C66
C68
C70
300
350
400
450
500
550
600
650
700
750
800
850
900
950
MOLECULAR WEIGHT

Fig. 2.

C_{70} (*a*) the molecular weight, (*b*) the most reliable value of the melting point given in the literature, (*c*) the value of the melting point calculated from equation (3), and (*d*) the difference between the experimental and calculated figures.

A graphical representation of Table I is given in Fig. 2.

The difference between the experimental and calculated figures is within 1° C. for all known members of the series having more than twenty-one carbon atoms in the molecule, and equation (3) may therefore be considered to represent the relation between melting point and molecular weight for the *n*-paraffins having molecular weight greater than 300.

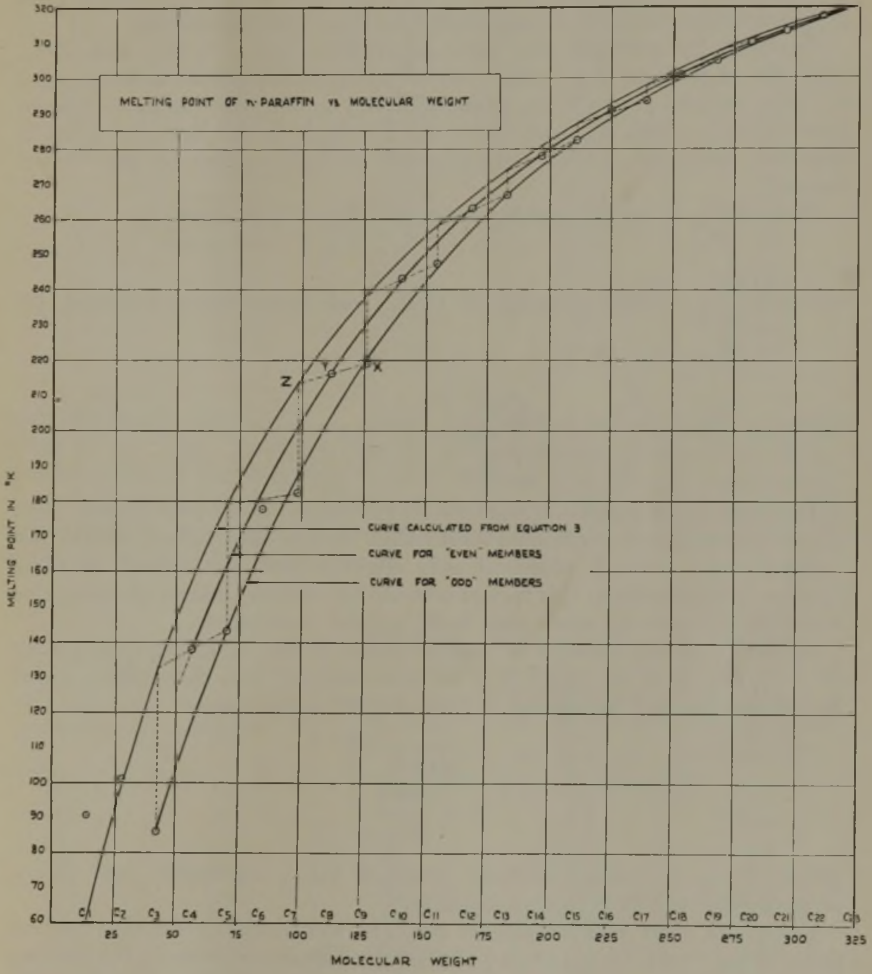

FIG. 3.

With the lower members of the series, the difference between the actual values and those calculated from equation (3) in general increases with decrease in the number of carbon atoms in the molecule, the difference being greater for the odd than for the even members, a fact well illustrated in Fig. 3, which shows the molecular weight and melting-point curve for this lower region drawn on a larger scale. Although the formula is not applicable with any degree of accuracy when the number of carbon atoms in the molecule is less than twenty-two, nevertheless there exists between the three curves shown in Fig. 3 a very interesting relation, which is of particular importance in its application to these lower members.

Consider, for example, the three n-paraffins C_7H_{16}, C_8H_{18} and C_9H_{20} (Fig. 3). Let X on the "odd" curve represent the actual melting point of C_9H_{20}, and let Z = melting point of C_7H_{16} on the curve calculated from equation (3). Join XZ and bisect at Y. It is found that the point Y coincides with the actual melting point of C_8H_{18} given on the "even curve."

Thus, if $T_{(9)}$ = actual melting point of C_9H_{20} ("odd curve")
$T_{(8)}$ = ,, ,, ,, ,, C_8H_{18} ("even curve")

and $\dfrac{414{\cdot}5}{1+\dfrac{94{\cdot}4}{M_{(7)}}}$ = melting point of C_7H_{16} calculated from equation (3)

then

$$T_{(8)} = \tfrac{1}{2}\left\{T_{(9)} + \frac{414{\cdot}5}{1+\dfrac{94{\cdot}4}{M_{(7)}}}\right\} \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad (4)$$

This relation (with two exceptions only) is found to be true in each case. For those members containing more than twenty-one carbon atoms the "calculated" curve is removed only slightly from the actual, and the relation is applicable to this region because the melting points of successive members increase by small and fairly regular increments.

Generally, if the number of carbon atoms in the molecule is given by $(n-1)$, (n), $(n+1)$, where n is an even integer, then the melting point $T_{(n)}$ of the "even" compound is given by the expression

$$T_{(n)} = \tfrac{1}{2}\left\{T_{(n+1)} + \frac{414{\cdot}5}{1+\dfrac{94{\cdot}4}{M_{(n-1)}}}\right\} \quad . \; . \; . \; . \; . \; . \; . \; . \quad (5)$$

where $T_{(n+1)}$ = actual melting point of $C_{(n+1)}$ n-paraffin, and $M_{(n-1)}$ = molecular weight of $C_{(n-1)}$ n-paraffin.

Using the most reliable figures given in the literature for the melting point of the "odd" n-paraffins (tabulated in Table I, column 3), the melting points of the "even" members have been calculated from equation (5). With two exceptions only (C_2 and C_6), the agreement between experimental and calculated values is within 1° C., as shown in Table II.

Equation 5 may be expressed in the form

$$T_{(n+1)} = 2T_{(n)} - \frac{414{\cdot}5}{1+\dfrac{94{\cdot}4}{M_{(n-1)}}}$$

TABLE II.

Member of Series.	Molecular Weight.	Melting Point, ° K. (from Literature).	Melting Point, ° K. (calculated from Equation 5).	Experimental — Calculated Melting Point.
C_2	30·0	101	73·0	+28·0
C_4	58·1	138·0	137·6	+ 0·4
C_6	86·1	177·6	180·9	− 3·3
C_8	114·1	216·2	216·4	− 0·2
C_{10}	142·2	243·3	242·1	+ 0·2
C_{12}	170·2	263·4	260·9	+ 0·5
C_{14}	198·2	278·5	278·6	− 0·1
C_{16}	226·3	291·1	291·0	+ 0·1
C_{18}	254·3	301·0	301·3	− 0·2
C_{20}	282·3	310·0	310·1	− 0·1
C_{22}	310·4	317·5	317·4	+ 0·1
C_{24}	338·4	324·1	323·7	+ 0·4
C_{26}	366·4	329·6	329·7	− 0·1
C_{28}	394·4	334·6	334·5	+ 0·1
C_{30}	422·5	339·0	338·8	+ 0·2
C_{32}	450·5	342·6	342·7	− 0·1
C_{34}	478·5	345·8	346·1	− 0·3
C_{36}	506·6	348·8	349·2	− 0·4

and obviously gives $T_{(n+1)}$, where $T_{(n)}$ is known—*i.e.*, the melting point of an "odd" member may be calculated from a knowledge of the melting point of the preceding "even" member and the molecular weight of the preceding "odd" member. With two exceptions only (C_3 and C_7) the agreement between experimental and calculated values is within 1° C., as shown in Table III below :—

TABLE III.

Member of Series.	Molecular Weight.	Melting Point, ° K. (from Literature).	Melting Point, ° K. (calculated from Equation 5).	Experimental — Calculated Melting Point.
C_1	16·0	90·4	—	—
C_3	44·1	85·9	141·8	−55·9
C_5	72·1	143·3	144·1	− 0·8
C_7	100·1	182·4	175·8	+ 6·6
C_9	128·2	219·3	219·0	+ 0·3
C_{11}	156·2	247·4	247·9	− 0·5
C_{13}	184·2	267·5	268·5	− 1·0
C_{15}	212·2	283·0	283·9	− 0·9
C_{17}	240·3	295·0	295·3	− 0·3
C_{19}	268·3	305·0	304·4	+ 0·6
C_{21}	296·3	313·4	313·1	+ 0·3
C_{23}	324·4	320·4	320·6	− 0·2
C_{25}	352·4	326·3	327·2	− 0·9
C_{27}	380·4	332·5	332·1	+ 0·4
C_{29}	408·4	336·9	337·1	− 0·2
C_{31}	436·5	340·8	341·3	− 0·5
C_{33}	464·5	344·5	344·4	+ 0·1
C_{35}	492·6	347·6	347·1	+ 0·5
C_{37}	520·6	350·4	349·7	+ 0·7

SUMMARY.

1. The melting point of any normal paraffin having more than twenty-one carbon atoms in the molecule may be calculated from the relation :—

$$T = \frac{414{\cdot}5M}{M + 94{\cdot}4}$$

where T = melting point in ° K. of the n-paraffin of molecular weight = M.

2. From the relation :—

$$T_{(n)} = \tfrac{1}{2}\left\{T_{(n+1)} + \frac{414{\cdot}5\,M_{(n-1)}}{M_{(n-1)} + 94{\cdot}4}\right\}$$

where n = even integer
$T_{(n)}$ = melting point in ° K. of C_n n-paraffin
$T_{(n+1)}$ = ,, ,, ,, C_{n+1} ,,
$M_{(n-1)}$ = molecular weight of C_{n-1} ,,

the melting point of C_n may be calculated when the melting point of C_{n+1} is known, and vice versa.

With four exceptions only (C_2, C_3, C_6, C_7) the agreement between experimental and calculated values is within 1° C., and in this connection it will be noted from Fig. 3 that the reported values for C_6 and C_7 do not lie on the respective curves, and that the melting point of C_3 is abnormal, as it is lower than the melting points of C_1 and C_2.

The authors wish to express their appreciation to Dr. T. G. Hunter, of this Department, for his interest and encouragement in this research.

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University of Birmingham.

References.

[1] Austin, *J. Amer. chem. Soc.*, 1930, **52**, 1049.
[2] Garner, van Bibber and King, *J. chem. Soc.*, 1931, 1533.
[3] Parks, Huffmann, and Thomas, *J. Amer. chem. Soc.*, 1930, **52**, 1032; Parks and Huffmann, *ibid.*, p. 4385.
[4] Merckel, *Proc. Acad. Sci., Amsterdam*, 1937, **40**, 164–173.
[5] Moullin, *Proc. Camb. Phil. Soc.*, 1938, **34**, 459–464.

THERMOMETRIC DETERMINATION OF TRANSITION POINTS IN PARAFFIN WAX.*

By H. D. Lord, Ph.D.

Synopsis.

It is shown that by the "inverse rate" method of plotting results it is possible to obtain transition points in paraffin wax conveniently and accurately. With an ordinary commercial wax containing a wide range of constituents of different melting points, the transition in crystalline form takes place slowly over a correspondingly wide range of temperature, but as the width of cut is reduced the transition range becomes narrower and more distinct, until for a narrow vacuum-fractionated wax it is quite marked and precise.

Figures for the fractionation of a white wax by sweating and by vacuum distillation are given, and it is shown that the differential between melting point and transition point of a paraffin wax decreases with increase in melting point and with narrowness of cut.

Thermal data for blends of 160 and 125/30 white waxes are included.

Mottling in wax is attributed to segregation of occluded air into the interstices between the crystal boundaries at the transition point.

Introduction.

It is a characteristic of many solid substances to change in crystalline form at a certain temperature or over a specific temperature range when heated or cooled. This change in structure is usually accompanied by evolution or absorption of heat and by change in physical properties, such as specific heat, conductivity, and coefficient of expansion; it is often possible by observation of these properties to determine the transition point with precision. Many investigations carried out have been mainly of purely academic interest, but highly important practical information has been obtained from the study of transition effects which occur in pure metals, and particularly alloys such as steels. In fact it may be truly said that almost all exact knowledge of the heat-treatment of steels depends on a knowledge of equilibrium diagrams constructed largely from transition-point data. Transition effects in paraffin wax are, of course, not nearly of such great moment, but they have attracted increasing attention during recent years, and many results of theoretical and practical importance have been obtained.

Transition Point of Paraffin Wax.

The transition point of a paraffin wax may be defined as that temperature at which its crystalline structure changes from a needle-like or α form to a plate or β form, with consequent evolution of heat and changes in physical properties such as density, coefficient of expansion, and air solubility. During this transition, wax, like other substances, is in a semi-amorphous condition, and it is obvious that this is of distinct importance if it is subjected in electrical or other industries to temperatures of this order.

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CRYSTALLINE FORM.

The exact nature of the change in crystalline form at the α/β transition point is not known with certainty. The above statement that the phase stable immediately below the melting point crystallizes in the form of needles which change to plates at the transition point is based on microscopical evidence, and is in agreement with the views of certain other writers, particularly those of Yannaquis [1] and Katz.[2] There is not general unanimity of opinion on this point, however, and the writer has himself observed that in certain cases no clear-cut change in crystalline form can be observed when specific waxes are cooled under the microscope. In view of these considerations, and since the present paper deals almost solely with the thermometric method of determination of transition points and not with the actual structural changes involved, in future that phase stable immediately below the melting point will be referred to as α and that below the transition point or transition range as the β form.

With an ordinary commercial wax containing a wide range of constituents of different melting points, the transition in crystalline form takes place slowly over a correspondingly wide range of temperature, but as the width of cut is reduced the transition range becomes narrower and more distinct, until for a narrow vacuum-fractionated wax it may be quite marked and precise.

PREVIOUS INVESTIGATIONS ON DETERMINATION OF TRANSITION POINTS IN PARAFFIN WAX.

The presence of a transition point at a temperature about 15° C. below the melting point in a number of waxes has been established by several investigators. Carpenter [3] came to this conclusion as a result of microscopic evidence and a discontinuity in the curve relating the coefficient of expansion of waxes to temperature variation. Yannaquis [1] arrived at the same conclusion by observation of waxes under crossed nicols, and Piper [4] and also Müller [5] by X-ray determinations on pure paraffins and mixtures of paraffins.

Scott-Harley [6] has determined transition points thermometrically.

The experiments described in the present paper have been carried out independently of Scott-Harley's work and prior to the writing of his paper, which has been commented on privately, particularly with regard to (*a*) low thermal capacity of the small quantity of wax used compared with that of the apparatus, and (*b*) interpretation of results.

There is only a small amount of heat evolved at the transition point, but, as the present paper shows, it is possible, by using suitable apparatus and the "inverse rate" method of plotting results, to obtain quite accurate and reliable value thermometrically.

EXPERIMENTAL.

In experiments of the nature considered here, where one is trying to measure the effect of a small heat evolution, it is advisable to choose conditions to show up this effect to best advantage. It is necessary, for instance, to adjust the quantity of substance used so that in determining a cooling curve the substance itself is the controlling factor and the apparatus has the least possible effect; that is why in metallurgical investigations of this sort a relatively large bar of material is used with apparatus of low thermal capacity. Since wax, however, unlike metals, has a low thermal conductivity, and it is inadvisable to have an appreciable temperature gradient throughout the cooling mass, the quantity of wax used in determining a cooling curve must of necessity be very much lower than in the case of metals.

It has been found that the normal I.P.T. Setting-Point apparatus for paraffin wax gives reliable cooling curves from which transition points can be readily ascertained. Accordingly this has been used throughout the present investigation, except that the thermometer has been replaced by a longer standard one graduated in tenths of a degree. With an optical attachment it was possible to read this thermometer to approximately the second place of decimals. Latterly, in experiments not reported, the jacket of the I.P.T. apparatus has been replaced by an open 1-gallon tin $9\frac{1}{2}$ in. × $5\frac{1}{2}$ in. × 5 in. high, fitted with a stirrer for more convenient control of water temperature; this does not affect the results obtained.

In all cases in determining a cooling curve the temperature of the cooling wax has been recorded every half-minute from about 5–10° C. above the melting point to approximately 20° C., the jacket temperature being maintained at $45 \pm 0{\cdot}2°$ F. From the primary cooling curves obtained, inverse rate curves have been plotted and transition points deduced as illustrated in the accompanying curves.

Inverse Rate Curves.

In this method, which has been used very successfully in metallurgical investigations, an ordinary cooling curve is first accurately determined, and the results are then plotted in the form of an inverse rate curve which accentuates any sign of heat evolution. This consists in plotting the time taken for the temperature to fall 1° (derived from the primary cooling curve) against the temperature at which this average time interval occurs, *i.e.*, $\frac{dt}{dT}$ = seconds per degree, against T (temperature). In order to get accurate values of $\frac{dt}{dT}$ it is necessary to plot the primary cooling curve on an open scale, and if the curvature is varying considerably, it is advisable to calculate $\frac{dt}{dT}$ from tangentials at the points in question.

The method can best be followed by reference to the accompanying curves.

In Fig. 1 *ABCDE* represents a primary cooling curve for a sample of commercial stearic acid which has a melting point similar to that of paraffin wax in common use, but no transition point. It was chosen because of this latter fact to illustrate the difference in inverse rate curves between such a substance and those of paraffin waxes in which transition takes place. The portion of the curve *AB* represents the cooling liquid and *BC* the melting or solidification point. For some time after point *C* is reached, however, solidification still takes place, tending to keep up the temperature, but eventually, after solidification is complete, normal cooling results,

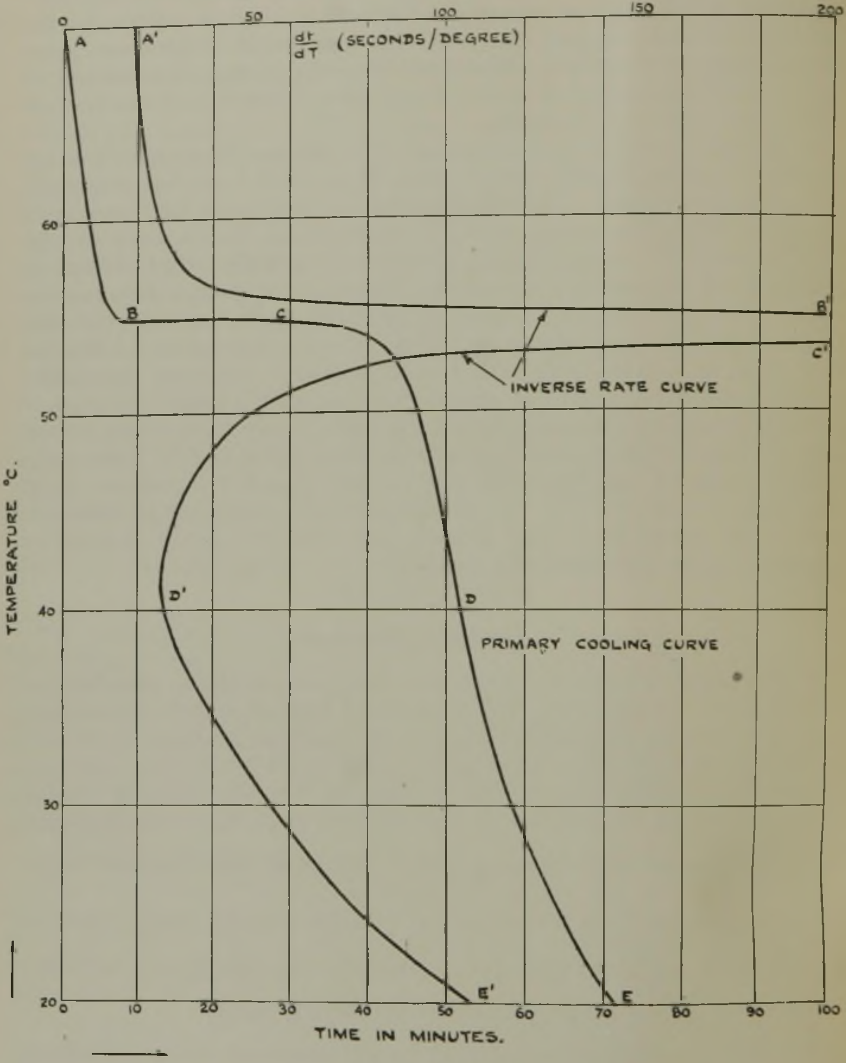

FIG. 1.

COOLING AND INVERSE RATE CURVES FOR COMMERCIAL STEARIC ACID. NO TRANSITION.

giving a curve *DE* with no further sign of heat evolution. As the rate of cooling of the liquid gradually falls along *AB* the function $\frac{dt}{dT}$ increases, as represented by the corresponding portion of the inverse rate curve *A'B'*.

Beyond B' $\frac{dt}{dT}$ increases still further, until at the melting point where dT is 0 it has a value of infinity. The curve $A'B'$ continued therefore approaches infinity, gradually reaching it eventually at the melting point.

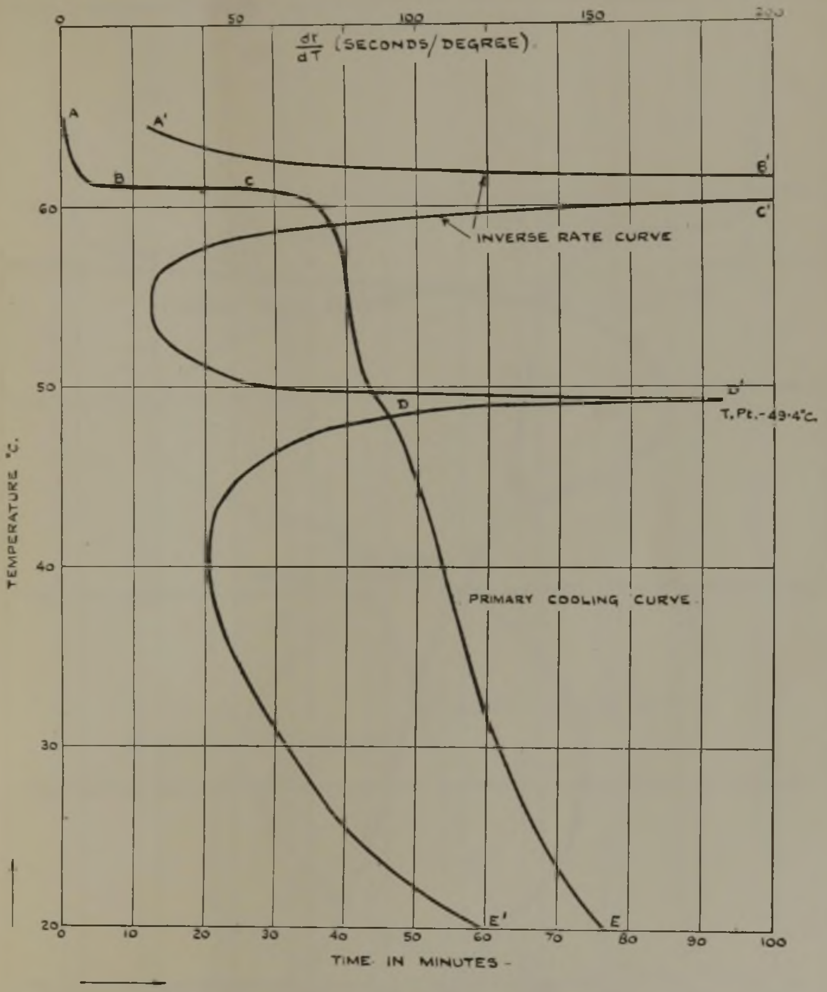

FIG. 2.

COOLING AND INVERSE RATE CURVES FOR NARROW-CUT WAX. SHOWING TRANSITION POINT.

Below the melting point, as the rate of cooling gradually increases the function $\frac{dt}{dT}$ shows a corresponding decrease from infinity to finite values C' and lower. The minimum point D' on the inverse-rate curve corresponds to the maximum rate of cooling D on the primary cooling curve and the gradual increase of $\frac{dt}{dT}$ along $D'E'$ to the reduction in cooling rate along DE. The main point to notice is that for a substance showing no transition point the portion of the inverse rate curve $C'D'E'$ below the melting point is quite smooth and regular, with no indication of abnormal thermal effects.

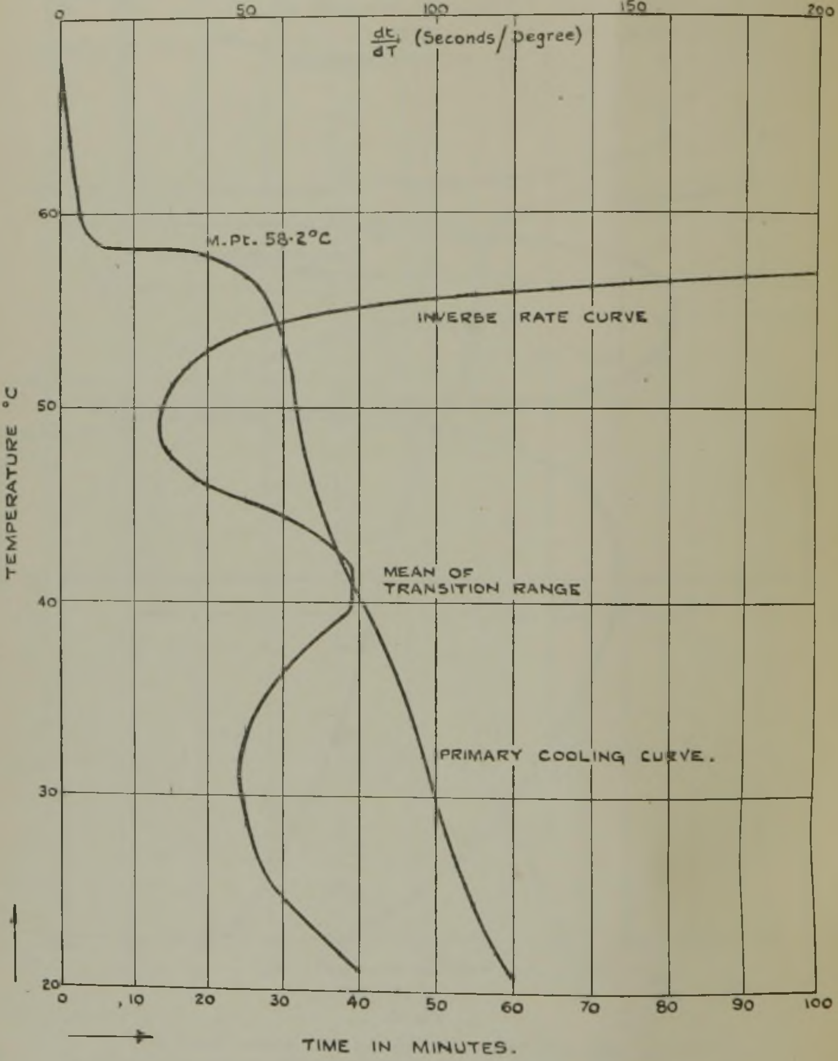

Fig. 3.

COOLING AND INVERSE RATE CURVES FOR 135/40 WAX.

Turning now to Fig. 2 we have similar curves for a relatively close-cut paraffin wax. In the primary cooling curve, after solidification is complete, there is a fairly pronounced kink at the point *D*, due to heat evolution taking place as a result of transition. Although this kink is fairly pronounced, however, it is in no way comparable with the halt at the melting point, and does not afford a precise indication of the actual position of the transition point. This can, however, be determined very satisfactorily from the inverse rate curve. The reduction in cooling rate during tran-

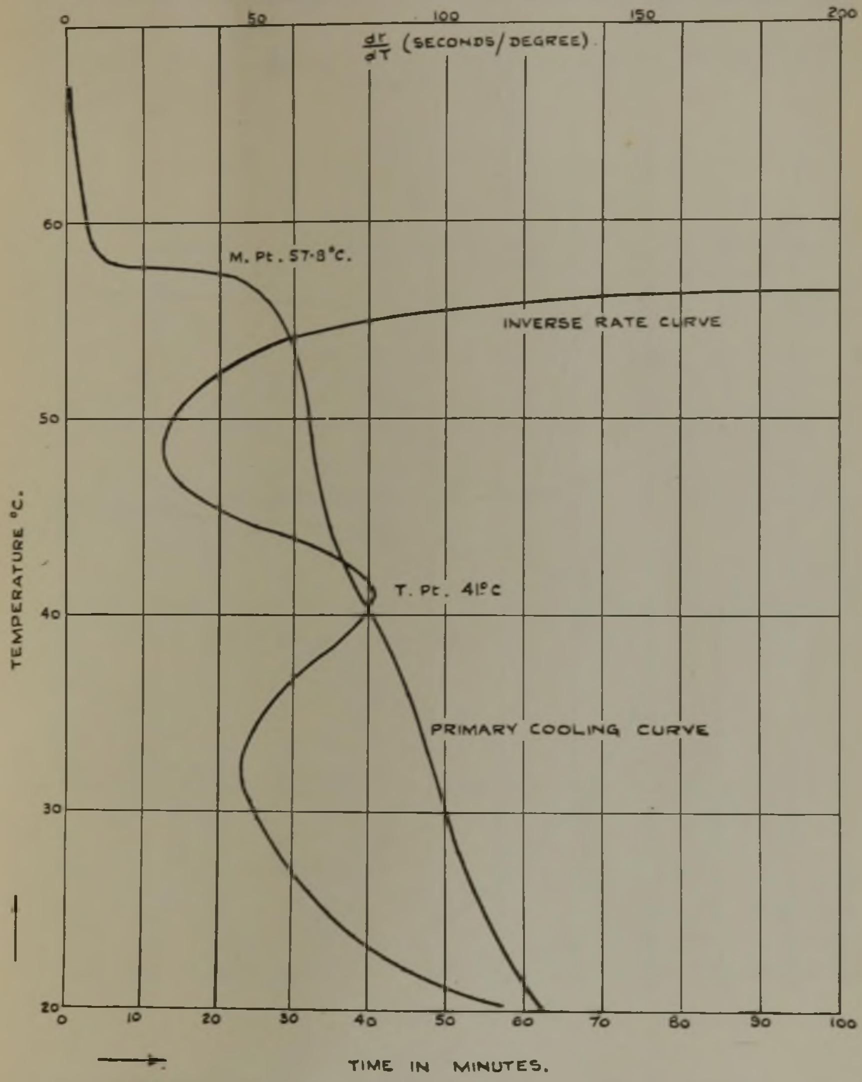

FIG. 4.

COOLING AND INVERSE RATE CURVES FOR 10TH FRACTION FROM SWEATING OF 135/40 WAX.

sition has a very marked effect on the function $\frac{dt}{dT}$, which reaches a sharp maximum value at a point D' corresponding to the lowest rate of cooling, thus enabling the transition point to be determined with precision. It

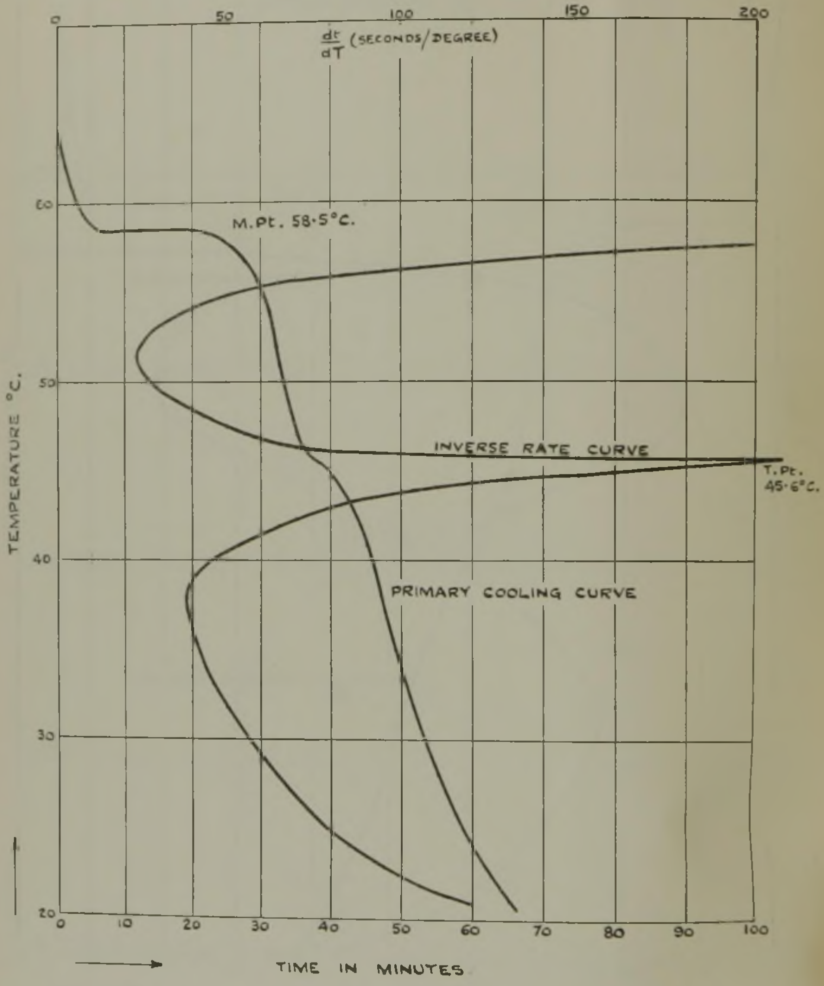

FIG. 5.

COOLING AND INVERSE RATE CURVES FOR 10TH FRACTION FROM VACUUM DISTILLATION OF 135/40 WAX.

will perhaps be as well to stress here that, in a substance like paraffin wax containing a range of constituents of different melting point, transition does not take place at any one particular temperature, but over a range of temperature depending on the number and range in melting point of the constituents present, *i.e.*, the width of cut. The wider cut the wax, the wider will be the transition range, and the narrower the cut of the wax the smaller the range of transition. The transition point D' therefore only strictly represents the mean of the transition range from α to β form of crystals or, more accurately, the point at which the change from α to β results in the greatest evolution of heat. It will be shown later that with wider-cut products than that considered in Fig. 2 it is at times impossible to obtain a precise transition point even with the inverse-rate method of plotting results.

EFFECT OF WIDTH OF CUT ON TRANSITION.

Cooling and inverse rate curves for a normal 135/40 grade wax and 5 per cent. middle-cut fractions of similar melting point to the original, obtained therefrom by (*a*) sweating and (*b*) vacuum distillation, are given in Figs. 3–5. The sweated fraction was obtained in a small efficient laboratory electrically controlled stove, whilst the vacuum-fractionated sample was prepared as follows :—

The apparatus consisted of a 1-litre round-bottomed flask fitted with a glass column, length 12·6 in. and internal diameter 0·9 in., connected to a condenser and vacuum receiver. The column was surrounded by a jacket through which air at 350–370° C. was passed. In order to secure good fractionation two iron spirals were fitted inside the glass column; the large spiral had an inner diameter of 0·83 in. and a pitch of 0·53 in., whilst the smaller spiral placed concentrically along the axis of the column had an inner diameter of 0·23 in. and a pitch of 0·36 in. Great care was taken to maintain the whole apparatus vacuum tight, the absolute pressure being kept below 1 mm. of mercury throughout. The charge consisted of 135/40 wax, and the flask was heated in a lead alloy bath; 5 per cent. fractions were collected.

In Figs. 3–5 only that portion of the inverse rate curve which falls below the melting point is drawn. The curves, which are typical of many others obtained, illustrate how the inverse rate method of plotting accentuates the slight kinks or points of inflection in the normal cooling curves, and enables the transition temperature or mean range of transition to be ascertained accurately. They also show clearly how the transition in a normal marketable white wax takes place gradually over a fairly wide range of temperature, due to the relatively wide range of constituents present; this temperature range is somewhat narrower for the sweated fraction, and narrowest of all for the vacuum fractionated wax containing still fewer individual components.

DISTILLATION *v.* SWEATING.

Complete cooling and inverse-rate curves were plotted and transition points determined for 5 per cent. fractions 1, 5, 10, 15, 19, and 20 prepared by sweating and vacuum distillation from 135/40 white wax, and the results obtained are given in Table I and Fig. 6, which also includes a curve for normal marketable waxes.

The melting-point figures in Table I illustrate the markedly superior fractionating power of vacuum distillation over sweating.

The curves in Fig. 6 show that the differential between melting point and transition point decreases with increase in melting point in all three cases. For a given melting point it is smallest for a vacuum-fractionated wax and greatest for a normal marketable wax. It follows that the differential between melting point and transition point decreases with increase in melting point and with narrowness of cut.

TABLE I.

Vacuum Distillation v. *Sweating of* 135/40 *White Wax.*

Fraction No.	Distillation.			Sweating.		
	M. pt., ° C.	T. pt., ° C.	Diff., ° C.	M. pt., ° C.	T. pt., ° C.	Diff., ° C.
1	47·1	26·0	21·1	54·0	34·3	19·7
5	54·4	38·8	15·6	56·5	38·6	17·9
10	58·5	45·7	12·8	57·8	41·0	16·8
15	62·6	51·3	11·3	59·4	43·8	15·6
19	66·4	57·8	8·6	62·4	49·8	12·6
20	67·3	60·0	7·3	63·1	50·8	12·3

WAX BLENDS.

Data deduced from inverse rate curves for blends of 160 and 125/30 white waxes are given in Table II. The data are of special interest as indicating what happens during the cooling of mixtures of two components of very different melting points, each consisting of a relatively large number of individual compounds.

TABLE II.

Blends of 160 (*H.M.P.*) *and* 125/30 (*L.M.P.*) *White Waxes.*

Per cent. 125/30 in Blend.	M. pt., ° C.	Thermal Points.		
		(1).	(2).	(3).
0	71·4	64·2	—	—
2·5	71·1	64·2	—	—
5	70·6	64·2	—	—
10	69·8	63·4	50 *	—
15	69·1	64·1	50·2	—
25	67·4	63 *	52·5	—
40	64·7	—	54·5	29·0
50	63·5	—	55·6	29·5
60	61·0	—	55·8	29·3
75	57·3	—	55·7	30·5
85	54·4	—	—	31·3
95	52·8	—	—	30·5
100	52·7	—	—	30·7

* Not very distinct.

With the addition of the low-melting-point wax there is a gradual reduction in melting point, but after the 50 per cent. mark is reached the relationship is no longer linear. The high-melting-point component shows a distinct transition point at 64·2° C., and although this transition becomes less distinct with increasing proportions of 125/30 wax, it takes place at approximately the same temperature, finally disappearing when the melting point of the blend is approximately the same as that of the transition point itself. With blends containing 10–75 per cent. of 125/30 wax there is an evolution of heat, represented by thermal point No. 2, at a mean temperature depending on composition, but always near to the true melting point of the low-melting-point constituent. There can be little doubt, in

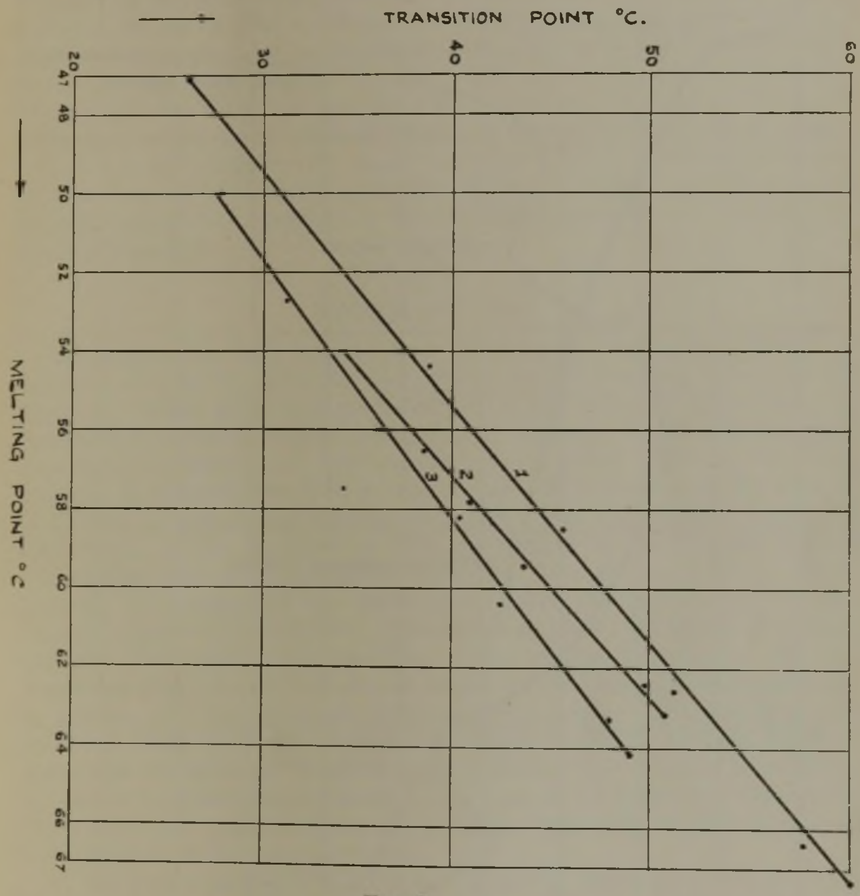

Fig. 6.

RELATIONSHIP BETWEEN MELTING POINTS AND TRANSITION POINTS.

1. Vacuum Fractions From 135/40 White Wax.
2. Sweated Fractions From 135/40 White Wax.
3. Commercial White Waxes.

fact, that this evolution of heat is due to solidification of the low-melting-point constituent, and not to any transition effect. The 125/30 wax solidifying here will not, of course, be pure; it may have lost some constituents and gained others to an extent depending on the original composition, thus accounting for the variation in temperature of thermal point No. 2. It is interesting to note that in three of the blends the high-

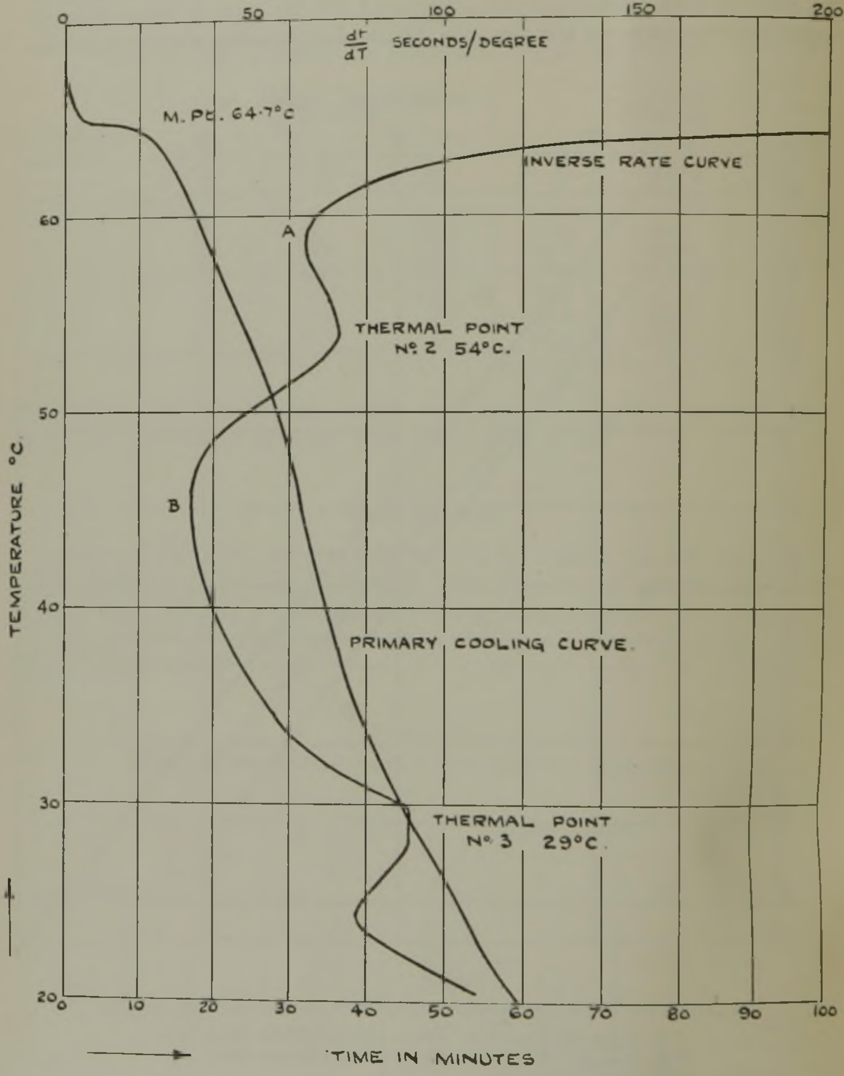

FIG. 7.

COOLING AND INVERSE RATE CURVES FOR 60/40 BLEND OF 160 AND 125/30 WAXES. (REF. TABLE II.)

melting-point component solidifying first, changes from the α to β crystalline form, whilst a portion of the wax is still liquid. For blends containing 40 per cent. or more of low-melting-point wax there is a thermal point No. 3 which gradually increases in intensity, and always takes place approximately at the true transition point of the 125/30 component which it represents.

Cooling and inverse rate curves, typical of the others obtained, are given in Fig. 7 for the 60/40 blend of 160 and 125/30 waxes. The primary cooling curve shows the original melting point distinctly, and two further signs of heat evolution which are accentuated admirably in the inverse rate curve. Since the minimum point *A* is considerably higher than *B*, *i.e.*, the rate of cooling at the higher temperature *A* is lower than at *B*, it appears probable that once solidification starts it carries on continuously to about 50° C., but it is more marked at 54° C., the maximum point on the inverse rate curve, than at temperatures slightly higher or lower than this value. Thermal point No. 3 represents the transition point of the low-melting-point component.

Mottling in Wax.

The appearance of a cake of wax, particularly when pan-moulded, is often spoiled by the presence of mottling, and it has long been realized that the effect is intimately connected with the presence of air in wax and increases to a marked degree with rising oil content. Further, it has been repeatedly demonstrated that mottling never takes place in the total absence of dissolved air even if considerable oil is present in the wax.

If wax is melted and allowed to solidify and cool slowly under the microscope, it can be observed that segregation of air into the crystal boundaries takes place during the transition from the α to the β type of crystal. It is suggested that immediately below the melting point a wax contains appreciable quantities of occluded air, with intrusions of oil and possibly low-melting-point paraffins in the crystal boundaries. At the transition point the crystals change to the β form, and simultaneously air is thrown into the intrusions between the crystals. This produces the mottling effect due to the difference in refractive indices between the wax mass and the intrusions containing air bubbles. The absence of mottling in waxes containing considerable proportions of oil without dissolved air is probably due to the fact that the refractive indices of the wax mass and oil intrusions in this case are similar.

It has been observed that a number of waxes, when quenched in water at about 15° C. from just below the melting point, are at first quite translucent, but after a few hours mottling appears, and gradually increases in intensity with time. This gradual mottling can be readily explained on the above views. These waxes which are quenched from a temperature immediately below the melting point exist at first in the α form. Since the room temperature of approximately 15° C. is well below the transition point, the change to the β form will be restricted. It will, however, take place slowly, accompanied by a very gradual liberation of air and a consequent parallel increase in the mottling effect with time.

It is fully realized that the actual crystal size will affect the degree of mottling, and it may well be that the action of a dope such as stearin in preventing mottling is to break down the crystalline structure. Alternatively it may reduce the solubility of air in the α modification of the wax.

It has been suggested that the strain in a wax cake due to unequal contraction on cooling produces mottling. If this were the case mottling should take place in the absence of air. It appears more likely that the strain produced in a wax cake, either as a result of unequal contractions in different places or due to the change in coefficient of expansion at the transition point, gives rise to the presence of definite cracks which usually extend to the surface. These cracks should not be confused with the mottling effect.

The author desires to express his thanks to the Directors of The Burmah Oil Co., Ltd., for permission to present this paper for publication.

References.

[1] Yannaquis, *Ann. Comb. Liquides*, May–June 1933, **8** (3), 486.
[2] Katz, *J. Instn Petrol. Tech.*, 1932, **18**, 37.
[3] Carpenter, *ibid.*, 1926, **12**, 288.
[4] Piper, *Biochem. J.*, 1931, **25**, 2072–2094.
[5] Muller, *J. Chem. Soc.*, 1925, **127**, 599.
[6] Scott-Harley, *J. Inst. Pet.*, 1939, **25**, 238–251.

ANALYSIS OF OIL–WAX MIXTURES.*

By H. D. Lord, Ph.D.

Synopsis.

The estimation of oil in oil–wax mixtures by the "Press Method" is not very accurate, and, as the A.S.T.M. book states, "The expressible oil and moisture content does not bear a direct relation to the actual oil content of a given sample of paraffin wax."

In the present report it is shown that a more accurate estimation of oil content, and therefore a closer control of refinery pressing and sweating operations, can be obtained by any one of the three methods developed involving measurement of :—

(*a*) Specific gravity at 65° C.
(*b*) Aniline point.
(*c*) Refractive index at 60° C.

The gravity method is perhaps the simplest and most convenient to carry out, and probably represents the best method for routine testing of scales and sweated fractions; it is sufficiently accurate as a control test, giving results to within ± 0·8 per cent. oil.

The refractive-index method is the most accurate of all, giving results to within ± 0·5 per cent. oil, and if an Abbé or other suitable refractometer is available, it can be used conveniently. It is perhaps best suited to research or investigational work where the highest order of accuracy possible is desired.

The methods are, of course, applicable only to scales containing more than, say, 2 per cent. oil as an absolute minimum, and cannot be used for the estimation of oil in finished waxes.

In the large-scale distillation of most crude oils an intermediate fraction preceding residuum is collected, known as H. O. and P. (Heavy Oil and Paraffin), which consists of a mixture of lubricating-oil base (Blue Oil) and crystalline paraffin wax. The paraffin in this fraction is usually removed in two or three stages in special presses, yielding scales of different setting points and still containing appreciable quantities of oil, plus a Blue Oil of relatively low set point, suitable for production of lubricating oils. The scales obtained are then subjected to a sweating operation which, irrespective of equipment used, consists essentially in cooling the molten scale to a solid state and then supplying heat gradually, whereby oil and low-melting-point paraffins are removed selectively, and eventually wax of suitable quality, after earth treatment, is produced. This procedure invariably involves re-cycling and re-sweating of a number of intermediate, or even first residue cuts; and a knowledge of the quality, particularly the oil content, of the primary scales and these intermediate cuts is of great importance if a close check is to be kept on refinery operation.

It is the purpose of this paper to demonstrate how methods have been developed by means of which a very close control of pressing and sweating operations can be maintained.

The paraffin in the H. O. and P. fraction of Burma crude is separated in four stages, and mean characteristics of the first two scales obtained are as follows :—

	M. Pt., ° F.	Tint 1 in. Cell.	Oil Content, % by wt.
First Scale	133·5	12/-	9–10
Second Scale	114	20/-	14

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* Paper received 10th February, 1939.

It is possible to obtain an approximate measure of the oil content of these scales and the cuts therefrom by the I.P.T. "Press Method" (P.S. 43). This is a method which has been accepted by the trade for many years, but is admittedly not scientifically accurate. It is of little value as a control test. Accordingly the following methods were developed, depending on the determination of :—

(*a*) Specific gravity.
(*b*) Aniline point.
(*c*) Refractive index.

EXPERIMENTAL.

It was necessary to treat each scale separately, and in the first place the scale was resolved into oil-free wax and oil of 40° F. setting point (equal to that of ordinary Blue Oil), by extraction with ethylene dichloride. Blends of the oil-free wax and the Blue Oil were then prepared, and the gravity, aniline point, and refractive index determined.

OIL CONTENT IN TERMS OF SPECIFIC GRAVITY AT 65° C.

Oil-content determination in terms of specific gravity at 65° C. was first suggested and employed by S. T. Minchin as a means of control of the more oily fractions involved in paraffin production. The development and present application of the method are described in this section.

Determination of the specific gravity of an oil–wax mixture in the liquid state by means of a hydrometer is a particularly easy and rapid operation. In the present experiments the mixture was placed in a wide tube 7 in. long and 1½ in. diameter maintained at 65° C. in a thermostat, and the gravity determined; the above temperature was chosen as being high enough to ensure that all samples tested would be in the molten state.

The results obtained are given in Table I.

The values up to 40 per cent. oil are represented graphically in Fig. 1, and the relationship between gravity and oil content over this range is

TABLE I.

Oil Content in Terms of Specific Gravity at 65° C.

Oil, % by wt.	Specific Gravity at 65° C.	
	First Scale.	Second Scale.
0	0·7800	0·7750
2·5	0·7820	0·7770
5·0	0·7850	0·7800
7·5	0·7875	0·7825
10·0	0·7900	0·7860
15·0	0·7950	0·7910
20·0	0·8000	0·7965
30·0	0·8090	0·8060
40·0	0·8200	0·8180
60·0	0·8430	0·8410
80·0	0·8660	0·8650
100·0	0·8915	0·8915

linear. The accuracy of the method is indicated by the maximum distance of any one point from the straight lines drawn, and it will be seen that it is possible to estimate the oil content of a scale to within ±0·8 per cent.; it is probably the best method of all for routine testing in controlling refinery operations. It can, of course, only be used for scales containing more than, say, 2 per cent. oil, and is not sensitive enough for the estimation of oil in finished waxes.

The method can be applied to oil–wax mixtures other than first and second scales, as the following considerations will show. The slopes of the lines in Fig. 1 are similar, and the oil content can be determined approximately by equation 1.

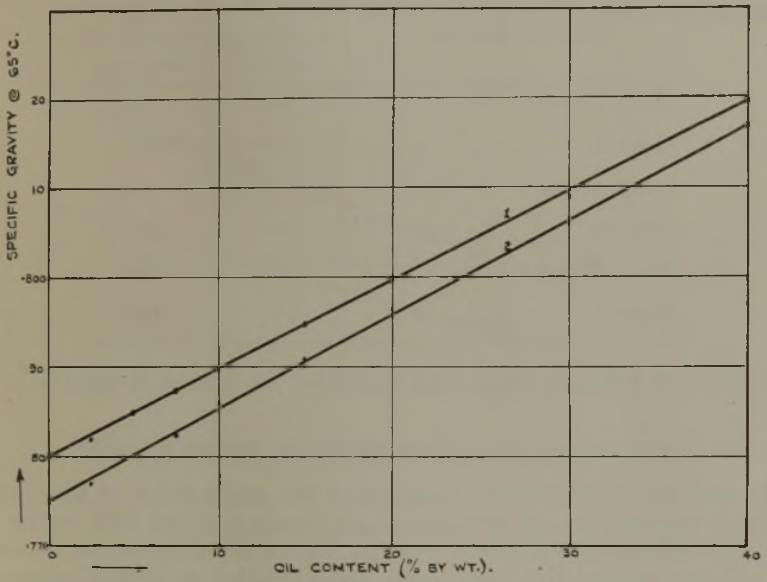


Fig. 1.

OIL CONTENT IN TERMS OF SP. GR. AT 65° C.

1. 1st Scale.
2. 2nd Scale.

$$\text{Oil, \% by wt.} = 976\,(S_x - S_o) \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where S_x = specific gravity at 65° C. of oil–wax mixture
S_o = specific gravity at 65° C. of oil-free wax in mixture.

The value of S_o can be determined from equation (2) if the melting of the wax in the oil–wax mixture is known approximately,

$$S_o = 0{\cdot}775 + (Mo - 120)\,0{\cdot}0003 \quad . \quad . \quad . \quad . \quad (2)$$

where S_o= specific gravity of oil-free wax.
M_o= melting point ° F. of oil-free wax.

The oil content of the mixture can therefore be calculated from its gravity if the melting point of the oil-free wax in the mixture is known approximately.

In order to test the accuracy of equation 1, a number of oil–wax mixtures of known oil content were prepared from commercial grades of Burma waxes and Blue Oil. The gravities were determined and the percentage of added oil calculated according to the equation. The results obtained are given in Table II.

TABLE II.

Agreement between Actual and Estimated Oil Contents from Specific Gravity Data.

Oil–Wax Mixture.	Oil, % by wt.	
	Added.	Calculated.
B.O.C. 125/30 + Blue Oil	10·0	9·9
	20·0	20·7
B.O.C. 130/35 + Blue Oil	5·0	4·6
	10·0	10·4
B.O.C. 135/40 + Blue Oil	10·0	10·4
	15·0	15·2

Agreement between actual and calculated oil content is quite good.

OIL CONTENT FROM ANILINE POINT DETERMINATIONS.

Various investigators have made use of the aniline point, or the critical solution temperature, of mixtures of petroleum products with aniline, in order to estimate the aromatic content, but as far as the author is aware no one has applied this method to the evaluation of oil–wax mixtures. The method appeared quite suitable for the estimation of oil in scales,

TABLE III.

Oil Content in Terms of Aniline Point.

Oil, % by wt.	Aniline Point, ° C.	
	First Scale.	Second Scale.
0	119·4	113·3
2·5	118·3	112·8
5·0	117·8	112·2
7·5	117·2	111·1
10·0	115·8	110·6
15·0	113·9	109·4
20·0	112·8	107·8
30·0	108·9	105·4
40·0	104·4	101·5
60·0	96·1	92·8
80·0	85·6	83·3
100	71·7	71·7

however, and it was accordingly studied at the suggestion of G. R. Nixon, together with the specific gravity and refractive index methods.

A quantity of the oil–wax mixture (approximately 5 gm.) was weighed accurately into a boiling tube and an equal quantity by volume of freshly distilled aniline added. The mixture was heated in a glycerine bath until homogeneous and clear, removed from the bath and stirred vigorously, and the temperature taken when the bulb of the thermometer became invisible. This process was repeated and the mean of the first three readings taken as the " aniline point." The individual readings never varied by more than 0·2° C.

The results obtained are given in Table III, and values up to 40 per cent. oil are represented in Fig. 2.

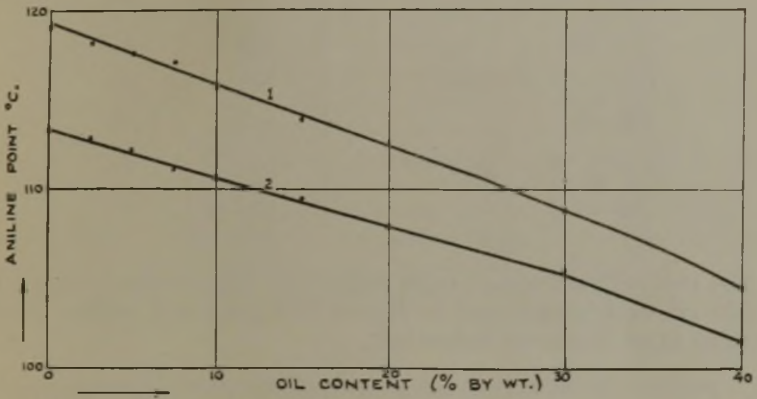


Fig. 2.

OIL CONTENT FROM ANILINE POINT.

1. 1st Scale.
2. 2nd Scale.

Over the range 0–30 per cent. oil the relationship between aniline point and oil content for both scales is linear and the lines are of similar slope. From the mean slope of these lines equation (3) has been deduced.

$$\text{Oil content (\% by wt.)} = 2{\cdot}97\,(A_o - A_x) \quad . \quad . \quad . \quad (3)$$

where A_o = aniline point ° C. of oil-free wax.

A_x = aniline point ° C. of oil–wax mixture.

It applies, of course, only for mixtures containing up to 30 per cent. oil.

In order to test the accuracy of equation 1 a number of oil–wax mixtures of known oil content were prepared from commercial grade Burma waxes and Blue Oil. The aniline points were determined and the percentage of added oil was calculated according to the equation. The results obtained are given in Table IV.

Agreement is quite good, and the method could probably be applied with success to routine testing. It requires only a very small quantity of scale, but this is not usually of importance, and as it possesses no other advantages above the gravity method previously described, the earlier method is presumably to be preferred in all cases.

The variation in aniline point with melting point of a wax is illustrated in Fig. 3. The relationship is linear and can be expressed by the following equation :

$$\text{Aniline Point} \,{}^\circ\text{C.} = 0{\cdot}319 \times \text{Melting Point} \,{}^\circ\text{F.} + 75{\cdot}6 \quad . \quad . \quad (4)$$

TABLE IV.

Agreement between Actual and Estimated Oil Contents from Aniline Point Data.

Oil–Wax Mixture.	Oil, % by wt.	
	Added.	Estimated.
B.O.C. M. pt. 127·8° F. .	5·0	5·4
+ Blue Oil	15·0	14·7
B.O.C. M. pt. 133·4° F. .	10·0	10·6
+ Blue Oil	20·0	21·3
B.O.C. M. pt. 138·4° F. .	10·0	9·6
+ Blue Oil	15·0	14·6

The two different temperature scales have been retained, since aniline points are usually expressed in degrees Centigrade and melting points of paraffin waxes in degrees Fahrenheit.

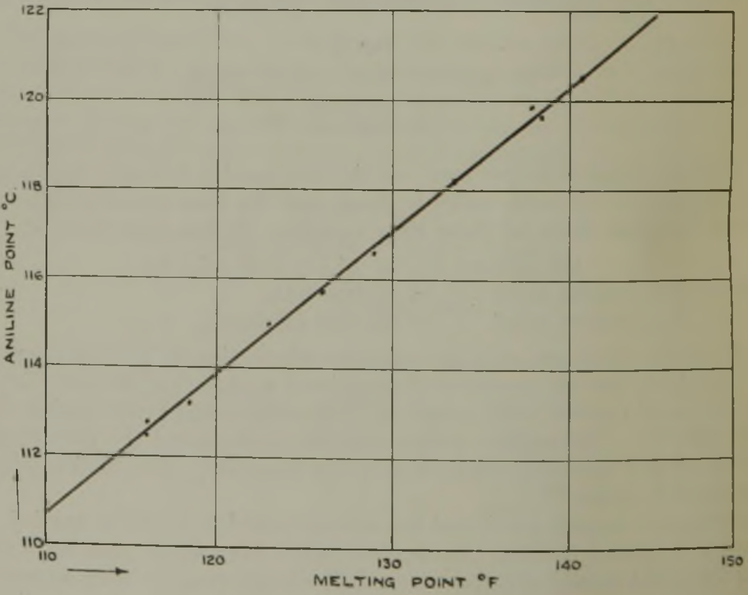


FIG. 3.

VARIATION IN ANILINE POINT WITH MELTING POINT OF PARAFFIN WAX.

OIL CONTENT IN TERMS OF REFRACTIVE INDEX AT 60° C.

Various investigators have suggested methods for the determination of oil in scales from refractive index data. Wilson and Wilkin [1] used ethylene dichloride to separate the oil from the wax, and estimated the oil in the filtrate after distilling off the ethylene dichloride and adding a known weight of oil of known refractive index. The method is rather laborious. Diggs and Buchler [2] used a direct refractometer method, but prepared so-called oils from waxes by filtration through clay. Piotrowski and Winkler [3] used a similar method, and assumed that after filtration of 10 gm. of scale through 5 gm. of Terrana earth at 80° C., the first few drops of the filtrate were oil-free. It will be shown later that the waxes in both cases probably contained oil.

In view of the above considerations, it seemed worth while to investigate the method further. Accordingly the refractive indices of the oil–wax mixtures described earlier in this paper were determined at 60° C. using an Abbé refractometer. It was possible to read this instrument to the fourth decimal place and to maintain the temperature constant to within 0·2° C. A temperature of 60° C. was chosen as being high enough to maintain any scale in the liquid state. In the case of finished waxes of melting point higher than 60° C. the refractive index was measured at 62° C. and the result corrected to 60° C. using a coefficient of 0·0004/° C. This coefficient was obtained for a number of waxes and for the Blue Oil used.

The results obtained are given in Table V.

TABLE V.

Oil Content in Terms of Refractive Index at 60° C.

Oil, % by wt.	Refractive Index at 60° C.	
	First Scale.	Second Scale.
0	1·4370	1·4348
2·5	1·4383	1·4359
5·0	1·4394	1·4373
7·5	1·4410	1·4388
10·0	1·4425	1·4404
15·0	1·4455	1·4434
20·0	1·4485	1·4463
30·0	1·4547	1·4529
40·0	1·4608	1·4594
60·0	1·4740	1·4727
80·0	1·4880	1·4870
100	1·5029	1·5029

The values up to 40 per cent. oil are represented in Fig. 4, and it will be seen that it is possible to estimate the oil in either scale to within ±0·5 per cent. by this method.

The curves in Fig. 4 do not depart far from a linear relationship, and the slope decreases slightly with increase in melting point. The variation in refractive index with the melting point of the wax constituent is very small compared with that due to the oil present, and this is an important practical result, since it implies that the method can be used with success for the evaluation of oil–wax mixtures and will not depend greatly on the melting point or width of cut of the wax in the mixture.

For mixtures containing from 5 to 40 per cent. oil the following equation can be deduced from the curves in Fig. 4.

$$\text{Oil content (\% by wt.)} = 1635\,\{\mu_x - (\mu_o - 0{\cdot}0007)\} \quad . \quad (5)$$

where μ_o = refractive index at 60° C. of oil-free wax.
μ_x = refractive index at 60° C. of oil–wax mixture.

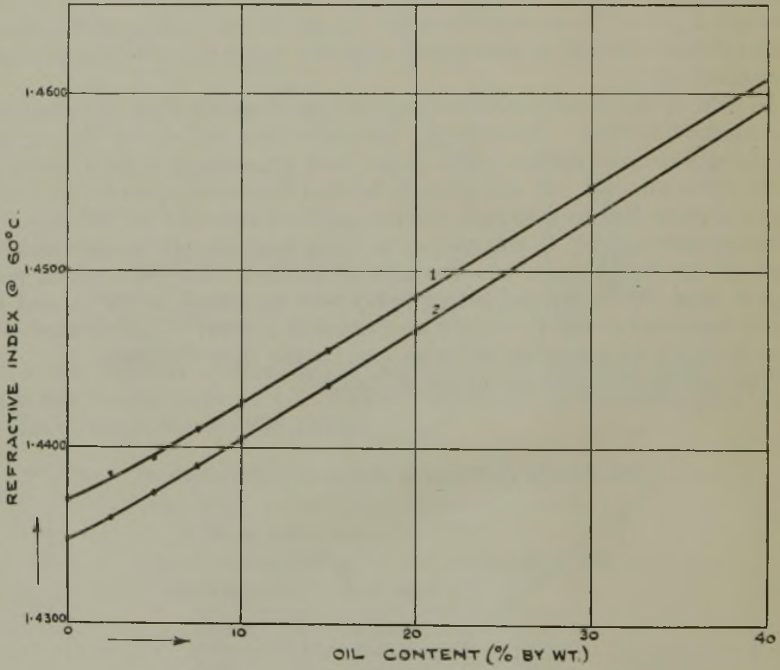


Fig. 4.

OIL CONTENT FROM REFRACTIVE INDEX.

1. 1st Scale.
2. 2nd Scale.

In order to test the accuracy of this expression, a number of oil–wax mixtures were prepared from commercial Burma waxes, the refractive index was determined at 60° C., and the percentage oil in the mixture calculated according to equation 5. The results obtained are given in Table VI.

Agreement between calculated and actual percentage of oil is very satisfactory. This is again more significant when it is remembered that the equation was deduced from figures for specially prepared waxes, whilst the values in Table VI apply to mixtures containing commercial waxes which have not received special treatment and are of different width of cut.

It is necessary in applying this method to know the refractive index of the oil-free wax in the mixture, and, if a very accurate value is desired, the wax can be separated by solvent extraction with ethylene dichloride, butanone, or alcohol–ether mixture. From a practical standpoint, however, it is desired to emphasize again that the refractive index of a wax varies only slightly with melting point, and therefore a sufficiently accurate evaluation of an oil–wax mixture can be obtained if the melting point of the wax in the scale is known approximately.

In normal refinery operations the wax present in any given scale does not vary much from time to time, and it is only necessary to separate this constituent for test at periodic intervals by, say, solvent extraction. Alternatively, it can be separated by laboratory pressing or filtration through earth, its melting point taken, and the refractive index read off from Fig. 5. Since the lowering in melting point of a wax due to oil is only approximately 1° F. for 5 per cent. oil, it follows that the small quantity of oil left in the wax by this procedure does not affect the result materially.

TABLE VI.

Agreement between Actual and Estimated Oil Contents from Refractive Index Data.

Oil–Wax Mixture.	Oil, % by wt.	
	Added.	Estimated.
B.O.C. M. pt. 113·9° F.	10·0	10·2
+ Blue Oil	20·0	20·4
B.O.C. M. pt. 127·8° F.	10·0	10·2
+ Blue Oil	15·0	14·9
B.O.C. M. pt. 133·4° F.	10·0	9·5
+ Blue Oil	20·0	19·5
B.O.C. M. pt. 138·5° F.	5·0	5·3
+ Blue Oil	15·0	15·6

In connection with filtration through earth or clay, which is the method used by Diggs and Buchler [2] to obtain oil-free waxes, it should be pointed out that this procedure almost certainly leaves appreciable quantities of oil in the wax. In order to test this, two oil–wax mixtures containing respectively 15 per cent. and 20 per cent. oil were filtered through fuller's earth at 100° C. The first three drops of wax to filter were collected separately in each case, and this represented a treatment of 500 lb./gall. of earth. Although the waxes were colourless they contained according to equation 5 approximately 4 per cent. oil in each case. Furthermore, the next fractions to filter, representing a treatment of 60–70 lb./gall., had the same refractive index as the first three drops corresponding to the same oil content. It therefore appears that this is the limit of oil removal by this method, and it is likely that filtration through other absorbent media will have a similar effect. Diggs and Buchler assumed that because the refractive index of a wax attained a constant value on repeated filtration through clay it was oil-free. It appears more probable that, as in the cases cited above, the limit of oil removal had been reached and the wax still contained oil.

In conclusion, it is considered that the method of evaluation of oil–wax mixtures suggested in this section is preferable to any other for the estimation of the oil content of scales in research or investigational work. The method is easy and rapid, and gives results to within ±0·5 per cent. oil. Further, only two to three drops of the liquid mixture are required. In view of this fact it is extremely important, however, to pay particular attention to sampling. The mixture should be melted and well stirred before removing two or three drops for test. The method is not sensitive enough to be applied to finished waxes.

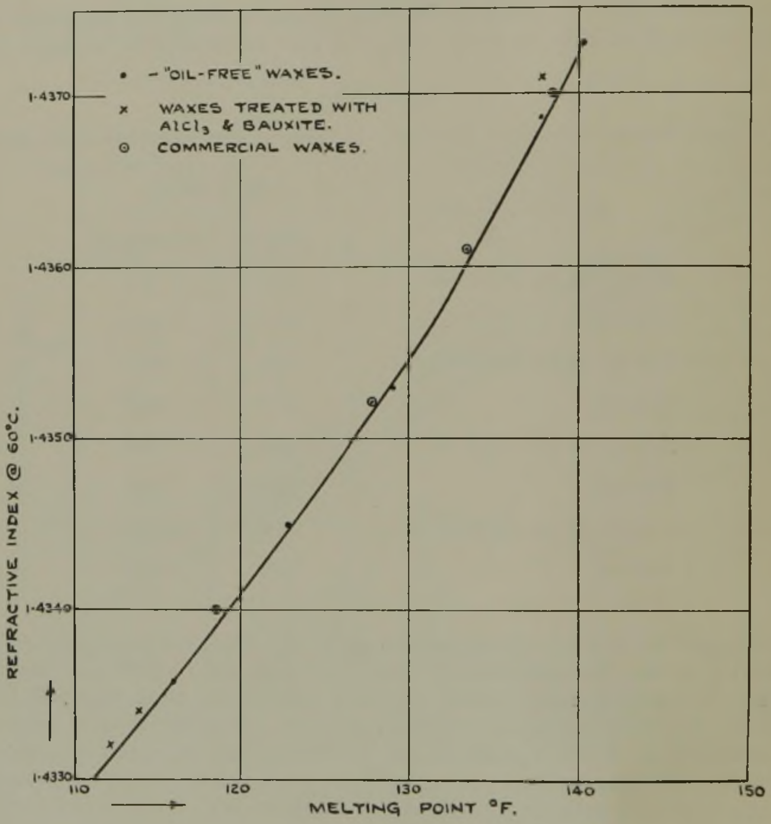


FIG. 5.

VARIATION IN REFRACTIVE INDEX AT 60° C. WITH MELTING POINT OF PARAFFIN WAX.

GENERAL CONCLUSIONS.

It is suggested that all three methods of estimation of oil in scales given in this report are more convenient, satisfactory, and accurate than the Press Method ref. I.P.T. Serial Designation P.S. 43 and A.S.T.M. D.308–29 T. This latter method, in fact, as the A.S.T.M. book suggests, gives results for expressible oil and moisture which do not bear a direct relation to the actual oil content of a given sample of paraffin wax.

The gravity method is probably the simplest and most convenient of all to carry out, and from that point of view it is the most suitable for routine testing of refinery scales and sweated fractions. It certainly does keep a good check on processing of H. O. and P. and normal sweating operations, and is sufficiently accurate for the purpose. If an Abbé or other suitable refractometer is available the Refractive Index method can be used conveniently, and is the most accurate of all. It is perhaps best suited to research and general investigational work where the highest order of accuracy possible is desired.

The methods are, of course, applicable only to scales containing more than, say, 2 per cent. oil as an absolute minimum, and cannot be used for estimation of oil in finished waxes.

The thanks of the author are due to the Burmah Oil Co., Ltd., for permission for the publication of this paper.

References.

[1] R. E. Wilson and R. E. Wilkin, *J. Instn chem. Eng.*, 1924, **16**, 9–12.
[2] Diggs and Buchler, *ibid.*, 1927, **19**, 125–127.
[3] Piotrowski and Winkler, *Erdöl und Teer*, 1930, **6**, 463–465; *J. Instn Petrol. Tech.*, 1930, 448A.

ROUMANIAN BRANCH.

TWELFTH ANNUAL DINNER.

The Twelfth Annual Dinner of the Roumanian Branch of the Institute of Petroleum was held at the Colonade Restaurant, Bucharest, on the 14th January, 1939. The Chairman, Mr. I. S. Rutherford, occupied the Chair and eighty-five members and visitors were present. After the toast of H.M. the King of Roumania, proposed by the Chairman, Mr. D. I. Maxwell proposed the toast of " The Petroleum Industry of Roumania."

Mr. Maxwell said :

The Petroleum Industry of Roumania.

In proposing this toast, it has been the custom to review briefly the progress made in the industry during the past year and to estimate the probable trends in the various branches. Beginning with the source of the raw material, I shall refer to each branch in its order of sequence.

Upon examining the production rate of crude oil, we find that in 1938 a total of 6,600,000 tons were produced, compared with 7,153,000 in 1937, which represents a drop of 550,000 tons, or 8 per cent. This decrease in production added to that of 1937 below 1936 shows a reduction of 2,104,000 tons, or 24·2 per cent. for the past two years.

With the drop in production there has been a decrease in drilling activity. The total meters drilled in 1938 amounted to 293,000, compared with 389,000 in 1937, a decrease of 24 per cent. Although a number of factors were responsible for the decreased drilling, the two principal ones were the cessation of work in the Bucşani field and the formation of unit agreements reducing competitive drilling. During 1937 there was much competitive drilling in the Bucşani, Moreni, Piscuri, and Boldeşti fields. Thus, excluding the Bucşani field from the comparison, we obtain a net reduction of 14 per cent. in drilling activity and an 8 per cent. drop in crude production for 1938 under 1937.

The seriousness of the situation is evident to all, because no major discoveries were made during the year, and it means that reserves are being drilled up. This condition will, in a few years, unless new discoveries are made, further decrease Roumania's influence in the world petroleum market. Their present share, 2·43 per cent., small though it may be, is of vital importance to Roumania, because the industry in 1937 exported products in an amount equivalent in value to 40·6 per cent. of the total exports, and contributed in taxes, royalties, etc., seven thousand million lei to the State, equal to 29 per cent. of the National Budget.

Of the various fields there are only two major increases in production—namely, Baicoi-Tintea with 360,000 tons and Ceptura with 335,000 tons. The greatest decreases among the major fields occurred in Bucşani, Boldeşti, and Moreni. Ceptura, which showed an increase over the previous year, is expected to show a decrease in 1939. Baicoi-Tintea, however, will continue to expand. Although the overall decrease in Roumanian production was only 8 per cent., this decrease would have been considerably greater without the increases in the Ceptura and Baicoi-Tintea fields.

Of the some thirty-five Roumanian fields or areas, the most important remain, with the exception of Bucşani, the same as those of last year. Those which during 1938 made over 535,000 tons are West Gura Ocniţei, Moreni, Baicoi-Tintea, Boldeşti, and Ceptura. Ceptura began to come into prominence during 1937 due to drilling on the North flank, but at present the most favourable areas have been drilled up, and the field will consequently begin to decline. At Tintea the Meotic development is still extending the productive area, and the field will assume an even more important position during 1939.

With the exception of Tintea, extensions in other fields contributed a negligible amount to the country's production.

As mentioned before, no major discoveries were made during 1938. The most important, however, would appear to be the well now testing at Magurele, but it does not seem likely that a major field will result. The results of the 1938 exploratory drilling are rather disappointing, since a total of ten wildcats were drilled in areas of known structure.

In viewing the region within which development has concentrated during the past year, we can see little prospect of opening new fields of importance or, with the exception of Baicoi-Tintea, greatly extending the present ones. We believe that it is the consensus of opinion that other regions of Roumania will have to be explored in order to find additional large fields.

Before the long and expensive search for this oil may be commenced, it is necessary that there be State land grants under conditions where the profit possibilities will justify the risks involved. Towards this end the mining laws are being revised, and are expected to come into force during the early part of 1939. At the request of the State, the oil companies submitted their recommendations for revision of the present mining laws, and a commendable spirit of co-operation among the companies, and between the companies and the State, has been shown.

When the new mining laws come into effect, we predict that Roumania will experience a new area of development; but this, of course, will have to be accompanied by a great amount of geophysical work and exploratory drilling and, consequently, will represent an enormous investment on the part of the companies.

During the year several very notable steps towards co-operation between the companies were carried out through conservation agreements and the formation of unit areas of pooling. Among these we might mention Ceptura North flank and Tintea pro-rating agreements, and the exploration agreement in the Malaeşti area; but the most important is the Tintea-Glieşti pooling agreement, since it paves the way for further unit areas of this type and will do much towards eliminating wasteful competitive operations and result in greatly conserving the country's resources.

Natural Gas.

In the natural-gas division of the industry there has been but little progress made in the past year for the utilization of this natural resource. The production of natural gasoline amounted to 306,446 tons in 1937 and approximately 275,000 in 1938. As the estimated total capacity of the gasoline recovery plants amounts to 650,000 tons per year, we observe that the plants were being operated at 42·5 per cent. rating. Gas blown to the air is estimated at 513,000,000 cu.m. equivalent to 500,000 tons of fuel. This waste is being permitted to continue in spite of the fact that wood and other fuels for domestic heating are increasing in price. Several gas-line projects have been proposed, but nothing tangible has yet been developed.

CRUDE OIL.

From a manufacturing standpoint the crude oil produced in Roumania is of exceptional quality, in that it averages about 0·850 density and is low in sulphur. The crude-oil quality may be roughly divided into two grades, non-paraffinous and paraffinous. The non-paraffinous, approximately 15 per cent. of the total production, is the source of the high-octane naphtha, tractor fuels, low pour-point gas and fuel oils, lubricating oils, asphalt and naphthenic acids. Primarily because of its low pour characteristics and the low quantities produced, this type of crude demands a price approximately 10 per cent. higher than paraffinous. The Roumanian non-paraffinous crude presents no unusual refining difficulties.

For the paraffinous crude, however, adequate heated storage must be provided to handle the high pour stocks, and in the past two years the increasing salt content has presented problems in salt removal, corrosion, and sediment in the residue. The products obtained from this type of crude with the usual refinery equipment cannot compete in the open market because of inferior quality, with special emphasis on octane and pour. The quality can be improved only by the installation of expensive refining processes, such as viscosity breaking, reforming, and solvent treating units.

REFINING INDUSTRY.

The crude refining capacity of Roumania is estimated at 11,657,000 tons per year, which is 176 per cent. more than the present production. Installed cracking capacity amounts to 1,800,000 tons per year, which is approximately 67 per cent. of the capacity required to obtain the most economical gasoline to fuel oil ratio.

For the production of high octane naphthas, 70 plus, there is less than 1000 tons capacity per day available. Eventually, in order to meet the demand for 70/72 clear octane naphthas, the refineries will be compelled to instal one of the modern thermal or catalytic cracking units. In the meantime the European consumers should be educated to the use of leaded gasolines; if this can be done successfully large expenditures on cracking equipment can be postponed.

At the present time no high viscosity index lubricating oils are produced from 100 per cent. Roumanian crude. Oils with a good viscosity index are to be found on the market, but they are either imported, or blends of imported with Roumanian oils. The factors responsible for this situation are: low consumption of motor oils, lack of good lubricating oil crudes, and no solvent treating units. It is true that good motor oils can be manufactured from Roumanian crude, but the enormous investment required cannot be justified economically.

As many of you doubtless know, the manufacturing end of the Petroleum Industry is rapidly developing into a chemical industry. The former simple distillation and cracking operations are fast becoming the initial steps in chemical processes that utilize the accumulated knowledge of physics and chemistry in their operation. The research worker has been able by means of catalysis, synthesis, and solvent extraction to develop processes that are commercially applicable. Among the more recent developments are catalytic cracking, thermal and catalytic polymerization of gases, polymerization of unsaturates with sulphuric acid, known commercially as the hot and cold acid contact processes, and alkylation. These processes produce superior motor fuels.

In the field of synthetic organic chemistry, beginning with the raw materials of petroleum, a great number of products are being manufactured, such as alcohols, glycols, glycerol, ketones, esters, fatty acids, plastics, and rubber. These developments are of far-reaching consequence to the consumer, in that a new source of supply has been made available.

Marketing.

A review of the marketing situation shows that domestic consumption increased from 22·2 per cent. to 27·4 per cent. of the total products available. Prices were lower on all products with the exception of asphalt and fuel oil. As the fuel oil, however, represented 68·46 per cent. of the domestic consumption, the weighted average price of all products shows a slight increase for 1938 over 1937.

Total exports dropped to a new low level of 72·6 per cent. Export prices for the first nine months of 1938 compared with the same period in 1937 show a weighted average decrease of 11·5 per cent. In addition to the reduced prices for products, the railway increased transportation costs 18·2 per cent. from 1st March. Later in the year—September—transport costs on fuel oil were reduced 20 per cent., which amounted to a weighted average reduction of 4 per cent. on all products.

The exceedingly high transport costs in Roumania, compared with the United States, often reduces the margin of profit to the point where the refiner cannot compete with products from the Gulf in the Western European market. This situation is offset somewhat by the higher Constanța price quotations above Gulf, and the clearing arrangements.

During the past year a number of changes were made in the regulations of the National Bank of Roumania governing the control of foreign currency, which were of decided benefit to the petroleum companies. The National Bank of Roumania revised practically all of the clearing agreements with the principal countries to which petroleum products are exported, with the result that collections for sales have been greatly facilitated and losses due to the re-valuation of various currencies have been practically eliminated.

New clearing agreements governing petroleum products were closed with several countries during the last year which opened new markets for the industry.

On 1st April, 1938, the National Bank arranged to place at the disposal of the petroleum companies for their own use a certain percentage of free exchange realized from exports to those countries in free exchange. This arrangment has proved to be of great benefit to the industry, as it has made it possible for the companies to purchase materials they require for exploitation and exploration that must be obtained from abroad in free currency, and to meet their financial obligations abroad.

The Minister of National Economy and the Directors of the National Bank of Roumania are fully cognisant of the difficulties with which the industry is now faced, and are doing everything in their power to improve the situation.

Although the results obtained in 1938 were less than the year before, conditions might have been worse, in that the outlook for this year is not too encouraging. It is believed, however, that the Government will enact legislation encouraging further development by the industry, and so it is with a spirit of faith and hope that I propose the toast of " THE ROUMANIAN PETROLEUM INDUSTRY."

The toast of " The Institute of Petroleum " was proposed by MR. PERCY R. CLARK, Past-Chairman of the Branch.

MR. CLARK said that since they had last met, the old Institution of Petroleum Technologists had become the Institute of Petroleum, and he was the first person in Roumania to have the privilege of proposing a toast to the Institute in its new form and under its new title. Some people had asked why the Institution should have been re-named. Without being facetious he would reply that the Institution was re-named because it concurrently became something else; and the Institution in making itself something else had also been conforming to the trend of modern industrial thought. The old Institution had catered mainly for the field and refinery technical staffs—in other words, for a part only of the industrial side of the petroleum world. They had to appreciate the marked change which had been coming over world economic conditions during the last few decades, owing to the excessive development of production in comparison with the development of distribution. But this problem, however, was no longer one of production, but of rational distribution. It was to the financial, and particularly the distribution, side of their business that they had to devote their closest attention to-day.

It was in conformity with this trend that the Council of the former Institution of Petroleum Technologists had been prompted to bring about a change in its constitution, so that in the new Institute's ranks can be included specialists from every branch of activity necessary to bring the petroleum industry to success. Experience told them that it was just as difficult to obtain a first-rate financial manager, chief clerk, chief accountant, or comptroller, whichever terminology they agreed to use, as it was to get a good engineer. Anyone at the head of a large industrial organization with a commercial end to it would know that the most difficult man of all to find was the competent sales manager.

The new Institute of Petroleum was a recognition of these basic principles, and henceforth it would not only be production and refinery men who would play a rôle in the affairs of the Institute, but also representatives of the financial and distribution ends.

It was therefore a great pleasure to him to offer the Council of the Institute of Petroleum their congratulations and the best wishes on this new era in the Institute's history. He hoped that 1939 would be a year of intensive and extensive development of their Institute.

In concluding his toast, Mr. Clark read a congratulatory telegram which would be sent immediately to the parent Institute.

THE INSTITUTE OF PETROLEUM.

TWENTY-FIFTH ANNUAL REPORT.

1938.

The Twenty-Fifth Annual Report of the Council covering the activities of the Institute during 1938 is presented for the information of the members.

Membership.

The changes in membership which occurred during 1938, and the total membership of all classes on 31st December, 1938, are summarized in the Table below :—

	Total Dec. 31, 1937.	Changes during 1937.							Total Dec. 31, 1938.
		New.	Transferred to.	Resigned.	Deceased.	Removed.	Transferred from.	+ or —.	
Hon. Mems. .	21	—	—	—	1	—	—	— 1	20
Members .	713	46	8	9	7	15	—	+23	736
Assoc. Mems.	527	41	7	13	2	22	7	+ 4	531
Students .	82	28	—	4	—	3	7	+14	96
Associates .	98	5	—	3	—	4	1	— 3	95
Totals .	1441	120	15	29	10	44	15	+37	1478

The new classes of membership (Fellow, Member, Associate Member and Student) were not operative during 1938.

The Council has to record with deep regret the decease of the following members during 1938 :—

	Date elected.	Class of membership.
Ashworth, A. A.	1924	M.
Chadwick, A.	1931	M.
Chittenden, A. L.	1922	M.
Holde, D.	1933	Hon. M.
Howlett, W. S.	1937	M.
Kennedy, E. D.	1937	A.M.
Miles, J. A.	1920	M.
Mitchell, J. P.	1933	M.
Muir, J. M.	1920	M.
Richmond, A. F.	1931	A.M.

Prof. D. Holde, who died in Berlin in June 1938, was elected a Life Honorary Member of the Institute in 1933, in recognition of his distinguished contributions to the chemistry of petroleum.

Honours.

Mr. F. C. Starling (Hon. Mem.) received the honour of Commander of the Order of the British Empire, in the New Year Honours List, 1939.

Representation on Other Bodies.

The Institute has been officially represented on the following bodies :—

The American Society for Testing Materials : Lt.-Col. S. J. M. Auld, Dr. A. E. Dunstan, Dr. F. H. Garner and Mr. J. Kewley (Honorary Members of Committee D-2 on Petroleum Products and Lubricants).
The British National Committee of the World Power Conference : Dr. A. E. Dunstan.
The Technical Committee of the Chemical Engineering Conference : Lt.-Col. S. J. M. Auld.
The British Standards Institution Petroleum Industry Committee : Lt.-Col. S. J. M. Auld, Prof. J. S. S. Brame, Dr. A. E. Dunstan, Mr. B. J. Ellis, Dr. F. H. Garner, Mr. J. Kewley and the Secretary.
The Permanent Council of World Petroleum Congresses : Lt.-Col. S. J. M. Auld, Mr. T. Dewhurst and the Secretary.
The International Standards Association Conference in Berlin, June 1938 : Dr. F. H. Garner.
XVIIIth International Geological Congress (London, 1940) : The President and Mr. T. Dewhurst.
Rubber Technology Conference (London, 1938) : Dr. F. B. Thole and Mr. W. E. Gooday.
Diesel Engine Users Association : Mr. L. J. Le Mesurier and Mr. N. Mitchell.
Ramsay Memorial Laboratory : Mr. J. Kewley.
Permanent International Association of Road Congresses : Dr. P. Spielman.
Benjamin Franklin Memorial Dedication, Philadelphia : Mr. W. D. Brown.
Parliamentary Science Committee : Lt.-Col. S. J. M. Auld, Mr. T. Dewhurst and Dr. E. R. Redgrove.
Imperial Institute, Advisory Council on Mineral Resources : Dr. A. E. Dunstan.

The Institute has also been represented on numerous Sub-Committees of the British Standards Institution.

Benevolent Fund.

The audited statement of Receipts and Payments of the Benevolent Fund during 1938 is submitted below. The Receipts of the Fund from all sources were £106 18*s.* 4*d.*, as compared with £136 14*s.* 2*d.* in 1937. (The 1937 contributions included the special donations received in response to the Council's Coronation Appeal.)

Contributions to the Fund during 1938 were received from :—

Adams, A. C.
Andrews, B. G.
Auld, S. J. M.
Beavan, A. M. E.
Blakiston, J. H.
Bolton, R. P.
Bressy, R. J.
Brodie, N. M.
Bush, L. A.
Cameron, I.
Carter, Ashley.
Charlton, A. E.
Clement, L.
Clifford, G.
Cohn, T.
Cole, F. A. J.
Crichton, R.
Dalley, C.
Dewar, K. G.
Downs, W. W.
Dunkley, G. W.
Dunstan, A. E.
Edeleanu, I.
Egloff, G.
Ellis, B. J.
Evans, R. J.
Fay, E.
Ferguson, B. C.
Fletcher, H. D.
Frewing, J. J.
Garner, F. H.
Gould, G. C.
Griffiths, P. M.
Hamilton, A.
Henson, F. R. S.
Higgs, P. G.
Hills, S. R.
Jackson, J. S.
Jameson, J. A.
Jennings, J. C.
Kelly, M. E.
Kewley, J.
Lavington, H. V.
Le Mesurier, L. J.
Lorne, H. T.
Mackilligan, R. S.
Masters, J. S.
McCreath, T. T.
Middleton, F.
Mitchell, J. P.
Moon, C. A.
Nash, A. W.
Owen, A. G.
Parr, R. W.
Parrish, J.
Perks, A. J.
Porter, P. N. D.
Purdie, A. C.
Purves, A. R.
Redgrove, E. R.
Reid, H. W.
Reynard, H. C.
Richard, A. H.
Richards, G. A.
Ruthven-Murray, A. J.
Samuel, D. L.
Sanders, J. McConnell.
Schlumberger, M.
Scott, G. H.
Smallwood, W.
Southwell, C. A. P.
Spielman, P. E.
Taitt, G. S.
Taylor, T. M.
Tullett, G. V.
Tweed, R. R.
Walsh, D. M.
Walter, G.
Wood, C. W.
Young, J. H. M.
Trinidad Branch.
Shell Marketing Company, Central Laboratories.
Oil Industries Club.

The Council wishes to thank all members who have contributed to the Fund, and in particular those members of the Trinidad Branch, whose contributions have formed a substantial proportion of the total during the past five years.

FINANCE.

The Audited Revenue Account for 1938 and the Balance Sheet as at 31st December, 1938, are given below. The deficit balance of £813 13*s*. 8*d*. is more than accounted for by expenditure on the new Adelphi premises, covering legal charges for the lease, electric and other fittings, removal expenses and new furniture. The whole of this expenditure has been charged to current revenue. The value of office furniture and library books has been written down to the round figure of £200.

Before charging the expenditure on the Adelphi, there was a surplus of £92 18*s*. 2*d*. Whilst this is considerably less than the corresponding surplus of 1937 (£720), a comparison of various items for the two years will indicate that the increased expenditure was mainly of a non-recurrent nature, notably in the case of Publications and Meetings. This was mainly due to the expenses of the Scottish Conference, followed by the publication in December 1938 of its transactions. A further item of extraordinary expenditure was that of legal expenses in connection with the change of name and constitution. The income from members' subscriptions and publications, on the other hand, show satisfactory increases.

The difference between cost and market value of investments is the normal consequence of market conditions at the end of the year. The regular valuation of securities was made during the year, and on the advice of financial advisers it was decided to make no change in the investments held.

CHANGES IN CONSTITUTION.

Important changes in the Memorandum of Association and Articles were approved by the members at a Special General Meeting on 22nd March, 1938. These modifications had been under discussion by the Council for a considerable time. They were designed to bring the constitution of the Institute into line with the trend of developments in its activities, to provide greater freedom for growth, and to broaden the basis of its membership. A corollary to these modifications was the change of name from the "Institution of Petroleum Technologists" to "The Institute of Petroleum."

The Special Resolution relating to the change of name was submitted to the Board of Trade, and the certificate of the Registrar of Companies approving the name "The Institute of Petroleum" is dated April 14th, 1938.

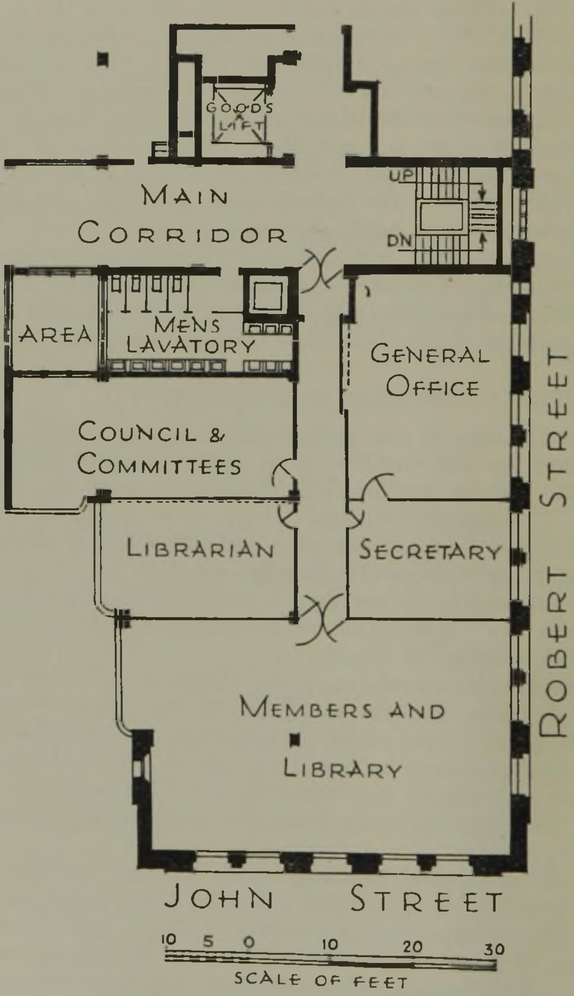
The Special Resolutions incorporating the changes in the Memorandum of Association and Articles were the subject of a Petition to the High Court of Justice. The approval of the Court was given by Mr. Justice Crossman on 30th May, 1938.

At the Annual General Meeting, which followed the Special General Meeting on 22nd March, alterations in the By-Laws were approved by the members. The principal change was that relating to the classes of membership. In lieu of Members, Associate Members, Associates, and Students, the new categories of membership are Fellows, Members, Associate Members, and Students. The definition of each category differs from the definitions of the former categories, in such a manner as will enable the new Institute to include in its membership persons engaged in all branches of the petroleum and allied industries.

For administrative reasons it was not considered advisable to make the new categories of membership operative before the end of 1938. They came into force in January 1939, when the Council's proposals for the re-classification of membership were approved at a Special General Meeting on 10th January, 1939.

PREMISES.

The lease of the Aldine House offices, which had been occupied since June 1923, expired in June 1937, and was thereafter renewed on an annual



PLAN OF OFFICES AT THE ADELPHI

basis. Whilst appreciating the advantages of the Institute possessing "a house of its own," the Council came to the conclusion that its limited capital resources and annual income did not at present justify it in takin over any premises in their entirety. The opportunity presented itself early in 1938 of renting space in the new Adelphi building, then in course of erection. Through the generous financial assistance of certain oil companies, the Council was enabled to take advantage of this opportunity, and concluded a seven years' lease of premises in the Adelphi.

The Institute entered into possession of its new headquarters in October 1938. The offices are situated on the sixth floor, in the North-West Block. They comprise a large Library and Members' Room (used also for meetings of the Students' Section and Groups); a Council and Committee Room; General Office; and offices for the Secretary and Librarian.

The situation of the Adelphi has many advantages. One entrance is directly opposite the Royal Society of Arts, where Ordinary Meetings of the Institute continue to be held. The Adelphi is readily accessible by Underground or bus from all parts of London. The building itself possesses architectural dignity combined with the amenities of a modern office building.

Older members of the Institute will note with interest that the site of the new headquarters almost coincides with No. 5 John Street, which was the home of the Institute from 1919 to 1923.

MEETINGS OF THE INSTITUTE.

Seven Ordinary Meetings of the Institute were held in London during 1938. In addition, a Special General Meeting and the Annual General Meeting were held on 22nd March, 1938.

The Conference in Scotland from 6th–10th June, and the Conversazione on 8th November are referred to in more detail later in this Report.

The Subjects of Papers presented at the Ordinary Meetings and their authors are given below :—

Date.	Subject.	Authors.
11th Jan.	"The Application of Automatic Control to Refinery Process Operations."	S. W. Adey.
8th Feb.	"Air-Raid Precautions in connection with Refineries and Storage of Petroleum."	Lt.-Col. R. A. Thomas.
22nd March.	Special General Meeting. Annual General Meeting.	
12th April.	Presidential Address. Presentation of Redwood Medal.	Lt.-Col. S. J. M. Auld.
10th May.	"Changes Occurring in Lubricating Oils."	Prof. H. Weiss and Dr. A. Maillard.
6th–10th June	Conference in Scotland on Oil Shale and Cannel Coal.	
11th Oct.	"Manufacture of Cutting Oils."	J. F. Miller.
	"Cutting Fluids and the Machine Tool."	A. H. Lloyd and H. H. Beeny.
	"Selection of Cutting Fluids."	H. J. Mason.
	"Function of Cutting Fluids."	Prof. H. W. Swift.
	Inauguration of Lubrication Group.	
8th Nov.	"The Search for Oil in Britain."	G. W. Lepper.
	Conversazione.	
13th Dec.	"Some Application of Asphaltic Bitumen in Industry."	J. S. Jackson.
	Inauguration of Asphaltic Bitumen Group.	

The average attendance at these Meetings (excluding the Conversazione and the Scottish Conference) was 98. This is a very satisfactory increase as compared with an average of 78 in 1937 and 67 in 1936.

In addition to the above, a joint meeting was held with the Road and Building Materials Group of the Society of Chemical Industry on November 1st, when Dr. Ing. F. J. Nellensteyn presented a Paper on " The Rôle of Surface Tension in Bituminous Substances."

Conversazione and Exhibition.

A Conversazione was held to mark the inauguration of the Institute of Petroleum on Tuesday, 8th November, at the House of the Royal Geographical Society by courtesy of the Council of that body. The attendance at this function was 500, including ladies. The guests were received by the President and Mrs. Auld.

Capt. H. F. C. Crookshank, M.P., Secretary for Mines, opened the formal meeting, and paid a high tribute to the work and achievements of the Institute. During the course of the evening Mr. G. W. Lepper lectured on " The Search for Oil in Britain," dealing with the subject from the geological, historical and legislative aspects.

An exhibition, illustrative of geological and geophysical methods of exploration and of the progress of drilling in Britain, was arranged for the Conversazione by Messrs. the Anglo-Iranian Oil Company, the Anglo-American Oil Company, Steel Bros., and the Gulf Oil Exploration Company. The exhibition was subsequently transferred to the Institute's premises at the Adelphi, and remained open for three weeks.

Annual Dinner.

The Twentieth Annual Dinner was held at Grosvenor House, Park Lane, W.1, on Monday, 12th December, and was attended by a record number (over 300) of members and guests. The Chair was occupied by the President.

The Rt. Hon. Lord Cadman, G.C.M.G., proposed the toast of " His Majesty's Government," to which Sir Kingsley Wood, P.C., M.P., Secretary of State for Air, responded. The toast of " The Institute of Petroleum " was proposed by The Rt. Hon. Lord Stamp, G.C.B., and replied to by the President.

Branch Lecture.

Mr. G. W. Lepper, A.R.C.S., B.Sc., Technical Adviser, H.M. Petroleum Department, accepted the invitation of the Council to deliver the Branch Lecture for the Session 1938–39. The subject of the lecture was " The Search for Oil in Britain." It was delivered in the first instance in London on 8th November, and repeated in Swansea on 27th January, 1939; in Glasgow on 16th February ; in Manchester on 9th March, and in Birmingham on 10th March.

Conference on Oil Shale and Cannel Coal.

The first international Conference on oil shale was organized by the Institute, and held in Scotland from 6th–10th June, 1938. It was attended by about 300 members, including official delegates and representatives from Australia, Canada, Estonia, France, Germany, Japan, Sweden and U.S.A.

In the organization of the Conference the Institute received the co-operation of the principal institutions and societies associated with the fuel and chemical industries of Great Britain, and of the various European scientific societies connected with petroleum.

The Conference received the distinguished patronage of members of H.M. Government, and of eminent authorities representing civic, educational and industrial interests.

The Conference was held at the time of the Empire Exhibition in Glasgow. The Lord Provost and Corporation of the City of Glasgow gave a civic reception to the members and their ladies on 9th June. A detailed account of other functions and works visits during the week of the Conference has been given in the report of the *Proceedings*, " Oil Shale and Cannel Coal," published by the Institute in December 1938, to which reference is made below. This volume contains the 32 Papers presented to the Conference, together with the discussions thereon.

The Council records its appreciation of the great help afforded by Captain W. H. Cadman, B.Sc., F.I.C., M.I.Chem.E., in the task of co-ordinating the organization of the Conference with such success.

PUBLICATIONS.

The Journal.

Vol. XXIV of the *Journal* was published throughout 1938 as " The Journal of the Institution of Petroleum Technologists," notwithstanding the change in name of the Institute in April. The title was retained to avoid confusion in bibliographical reference.

The volume contained 8 Papers presented at meetings of the Institute held in London; 3 Papers presented to Branches of the Institute; and 33 contributed articles. The Abstracts Section of the *Journal* contained 1469 abstracts of technical literature and patents.

Two Papers sponsored by the Institute and presented to a Sectional Meeting of the World Power Conference in Vienna, August 1938, were also included in the Journal (*J.I.P.T.*, **24**, 621–641).

" *Annual Reviews of Petroleum Technology*," *Vol. III.*

The third volume in the series of *Annual Reviews* of progress in petroleum technology was issued in August. The book was considerably larger than its predecessors, and contained additional chapters on " Production Engineering " and " Aero Engines." An outstanding review of developments in Cracking and Polymerization was contributed by Dr. G. Egloff.

The Abstracts Sub-Committee which nominates the authors of the various chapters in the *Annual Reviews* has arranged that the same author shall be invited to deal with a particular subject for three successive years.

The *Annual Reviews* are becoming widely known in the petroleum industry. Their authoritative and comprehensive character renders them invaluable as a work of reference to the increasing volume of technical literature.

Oil Shale and Cannel Coal.

The *Transactions* of the Conference on Oil Shale and Cannel Coal were published by the Institute in December, as a volume of 492 pages distinct from the *Journal* and *Annual Reviews*. Captain H. F. C. Crookshank, M.P., Secretary for Mines, contributed a foreword to the book, from which the following passage is quoted :—

> " The Institute of Petroleum is to be congratulated on rendering yet another service to the world of science and industry, and it affords me great pleasure to commend this record of the transactions at the Conference to all who have a share in the fuel economy of our country."

The volume contains the 32 Papers presented at the Conference. It constitutes a complete review of the present state of knowledge regarding the geology, mining, treatment, and utilization of oil shale and cannel coal in all countries where these materials occur.

Standardization.

Chemical Standardization Committee.

Two revisions of methods of test were published during 1938, viz. :—

Ignition Quality of Diesel Fuels (Tentative) (*J.I.P.T.*, **24**, 176–179);
Sampling Asphaltic Bitumen in Packages (Tentative) (*ibid.*, pp. 348–349),

in addition to a Report by the Diesel Oil Panel on the Calibration of I.P.T. Diesel Reference Fuels in terms of Cetane and Cetene Numbers.

International Standards Association.—The Chemical Standardization Committee has dealt with technical questions referred to it by the British Standards Institution in connection with the work of I.S.A. Committee 28 (Petroleum Products). During the year the following methods of test have been the subject of consideration by the Chemical Standardization Committee—distillation, water in petroleum products, burning tests for kerosine, viscosity, and nomenclature (products).

Engineering Standardization Committee.

The Engineering Standardization Committee has been represented on committees of the British Standards Institution dealing with oil-well cement, pipe-threads and fittings, identification of pipe-lines, and containers for inflammable liquids.

Branches and Groups.

The Annual Reports of the activities of the Trinidad, Rumanian, Northern, and South Wales Branches are appended. Reports from the other Branches will be published in the *Journal* as they are received.

Scottish Branch.—A direct outcome of the Conference on Oil Shale and Cannel Coal was the formation of a Scottish Branch of the Institute at the end of 1938. Mr. R. Crichton has been elected first Chairman of the Scottish Branch, and Prof. W. M. Cumming its first Honorary Secretary. The Branch was formally inaugurated by the President at a meeting in Edinburgh on 20th January, 1939.

Formation of Groups.—The Council has initiated a policy of providing for the specialized requirements of members by the formation of Groups. Two such Groups were inaugurated in 1938—a Lubrication Group (Chair-

[To face p. 300.

THE ADELPHI FROM THE EMBANKMENT.

ENTRANCE CORRIDOR.

COUNCIL AND COMMITTEE ROOM.

MEMBERS' ROOM AND LIBRARY.

SECRETARY'S OFFICE.

LIBRARIAN'S OFFICE AND PERIODICALS ROOM.

man: Mr. E. A. Evans) and an Asphaltic Bitumen Group (Chairman: Mr. J. S. Jackson).

Meeting of Members in U.S.A.—The Fourth Annual Meeting of members in U.S.A. was held in Chicago on 16th November, under the Chairmanship of Dr. J. Bennett Hill. Following the Annual American Members' Dinner, five short talks were given by the following speakers: Dr. G. Egloff, Dr. F. H. Lahee, Mr. T. Whasson, Dr. E. C. Williams, and Mr. W. B. Wray.

LIBRARY.

The removal of the Institute's library from Aldine House to the Adelphi was made the occasion of an elimination of certain redundant and duplicate books, pamphlets, and Proceedings. Certain of these were presented to the libraries of the Royal School of Mines, Birmingham University and Leeds University. Cataloguing of pamphlets, maps, and trade literature has been completed.

During the year 323 books were loaned to members, as compared with 403 books in 1937. This reduction is due to the fact that the library books were not available for several weeks in September and October, whilst they were being transferred to the Adelphi.

The following periodicals have been added to the list of those regularly taken by the library during the year:—

Argentine.	*Anales del Instituto de investigaciones cientificas y technologicas.*
Canada.	*Canadian Chemistry and Process Industries.*
France.	*Chimie et Industrie.*
Germany.	*Beiträge zur angewandten Geophysik.*
Italy.	*La Strada.*
Poland.	*Kopalnictwo Naftowe w Polsce.*
	Przeglad Chemiczny.
	Przemysl Naftowy.
United Kingdom.	*Automobile Engineer.*
	Transactions of the N.E. Coast Inst. of Engineers and Shipbuilders.
	Science in Parliament.
U.S.A.	*O'Shaughnessey's Oil Bulletin.*

The Council records its thanks to the various Government departments, authors, and publishers who have generously presented publications to the library.

RESEARCH.

Two grants were made during the year from the Research Fund of the Institute, viz.:

To Dr. G. M. Dyson, Ph.D., F.I.C., M.Inst.Pet., Loughborough Technical College, a further grant of £10 17*s*. 6*d*. in aid of a research to investigate the effect of metallic detritus on the oxidation of mineral lubricating oils.

To the British Electrical and Allied Industries Research Association, a grant of £25 in aid of investigations on the Creep and Corrosion of Steel at High Temperatures. The major portion of this research work is being carried out at the National Physical Laboratory.

In conjunction with the National Physical Laboratory the Research

Committee has made arrangements for the supply of four typical "reference" lubricating oils for research purposes.

AWARDS.

The Redwood Medal of the Institute was awarded to Dr. A. E. Dunstan, D.Sc., F.I.C., F.C.S., Past-President, and Honorary Editor of the *Journal.* The presentation was made by the President at the Royal Society of Arts on April 12th.

Two scholarships of £40 each, tenable by Students of the Institute at the Universities of London and Birmingham for the year 1938–39, were awarded to J. D. Dewhurst (Royal School of Mines) and A. B. Horne (Department of Oil Engineering and Refining, Birmingham University), respectively.

The Council has instituted a Branch Prize of value three guineas, to be awarded to the member who, in the opinion of the local Committee of each Branch, has done most to foster the development of the Branch. The Prizes were awarded in 1938 to E. J. Horley (South Wales Branch) and J. E. Bennion (Northern Branch).

COUNCIL, OFFICERS, AND COMMITTEES.

Ten meetings of the Council and 29 meetings of Committees of the Council were held during the year. In addition, 10 meetings have been held of various sub-committees of the Chemical Standardization Committee.

The following Committees of the Council have met during the year :

Awards Committee : *Chairman*—The President.
Benevolent Fund Committee : *Chairman*—Dr. A. E. Dunstan.
Branch Committee : *Chairman*—Mr. C. Dalley.
Chemical Standardization Committee : *Chairman*—Prof. J. S. S. Brame.
Congress Committee : *Chairman*—Mr. J. Kewley.
Election Committee : *Chairman*—Mr. J. McConnell Sanders.
Finance Committee : *Chairman*—Mr. C. Dalley.
House Committee : *Chairman*—Mr. Arthur W. Eastlake.
Library Committee : *Chairman*—Prof. J. S. S. Brame.
Publication Committee : *Chairman*—Dr. A. E. Dunstan.
Research Committee : *Chairman*—Mr. J. Kewley.

The Council has delegated the detailed work of preparation of the *Journal* and other publications to a small Publication (Executive) Committee consisting of Dr. Dunstan, Dr. Garner, the Secretary, and Assistant Secretary.

Professor A. W. Nash, M.Sc., M.I.Mech.E., has been elected President for the year 1939–40, and will take office at the Annual General Meeting on 27th April, 1939.

Mr. Ashley Carter, Mr. C. Dalley, Dr. F. H. Garner, Mr. J. McConnell Sanders, and Dr. F. B. Thole have been elected Vice-Presidents for the year 1939–40.

The following were elected members of Council as a result of the ballot declared at the Annual General Meeting on 22nd March, 1938 : Mr. A. F. Dabell, Prof. V. C. Illing, Dr. E. R. Redgrove, Mr. W. J. Wilson, and Mr. C. W. Wood.

The Council records its appreciation of the services to the Institute of the Rt. Hon. Lord Plender, G.B.E., Honorary Treasurer; Messrs. Price, Waterhouse & Co., Auditors; and to Mr. T. Outen of Messrs. Ashurst, Morris, Crisp & Co., Solicitors, upon whom fell the burden of the detailed legal work involved in the change to "The Institute of Petroleum."

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

S. J. M. Auld, President.
Arthur W. Eastlake, Honorary Secretary.
S. J. Astbury, Secretary.

THE INSTITUTE

REVENUE ACCOUNT FOR THE

	£ s. d.	£ s. d.	£ s. d.	1937 £
To **Administration Expenses** :—				
Staff Salaries		1616 10 7		*1648*
Printing and Stationery		281 8 6		*221*
General Postages		254 7 7		*221*
Telephone, Cables and Telegrams		27 17 0	2180 3 8	*32*
,, **Establishment Charges** :—				
Rent and Rates	1133 18 2			
Less Grant in aid of Rent (Proportion)	533 6 8	600 11 6		*448*
Cleaning and Lighting		75 10 0		*88*
Repairs and Renewals		44 13 0	720 14 6	*22*
,, **Publications** :—				
Journal Printing		1507 19 9		*1411*
Abstractors' Fees		253 11 0		*216*
Postage on Journals		185 10 3		*186*
Cost of Other Publications		907 0 9	2854 1 9	*252*
,, **Meetings** :—				
Hire of Hall, Preprints, Reporting		165 8 6		
Conversazione and Annual Dinner		176 8 4		
Scottish Conference	515 9 3			
Less Registration Fees Received	396 3 8	119 5 7	461 2 5	*265*
,, **Professional Fees** :—				
Legal Expenses		146 16 4		*80*
Auditors' Fee		42 0 0	188 16 4	*42*
,, **Students' Scholarships**			80 0 0	*80*
,, **Library Expenditure**			59 19 0	*46*
,, **Branches and Sections** :—				
Students Section		39 0 5		*30*
Trinidad Branch		40 0 0		*40*
Burma Branch		6 0 0		*18*
Branch Prizes		6 6 0		—
Sundry Expenses		2 12 3	93 18 8	*24*
,, **Sundry Expenses**			164 11 2	*195*
,, **Depreciation of Office and Library Furniture and Library Books**			12 12 4	*107*
,, **Expenses in connection with the Adelphi :** Legal, Removal, Installation, Furniture, etc.			906 11 10	
			£7722 11 8	

RESEARCH FUND Income and Expenditure

	£ s. d.
To **Grants Made During Year**	35 17 6
,, **Balance as at 31st December, 1938**	213 7 8
	£249 5 2

OF PETROLEUM.

YEAR ENDED 31ST DECEMBER, 1938.

	£	s.	d.	£	s.	d.	1937 £
By **Subscriptions for 1938 Received** :—							
Members	2110	1	0				*2010*
Associate Members	1235	16	6				*1179*
Students	88	4	0				*66*
Associates	163	16	0				*171*
	3597	17	6				
Special	20	0	0				*20*
				3617	17	6	
,, **Subscriptions in Arrear Received During Year**				156	18	0	*145*
,, **Publications**				2921	16	0	*2514*
,, **Interest and Dividends, Gross**				212	6	6	*195*
,, **Balance,** being Deficit for Year carried to Balance Sheet				813	13	8	
				£7722	11	8	

ACCOUNT FOR THE YEAR ENDED 31ST DECEMBER, 1938.

	£	s.	d.
By **Balance as at 31st December, 1937**	239	3	5
,, **Interest Received During Year**	10	1	9
	£249	5	2

THE INSTITUTE

(A Company limited by Guarantee

BALANCE SHEET AS

	£ s. d.	£ s. d.	£ s. d.
Capital of the Institution under Bye-Law Section 6, Paragraphs 14 and 15 :—			
Life Membership Fund—			
As at 31st December, 1937 . .	718 10 0		
Additions during year . . .	44 5 0		
		762 15 0	
Entrance Fees—			
As at 31st December, 1937 . .	3018 14 0		
Additions during year . . .	153 6 6		
		3172 0 6	
Profit on Sale of Investments—			
As at 31st December, 1937 . .		351 10 11	
Donations—			
As at 31st December, 1937 . .		326 5 0	
			4612 11 5
Research Fund			213 7 8
T. C. J. Burgess Prize Fund . .			10 0 0
Members' Subscriptions Received in Advance			221 10 0
Journal Subscriptions Received in Advance			543 13 5
Sundry Creditors—General Account .			1364 9 4
World Petroleum Congress . . .			184 16 3
Revenue Account :—			
Balance as at 31st December, 1937 . .		2605 2 6	
Less Deficit for year as per separate Statement		813 13 8	
			1791 8 10
			£8941 16 11

C. DALLEY, Chairman, Finance Committee.
S. J. ASTBURY, Secretary.

AUDITORS'

We report to the Members of THE INSTITUTE OF PETROLEUM that we have
obtained all the information and explanations we have required. We are of opinion
view of the state of the Institute's affairs at 31st December, 1938, according to the
of the Institution.

3, FREDERICK'S PLACE,
OLD JEWRY, LONDON, E.C. 2.
18*th April*, 1939.

OF PETROLEUM.

and not having a Share Capital.)

AT 31ST DECEMBER, 1938.

	£	s.	d.	£	s.	d.
Investments :—						
On Account of Capital—						
£461 12 0 3% Conversion Stock (1948/53)	491	12	6			
664 6 6 3% London County Consolidated Stock	481	10	6			
806 8 3 3% Manchester Corporation Stock 1958	845	17	7			
867 8 6 2¾% Bristol Corporation Redeemable Stock 1955/65	845	17	7			
150 0 0 5% Wandsworth District Gas Co. Debenture Stock	154	8	6			
400 0 0 3% Metropolitan Water Board " A " Stock 1963	346	10	7			
125 0 0 5% Great Western Railway Co. Consolidated Preference Stock	105	4	9			
150 0 0 3% Luton Corporation Redeemable Stock 1958	151	6	7			
150 0 0 3% Smethwick Corporation Redeemable Stock 1951/8	151	4	9			
600 0 0 3% Bristol Corporation Redeemable Stock 1958/63	597	7	3			
				4171	0	7
(Market Value at 31st December, 1938, £3975 4*s*. 5*d*.)						
On Account of Revenue—						
£790 8*s*. 3*d*. 3% Conversion Stock	842	8	0			
On Account of Research Fund—						
£336 5*s*. 6*d*. 3% Conversion Stock	357	14	8			
				1200	2	8
(Market Value at 31st December, 1938, £1112 10*s*. 5*d*.)						
Office and Library Furniture (Excluding Presentations) :—						
As at 31st December, 1937	198	4	0			
Less: Sales and Depreciation	18	4	0			
				180	0	0
Library Books (Excluding Presentations) :—						
As at 31st December, 1937	23	8	4			
Less: Depreciation	3	8	4			
				20	0	0
Members' Subscriptions in Arrear (not valued).						
Sundry Debtors and Payments in Advance :—						
Sundry Debtors, less Reserve for Doubtful Accounts	428	13	0			
Payments in Advance	237	10	2			
				666	3	2
Cash at Bank and in Hand				42	11	4
Cash on Deposit, General Account :—						
Chartered Bank of India, Australia and China	500	0	0			
Post Office Savings Bank	2002	13	4			
World Petroleum Congress Account	159	5	10			
				2661	19	2
				£8941	16	11

REPORT.

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

PRICE, WATERHOUSE & Co.

BENEVOLENT FUND.

Receipts and Payments Account for Year ended 31st December, 1938.

RECEIPTS.

	£	s.	d.	£	s.	d.
Balance on Current and Deposit Accounts on 1st January, 1938 :—						
Benevolent Fund Account	654	5	7			
Specific Endowment Fund	174	13	2			
				828	18	9
Receipts during 1938 :—						
Benevolent Fund:						
Donations	50	6	11			
Subscriptions	46	4	6			
Interest (nett)	10	6	11			
				106	18	4
Specific Endowment Fund:						
Interest (nett)				1	16	5
				£937	13	6

PAYMENTS.

	£	s.	d.	£	s.	d.
Grants in Aid :—						
Benevolent Fund	42	0	0			
Specific Endowment Fund	133	6	8			
				175	6	8
Cheque Stamps					8	4
Balance on 31st December, 1938 :—						
Benevolent Fund	718	15	7			
Specific Endowment Fund	43	2	11			
				761	18	6*
				£937	13	6

* The Balance on Current and Deposit Accounts and Invested on 31st December, 1938, was made up as follows :—

	£	s.	d.
Cash at Bank	33	1	6
Deposit Account	200	0	0
£600, 3% Local Loans (at cost)	528	17	0
	£761	18	6

We have examined the above Receipts and Payments Account with the books and vouchers of the Fund and find it to be in accordance therewith. We have verified the Balances with Bankers.

3, Frederick's Place,
Old Jewry, London, E.C. 2.
18*th April*, 1939.

Price, Waterhouse & Co.

TRINIDAD BRANCH.

Report of the Committee on the Working of the Branch during the Session 1937–1938.

Seven meetings were held during the session, at which the following papers were read :—

1st December, 1937.	10th Annual General Meeting. " Accelerated Oxidation as a Control Test in the Treatment of Cracked Gasoline," A. Newton.
26th January, 1938.	" Rotatory Rig Drives Powered by Internal-Combustion Engines," C. R. Massy.
23rd February, 1938.	" Oil Well Pumping," P. E. T. O'Connor.
23rd March, 1938.	" Steel : its Manufacture and Special Uses," C. H. Hayward.
11th May, 1938.	" A Laboratory Method for Evaluating Crude Oil," R. Edgeworth Johnstone and R. Palmer.
1st June, 1938.	" Notes on Seismic Deflection Methods," E. P. Van der Linden.
22nd June, 1938.	" A Visit to Russian Oil Districts," Dr. H. G. Kugler.

The average attendance of members and guests at meetings was 30.

There were 76 members on the roll at the end of the year.

Mr. J. L. Harris was elected Chairman, and Mr. W. N. Foster was elected Honorary Secretary and Treasurer for the session.

The Annual Dinner, which would have been held in October, was postponed to December, owing to the illness of His Excellency the Governor, who had accepted the Committee's invitation to be present. It was again postponed to 14th January, 1939, as His Excellency the Acting Governor could not attend due to Court mourning.

An epidiascope was purchased during the year, and was first used for Dr. Kugler's paper.

J. L. Harris,
Chairman.

W. N. Foster,
Hon. Secretary.

28*th November*, 1938.

TRINIDAD BRANCH.

Accounts for the Year ended 31*st October*, 1938.

REVENUE ACCOUNT.

Stenographer's remuneration	$ 47.00	Quarterly grants from London	$192.00
Epidiascope and box	197.33	Excess of expenditure over income	99.74
Cost of draft on London	.30		
Postage, printing, etc.	47.11		
	$291.74		$291.74

BALANCE SHEET.

Surplus brought forward	$277.41		Balance at Bank	$270.66
Less Deficit for year	99.74		Cash in hand	8.15
		$177.67		
Sundry Creditors		$101.14		
		$278.81		$278.81

(*Sd.*) J. L. HARRIS,
Chairman.

W. N. FOSTER,
Hon. Secretary and Treasurer.

(*Sgd.*) C. MIDDLETON } *Auditors.*
D. M. WALSH

ROUMANIAN BRANCH.

Annual Report, 1938.

THE Committee of the Roumanian Branch has pleasure in presenting the Twelfth Annual Report for the Session 1938 together with Accounts for this period.

The Branch Register shows the following list of Members :—

Honorary Members . . .	1
Members	22
Associate Members . . .	12
	35

which is a decrease of 10 as compared with a year ago.

The Eleventh Annual General Meeting was held on 17th April, 1938, at which the Chairman, Mr. E. C. Masterson, retired, and was succeeded by Mr. I. S. Rutherford.

Four General Meetings were held during the year and the following papers were read :—

7th April, 1938.	" Principles of Rational Exploitation," C. A. Dimitriu.
12th May, 1938.	" Safety," C. B. Stults.
9th June, 1938.	" Drilling Muds," M. Constantinescu.
8th December, 1938.	" Directional Drilling," C. A. Brokaw.

The Twelfth Annual Dinner was held on 14th January, 1939, under the Chairmanship of Mr. I. S. Rutherford, and 85 Members and Visitors were present.

A copy of the audited Statement of Accounts for the 1938 Session is given below.

The following is a list of the Members of the Committee of the Roumanian Branch.

Officers.

Chairman—Mr. I. S. RUTHERFORD.
Secretary and Treasurer—Mr. O. A. BELL.

Committee.

Mr. E. C. MASTERSON.
Mr. D. I. MAXWELL.
Mr. L. W. FORSTER.
Mr. I. EDELEANU.
Mr. P. R. CLARK.
Capt. J. E. TREACY.
Mr. C. R. YOUNG.
Mr. G. PRIKEL.

The Committee again wish to record their thanks to the Chamber of Commerce, Ploesti, for the use of their Hall for the meetings during the 1938 Session, and to Messrs. Brasier and Suciu for acting as Honorary Auditors.

I. S. Rutherford,
Chairman.

O. A. Bell,
Hon. Secretary.

Receipts and Payments for the 1938 *Session* (*up to and including* 15*th January*, 1939).

Receipts.		
Balance from 1937 Session		Lei 7014
Sundry Receipts		,, 900
Expenditure.		
Cost of Meetings, Printing, Postage, and Chamber of Commerce	Lei 1725	
General Stationery and Postage London	,, 230	
Administration Expenses	,, 2200	
Annual Dinner, Printing and Postage of invitations, Menu Cards and Gratuities	,, 2441	
Balance in Hand	,, 1318	
	Lei 7914	Lei 7914

We have verified the above Receipts and Payments Account with the books, records, vouchers, and other documents of the Roumanian Branch of the Institute of Petroleum, and having obtained all the information and explanations we have required, we are of the opinion that such account is properly drawn up to represent a true and correct statement of the receipts and payments for the period under review.

C. Brasier }
G. Suciu } *Hon. Auditors.*

NORTHERN BRANCH.

Report, Session 1938–1939.

Membership.

Members of Parent Institute	79
Branch members only	178
	257

Officers.

Chairman : Mr. A. McCulloch.
Deputy Chairman : Mr. J. Cuthill.
Hon. Treasurer : Mr. E. J. Dunstan.
Hon. Secretary : Mr. J. Eric Haslam.

Committee.

Mr. H. C. S. Fothergill.
Mr. J. S. Parker.
Mr. G. H. Thornley.
Mr. C. E. Burnett.
Mr. W. T. Collings.
Mr. H. O. Clayton.
Mr. P. M. Griffiths.
Mr. T. G. Provest.
Mr. E. W. Unmack.

Meetings.

Place of meeting—Engineers' Club, Albert Square, Manchester. Time—7.15 p.m.

22nd September, 1938.	Visit to Gunhill well borings by kind permission of D'Arcy Exploration Co., Ltd.
6th October, 1938.	Joint meeting with the Institute of Chemistry. "Natural Petroleum—The Deficiencies of Nature and their Rectification," Dr. F. B. Thole.
3rd November, 1938.	"Industrial Greases," R. McDonald.
8th December, 1938.	Joint meeting with North-Western Branch of the Institute of Automobile Engineers. "Light Lubricants for Automobile Engines," C. G. Williams.
5th January, 1939.	"Modern Methods Applied to the Manufacture of Lubricating Oils," J. C. Wood-Mallock. (At this meeting a presentation was made to Mr. J. E. Bennion, inaugural Hon. Secretary, on his retirement.)
19th January, 1939.	Special meeting for Ellesmere Port, Liverpool, and Birkenhead area, held at Ellesmere Port. "Modern Methods Applied to the Manufacture of Lubricating Oils," E. J. Dunstan.
9th February, 1939.	Joint meeting with the Institute of Chemistry. "What happens to Motor Oil and What Happens to the Engines," C. I. Kelly.
16th February, 1939.	Annual Dinner and Dance.
9th March, 1939.	Annual General Meeting. Branch Lecture: "The Search for Oil in Britain," G. W. Lepper.

(*Signed*) A. McCulloch.
Chairman.
9th February, 1939.

J. E. Haslam.
Hon. Secretary.

NORTHERN BRANCH.

Balance Sheet—January–December, 1938.

RECEIPTS.

	£	s.	d.
Balance brought forward :			
Bank	28	7	4
Cash	6	1	7
Subscriptions	38	8	6
Preprints	9	16	0
Dinner Tickets	33	15	0
Visit to Gunhill	9	19	0
Chemical Society	1	16	2
Return of cheques (Clayton)		1	2
Bank Interest			6
	£128	5	3

PAYMENTS.

	£	s.	d.	£	s.	d.
Printing and Postages				32	4	11
Hire of Rooms				22	17	9
Dinner Account				42	11	0
Visit to Gunhill :						
Hotel	4	16	0			
N.W.R.C.C.	4	5	0			
				9	1	0
Manchester Chemical Societies' Joint Advisory Committee				5	10	0
Petroleum Times Subscription				1	19	0
Cheque-Books					7	0
Commission					9	0
Bank Balance				12	4	6
Cash in hand				1	1	1
				£128	5	3

E. J. DUNSTAN,
Hon. Treasurer.

W. COWAN
E. WALPOLE } *Hon. Auditors.*

SOUTH WALES BRANCH.

Report of Committee for Year 1938.

Membership.—The membership of the South Wales Branch now stands at 85, of whom 10 are members of the parent Institute. The corresponding figures for 1937 were 84 and 6, respectively.

Meetings.—Nine Papers were read during the year at meetings, two of which were held jointly with the Chemical Society in Swansea, and one with the Institute of Chemistry (South Wales Branch).

The following is a List of Papers presented :—

14th January, 1939.	"The Production of Fischer Tropsch Spirit and its improvement by Cracking," C. S. Snodgrass and M. Perrin.
4th February, 1939.	"Crystallography," E. G. Cox. (Joint Meeting with Chemical Society.)
11th February, 1939.	"Reminiscences of Llandarcy," E. J. Horley.
18th March, 1939.	"Cracking," M. A. L. Banks.
1st April, 1939.	"Progress in Lubrication," Col. S. J. M. Auld.
8th April, 1939.	"Asphaltic Bitumen Properties and Application," A. W. Jarman.
28th April, 1939.	"Petroleum and Posterity," Dr. A. E. Dunstan.
10th November, 1939.	"Chemical Carcinogenic Agents," Dr. J. W. Cook.
9th December, 1939.	"Engine Knock and its effect on Fuel Development," Dr. Newitt.

Finance.—The Income and Expenditure Account for the year and Balance Sheet on 31st December, 1938, are given below.

Committee.—The following constitutes the Committee of the Branch for the Session 1939–1940.

Officers.

Chairman : Mr. A. E. Holley.
Vice-Chairman : Mr. R. B. Southall.
Hon. Secretary : Mr. E. Thornton.

Mr. F. V. M. Bell.
Mr. S. W. Cooke.
Mr. E. H. Ettlinger.
Mr. C. Gourlay.
Mr. E. J. Horley.
Mr. W. C. Mitchell.
Mr. W. Neville.
Mr. E. S. Squire.

SOUTH WALES BRANCH.

Income and Expenditure Account for Year ended 31st December, 1938.

	£	s.	d.		£	s.	d.
To Hire of room and screen	1	14	3	By Subscriptions from Branch Members	6	15	0
,, Canteen charges for tea supplied prior to lectures	3	13	0	,, *Balance*, being excess of expenditure over income, carried to Balance Sheet	2	6	5
,, Sundry expenses	3	8	8				
,, Cheque book and receipt book		5	6				
	£9	1	5		£9	1	5

Balance Sheet at 31st December, 1938.

	£	s.	d.		£	s.	d.
Balance as at 1st January, 1938	24	10	4	Cash at National Provincial Bank, Ltd., Neath	22	3	11
Less Balance transferred from Income and Expenditure Account	2	6	5				
Balance on 31st December, 1938	£22	3	11		£22	3	11

THE INSTITUTE OF PETROLEUM.

ANNUAL GENERAL MEETING.

THE TWENTY-SIXTH ANNUAL GENERAL MEETING of the Institute was held in the Lecture Theatre of the Institution of Mechanical Engineers on Thursday, 27th April, 1939, at 5.30 p.m. The Chair was taken by the President, LT.-COL. S. J. M. AULD.

THE SECRETARY read the Notice convening the Meeting and the Reports of the Auditors.

The Minutes of the Twenty-fifth Annual General Meeting were read, confirmed and signed.

BALLOT FOR COUNCIL.

THE SECRETARY announced that nine nominations had been received for six vacancies on the Council. As a result of the ballot the following had been elected: MR. G. H. COXON, DR. E. B. EVANS, MR. A. C. HARTLEY, MR. J. S. JACKSON, MR. H. C. TETT and DR. A. WADE.

NEW MEMBERS.

It was agreed that the list of Members, Associate Members, Students, and Associates elected and transferred during 1938 should be laid on the table.

ANNUAL REPORT AND ACCOUNTS.

THE PRESIDENT said that the Annual Report of the Council for the year ended 31st December, 1938, had been circulated to all the members, and it was with pleasure that he submitted it for their approval at the Twenty-sixth Annual General Meeting. He would be glad if, for the purposes of the Meeting, the Report could be taken as read. (Agreed.)

He commended to the attention of the Meeting the full and able manner in which the Report had been prepared. It clearly indicated the chief activities of the Institute during the last year. It was not his intention to summarize the summary, or again to re-state the position in regard to their recent development. Opportunity had been taken to do that on numerous occasions during the past year, and particularly at the Special General Meetings, the Annual Dinner, the inauguration of branches and groups, and the Conference held in Scotland in June. He wanted to state, however, that the optimism expressed on all those occasions regarding the changes in constitution and the activities of the Institute appeared to be fully justified. They continued to forge ahead in membership, in decentralization of their work, and he trusted in breadth of outlook as well as in breadth of interest. The membership at the end of the year was only 22 short of 1,500, a landmark which he was glad to say had since been passed.

There was one matter to which he wanted to refer under the heading of "Premises." That was to emphasize their thanks for the generous and understanding help of certain companies within the industry which had enabled them to take possession of the new and beautiful premises in the Adelphi.

On previous occasions he had made it clear that the Council regarded that aid as a temporary measure and that, at the earliest suitable moment, steps would be taken to found a Building and Capital Fund with the object in view of acquiring their own and separate premises. The Council had empowered him to take initial steps to develop that Fund, but he felt that the condition of national and international tension was not conducive to the successful launching of an effort of that kind at the present. It would be better to await, what he fervently hoped would be imminent, quieter conditions. He could assure them, however, that when the time came to make a start there was every indication that they would receive the strong and highly appreciative support of the industry.

It was with satisfaction also that he referred to the activities of the branches and groups. Especially gratifying was the formation of the Scottish branch, which was already proving itself one of their most active constituent parts. They might well be optimistic also in regard to the formation of two groups, which it might be anticipated were the forerunners of others, to meet the needs of members' interest in specialized subjects. In each case the inaugural meetings had been well attended and enthusiastic. Evidence of the continually growing enthusiasm of the members in general was shown by the largely increased attendances at the Ordinary Meetings of the Institute. An average of nearly 100 spoke for itself.

Without being self-satisfied or smug, he thought they could look back on their efforts of the last year with pride. 1938 had brought to fruition much work conceived in the past and carried out patiently and determinedly over a number of years. For that reason he was convinced that all the evidence shown of fresh outlook could be regarded also as a measure of future attainment.

In presenting the Report of Council for the year he wished to indicate to the members the labour of love which it represented on the part of ordinary Members of Council, of the Honorary Officers, and the Staff. It was impossible adequately to appraise the whole-hearted devotion of those constituent parts of the organization of the Institute, but he could assure them that the Institute had been well served. He wanted to refer particularly, however, to the able and ardent work of the Secretary, Mr. S. J. Astbury, on whom they had learnt to lean with confidence.

The Council, Officers, and Staff, on their side, continued to feel that they had the ordinary members' fullest confidence and support. That made their work so much more pleasant and efficient.

He formally moved the adoption of the Annual Report of the Council together with the Accounts for the year ended 31st December, 1938, and asked Mr. Christopher Dalley, Chairman of the Finance Committee, to deal with the accounts and to second the motion.

Mr. Christopher Dalley, in seconding the motion, said the Accounts, which had been circulated, called for very little comment, as it was obvious that the deficit on the Revenue Account was entirely due to the fact that the whole of the expenditure on the new premises had been charged to current revenue. The valuation placed on the furniture and books had been written down on the Balance Sheet to the round figure of £200. This was sound policy, and he hoped they would be able to continue it. He did not want it to be assumed that the expenditure on the Adelphi was finished. There were many more amenities which it was necessary to introduce into the Members' Room, which admittedly looked a little bare. The Council proposed to complete the furnishing of that room in a few months, and he hoped that members would use it to the full. The room had already proved very adaptable to the holding of small exhibitions, and the Council proposed to hold similar exhibitions of technical interest from time to time.

The Balance Sheet indicated a sound position. Although the bank balance at the end of the year was only £42 as against sundry creditors £1,364, it would be noted that the Council had taken full advantage of the facilities of investing small surpluses in the Post Office Savings Bank. There was a balance in the Post Office of £2,002. It was also a feature of Institutional finance, in contrast to ordinary commercial finance, that a large part of the Institute's income was received at the beginning of the year. In consequence, practically the whole of the £1,364 owing on the 31st December, 1938, was paid on the 1st January, 1939.

As the President had said, it was the great generosity of certain oil companies which had enabled them to move into the excellent premises at the Adelphi.

He had much pleasure in seconding the adoption of the Annual Report and Accounts.

The motion was carried unanimously.

ELECTION OF AUDITORS.

MR. A. CARRICK SMITH proposed, MR. T. C. R. BAKER seconded, and it was carried unanimously that Messrs. Price, Waterhouse & Co. be elected Auditors for the ensuing year.

THE PRESIDENT asked whether any member wished to raise any other business. As no other business was raised, THE PRESIDENT proceeded to the induction of PROFESSOR A. W. NASH.

INDUCTION OF NEW PRESIDENT.

The Council had unanimously chosen as President of the Institute of Petroleum for 1939–40 PROFESSOR A. W. NASH. It was now his great pleasure to herald that decision and to lead Professor Nash to the Presidential Chair.

His eulogy of the incoming President would be brief but sincere, because the Meeting was well acquainted with his worth and exceeding fitness for that position.

At the University of Birmingham Professor Nash had developed and led a School of Petroleum Technology which had achieved outstanding success. It had had fundamental influence on the training and outlook of British Oil Technologists and had attracted students from all over the world. The high standard of investigation and research work which Professor Nash and his collaborators had carried out during the last decade or so had been the great admiration of his friends and colleagues in the petroleum industry in Great Britain. He could assure the members that it was also fully appreciated abroad. Professor Nash's interests in that direction had been catholic. Considering that Great Britain was not an effective oil-producing country, it was significant of Professor Nash's wide knowledge and interests and his understanding of the requirements of his students, and the British petroleum industry as a whole, that so many of his investigations had dealt with practical problems ranging from oil-field to user.

Looking at Professor Nash's career, this breadth of outlook was perhaps more readily understandable, since he joined the oil industry as far back as 1909 and had subsequently extended practical experience of production both in Persia and Russia. After the War, during which he was in the service of the Air Ministry, Professor Nash had considerable general and consulting experience in petroleum. Having in 1922 been appointed lecturer in Oil Engineering and Refining at the University of Birmingham, he succeeded only two years later to the Professorial Chair—a Chair which he had distinguished by his occupancy ever since.

Professor Nash was unsparing in his work and prolific in his output. He had already left a permanent mark upon the literature of petroleum by his share as Editor of Contributions of that great work " The Science of Petroleum " which appeared last year. Text-books on Motor Fuel and Lubrication also stood to his credit. The Institute could, he was sure, look forward to Professor Nash putting into his work as President of the Institute of Petroleum the same high standard of effort which he had set himself elsewhere. They could congratulate themselves on their choice and look forward under his leadership to a continuity and development of the great work of the Institute in which they all took such a pride.

He then asked Professor Nash to occupy the President's Chair.

Professor A. W. Nash, who was received with warm acclamation, thanked Colonel Auld for the gracious manner in which he had inducted him into the Presidential Chair.

When reviewing the long and distinguished list of Past Presidents—Professor Brame, Sir Thomas Holland, Mr. Adams, Dr. Dunstan, Mr. Kewley, Mr. Dewhurst, Lord Cadman, and Colonel Auld—he appreciated the more the honour of being chosen as President. It was interesting to recall that his immediate predecessors, Lord Cadman and Colonel Auld, had carried through a great change in the constitution of the Institute and its outlook, and he asked the members to collaborate with him so that they might build worthily on the substantial foundations which had been laid.

The standard set by his predecessors in the past had been a high one, and although he would do his very best to emulate their example, he realized that the task was no easy one. In that respect he was fortified with the knowledge that he would have the help and support of a body of men, the members of the Council, whose loyalty to the Institute he had had the opportunity of witnessing and admiring for some years past.

By broadening the basis of membership he was hoping that in the future there would be papers embracing other branches of petroleum technology besides the purely scientific, and in that respect they had his assurance that he would do all in his power to uphold the dignity of the Institute and to maintain the same high standard of such papers as had prevailed in the past.

It would also be his ambition to make the Institute of even greater usefulness to its members and to the petroleum industry. He might perhaps be allowed to touch on a point which was of particular interest to him, the Summer Meeting to be held in Birmingham in a few weeks' time. It was a happy thought of the Council that such a Meeting should be held in the city in which he had worked for so many years, and he sincerely hoped that the members of the Institute would give the Meeting their full support.

The occasion was not one which called for a long address, and he would therefore conclude by expressing his sincere thanks to the members of the Institute for the honour they had accorded to him by electing him as President.

Vote of Thanks to Retiring President.

Professor J. S. S. Brame, in proposing a Vote of Thanks to the retiring President, said it was a duty which gave him great pleasure. They all admired the tremendous energy which Colonel Auld had put into the work of the Institute. When it was remembered that during his term as President of the Institute he was also for a great part of the time President of the Oil Industries Club, it seemed marvellous that he should have found time to give to the work of the Institute in the unstinting manner in which he had given it.

People might be inclined to think the work of a President was a once-a-month job, but they had to realize what a tremendous amount of Committee work and general supervision work necessarily fell to the President of an Institute such as the Institute of Petroleum, with something like 1,500 Members. Colonel Auld had been unstinting in the amount of time and energy he had put into the work of the Institute.

In addition to the purely business side of the work, the members had to thank the President for presiding, and very ably presiding, at their social functions. The last Annual General Dinner created a record for attendance, and, if he could be allowed to say so without offending any of the Past Presidents like himself, a record in the matter of the after-dinner speech made by the President on that occasion. There was also the very happy function held at the rooms of the Royal Geographical Society. The President and Mrs. Auld had carried out most successfully the social duties attaching to that meeting.

One thing of particular importance was that Colonel Auld was really the last President elected to the Institution of Petroleum Technologists, and during his term of office there were considerable changes. It would be appreciated that great as were the normal duties of the President of such an Institute, when great changes were being made, when such things as Articles of Association, new Bye-Laws, and so on, had to be most carefully considered, sent to solicitors, returned by solicitors, and gone through by the President and Committees, the duties of the President were particularly onerous. A very special Vote of Thanks was due to Colonel Auld for his work in this connection.

Sometimes the Institute was criticized because those who had passed the Chair remained perpetual Members of Council. He was the oldest Past President present, and he therefore felt he would be forgiven if he said that that had not really operated against the Institute. Quite a number of Past Presidents had worked most strenuously from the date of laying down their office until the present time, and he had every reason to think that Colonel Auld would be among them. He hoped that for many years they would have the benefit of his advice and guidance at the Meetings of the Council.

He therefore had great pleasure in proposing a most hearty Vote of Thanks to Colonel Auld.

(*The motion was put to the Meeting by the President and carried by acclamation.*)

Colonel Auld briefly thanked the members and assured them that his term of office had been a most pleasant one.

The President then declared the Meeting closed, and the proceedings terminated at 6.5 p.m.

ABSTRACTS.

AUTHOR INDEX.

The numbers refer to the Abstract Number.

Geology.

440. " Park City " Beds on South-west Flank of Uinta Mountains, Utah. J. S. Williams. *Bull. Amer. Ass. Petrol. Geol.*, 1939, **23**, 82–100.—It is considered that the " Park City formation " (as defined by Boutwell) is not a valid stratigraphic unit, and the name applied in that sense should be discontinued.

From faunal evidence obtained by the author it is shown that the lower member of the " Park City formation " is Lower Pennsylvanian in age, and the middle member apparently Middle Permian. Therefore, it is concluded, it is imperative that the " Park City formation " should be divided.

The upper member (Rex) and the middle member (Phosphatic Shale) may be extended from south-east Idaho, and can be recognized as far south-east as Ashley Creek. These members now constitute the Phosphoria formation.

The lower member of the " Park City formation " thins to the east on the south flank of the Uinta Mountains and dies out beyond the Duchesne River. On the north flank, to the east, it thickens and its limestone content is much increased.

Due to lack of available data, the true relationship of the lower member of the " Park City formation " is unknown, but on lithological characters the author is of opinion that it is merely a lithologic facies of the Weber formation. G. S. S.

441. Geologic Structure of St. George District, Washington County, Utah. C. E. Dobbin. *Bull. Amer. Ass. Petrol. Geol.*, 1939, **23**, 121–144.—This paper gives a brief outline of the structural history, geological structure, and the results of deep drilling in the south-west corner of Utah.

Cambrian quartzite, with a thickness of 500 ft., lies unconformably on Pre-Cambrian metamorphics and granite. The quartzite is followed by rocks of the Carboniferous and Permian systems to deposits of Quaternary age. Frequent oscillations occurred during the transition from Palæozoic to Mesozoic times, with a period of uplift and erosion prior to the Cretaceous, and orogenic movements either in late Cretaceous or early Eocene.

Nearly the whole area lies west of the Hurricane fault and is divisible structurally into five easterly dipping monoclinal blocks, separated in part by major north-trending normal faults with the downthrow to the west. The faults are both straight and curved and terminate abruptly. They vary in vertical displacement along any one fault surface, and it is estimated their stratigraphic displacements are from about 1,500 ft. to nearly 5,000 ft.

The Virgin field (6 miles east-north-east of La Verkin) was discovered in 1907, and has produced a small amount of oil since that date. As a result of this discovery six deep wells have been drilled in the St. George district, but no economic quantities of oil or gas have been found. G. S. S.

442. Stratigraphy and Historical Geology of Gulf Coastal Plain in Vicinity of Harris County, Texas. W. G. Meyer. *Bull. Amer. Ass. Petrol. Geol.*, 1939, **23**, 145–211.—In this paper a detailed study is made of the surface formations of an eastern Texas area, followed by an investigation up the regional dip to the outcrop of these formations. The results of the work are given in the form of a generalized comparison of the deposits in the area with those of south-west Texas and southern Louisiana.

The rocks occurring in the area are of Cenozoic age, and a notable feature concerning them is their great thickness, estimated at more than 24,000 ft. Moreover, it is shown that a gulfward thickening of the constituent formations takes place. As deeper drilling progresses in the Gulf Coast, so it becomes more certain that thickening continues as far as the present shore-line.

The deposits are alternately marine and continental, the oldest formation penetrated by wells drilled for oil in Harris Co. being the Crockett (Claiborne Group). A thickness of 1,465 ft. has been proved in the central part of the County. These Eocene beds, and others ranging through the Oligocene, Miocene, Pliocene, and Pleistocene, are described and also figured in a table.

The pre-Tertiary history of the Coastal Plain in the vicinity of Harris County is entirely conjectural, and conclusions must therefore be based on evidence farther inland, where more is known of the older rocks.

It has been proved that a geosyncline of major dimensions occurs near the outer margin of the Gulf Coastal Plain in eastern Texas and Louisiana ; the axis is placed approximately at the site of the present shore-line of the Gulf. The formation of this huge depression and its accumulation of sediments (estimated to be 35,000 ft. thick) have played an important part in the Cenozoic history of the region. Discussion follows on the various theories of the origin of geosynclinal depressions. G. S. S.

443. Geologic Aspects of Heaving Shale in Texas Coastal Plain. J. M. Frost. *Bull. Amer. Ass. Petrol. Geol.*, 1939, **23**, 212–219.—Considerable time has been spent and a thorough search made for all fields and wells where heaving shale has been recorded in Texas Coastal Plain. This research includes all wells drilled prior to March 1, 1938.

As a result, it is found that there are five groups into which heaving shale wells may be divided : Lower Miocene, Middle Oligocene, Vicksburg, Jackson, and Yegua formations. The groups form belts or trends, have approximately the same width, and are parallel with the present shore-line of the Gulf of Mexico.

The fields and wells used to determine the various trends are shown in a table and a map is also supplied giving the location of these trends.

As hitherto there has been a lack of references on this subject, the author adds a comprehensive bibliography containing over fifty entries. G. S. S.

444. Petrography and Genesis of Asphaltic Rocks. III. Asphalt from Berseba, South-west Africa. H. Müller. *Bohrtech. Z.*, 1939, **57** (2), 21–24.—An asphaltic rock is found in the Fish River Sandstone at Berseba, South-west Africa, and the origin of this had been ascribed to hydrothermal action. Detailed examination of a hand specimen—thin sections, heavy minerals, character of the asphalt, etc.—has shown that it is a normal bituminous material in a rock composed mainly of Radiolaria remains. From a consideration of the heavy mineral residue it is suggested that the sedimentation of finely divided fragments of basic eruptive rocks so altered conditions that the organic matter of the Radiolaria was not destroyed by oxidation, and so was converted into asphalt. S. E. C.

445. Reservation of a Zone in Province of Salta, Argentina. Anon. *Bol. Inform. Petroleras*, Oct. 1938, **15** (170), 125–126.—Decree reserving for two years, from 28.9.38, a zone in the north of Salta, to allow of geological surveys being carried out with a view to locating mineral oil deposits. H. I. L.

Geophysics.

446. Application of Geophysical Methods in the Search for Oil. H. Jung. *Bohrtech. Z.*, 1939, **57** (2), 25–27.—The geophysicist makes use of certain physical characters of the rocks, the most important of which are density and the magnetic, electrical, and elastic properties. Thus it must be noted that geophysical methods are useless if the physical properties of the body sought are not different from those of the surrounding rocks. The application of these methods to the search for oil is based on the principle that oil occurs in certain geological structures, and if these can be discovered, then there is a chance of finding oil. The gravity, magnetic, electrical, and seismic methods are outlined. S. E. C.

447. Electrical Methods in Geophysical Exploration. H. M. Evjen. *Geologie en Mijnbouw*, Jan. 1939, **1** (1), 2–8.—Electrical methods can be divided into ore prospecting and structural prospecting, of which the former has had by far the greater success. This is probably due to the fact that for the latter the changes in value of the properties involved are much less than for ores, whilst the depths to be explored are greater.

In purely conductive methods, employing D.C., the conductivity alone determines the electrical field. In the magnetic method, in which a direct current is sent through a loop and the magnetic field is measured, the magnetic permeability by itself determines the results. In the other methods, in which alternating, commutated, or interrupted current is used, the parameters electrical conductivity, magnetic permeability, and dielectric constant are involved. Owing to the small variations in the last two, it is permissible to confine attention to the conductivity, even in electromagnetic methods.

Maxwell's Field Equations are examined from the point of view of absorption, and for practical purposes it is seen that for D.C. one half of the current penetrates a depth of one half of the electrode spacing, in uniform ground. This depth, which may be called the depth of penetration, is therefore proportional to the electrode spacing. In using A.C. the penetration is no longer proportional to the electrode spread, but reaches an asymptotic value as the spread is increased. This asymptotic value is approximately one-tenth of the computed wave-length, and may therefore be quite small, even at relatively low frequencies. This means that the parts of the earth shallower than the asymptotic value contribute preponderatingly to the result, no matter how great the electrode spread. Allowance must be made for absorption in interpretation ; for failure to do so, in say the Wenner arrangement, gives apparent resistivities which are far too high. For the ground resistivities of 180–1,000 ohm cm., which are common, absorption cannot be neglected, even at very low frequencies and relatively short electrode spacing.

The modern tendency is towards lower frequencies and an approach to D.C., with the consequent elimination of inductive methods requiring relatively high frequencies. With suitably low frequencies for practical purposes it is permissible to use D.C. theory in interpretation. However, a truly three-dimensional method of interpretation is desirable. To separate deep from shallow effects in the D.C. method the electrode spacing is increased at the same location, but the resolving power of this process is low, due to the great distances and other complicating factors. To overcome these drawbacks the transient methods have been introduced. They are comparable to reflection seismography. However, the depth of reference of transient methods is still very small, owing to technical difficulties, and detailed and quantitative interpretations of the observations are not yet feasible. Nevertheless, this innovation seems to be a step in the right direction.

The seismic and electrical methods are compared. G. D. H.

448. Interpretation of Well-shot Data. C. H. Dix. *Geophys.*, Jan. 1939, **4** (1), 24–32.—The distribution of seismic velocity with depth is frequently determined by well-shooting. A method of interpreting well-shot data is presented which has the advantage that the velocity distribution can be made to fit the observations with any desired closeness. The method is not difficult to apply in practice, although with discrete data a unique interpretation evidently cannot be given. However, in the case of ideal data, including also surface refraction data, the velocity distribution can be determined uniquely. G. D. H.

Aerial Survey.

449. Aerial Observation and Photography in the Search for Oil. E. Fossa-Mancini. *Bol. Inform. Petroleras*, Sept. 1938, **15** (169), 51–97.—It is necessary to distinguish between aerial observation, aerial photographs taken obliquely, and those taken vertically. The first two serve for geological inspections, the last for geological and, under certain conditions, for topographical survey. The last-mentioned case suffers from difficulty of securing accurately vertical lens and correct bearings of plane at the instant of exposure.

Multiple cameras for taking simultaneously vertical and oblique views are useful; the oblique views enable recognition of fixed points in a survey, give indication of an outcrop showing marked resistance to erosion in a region which is otherwise not of great interest; they are also useful for instructional purposes. Advantages of direct observation :—

(*a*) It cannot be replaced by photos, as the latter do not reproduce colours, only light and shade, which again may be due to difference of colour or difference of light intensity, moreover—

(*b*) Panchromatic films are misleading, *e.g.*, a light grey rock will come out the same as a vivid red one.

(*c*) When observing, flight may be made at different heights and in any direction, so that the most favourable points for examination may be sought out and it is possible to swoop down momentarily to examine at close range a promising outcrop.

In this report the subject is treated in great detail and is illustrated by compound photographs; an historical section is included, as well as a very complete bibliography.

H. I. L.

Drilling.

450. Methods that Drilled Heaving Shale to 13,708 ft. in Aqua Dulce Field. C. A. Sullins and O. Van Dyke. *Oil Wkly*, 23.1.39, **92** (7), 52.—A string of 10-in. casing was set and cemented at 8,007 ft. in the Minnie Brown 1 well, as the geological section down to 8,000 ft. was thoroughly understood by the operating company and as large a hole as possible was required in which to work.

Drilling was carried out to a depth of 9,613 ft., when heaving shale prevented further progress. Cavities caused some trouble below 8,750 ft., and the mud was changed at this point to the silicate mud and the hole reamed to remove any accumulation of shale cavings.

From 9,613 ft. to 10,523 ft. the rate of drilling was 100 ft. per day with a fishtail bit. The first serious trouble after changing the mud occurred at 10,768 ft. Circulation was lost, and although efforts were made to regain it, it was not until attempts were made above 8,760 ft. that they were successful. Four days reaming and washing from this depth to 9,200 ft. yielded evidence that the cavities which had been developed in this interval were still actively enlarging and were not being cleaned out properly. Slow reaming effected the removal of the accumulated shale from the cavities.

The hole was carried to 10,792 ft. when two attempts to set a liner were made. It was found to be impossible to run this below 9,570 ft. It appeared from this that three major cavities had been formed between 8,800 and 9,600 ft. during the time of drilling with water and that no wall failure had occurred since drilling with silicate mud. This knowledge at this stage enabled the washing-out process to be used, and no further troubles from cavities occurred. A further practice which expedited the making of round trips was that of circulating for 15 to 20 min. after the removal of each 600–900 ft. of pipe. The pipe was therefore pulled in stages.

Wire-line coring was started at 10,676 ft., and the remainder of the hole was drilled with a wire-line core bit.

L. V. W. C.

451. Shifting of Rigs Cuts Drilling Costs. C. Johnston. *Oil Wkly*, 23.1.39, **92** (7), 61.—Delta Drilling Co. in the Schuler field are using a light rig for the first 5,000–6,000 ft., and are then replacing this by a heavy rig capable of reaching depths of over 7,700 ft. The object of this is that with locations ahead derricks are erected on the next location to be drilled, and the initial hole is drilled up to 6,000 ft. with a light rig, which is able to maintain maximum drilling speed up to this point. When the heavier rigs are released these are moved into position. By having two light rigs and one heavy rig and carrying out this programme, the same number of completions is secured as would be possible if all derricks were equipped with the heavy equipment. There is a loss of time in changing over, but this averages only from 16 to 22 hr., but the maintenance costs of the light rig are much smaller than those for the heavy rig, and the advantages are all in favour of the programme.

L. V. W. C.

452. World's Third Deepest Test Drills Record Heaving Shale Body. E. S. Post. *Oil Wkly*, 23.1.39, **92** (7), 30.—Union Producing Co.'s Minnie Brown 1 reached a depth of 13,728 ft., the last 5,000 ft. of which consisted of heaving shale. In spite of this handicap, at no time was the drill-pipe stuck. It is possible that the drilling methods used on this well may constitute, in some measure, the answer to the problem of fighting heaving shales. Careful supervision, extreme care, and drilling mud were the outstanding contributory factors in the drilling of this well, as no special technique was utilized in performing the drilling operations. Silicate mud was used and its physical and chemical properties were checked and controlled constantly, and all cuttings from the hole were removed from the stream to eliminate contamination. Because of the rising temperature shown by the returning fluid, a mud-cooling system was installed. This device consisted of a series of nozzles through which the mud was sprayed into a cooling pit.

Pressures and speed of pumps, torque, and other factors that would reveal the condition of the hole were recorded continuously. L. V. W. C.

453. Drilling Footage Costs Cut by Special Wire Line Procedure. C. Johnston. *Oil Wkly*, 13.2.39, **92** (10), 32.—Normal drilling line costs in the Schuler field have been approximately 10·9 cents per foot of hole, but an innovation in drilling-line practice pioneered by the Delta Drilling Co. has cut the cost to slightly under 3·75 cents per foot of hole made.

Instead of buying the usual 1,250-ft. line, Delta buys a 2,000-ft. line and uses one end for starting a well. As work progresses this line is fed through the rig to distribute drum and sheave wear. The free end of the line is wound on to a storage reel which is provided with a friction brake. From the reel the line feeds on to the derrick floor, passing through jaws of a screw clamp, then making two or three complete turns around a drum equal to, or greater in diameter than, the sheaves over which the line is destined to work.

As new line is carried through the sheaves and on to the drum, it is necessary only to release the screw clamp and adjust the tension on the locking-drum until the required amount of line has carried over from dead storage to live service.

As new line gradually replaces that already having seen service, the ends of the line are exchanged.

With efficient splicing and using two lines which have each completed three wells the company has another 2,000-ft. line which in turn will make three holes before its service life is exhausted. L. V. W. C.

Production.

454. Gas-lift as a Production Method in East Texas Field. W. N. Rees. *Oil Wkly*, 13.2.39, **92** (10), 11.—With the continual improvement in gas-lift equipment and methods, gas-lift as a production method is destined to play an important part in the future production of the East Texas field.

Correct installation of the surface and sub-surface equipment is necessary if the desired efficiency of operation is to be obtained. Periodically running flow tests on the wells and repairing and resetting the flow valves in those wells where high gas-fluid ratios exist will keep the operating costs at a minimum.

Future gas-lift operations will use gas from the gasoline plants as well as extraneous high-pressure gas, as the gas available from the plants will be insufficient where large volumes of water have to be handled. The quantities of extraneous gas to be used will be dependent on the cost of gas and on future developments of high-pressure gas reserves. L. V. W. C.

455. Production Characteristics of some Typical Distillate Fields in the Gulf Coast Region. L. S. Reid and R. L. Huntington. *Oil Wkly*, 13.2.39, **92** (10), 23.—The development of many new deep fields in Texas and Louisiana has been retarded on account of the predominance of high gas–distillate ratios under which the wells in these fields must be produced.

Data provide evidence that most of the deep reservoirs in these areas contain a single-phase fluid under the initially high pressures which exist at the time of discovery. The holding of a high pressure within the reservoir will enable a single homogeneous fluid to be maintained, thus permitting depletion of the reservoir with a 160–640 acre spacing, where 10–40 acres might be economical for each well under ordinary oil-field conditions.

Any lowering of the pressure in these distillate reservoirs enables the sand-grains to become wetted with the condensate which could not be recovered easily.

As a result of the variations in distillate content in the Gulf Coast Field, it is important that detailed studies be made of the producing characteristics of these deep fields if they are to be operated on an efficient basis. L. V. W. C.

456. Methods Employed in the Upper Producing Levels' Tranquitas Zone (Salta, Argentina). J. O. Martinez. *Bol. Inform. Petroleras*, Nov. 1938, **15** (171), 13–30.—Characteristics of the deposits are given, together with a summary of the geological features, followed by a description of the methods adopted for maintaining the natural flow of oil. Broadly speaking, this consists in selecting two of the wells which indicate the lowest pressures at the bottom and using these for injecting gas (and possibly later on water) into the oil-bearing sands, and thus maintaining a steady flow of oil from the remaining wells in that group which draws its oil from the upper levels of the Tranquitas zone. H. I. L.

457. Important New Deposit at Tupungato (Mendoza, Argentina). Anon. *Bol. Inform. Petroleras*, Nov. 1938, **15** (171), 1–8.—Description of well No. T. 19, giving details of yield during the first days after completion of the new boring. Pressures up to 300 atm. had to be applied to control the surge of gas and oil. Between the 5th and 18th November, when the output was finally restricted to normal conditions, the total yield was 2,917 m^3. of oil, or a daily average of 208 m^3. A new well, T. 20, is being sunk to the north-east of T. 19, and is expected to be in production by the end of the year. H. I. L.

458. New Productive Area in Plaza Huincul. Anon. *Bol. Inform. Petroleras*, Nov. 1938, **15** (171), 9–11.—Three wells have been drilled in an area to the north of the mine "La Republica." Up to date their controlled daily yields amount to 54 cu. metres, and a fourth well is now being drilled. H. I. L.

Transport and Storage.

459. Engineering Significance of National Bureau of Standards Soil-corrosion Data. K. H. Logan. *Bur. Stand. J. Res. Wash.*, 1939, **22**, 109–125.—Approximately 33,000 specimens of various pipe materials have been buried by the Bureau of Standards in representative soils for the purpose of investigating the effect of soils on pipe-lines. However, the corrosion of pipe-lines depends on a number of factors, which makes it impossible to report fully underground-corrosion phenomena in terms commonly used for the reporting of corrosion data.

Thus data presented in previous reports do not give a clear idea of the corrosiveness of soils, and this is particularly important with respect to maximum pit depths.

A number of empirical equations have been developed for the purpose of expressing the relations of area, time, and maximum pit depths. No one equation, however, fits every set of pipe-line data better than any other.

A comparison of the computed pit depths with field experience has been attempted for a few soils. It is shown that although no close correlation should be expected, since experiences in the same soil may differ, the data indicate in a general way the corrosiveness of the soils tested. D. L. S.

Crude Petroleum.

460. Examination of Stavropol Crude. G. P. Grigoryev and W. W. Trophimov. *Neft. Khoz.*, January 1939, 22–25.—The Stavropol crude is classified as a heavy, methane–naphthenic crude oil with high asphalt, high sulphur, and low paraffin content. Laboratory fractionation yielded : gasoline (up to 150° C.), 10·1% ; ligroine (150–200° C.), 7·7% ; kerosine (200–275° C.), 15·3% ; light gas-oil (275–300° C.), 6·9%—*i.e.*, light oil fractions (up to 300° C.) 40% ; lubricating-oil fractions, 35·2% ; heavy ends, 23·6%—*i.e.*, residual oil (above 300° C.), 59·3%.

The gasoline fraction of Stavropol crude is similar to Baku aircraft gasoline, its S content is within permissible limits, but the octane number is below 53. The ligroine fraction is unsuitable as a tractor fuel, owing to its low anti-knock value. Both fractions contain less aromatic compounds than the analogous fractions of Sysran crude. The chemical constitution and the boiling characteristics of the kerosine fraction correspond to the standards for illuminating kerosine, but its S content is high. The residual oil fraction has a high specific gravity and a viscosity similar to that of residual oil obtained from asphalt-base crude. The lubricating-oil fractions, however, prepared from the residual oil have a low specific gravity, a high flash, and a high pour point.

Under full-scale refinery conditions, after deparaffinization and desulphurization, oils similar to intermediate grade oils from heavy crude will be obtainable.

From the heavy ends bitumins corresponding to the road bitumen standards can be produced. L. R.

Cracking.

461. Effect of Capacity on the Cost of a Cracking Plant. W. L. Nelson. *Oil Gas J.*, 23.3.39, **37** (45), 80.—The type of plant studied is the distilled oil re-circulation type. Three plants operating on a 24° A.P.I. Mid-Continent reduced crude were designed for capacities of 750, 1,500, and 3,000 brls. per day of reduced crude, and in addition two other designs of 1,500 brls. a day capacity operating on 21° and 27° A.P.I. stocks were examined. Percentage construction costs of the plants of varying capacity are tabulated under thirteen heads, and graphs show (1) total, material, labour, and overhead plus profit costs, plotted against (*a*) reduced crude capacity, (*b*) charge to pipe-still per day; (2) cost in terms of dollars per barrel per day against charging stock capacity.

In addition to higher construction cost per barrel per day, a small plant is also penalized by high supervision costs. A cost balance of each of the five plants is given using assumed values for intake and output products. These figures show not only the reduced percentage profit, but also the appreciably reduced profit in cents per barrel of charging stock, for the small plant as compared with the larger ones. Calculations are made of the increased price which must be obtained for raw gasoline produced or, alternatively, the reduced price at which feed-stock must be purchased by the small-plant operator in order to give a profit per barrel of stock processed similar to that obtained by the larger plant operator. R. A. E.

462. Patents on Cracking. Gulf Oil Corp. E.P. 499,839, 30.1.39. Appl. 30.7.37. Cracking of hydrocarbons to produce high anti-knock gasoline by treating the oil with normally gaseous hydrocarbons with 3–4 C atoms per molecule in an elongated conversion zone of restricted cross-sectional area under super atm. pressure.

E. W. Rembert. U.S.P. 2,146,553, 7.2.39. Appl. 22.7.32. Conversion of hydrocarbon oil by atomizing the liquid oil in its own vapour to produce fog or suspension of fine liquid particles. After removing the oil which is insufficiently atomized, the suspension is then mixed with hot gas, the heat of which vaporizes the liquid particles and subjects the vapours to a cracking reaction.

C. S. Read and V. W. Smith. U.S.P. 2,147,609, 14.2.39. Appl. 8.9.32. Direct-fired oil-heater for cracking operations. W. S. E. C.

Hydrogenation.

463. Plants for Hydrogenation of Fuels in Italy. G. Coppa-Zuccari. *Petrol. Z.*, 1939, **35**, 190–194.—Two plants, one at Livorno and one at Bari, are described which together are able to handle 300,000 tons of raw material per year, including among the finished products 100,000 tons of aircraft fuel. In the first place Albanian crude will be cracked and hydrogenated, but when the Albanian oil-fields are exhausted—which is expected within ten years—it will also be possible to use as raw materials oil shale from Sicily and lignite tar from Italy. The plants are said to be unique, in that solid and liquid products can be treated in every way possible. E. W. S.

464. Patents on Hydrogenation. H. E. Potts. E.P. 500,282, 6.2.39. Appl. 6.5.37. Production of diesel fuel by hydrogenation of heavy liquid carbonaceous material in the liquid phase at 350–420° C. and under at least 200 atm. pressure using WS or MoS as catalyst.

H. D. Elkington. E.P. 501,278, 21.2.39. Appl. 21.8.37. Hydrogenation of ethylene using silver catalysts prepared by subjecting silver or its compounds in an aqueous medium to H_2 in *statu nascendi*, *e.g.*, by the electrolytic reduction of a silver salt.

H. E. Potts. E.P. 501,318, 25.2.39. Appl. 7.5.38. Production of knock-stable motor spirit by hydrogenation of hydrocarbons obtained by synthesis of CO and H_2 using oxides or sulphides of Mo or W as catalysts.

N. V. International Hydrogeneerings-Octrooien Mij. E.P. 501,325, 24.2.39. Appl. 13.6.38. Hydrogenation of liquid olefine polymers of the gasoline boiling range using as catalysts sulphides of Mo and/or W and sulphides of Ni and/or Co.

M. Pier, W. Simon, and E. Donath. U.S.P. 2,149,900, 7.3.39. Appl. 12.11.34. Production of liquid hydrocarbon products of low-boiling point, from an unhydrogenated liquid carbonaceous material containing high-molecular substances of the nature of pitch, asphalt, resins, and similar substances which impair the activity of hydrogenation catalysts. The unhydrogenated material is distilled under atm. pressure without decomposition and completely distilled under reduced pressure to give an overhead fraction (free from high-molecular substances) and a pitchy residue. The overhead fraction and the residue are destructively hydrogenated, and the products obtained from the latter are returned to the initial distillation step.

H. Dreyfus. E.P. 500,264, 6.2.39. Appl. 5.8.37. Manufacture of hydrocarbons by the reaction of CO and H_2 in the presence of a hydrogenation catalyst. The absolute pressure in the reaction zone is normally above 0·5 atm., but is periodically reduced to below 0·5 atm.

W. S. E. C.

Polymerization.

465. Patents on Polymerization. A. Wassermann. E.P. 499,958, 25.1.39. Appl. 25.5.37. Preparation of catalyst for the polymerization of high-molecular-weight substances from those of low molecular weight, consisting of a mixture of aluminium oxide or other metal oxides with an activated heavy metal sulphide with or without a carrier substance.

Distillers Co., Ltd., H. M. Stanley, G. Minkoff, and J. E. Youell. E.P. 499,969, 1.2.39. Appl. 9.8.37. Production of soluble polymerization products of styrene by heating a solution of styrene in *iso*propylbenzene in the presence of not more than 1% by weight of a hydrocarbon having at least 2 aliphatic $< C = CH_2$ groups separated by at least 2 C atoms, *e.g.*, *p*-divinylbenzene, 1 : 4-divinylnaphthalene, etc.

I. G. Farbenindustrie A.-G. E.P. 500,769, 15.2.39. Appl. 24.3.38. Polymerization of dienes in the liquid phase using anhydrous hydrogen halides as polymerization agents at below 20° below zero °C., separating the products boiling without decomposition under pressure of 10 mm. Hg by distillation or by treatment with a selective solvent and subjecting the remaining substance to a further polymerization.

Standard Oil Development Co. E.P. 501,145, 22.2.39. Appl. 2.9.37. Acid polymerization of straight-chain olefines, *e.g.*, *iso*butylene.

P. V. McKinney. U.S.P. 2,142,324, 3.1.39. Appl. 5.5.36. Preparation of catalysts for use in polymerization processes, consisting of silica gel activated with an aluminium salt.

F. W. Sullivan, Jr., and R. F. Ruthruff. U.S.P. 2,145,900, 7.2.39. Appl. 25.11.31. Conversion and stabilization of a mixture of hydrocarbons, at least a substantial portion of which is sufficiently stable to incorporate in motor fuel and a portion of which is of lower boiling range and too unstable to blend with motor fuel. The mixture is heated to 900–1,150° F. and under 750–3,000 lb. pressure/sq. in., and the total converted material is rectified to obtain uncondensed gases, a motor-fuel fraction, and a fraction intermediate in volatility between these gases and motor fuel; the intermediate fraction is then returned for reprocessing.

H. V. Atwell. U.S.P. 2,146,667, 7.2.39. Appl. 23.5.36. Production of liquid hydrocarbons from normally gaseous hydrocarbons containing unsaturated constituents by contacting the gaseous hydrocarbons with a catalyst in a heated reaction zone to effect polymerization.

H. Haeuber and F. Winkler. U.S.P. 2,147,838, 21.2.39. Appl. 29.10.36. Prevention of carbon deposition in polymerization reactions by using apparatus constructed of nickel-chrome steel.

P. V. McKinney. U.S.P. 2,147,985, 21.2.39. Appl. 29.6.36. Preparation of catalyst for polymerization of normally gaseous hydrocarbons into high-molecular-weight products, consisting of silica gel activated by an aluminium salt. The catalyst is prepared from gelatinous silica by the reaction of a soluble silicate and aqueous phosphoric acid.

H. L. Gerhardt and C. M. Hull. U.S.P. 2,148,115, 21.2.39. Appl. 19.6.36. Olefine polymerization into gasoline by forming a complex hydrocarbon compound of a boron halide and contacting the olefines at temperatures above the decomposition temperature of the said complex compound when the olefines are polymerized and the boron compound is decomposed.

H. L. Gerhardt and M. H. Arveson. U.S.P. 2,148,116, 21.2.39. Appl. 19.6.36. Conversion of gaseous hydrocarbons containing propylene and butylenes into liquid hydrocarbons by contacting them in an upright elongated reaction zone with gaseous boron fluoride. The latter forms a complex compound with the unsaturated hydrocarbons.

H. V. Atwell. U.S.P. 2,149,493, 7.3.39. Appl. 1.11.34. Production of motor fuel from cracked gases, which are first separated by fractionation into a normally gaseous fraction substantially free from H_2 and CH_4, a liquid fraction and a cracked distillate, both the liquid fraction and the distillate having a lower initial and end boiling point than those of the final product. The liquid fraction and the normally gaseous fraction are separately polymerized, and the gasoline-like products are blended with the cracked distillate.

H. Velde and H. Tramm. U.S.P. 2,149,562, 7.3.39. Appl. 24.4.37. Production of motor fuel by polymerization of gaseous olefines without catalysts, in which the cross-section area of the stream of gas is gradually reduced as polymerization progresses.

Le R. G. Story. U.S.P. 2,149,800, 7.3.39. Appl. 23.7.36. Conversion of high-boiling hydrocarbons into low-boiling hydrocarbons such as gasoline by treatment with O_2 or oxygenated gases. The large amount of gaseous products formed is divided into a lighter fraction containing oxygenated gas and a heavier fraction. The lighter fraction is recycled and the heavier fraction is polymerized. W. S. E. C.

Synthetic Products.

466. Synthesis of Hydrocarbons and the Production of Lubricating Oils. Anon. *Report of Fuel Res. Board for year ending* 31.3.38, 186–206.—An investigation has been carried out into the mechanism of the Fischer–Tropsch reaction. Work has also been done on the preparation of suitable catalysts, and the most satisfactory one found consisted of cobalt promoted with thoria and supported on acid-washed kieselguhr.

Semi-technical scale-runs have been made on a plant designed for an input of 100–150 cu. ft. synthesis gas per hour. The highest yield of recovered oil product was 77·0 gm./normal cu. m. gas, which is somewhat lower than yields obtained on the laboratory scale plant.

The spirit from the charcoal scrubbers and the directly condensed oil have been investigated and experimental data are given.

The oil obtained by this synthesis contains olefines which can be polymerized to lubricating-oil fractions. This has been carried out on a semi-technical scale using $AlCl_3$ as catalyst.

The resultant product showed good characteristics in regard to coke numbers, before and after oxidation, setting point, flash point, whilst its other properties were up to average values for mineral oils. However, the change of viscosity on oxidation was greater than is usually given by good mineral oils.

The polymerization of gaseous olefines has been studied, and work has also been carried out on the formation of esters by the direct union of olefines and acids.
D. L. S.

467. Patent on Synthesis. Ruhrchemie A.G. E.P. 500,182, 1.2.39. Appl. 1.5.37. Production of catalysts for benzine synthesis from CO and H_2 using a catalyst of the iron group prepared by precipitating the catalytically active substance in the presence of a carrier metal.
W. S. E. C.

Refining and Refinery Plant.

468. Control of Wax Distillate Quality. Part III. L. L. Davis and A. Nelsen. *Nat. Petrol. News*, 11.1.39, **31** (2), R. 14.—A routine laboratory vacuum distillation apparatus and procedure have been developed which give sufficiently reproducible results for accurate wax-distillate control. For a given crude source and commercial distillation unit the viscosity-mid-distilling temperature characteristic may be used to estimate pale oil yields. In the case of distillates from different crudes or from different distillation units, it is necessary to use viscosity–temperature characteristics of the dewaxed distillate to estimate relative pale-oil yields from different distillates.
H. G.

469. Control of Wax-Distillate Quality. Part IV. J. W. Donnel. *Nat. Petrol. News*, 25.1.39, **31** (4), R. 34.—An investigation of the pressing and sweating characteristics of a number of Oklahoma waxy distillates is described. A standard procedure was used throughout, and it was concluded that although the distillation range of a wax distillate is a valuable measure of the quality and uniformity of such distillate from a given source, it is not an inherent characteristic and is not necessarily an absolute criterion of quality. The pale-oil yield of a wax distillate depends on the distillation range, viscosity/temperature characteristics, and the wax content of the distillate. Viscosity, wax content, and the crystal structure of the wax are the factors affecting pressability. Pressing efficiency or wax yield are affected by the condition of the press, operating conditions, and crystal structure. The yield of scale wax from the sweating process depends principally on the oil content of the slack, which in turn is dependent on the efficiency of pressing.
H. G.

470. Solvent Dewaxing and its Bearing on Manufacture of Waxes. R. Lee and E. S. Nicholls. *IIme Congrès Mond. Pétrole*, 1937, **2** (Sect. 2), 9–13.—The authors discuss solvent dewaxing with reference to character and quality of the wax removed from oil by this method. It is possible to obtain " slack wax " or petrolatum (according to the stock which is treated) with a much lower oil content than in the products obtained by cold-pressing or cold-settling and centrifuging. High-melting petrolatums and petroleum ceresins may be made by sufficiently well separating wax from oil.

A slack wax containing a wide range of waxes may be first distilled *in vacuo* to remove distillate wax, which may be sweated in the usual way. The high-melting residue may yield petrolatum or petroleum ceresin.
P. G. H.

471. Progress in Centrifugal De-waxing. B. K. Engel and N. O. Backlund. *IIme Congrès Mond. Pétrole*, 1937, **2** (Sect. 2), 25–30.—A description of modern methods for the continuous centrifugal separation of wax from oils and residues of varying origins. The choice of a suitable solvent is made after laboratory trials. Special importance is attached to the " heavy solvent " process, in which chlorinated hydrocarbons are used, either alone or in admixture with other solvents.
P. G. H.

472. Differentiation of Paraffins and Centrifugal Dewaxing. M. B. Brute. *IIme Congrès Mond. Pétrole*, 1937, **2** (Sect. 2), 43–53.—The microscopical appearance (polarized light) of Pechelbronn distillates is used to decide when dewaxing must be effected by centrifuging in place of cold pressing. Pressable wax appeared as large, ribbon-like crystals. Non-pressable wax consisted of short, fine needles. The presence of a proportion of crystallizable wax (derived from lighter fractions of the oil) in non-pressable distillate did not influence microscopical appearance, but caused considerable increase in pour point of oil after centrifugal dewaxing. After removal of the light wax fractions by steam distillation it is possible to obtain oils with good pour points.

From their refraction and crystalline appearance the oil waxes for the heavier distillates were judged to approach ozokerite ceresin. Re-distillation without vacuum converted them into crystallized paraffins. X-Ray spectra show that this transformation is due to molecular chain shortening. P. G. H.

473. Microscopical Control of Dewaxing. J. Ferraud. *IIme Congrès Mond. Pétrole*, 1937, **2** (Sect. 2), 55–62.—A definite relationship has been observed between the crystalline form of paraffin wax and the efficiency with which dewaxing may be effected, either by cold pressing or by centrifugal treatment.

A technique is described for studying the various fractions from a vacuum distillation bench by means of a polarizing microscope. The information so obtained enables the appropriate dewaxing conditions to be applied and may be of assistance in investigating dewaxing difficulties. P. G. H.

474. "Carrier" Distillation Process for Asphalt and Lubricants. W. W. Kraft and W. J. Bloomer. *Nat. Petrol. News*, 22.2.39, **31** (8), R. 58.—The process is a development of the well-established principle of the application of the partial-pressure effect by the introduction of a third vapour for the purpose of better fractionation. In considering the substitution of steam as the "carrier" the desirable characteristics of the carrier are: (*a*) low molecular weight, (*b*) ability to condense completely at reasonably low pressures, (*c*) final boiling point should be at least 50° below the initial boiling point of the residue. In the Coubrough process a light, non-viscous distillate such as gas-oil or kerosine fulfils these requirements. It is mixed with the charging stock and removed from the top of the vacuum fractionating tower and re-circulated. The innovation is claimed to increase the flexibility of the plant and the quality and yield of the lubricating-oil fraction. H. G.

475. Influence of Distillation Conditions on Characteristics of Mineral Oils. A. Hanriot and R. Weick. *IIme Congrès Mond. Pétrole*, 1937, **2** (Sect. 2), 71–75.—The authors distilled crude oils by high vacuum and by steam-distillation processes and determined the viscosity, refractive index, and A.S.T.M. carbon-test characteristics of the resulting distillates. They show that the method of distillation appreciably affects these characteristics. Up to viscosities of Engler 100° at 50° C., the carbon-test figures and refractive indices are substantially identical for oils of equal viscosity whether produced by high vacuum or by steam distillation. Above this viscosity limit the high vacuum oils have carbon-test figures and refractive indices appreciably worse than the others, indicating the presence of products other than those originally present in the crude produced by thermal decomposition.

Viscosity–Carbon Test and Viscosity–Refractive Index graphs are a useful means of control, since abnormal points indicate the presence of such products. W. P.

476. Refining Lubricating Oils with Aniline. A. V. Kirsanov and A. F. Novikova. *Nat. Petrol. News*, 28.12.38, **30** (52), R. 616.—Pure aniline has been used as a selective solvent in the refining of a 290–350° C. cut from Chusovsky crude. Aniline was used in proportions varying from 1 : 4 to 2·5 : 1 and at temperatures varying from 0° C. and 20° C., and was recovered from the extract by washing with dilute HCl. The oils were separated into two fractions which differed from each other by the following amounts: density, 0·04–0·08; refractive index, 0·023–0·096; iodine value, 8–11; average molecular weight, 21–46. The sulphur content of the original oil was 5·4% weight and the separated fractions contained 0·3–1·5% more and 1·5–2·4% less sulphur, respectively, than the original oil. The considerable differences between the properties of the separated fractions are taken as an indication that aniline has a selective action on different and definite hydrocarbons and that it dissolves aromatic bodies and certain sulphur bodies, leaving paraffinous bodies and other sulphur compounds undissolved. H. G.

477. Boiling-Film Heat-Transfer Coefficients in a Long-Tube Vertical Evaporator. G. W. Stroebe and E. M. Baker. *Industr. Engng Chem.*, 1939, **31** (2), 200.—A vertical tube 1·76 in. i.d. 20 ft. long was arranged so that it could be fed at the base with liquid (water, sugar, or " Dupanol " solutions) at the boiling point. The tube was steam heated. Feed rates varied from 250 to 2,000 lb. per hour. The results were correlated by the equation :

$$h_l = \frac{7{\cdot}8 \times 10^6 \times v^{0\cdot1}}{\left(\frac{C_p\mu}{k}\right)^{0\cdot3} \sigma^2(\Delta t_l)^{0\cdot13}}$$

where h_l = boiling liquid film heat-transfer coefficient, B.T.U./(hr.) (sq. ft.) (°F.).
v = specific volume of vapour, cu. ft./lb.
σ = surface tension, dynes/cm.
Δt_l = liquid film temperature difference, °F.
C_p = specific heat, B.T.U./(lb.) (°F.).
μ = viscosity, lb./(ft.) (hr.).
k = thermal conductivity, B.T.U./(hr.) (sq. ft.) (°F./ft.).

The variables are based on the average liquid temperature, and this may be estimated by means of a chart as a function overall temperature difference, vapour head temperature, feed rate, liquid specific gravity, and specific volume.

The work does not allow terms to be included for the dimensions of the tube, but recalculation of the work of other observers on the basis of the above equation indicates a trend towards lower coefficients with decrease of boiling length. P. D.

478. Liquid Velocity and Coefficients of Heat Transfer in a Natural Circulation Evaporator. A. S. Foust, E. M. Baker, and W. L. Badger. *Industr. Engng Chem.*, 1939, **31** (2), 206.—Experiments were made on the evaporation of water in a basket-type evaporator containing thirty-one 2·5 in. o.d. tubes 48 in. long. The effects of temperature drop and boiling point on the heat transfer coefficients and rate of circulation were investigated. P. D.

479. Steam-Film Heat-Transfer Coefficients for Vertical Tubes. E. M. Baker, E. W. Kazmark, and G. W. Stroebe. *Industr. Engng Chem.*, 1939, **31** (2), 214.—Steam-film coefficients were measured for a vertical tube 2 in. o.d. 20 ft. long. The results obtained, together with those of other workers using tubes of different length, can be represented by the equation :

$$h_s\left(\frac{\mu^2}{\rho^2k^3g}\right)^{\frac{1}{3}} L^{\frac{1}{2}} = 0{\cdot}29\left(\frac{k\Delta t_s}{\mu\lambda}\right)^{-0\cdot2}$$

where h_s = steam film coefficient, B.T.U./(hr.) (sq. ft.) (°F.).
μ = viscosity, lb./(ft.) (hr.).
ρ = density, lb./cu. ft.
k = thermal conductivity, B.T.U./(hr.) (sq. ft.) (°F./ft.).
L = length of tube, ft.
Δt_s = steam film temperature difference, °F.
λ = latent heat of condensation, B.T.U./lb. P. D.

480. Extension of Plant at the Destileria Fiscal de la Plata. Anon. *Bol. Inform. Petroleras*, Nov. 1938, **15** (171), 104–106.—Decree authorizing installation of a topping, cracking, and polymerization plant at the above works for the purpose of securing an improved grade of petrol from the crude oils dealt with there. H. I. L.

481. Patents on Refining. Manvers Main Collieries, Ltd., W. F. Carr, T. G. Woolhouse, and W. Green. E.P. 501,077, 21.2.39. Appl. 4.10.37. Steam treatment of acid sludge from mineral oil and benzole refining to recover hydrocarbons and dilute acid.

W. W. Kraft. U.S.P. 2,149,058, 28.2.39. Appl. 15.11.35. Method and apparatus for the fractional distillation of petroleum oils.

W. J. von Piotrowski and J. Winkler. U.S.P. 2,151,147, 21.3.39. Appl. 23.10.37. Preparation of organic compounds from acid sludge obtained from the refining of mineral oils.

R. L. Rude. U.S.P. 2,152,155, 28.3.39. Appl. 30.9.35. Method of protecting vacuum-creating equipment of distillation plants. W. S. E. C.

482. Patents on Distillation. Kodak, Ltd. E.P. 500,195, 30.1.39. Appl. 29.7.37. An improved vacuum distillation apparatus.

J. H. W. R. Van Tonningen. U.S.P. 2,149,943, 7.3.39. Appl. 23.12.35. Method of fractionation of hydrocarbons. W. S. E. C.

Chemistry and Physics of Petroleum.

483. Effect of Pressure on Viscosity of *n*-Butane and *iso*Butane. B. H. Sage, W. D. Yale, and W. N. Lacey. *Industr. Engng Chem.*, 1939, **31** (2), 223.—The viscosity of gaseous and liquid normal- and *iso*butane was measured over the temperature range 100–220° F., and at pressures up to 2,000 lb. per sq. in. The results are given in tabular and graphical form. P. D.

484. Separation Processes : Separation of Isotopes by Fractional Distillation of Water. M. Randall and W. A. Webb. *Industr. Engng Chem.*, 1939, **31** (2), 227.—A description of the construction and method of operation of two packed columns used for concentrating deuterium oxide from water. P. D.

485. New Reaction for Unsaturated Hydrocarbons and Peroxides. E. L. Lederer. *IIme Congrès Mond. Pétrole*, 1937, **2** (Sect. 2), 85–89.—The author studies colorimetrically the reaction between unsaturated bodies and salts, formed by the combination of metals exhibiting variable valencies, with carboxylic and sulphonic acids of the aliphatic, aromatic, and hydro-aromatic series. Co and Mn salts are stated to be most suitable for this purpose and a high sensitivity is claimed.

Parallel with the above colour reaction, the formation of peroxides has been established in an appreciable amount for the unsaturated hydrocarbons and in less quantities for the saturated hydrocarbons.

The author has used the reaction of the Mn salts for the estimation and elimination of peroxides.

A method is described for the elimination of sulphur and its components by the use of Ag salts. J. K.

486. Thermal Stability of Butane and *iso*Butane. G. R. Schultze and H. Weller. *Oel u. Kohle*, 1938, **14**, 998–1011.—The apparatus used in this work is described in detail and illustrated by diagrams, showing how it can be used to investigate the kinetics of the decomposition both of the pure butanes and of mixtures of them with nitrogen. Two methods were used for analysis of the resultant hydrocarbons based on fractional distillation at low and atmospheric pressures, respectively. Olefines were confirmed by absorption in a solution of mercuric nitrate in nitric acid saturated with sodium nitrate.

As a result of analyses of the products of decomposition, it was deduced that the primary reactions at 700° C. were :—

In the case of *n*-butane :—

$n\text{-}C_4H_{10} \longrightarrow C_4H_8 + H_2$	15%
$n\text{-}C_4H_{10} \longrightarrow C_3H_8 + CH_4$	54%
$n\text{-}C_4H_{10} \longrightarrow 2C_2H_4 + H_2$	16%
$n\text{-}C_4H_{10} \longrightarrow C_2H_4 + C_2H_6$	13%

In the case of *iso*butane :—

$iso\text{-}C_4H_{10} \longrightarrow iso\text{-}C_4H_8 + H_2$	52%
$iso\text{-}C_4H_{10} \longrightarrow C_3H_6 + CH_4$	48%

In the first case the primary decomposition consists in the breaking of bonds in the middle and at the end of the molecule, with evolution of hydrogen, whereas in the latter the bonds at the ends of the molecule only are broken.

The influence of temperature and pressure and of the presence of inert diluents was investigated, and the results were recorded with numerous tables and diagrams. Velocity constants are given for the different reactions, and their dependence on temperature is illustrated. Finally, from considerations of the kinetics of the reactions, it was concluded that chain reactions, resulting from the production of free radicals, play an important part in the complex decomposition. T. T. D.

487. Stereoisomeric Hexaethyl*cyclo*hexanes. H. Koch and H. Steinbrink. *Brennst Chemie*, 1.11.38, **19** (21), 407, 408.—In continuation of previous investigations (Abstr. No. 1331, 1938) a new hydrocarbon has been isolated having a melting point of 104·7–105·0° C., and has been identified as the solid stereoisomeric hexaethyl*cyclo*hexane. Elementary analysis yielded: 85·51; 85·61% C, and 14·33; 14·46% H (calculated 85·62% C; 14·38% H). Molecular weight was found to be according to Beckmann 250, 251, 253; according to Rast 248; and ebullioscopic according to Riesche 246; theoretically 252. L. R.

488. Chemical Constitution and Viscosity, with Reference to Benzene Hydrocarbons with Longer Side-chains. A. W. Schmidt, G. Hopp, and V. Schoeller. *Oel u. Kohle*, 1938, **14**, 985–990.—Distillation, fractional crystallization, selective solvents, and adsorption have all been suggested, without success, as instruments to aid in the separation of pure compounds from lubricating oil or to throw light on its constitution. An alternative is the synthesis of lubricating oil-like substances of known composition and comparison of properties with those of natural lubricating oils. A most important property for this purpose is the viscosity–temperature relationship.

The dependence of this relation on chemical constitution is shown by plotting "*m*" (the constant from the Walther formula) against the number of carbon atoms in the molecule. In the series $C_6H_5–C_nH_{2n+1}$, a smooth curve is obtained, "*m*" decreasing as the number of carbon atoms in the side-chain increases. From the data on paraffins published by Evans, the authors show that in this series too the value of "*m*" decreases with increasing chain-length, and attribute their similar results with the alkylbenzenes to the increasing importance of the side-chain as its length increases and the molecule becomes essentially paraffinic.

The authors observe a similar relationship between "*m*" and the number of carbon atoms in the molecule in the monochlorparaffins.

By extrapolation, it should be possible to estimate, from measurements on lower members of the series, the viscosity–temperature relationship of higher members, which would be very difficult to synthesize and measure directly. Reciprocally, from the viscosity–temperature relationships of the natural lubricating oils it may be possible to obtain a clue as to their composition. T. T. D.

489. Experimental Researches on the Inflammability of the Vapours of Some Combustible Liquids. J. Baron. *Ann. Off. Combust. liq.*, 1938, (5), 875–947.—After a discussion of the theory and previous work, the apparatus used is described. The method used is the static method, sometimes called the pyrometer method. The effect of different oxygen-combustible ratios was tried together with the effect of inert gases, *e.g.*, N_2 and CO_2, all experiments being carried out at pressures of 700 mm. of mercury or lower. Inhibitors, such as acetaldehyde and $PbEt_4$, were also tried. With ethyl ether increase in the concentration of N_2 lowers the spontaneous ignition temperature (S.I.T.), and a decrease in the oxygen ratio from 6 to 0·5 : 1 causes a slight increase. CO_2 also causes a decrease in S.I.T., but lowering the pressure causes a slight increase. These results conform with what would be expected from the chain theory. Additions of acetaldehyde and $PbEt_4$ cause an increase in the S.I.T. The condition of the walls of the pyrometer affect the results, and it was found that after the use of $PbEt_4$ it was impossible to reproduce previous figures, apparently due to PbO having combined with the glass. The critical pressure of inflammability gives the critical temperature = 221 ± 0·5°·C. for mixtures of ether, oxygen, and inert gas. It is also found that the product of the partial pressures of ether and oxygen equal a constant, K = 49. Normal propyl ether behaves in a similar manner to ethyl ether. Experiments with acetaldehyde show that pressure has a much greater effect than with ethyl ether. Also increasing the richness of the mixture gives first a lowering and then an increase in the S.I.T. H. L. W.

490. Separation of 1 : 2 : 4-Trimethyl*cyclo*hexane and an *iso*Nonane from a Mid-Continent Petroleum. J. D. White and A. R. Glasgow, Jr. *Bur. Stand. J. Res. Wash.*, 1939, **22**, 137–152.—A fraction b.pt. 130–145° C. from an Oklahoma crude was treated with liquid SO_2 to extract aromatics, the immiscible portion redistilled, and the fraction boiling at 140–145° C. treated with silica gel.

The residual oil consisting of paraffins and naphthenes was then distilled at 215 mm. Hg and separated into two main fractions, one b.pt. 101–102·2° C. and already dealt with, the other b.pt. 98–99° C.

The latter fraction was found to consist of nonanaphthenes and *iso*nonanes, and was separated by distillation at 215 mm. Hg into one portion containing the bulk of the naphthenes and another rich in paraffins. From the former nearly pure 1 : 2 : 4-trimethyl*cyclo*hexane was isolated by crystallization from solution in dichlorodifluoromethane, whilst continued distillation of the latter at normal pressure alternated with distillation at 215 mm. Hg yielded a fraction containing 85 mole-% of an *iso*nonane—probably 2 : 3-dimethylheptane.

With reference to this method of separation of the paraffinic fraction, it is a general principle that with paraffins, naphthenes, and aromatics boiling at nearly the same temperature, members of one class differ materially from those of another class in the change of their vapour pressure with temperature. Because of this, a binary mixture composed of a paraffin and naphthene boiling close together can have the partial pressures of its components so altered as to enhance their separation by fractional distillation or to reverse the order in which they distil.

The boiling point, freezing point, density, refractive index, and critical solution temperature in aniline have been determined for the 1 : 2 : 4-trimethyl*cyclo*hexane and the *iso*nonane.

Comparison of the properties of the naphthene with those reported for its synthetic stereoisomers indicates that the petroleum hydrocarbon is either 1-$_{cis}$-2-$_{trans}$-4-$_{cis}$-trimethyl*cyclo*hexane, or 1-$_{cis}$-2-$_{trans}$-4-$_{trans}$-trimethyl*cyclo*hexane.

This naphthene constitutes about 0·1% and the *iso*nonane about 0·05% of the original petroleum. D. L. S.

491. Summary of an Investigation of the Composition of a Mid-Continent Petroleum Distillate Boiling between 100° C. and 130° C. R. T. Leslie. *Bur. Stand. J. Res. Wash.*, 1939, **22**, 153–170.—This paper summarizes the work done since 1929, and includes some new information obtained since the publication of previous specialized and summary papers.

About 6% vol. of the total crude distilled between 100 and 130° C. and 130 litres of this fraction were obtained after the first laboratory distillation. The constituents of about one-sixth of the volume of this fraction were identified or characterized by physical properties, isolated or concentrated, and their concentration in the crude estimated.

About $\frac{1}{4}$ vol. remained as unidentified distillate, and consisted of about one-twelfth vol. of material, of which the constitution was only predicted, and about $\frac{1}{6}$ vol. of additional quantities of constituents isolated previously. The remainder was lost during the investigation or fell outside the range on subsequent distillations.

Photomicrographic studies were made of those concentrations of distillates which could be crystallized.

A table is included which summarizes most of the conclusions reached in the investigation. This gives, in addition to the relative quantities of constituents actually isolated, conclusions as to the probable presence or absence of each of the other hydrocarbons boiling at 98–131° C. on which data have been found in literature.

D. L. S.

See also Abstract No. 530.

Analysis and Testing.

492. Determination of Gum in Oils Heavier than Kerosine. F. L. Smith and E. B. Shannon. *Refiner*, 1939, **18**, 53.—According to the authors, the following method of estimating gum is suitable for oils to which the air jet method (A.S.T.M. D.381 34T) cannot be applied. 100 ml. of the sample are diluted with 50 ml. 80° petroleum naphtha in a 500-ml. separating funnel and 20 ml. of absolute ethanol are added. After 30 sec. vigorous shaking 10 ml. of distilled water are added and a swirling motion is applied. The emulsion is allowed to break, adding 5 ml. water if necessary. The alcohol–water layer is transferred to a beaker. The extraction is repeated twice on the oil layer. The total alcohol–water extract is washed with 80° naphtha to remove any oil, then evaporated in a tarred glass dish on a steam bath, and finally heated for 12 hr. in a constant-temperature oven at 212° F. to 220° F. G. R. N.

493. Miscibility Relations in Solvent Dewaxing. F. W. Hall and B. Y. McCarthy. *IIme Congrès Mond. Pétrole*, 1937, 2 (Sect. 2), 15–24.—The factors involved in the choice of conditions for dewaxing by means of ketone–benzol solvent are discussed.

A cloud-point test makes it possible to establish temperatures of initial separation of wax, oil, solid benzol, and water. An apparatus is described and interpretation of phase diagrams is explained.

A method of determining wax content in charge stock is also given. This is based on the change in the ratio solvent in waxy solution : solvent in dewaxed filtrate.

P. G. H.

494. Observations on Fractionation of Paraffins. M. Bertrand. *IIme Congrès Mond. Pétrole*, 1937, 2 (Sect. 2), 31–34.—The melting point of paraffin contained in a given distillate or re-cycled product may be gauged from the congealing point of the paraffinous oil (cooling curve, rotating thermometer, or A.S.T.M. methods may be used). Curves are given showing relationship between percentage paraffin of different melting points and congealing point of oil. The relationship is linear above 40% paraffin content. A curve is also given showing corrections for various viscosities of oil.

Practical applications of the curves are given, of which the chief is the calculation of the proportion and melting point of paraffin contained in a paraffinous oil. In this case it is necessary to know the density, congealing point, and viscosity of the oil before and after cold filtration. P. G. H.

495. Identification of Paraffin in Ozokerite/Paraffin Mixtures. P. Woog, J. Givaudon, and Chmelevsky. *IIme Congrès Mond. Pétrole*, 1937, 2 (Sect. 2), 35–41.—The authors discriminate between paraffin and ozokerite by means of the high-melting constituents which characterize ozokerite.

Distillation curves of paraffin (obtained by distillation in cathodic vacuum) are regular, whilst those of ozokerite, or mixtures with paraffin, consist of two parts. The second, steeply rising part of the curve relates to the high-melting constituents. The detection of fractions melting at least at 85° C. indicates that ozokerite is present. A fractional crystallization from solution at 0° C. may be used in place of distillation.

P. G. H.

496. Estimation of Paraffin in Petroleum Products. A. Spack. *IIme Congrès Mond. Pétrole*, 1937, 2 (Sect. 2), 67–69.—In the usual methods of precipitating wax from oil by means of solvents it is found that variation in melting point and percentage wax occurs from one test to another. The author's method is based on simultaneous variation in the percentage and melting point of wax precipitated from a given solvent at different temperatures.

The relationship between percentage and melting point of wax is linear. It is possible to read off from graph the proportion of wax of any selected point which is obtainable from an oil.

If acetone be used as the solvent, asphaltic material is precipitated, and may be filtered off before the oil–wax solution is cooled. P. G. H.

497. Standard Method and New Apparatus for Analyses of Pyroschists and Lignites. J. Barlot. *IIme Congrès Mond. Pétrole*, 1937, **2** (Sect. 2), 77–80.—The author describes a method of analysis and an apparatus for the quantitative estimation of yields of oil by pyrolysis. Analysis involves (*a*) the determination of the total organic matter, which is dispersed in a mineral mass which has to be eliminated, (*b*) the assessment of the quality of the material by processing quantitatively to determine oil yield.

The method of analysis consists in subjecting a well-pulverized sample to the following procedure: (1) remove soluble bitumens by extraction with benzene, carbon tetrachloride, etc.; (2) extract with HCl to remove carbonates of alkaline earths, iron, and aluminium salts, etc.; (3) extract with HF and H_2SO_4 to remove silicates. The residue then consists of organic matter together with pyrites and traces of silica. These are determined on aliquot portions, thus giving total organic material.

The method of processing consists in heating about 1 kg. of material in an iron tube in an electric furnace and collecting the water and oil so formed in a series of washers. The apparatus is described in detail and permits of the process being carried out either with or without a stream of inert gas or with a stream of reactive gas, *e.g.*, hydrogen. The amounts of water, oil, and sulphur products (namely, H_2S) are measured. W. P.

498. Continuous Distillation Apparatus for Laboratory Use. G. de Ponte. *IIme Congrès Mond. Pétrole*, 1937, **2** (Sect. 2), 81–83.—The apparatus, which is based on the principles of Walther, is designed to reproduce industrial pipe-still conditions on a laboratory scale. It consists of a long metal tube wound in a spiral and immersed in a molten metal bath. The temperature of the bath is regulated by a thermoregulator which controls the temperature of the liquid leaving the tube. The fractionating column consists of a long tube having an internal reflux and divided into a number of units, each having a worm condenser actuating the reflux. A thermo-regulator controls the temperature of each unit. The bottom of the column has an annular space to receive the condensate. The whole apparatus is heat insulated. Receiving vessels are connected by means of normal ground joints to each unit of the column, these being in turn connected to a common vacuum line. The apparatus permits all the operations of distillation and rectification to be carried out at atmospheric pressure, *in vacuo*, under pressure, and in a current of steam. The distillation speed should not be allowed to exceed 2–3 litres/hr. in order to maintain the internal pressure at a few mm. of Hg. If mercury-vapour pumps are employed, it is essential to insert a froth separator, in order to prevent the formation of mixed oil–mercury vapours which corrode the pumps. It is also possible to collect the " dry " gases by connecting a silica-gel tube to the common vacuum and/or pressure line. M. M. L.

499. Simple Calorimeter for Rapid Determination of Calorific Values of Liquid Fuels. P. Woog, J. Givaudon, and Paulette Dacheux. *IIme Congrès Mond. Pétrole*, 1937, **2** (Sect. 2), 91–95.—A calorimeter consisting of a direct-reading thermoelectric Fery bomb is described. Temperature rise is appreciable, rapid, and regular, and is measured by means of a thermocouple, the recording millivoltmeter being calibrated to record calorific values directly. The original form of apparatus was not reliable, but satisfactory results are claimed for a modified form of Fery bomb immersed in a liquid of low specific heat (perchlorethylene). M. M. L.

500. Determination of the Vapour-locking Tendency of Gasolines. P. Woog, R. Sigwalt, and Mlle. de Mouillac. *IIme Congrès Mond. Pétrole*, 1937, **2** (Sect. 2), 97–100.—The gasoline under test is led, by way of a constant-level device containing a carburettor float valve, through a copper spiral (1) and a specially designed, vertical glass tube (2). (1) and (2) are immersed in a water-jacket through which water from a thermostat at any desired temperature can be passed. A water-pump and Mariotte tube connected to the other end of the system maintain a constant vacuum of 1 m. of water. One type of tube (2) contains a glass bell fitted with a metallic diaphragm, the other has a bulb blown eccentrically to its axis, whereby in each case the appearance of vapour-lock in the system can be observed.

The temperature of the water in the water-jacket is raised until vapour-lock makes its appearance, when the temperature is noted. Although the results obtained on fuels by this method class them in the same order as their vapour pressures (Reid), the authors do not consider that this is conclusive, as only ten fuels have been examined. T. M. B. M.

501. Graphical Representation of Control Tests Employed in Petroleum Refining. R. Pimor. *IIme Congrès Mond. Pétrole,* 1937, **2** (Sect. 2), 101–106.—A chart of tests is given in which tests are listed as abscissæ and products as ordinates, symbols being used to indicate for each product the tests which are essential, auxiliary, unnecessary, and impossible. From this it is immediately apparent as to which tests must be applied to a certain product and to which products a given test is applicable.

W. P.

502. Advances in the Technique of Desorption Gas Analysis. R. Henjes. *Oel u. Kohle,* 1938, **14,** 1079–1083.—The author gives a full description of apparatus for the analysis of mixtures of hydrocarbons, with special reference to natural gases, by adsorption and desorption from active carbon. The individual gases on desorption are characterized by measurements of their thermal conductivities, the apparatus being calibrated for this purpose with a reference gas. Since air has a thermal conductivity intermediate between that of methane and the higher hydrocarbons, it may be used with advantage for this purpose. An electrical circuit for the measurement of the conductivity is described, the deflection of a galvanometer being proportional to the conductivity. Since only comparative readings are required, it is arranged that the galvanometer shall read zero when the apparatus is filled with the reference gas, and the analysis is followed by plotting millivolts against the volumes of gas evolved.

Typical analysis data are given showing good separation of helium, nitrogen, carbon dioxide, and paraffins from methane to the butanes. *iso*Butane is separated from *n*-butane, but the division is not very sharp; olefines cannot be separated from the analogous paraffins with the exception of ethylene from ethane. This, however, is not important, as the fractions containing paraffins and olefines with the same number of carbon atoms can be analysed in the normal way with bromine water.

The author stresses the advantages of this method compared with fractional distillation, both as regards time taken for the analysis, the purity of the fractions obtained, and the ease of manipulation. T. T. D.

503. Ultra-violet Absorption as a Basis of a New Method for the Estimation of Aromatics in Fuels and Lubricating Oils. F. Jactes. *Oel u. Kohle,* 1938, **14,** 1012–1033.—Investigations of the composition of petroleums are concerned in general with the quantities of paraffins, naphthenes, olefines, and aromatics present, as determination of the individual compounds is impracticable, if not impossible. Even so, this analysis into groups is applicable only to gasolines, and depends on the varying reactivity of the different types towards sulphuric acid. Since there is no sharp differentiation between the reactivity of the different classes, methods based on this separation are bound to involve the introduction of errors, to which must be added those due to solution of products of reaction in the gasoline layer. The error involved varies enormously with the concentration of the acid and the conditions of the reaction and even when the same method is used on gasolines of different types and origins.

It is suggested that the measurement of ultra-violet absorption may solve this problem. Extensive work on the relationship between ultra-violet absorption and the constitution of benzene homologues shows that it is possible to make a quantitative estimation of the aromatics in gasoline by means of ultra-violet absorption. The extinction coefficients at 2600–2700 Å.U. of all aromatics boiling below 200° C. at atmospheric pressure that are likely to occur in gasoline have been measured, and from these values have been calculated mean extinction coefficients applicable to the aromatics in the whole gasoline fraction, and to those boiling up to 95° C., 95–122° C., 122–150° C., and 150–200° C. Hence, by measuring the absorption of the gasoline at 2,600–2,700 Å.U., the aromatic content can be calculated in moles per litre, and by the use of mean mol. wt. and mean sp. gr. be converted into volume percentages.

From a critical examination of the accuracy of the method an error of not more than ± 10% of the amount found should be expected, but experimental work has shown that the actual error is usually less than ± 5%.

This quantitative estimation of aromatics is confined to the gasoline range. With increasing boiling point the number of possible aromatics increases rapidly, as does also the number actually present in petroleum. Further, the position and intensities of the maxima are more varied as a result of the presence of derivatives not only of benzene, but also of naphthalene and other condensed ring systems.

Work on a large number of commercial and synthetic lubricating oils shows that, without knowledge of the absorption curves of variously substituted polynuclear compounds, the absorption of lubricating oils cannot be quantitatively interpreted, and only a suggestion of the constitution and amount of the aromatic constituents can be obtained.

More work on this subject is of great importance, especially as the ring analysis method of Vlugter, Waterman, and Van Westen—at present the only other method available for giving an indication of the aromatic content of lubricating oil—gives values which are not more than of the right order of magnitude, and fails in limiting cases. T. T. D.

504. Viscosity and Lubrication. G. Vogelpohl. *Oel u. Kohle*, 1938, **14**, 991–997.—In laboratory measurements of the viscosity of oil in bulk, the temperature can be controlled to 0·01° C. by the use of a thermostat; in the case of viscosity measurements on thin films of oil, great difficulty is encountered in estimating the temperature, which may vary throughout the film. In this paper a mass of work on the subject is critically reviewed under the headings: methods of measuring temperature; results from these measurements; calculation of mean values; temperature fluctuation across the film; methods of estimating the actual temperature.

The questions dealt with are directly connected with the problem of "oiliness," which is dependent on the assumption of "uniform viscosity" in the bearing. As a result of work on the measurement of the actual temperature of the oil film, it is suggested that in those experiments the results of which led to the conception of oiliness, etc., the viscosity was not uniform throughout. T. T. D.

505. Determination of Sulphur in Light Refined Petroleum Oils. W. A. Schulze, V. W. Wilson, and A. E. Buell. *Oil Gas J.*, 23.3.39, **37** (45), 76.—Modifications of the Ethyl Corporation method for determination of total sulphur content by the lamp method are described. It has been found that in the presence of air, at the ordinary temperatures realized during the combustion of gasoline in air, some nitrogen is oxidized, resulting in formation of nitric acid, which reacts with the carbonate absorber solution, thus giving incorrect results for sulphur content of the gasoline. The amount of nitrate found in the absorber solution varies from one analysis to another owing to variation in flame temperature. The use of air or commercial oxygen (which normally contains 0·25–0·5% N_2) is therefore substituted by a carbon dioxide–oxygen atmosphere, using 27–30% vol. of commercial welders' oxygen and 73–70% vol. of dry CO_2 gas. This method also has the advantage of eliminating the usual air-purifying tube. Results of tests carried out comparing results by the air method, corrected for nitrate formation, and by the CO_2–O_2 method are tabulated, and show good agreement. Should the product tested contain nitrogen compounds, then nitrate determinations must be made on the samples after titration, since a portion of the nitrogen present is oxidized. Six tests carried out on a fuel of 0·182 sulphur content gave a maximum deviation of 0·001% in results. A description and illustrations of various parts of the apparatus and assembly are provided. Lamps of 5 ml. capacity are provided for oils of high sulphur content and lamps of 30 ml. capacity for oils of low sulphur content. The reagents employed are sodium carbonate solution of 0·05*N*, hydrochloric or sulphuric acid of 0·05*N* and methyl-orange solution 0·2 gm. in 100 ml. of distilled water. 10 ml. of acid must neutralize exactly 10 ml. of carbonate solution. Procedure for cleaning absorbers, adjustment of pressure, burning of sample, and removal of carbonate solution from absorber is fully described. In titrating, a reference blank is prepared by pipetting 10 ml. of carbonate solution into a clean flask, diluting to same volume as test samples, adding two drops of methyl-orange indicator and neutralizing the sample. The test sample is titrated with acid until the solution colour matches the reference blank. Two drops of acid are then added to the reference blank. The amount of acid added to the test sample to match the altered shade of the reference blank is estimated to the fraction of a drop. The shade of the acidified blank is easier to match than the neutral sample, and a correction can be made to the neutralization value of the test sample. Duplicate determinations should not differ by more than 0·0005% if the sulphur content is under 0·03%, 0·001% if between 0·03 and 0·07, or 0·0015% if 0·07 and higher. R. A. E.

506. Accurate Fractionation of Hydrocarbon Blends. H. Brueckner. *Brennst. Chemie*, 1.1.39, **20** (1), 9, 10.—In a previous article (Abstr. No. 166, 1939) H. Macura and H. Grosse-Oetringhaus claimed that the method of accurate fractionation given by the author is unsuitable for engine benzoles containing less than 10% toluene.

The author presents test results with blends containing less than 10% toluene and shows that contents as low as 2% can be detected by his original method. Details of test procedure given in the article referred to are partly in agreement with the description given by the author several years ago, whilst no essential improvements have been suggested. L. R.

507. Laboratory Study of Condensate. W. F. Fulton. *Oil Gas J.*, 23.3.39, **37** (45), 104.—To ensure the representative nature of the samples of gas and liquid, the well is allowed to produce at the desired rate for a stabilization period of at least 24 hr. before sampling. The sampling period may extend over the following 24 hr., the gas flow being metered and the liquid production determined preferably in the separator. Liquid samples are taken under separator pressure by downward displacement of mercury, and gas samples are taken at separator pressure from taps located at the blow-off on the down-stream side of the separator. Containers and procedure used are described. A gas sample is analysed in a Podbielniak low-temperature fractionation apparatus for all hydrocarbons lighter than heptane; nitrogen is determined by interferometer in the methane fraction and CO_2 by absorption in KOH. A 50-c.c. cylinder of liquid is analysed and the volume, density and mol. wt. of the heptanes and heavier fraction are determined in order that the analysis can be reported in terms of mol. percentages. A high-pressure apparatus is described in which the gas from the separator can be compressed to the desired reservoir pressure, and the compressibility factor determined. Knowing the volume of the experimental recombination bomb and the pressure and temperature, it is possible to calculate the absolute amount of the gas, and to determine, from the liquid–gas ratio measured at the well, the volume of liquid sample to be introduced into the bomb. Correction factors applied and the method employed for introducing the correct amount of liquid are described. The construction of the experimental recombination bomb, which is fitted with an internal stirring motor directly connected to an agitator, is described and illustrated. Liquid and gas samples may be drawn from the container for analysis after equilibrium conditions have been reached. Making use of the amount of gas initially present in the bomb and the calculated density, mol. wt., and volume of the separator liquid introduced, the analyses of gas and liquid may be combined on a molal basis and compared with the analysis of the sample of the equilibrium gas phase from the bomb. R. A. E.

508. Viscosity Determination with the Road Tar Viscometer. H. Mallinson. *Asph. u. Teer*, 1939, **9**, 125–127.—A description is given of the Road Tar viscometer adopted by the Eighth Assembly of the International Permanent Association of Road Congresses. This apparatus, essentially the British Road Tar viscometer, with tubes having orifices of 10 and 4 mm. will be adopted by all member countries, and a brief description will be given in the specification D.I.N. 1995. The test temperatures recommended are 25°, 30°, and 40° C. The procedure of test is given, and it is hoped that other non-member countries will adopt the same apparatus and procedure. H. L. W.

509. Mechanical Testing of Bituminous Road Surfacing Materials. E. Neumann. *Bitumen*, 1939, **9** (1), 1.—The author discusses the results of an investigation of the effect of various factors on the compression strength of sandasphalt, asphaltic concrete, and mastic asphalt, and makes proposals for the revision of the D.I.N. 1996 test for compression strength. It is suggested that a cylindrical specimen is more suitable than the cube of 7·09 cm. edge and can be more easily obtained from a road surface, a cylinder 8 cm. in height and 8 cm. dia. is therefore recommended. The specimen is prepared in a press instead of by tamping, test temperatures of 20 and 40° C. are proposed and rates of application of load of 20 mm./min. for sandasphalt and fine asphaltic concrete and 30 mm./min. for coarse asphaltic concrete are recommended. A. O.

See also Abstract No. 530.

Motor Fuels.

510. Action of Inhibitors on Polymer Gasoline. W. B. Ross and L. M. Henderson. *Oil Gas J.*, 23.3.39, **37** (45), 107.—Data are presented to show that the addition of small amounts of commercially available anti-oxidants to Gray-treated polymer distillates inhibits gum formation. Tests carried out on the gasolines included determination of the induction period by the oxygen-bomb test of the Ethyl Gasoline Corporation type and of the copper-dish gum content as determined by the Bureau of Mines method or by that described in Federal Specification VV-L-791a, method 330·1. These tests were carried out on a sample blend of equal parts of Pure Oil Co. polymer gasoline and straight-run gasoline to which varying amounts of inhibitors AO-3, AO-9, AO-14, U.O.P.-4, G-10 (solid) were added in quantities up to 45 lb. per 1,000 brl. of gasoline. The results are tabulated and plotted on curves, and are compared with results obtained by similar inhibitor additions made to ordinary unleaded doctor-treated Mid-Continent gasoline. The tables show that the susceptibility of the polymer blend to inhibitors is of the same general order as that of ordinary cracked gasoline. Other tests carried out with inhibited polymer blends to which varying amounts of T.E.L. had been added show that the effect of T.E.L. on the induction period was negligible, but the copper-dish gum content generally increased with increasing additions of T.E.L. up to 5 ml./gallon. Other tables and graphs show results obtained by addition of varying amounts of inhibitors U.O.P.-1 and U.O.P.-4 to six samples of polymer gasolines obtained by the U.O.P. catalytic process. The susceptibilities of these gasolines to inhibitors is of the same order as that of the polymer blend previously described. The properties of all the polymer gasolines and of the blend of Pure Oil Co. polymer and straight-run gasoline are shown. The octane ratings of the polymer gasolines were all between 80·5 and 83·0 A.S.T.M. motor method or L-3 method. Octane ratings carried out on blends with gasolines of lower octane rating show polymer gasoline to have a higher blending value than its actual rating. R. A. E.

511. Colouring of Petrol—Reasons Justifying the Practice. Anon. *Bol. Inform. Petroleras*, Nov. 1938, **15** (171), 107–109.—Note explaining the reasons why high octane number, anti-knock petrols are now coloured, by common consent in U.S.A., Great Britain, Germany, Canada, Uruguay, and other countries, to distinguish them from the low grade or third quality spirit, which is colourless. This practice has now been adopted in the Argentine Republic as well. H. I. L.

512. Patents on Motor Spirit. N. V. de Bataafsche Petr. Mij. E.P. 499,978, 1.2.39. Appl. 8.9.37. Removals of mercaptans from petroleum distillates by extraction with the aid of an alkaline-reacting substance. The reaction is carried out with a ternary sulphonium base dissolved in water or in a non-acid organic solvent which is totally immiscible in water and substantially immiscible with the liquid hydrocarbon mixture.

Standard Oil Development Co. E.P. 500,380, 8.2.39. Appl. 4.10.37. Desulphurizing gasolines consisting of a considerable quantity of olefines by mixing with H_2SO_4 (45–75% concentration), at an elevated temperature and under sufficient pressure to prevent vaporization of the gasoline. The mixture is separated into an extract and a raffinate phase and the gasoline recovered from the extract phase. The raffinate is passed over a dehydrogenation and desulphurization catalyst at 800–1100° F. and gasoline of improved octane number is recovered from the product.

N. V. International Hydrogeneerings-Octrooien' Mij. E.P. 500,859, 16.2.39. Appl. 31.8.38. Production of non-knocking benzines by treating unstable benzines (boiling below 260° C. and at least for the most part above 130° C.), in the vapour phase with H_2 in the presence of catalysts, and separating from the final product a safety fuel of high anti-knock stability boiling within 130–260° C.

J. M. Whiteley. U.S.P. 2,146,039, 7.2.39. Appl. 29.11.35. Improving the octane number of motor fuel containing paraffinic and non-paraffinic hydrocarbons by separating the fuel into light and heavy naphtha fractions; the heavy fraction is treated with a selective solvent and the paraffinic raffinate is passed over a dehydrogenating catalyst and the product blended with the light naphtha to produce the desired motor fuel.

T. W. Rosebaugh. U.S.P. 2,146,353, 7.2.39. Appl. 13.4.36. Desulphurizing hydrocarbons containing sulphur in the form of carbonyl sulphide by circulating a stream of the substance through an anhydrous alcoholic alkaline hydroxide solution under conditions to form H_2S, and then further treating with aqueous alkaline hydroxide to remove the H_2S.

O. S. Pokorny. U.S.P. 2,146,650, 7.2.39. Appl. 11.1.34. Refining oils of the naphtha and burning oil range by agitating them with tricresylphosphate, and, in the case of lubricating oils, with mixtures of esters, are used, and an aliphatic alcohol, acetone, phenol, cresol, etc.

R. E. Burk and E. C. Hughes. U.S.P. 2,148,056, 21.2.39. Appl. 9.3.36. Desulphurizing petroleum distillates in several stages with a sulphur-removing media, *e.g.*, caustic soda solution.

G. H. von Fuchs and L. E. Border. U.S.P. 2,149,035, 28.2.39. Appl. 19.2.37. Removal of mercaptans from hydrocarbon liquids by treating them in the liquid state at temperatures below 200° F. with metallic copper in the presence of a small amount of SO_2 in the absence of H_2SO_4. W. S. E. C.

Gas, Diesel and Fuel Oils.

513. Requirements of Present-day Diesel Fuels. R. Heinze and M. Marder. *Oel u. Kohle*, 1938, **14**, 832–843.—The increasing importance of diesel engines is illustrated by statistics dealing with the consumption of diesel fuels of various origins in Germany from 1931 to 1937. American (A.S.T.M.), British (B.S.I.), and German specifications for the various classes of diesel fuel are quoted and methods compared under the following headings: (1) Requirements as to Purity, Flash Point and Calorific Value; (2) Coke Number and Hard Asphalt; (3) Corrosive Properties; (4) Cold Test and Viscosity; (5) Ignition Properties (Cetane Number, etc.); (6) Stability on Storage and Miscibility. The individual tests are discussed at some length, particular attention being paid to the effects of differences in detail in the tests as performed in different countries, on the significance of the results obtained. T. T. D.

514. Miscibility and Storability of Diesel Fuels. O. Roelen. *Oel u. Kohle*, 1938, **14**, 1077–1079.—Diesel fuels derived from different sources have a widely differing content of, and solubility for, asphaltic material. The cyclic hydrocarbons obtained by dry distillation or hydrogenation of lignite and coal have a fairly high content of asphaltic bodies in solution. On the other hand, the synthetic diesel fuels have little solvent power for asphalt, whilst that obtained by the Fischer–Tropsch hydrogenation of carbon monoxide is purely aliphatic. It will thus be realized that storage of blends of fuels of different origin is bound to be difficult, and that a practical test that can be used to determine whether a fuel may be safely stored without deposition of asphalt, either alone or mixed with others, is essential.

The author reviews the work of Marder on this subject, and gives an account of the work carried out by the Ruhrchemie Aktien-Gesellschaft. As a result of more than 100 storage tests of mixtures of various fuels with a highly asphaltic fuel, diesel fuels were divided into three classes: (*a*) those which gave mixtures which remained clear indefinitely; (*b*) those which started precipitating after 3–9 months; (*c*) those which gave a precipitate on mixing, whilst more came down on long standing. No class was found in which, if the precipitate formed on first mixing were filtered off, the filtrate remained clear on standing.

The author proposes the following as a test for the miscibility and storability of diesel fuels : to the fuel under test is added a fixed amount of precipitant ; part of the mixture is allowed to stand for 24 hr. at room temperature in the dark ; part is heated for 1 hr. to 180–200° C. under fixed atmospheric conditions. In evaluating the quality of the oil, the amount of precipitate in each case is taken into account. As precipitant is used a special highly aliphatic fuel, "RCH-Bezugdieselkraftstoff," of fixed physical and chemical properties ; this fuel also has a very good cetane number, and may thus be used as a reference fuel in cetane number determinations.

T. T. D.

Lubricants and Lubrication.

515. Technical Control Required in the Manufacture of Greases. W. A. Lutz, H. A. Ambrose, and W. A. Gruse. *Oil Gas J.*, 9.2.39, **37** (39), 62 ; 16.2.39, **37** (40), 49.—The paper opens with a general survey of the applications of grease and the significance of the melting-point and other physical tests.

The authors state that attempts to set up a theory of grease consistency cannot be very successful without taking into account the nature of grease structure, and at present no generally accepted explanation of the latter exists.

The determination of consistency is discussed with special reference to the work of Bingham, Porter and Gruse, and Arveson. It is suggested that the rotary viscometer is a suitable instrument for investigating the apparent viscosities of soft greases. By carrying out determinations at temperatures on both sides of the approximate melting point, it may be possible to obtain a more accurate measure of the softening and melting points. At the present time, however, no method for studying flow and consistency properties of greases appears to be in a satisfactory state of development.

The separation of oil from grease is of considerable practical importance, and in this connection the work of Herschel and of Farrington and Humphreys is discussed. Chemical stability is also of great importance, and this is influenced by, among other things, the nature of the hydrocarbon oil present. It is well known that greases oxidize in storage and service, and various tests of oxidation stability have been devised, of which the best known are those due to McConville, and Wright and Lutz. The paper concludes with a criticism of the practice followed by many purchasers of buying greases to their own narrow specifications. D. L. S.

516. Effect of Pressure on Lubricating Greases. B. B. Farrington and R. L. Humphreys. *Industr. Engng Chem.*, 1939, **31** (2), 230.—Ten compounded oil–soap greases were tested in a press designed by Herschel (*Proc. Amer. Soc. Test. Mater.*, **33**, Part I, 343). The variables studied were oil content, type of soap, time of pressing, pressure, and oil viscosity. It was found that the results could be correlated by the empirical equation

$$\frac{T}{L} = a + bT$$

where L = oil loss in weight per cent.
T = time in hours.
a, b = constants.

The ultimate oil loss is equal to $\frac{1}{b}$, whilst the constant a is found to be a qualitative measure of the bleeding of oil.

Increasing oil content increases rate of loss and ultimate loss. Increase of pressure has a similar effect. Decreasing the viscosity of the oil and keeping the content unchanged increases the rate of loss, but does not affect the ultimate loss. For the same grease consistency more oil can be pressed from sodium soap greases than from calcium or aluminium soap greases. The type of soap used is not the most important factor in bleeding.

P. D.

517. Effect of Fatty Acid Derivatives on Lubricants. A. W. Ralston and E. J. Hoffman. *Nat. Petrol. News*, 8.1.39, **31** (6), R. 50.—The addition of small quantities, up to 5%, of alkyl-aryl ketones, RCOR[1], to low-viscosity petroleum lubricating oils reduces running friction and increases film strength. The mono- and di-chlorinated derivatives of these bodies also are useful addition agents. Xylylheptadecyl ketone was prepared by Friedel and Craft's reaction thus :

$$C_{17}H_{35}CoCl + AlCl_3 \longrightarrow C_{17}H_{35}CoCl\ AlCl_3$$
$$C_{17}H_{35}CoCl\ AlCl_3 + C_8H_{10} \longrightarrow C_{17}H_{35}CoC_8H_9AlCl_3 + HCl$$
$$C_{17}H_{35}CoC_8H_9AlCl_3 + nH_2O = C_{17}H_{35}CoC_8H_9 + AlCl_3 + nH_2O$$

The ketone is light coloured and miscible with spindle oil. Products of this type have flash points 415–460° F. and viscosities (S.U. 100° F.) 83–315 sec. Mixtures of monochloroxylylheptadecyl ketone and xylylheptadecyl ketone have excellent lubricating properties as judged by the data derived from dynamic tests. H. G.

518. Present Position of the Problem of the Lubrication of Engine Cylinders. C. A. Bouman. *Centre d'Etudes Thermiques, X^e Séance*, 16.12.38. *Chal. et Ind.*, Jan. 1939, **20** (225), 168.—The mechanical considerations are first considered, particularly the effect of the viscosity of the lubricating oil on fuel consumption. The temperature of cylinder and piston render fluid lubrication almost impossible. The deposits causing ring sticking are next discussed, and it is considered that this trouble is most serious in aero and diesel engines. Incomplete combustion of fuel (in which is included lubricating oil which finds its way into the combustion space) has been shown to cause ring sticking in diesel engines, and the possibility of overcoming this by increasing operating temperatures has been suggested. The methods of overcoming this trouble differ with I.C. and C.I. engines. In the first, the use of more stable, less volatile oils has helped, whilst in the latter, particularly with high-speed diesels, some success has attended the use of less stable oils which are capable of dissolving or dispersing the gummy products of incomplete combustion. A study of these deposits has led to attempts to differentiate between "soot" and "carbon." A more extensive examination has been undertaken by a collaborator, M. Th L-A van der Poel, by extraction with 70% alcohol instead of aromatic-free 60/80 spirit. Up to the present this method has not clarified the mechanism of oxidation of oil in the ring grooves. H. L. W.

519. Patents on Lubricating Oil. Standard Oil Development Co. E.P. 500,385, 8.2.39. Appl. 25.10.37. Lubricant consisting of a hydrocarbon lubricating-oil base and a sulphurized polymer of rapeseed or mustard-seed oil or a blended oil having the approximate properties or rapeseed oil.

A. P. Lowes and Imperial Chemical Industries Ltd. E.P. 500,979, 20.2.39. Appl. 20.8.37. Production of synthetic lubricating oils by the condensation of chlorinated long-chain aliphatic hydrocarbons with benzene or homologues in the presence of aluminium or anhydrous aluminium chloride. The condensation products are subjected, either during or after isolation from the reaction mixture, to a mild cracking operation.

E. W. Fawcett and Imperial Chemical Industries Ltd. E.P. 501,194, 20.2.39. Appl. 18.6.37. Stabilization of vegetable, animal, or fish oils and fats by adding an anti-oxidant obtained by high vacuum distillation of a triglyceride oil or fat containing natural anti-oxidants.

Standard Oil Co. and A. H. Stevens. E.P. 501,369, 27.2.39. Appl. 31.8.37. Refining of hydrocarbon oils and wax by subjecting the mixture at between + 5° and − 15° F. to the action of a mixture of liquid SO_2 and isopropyl ether.

W. H. Bahlke and F. W. Scheineman. U.S.P. 2,145,852, 7.2.39. Appl. 23.8.34. Refining heavy oil to form bright stocks by mixing the oil with propane in several stages, and fractionating the mixture at 250–650 lb./sq. in. at 110–200° F. in a high-pressure settling zone. The asphalt and propane–oil solution are separately withdrawn, and the pressure of the propane–oil solution is reduced. The solution is then acid-treated at a lower pressure than that used in the asphalt separation ; the oil is neutralized and the propane removed.

P. C. Keith, Jr., and H. O. Forrest. U.S.P. 2,146,147, 7.2.39. Appl. 28.6.34. Lubricating-oil refining by counter-current extraction with a mixture of a naphthenic solvent and propane. After removing the propane from the extract, it is extracted counter-currently with the naphthenic solvent.

L. W. Cook and C. C. Towne. U.S.P. 2,147,573, 14.2.39. Appl. 27.11.37. Solvent dewaxing of hydrocarbon oils by means of a wax crystal modifying substance which is a reaction product of rubber in an aromatic solvent in the presence of glacial acetic acid and stannic chloride.

E. C. Knowles. U.S.P. 2,147,579, 14.2.39. Appl. 20.9.35. Dewaxing of hydrocarbon oils using a mixture of an aliphatic ether containing up to 8 carbon atoms, and methyl ethyl ketone. The latter is used in excess of 40% by vol. of the solvent mixture.

C. L. Read. U.S.P. 2,148,710, 28.2.39. Appl. 21.11.36. Process of increasing the yields of high-quality lubricating oils by extracting the lubricating fraction of petroleum with phenol, removing the extract phase and adding 5–10% of water and then propane in quantities of ½–4 vols. of propane to 1 vol. of extract–water mixture. After standing for some time, the bottom layer is discarded, and the upper layer, after removing the propane, is returned to the extraction tower.

J. M. Whiteley and G. A. Beiswenger. U.S.P. 2,148,716, 28.2.39. Appl. 23.5.32. Fractionation of heavy oil into several fractions by means of light hydrocarbons consisting principally of propane. W. S. E. C.

See Abstract No. 504.

Asphalt and Bitumen.

520. Bubble Formation in Mastic Asphalt. W. Neukom. *Asph. u. Teer*, 1939, **39** (5), 62–66.—A description is given of analyses undertaken on samples of road constructed with mastic asphalt of various types with a view to determining the reason for excessive bubble formation. Bubbles are formed owing to the action of heat on open spaces in the mastic asphalt which contain air and traces of water. It is stated that in order to reduce the possibility of bubble formation, the concrete formation should be dry and that an insulating medium such as absorbent paper, wrapping paper, or newspapers should be placed between the concrete and mastic. The type of bitumen used should be carefully selected, since it has been found that where bubbles occur, the bitumen extracted from the road sample shows a great degree of hardening, whereas when the bitumen properties are essentially the same as when laid, few bubbles are found. A sample taken from a satisfactory section of road showed a decrease in penetration of 38%, in ductility of 50%, and an increase in Ubbelohde drop point of only 11%. E. W. H.

521. Roughness and Grip Characteristics of Asphalt and Tar Roads. F. J. Nellensteyn. *Asph. u. Teer*, 1939, **39** (5), 66–68.—The article describes determination of the coefficient of friction on various stretches of road in Holland by means of a dynamometer road car using a partly braked wheel. It was found that the coefficient of friction of road surfaces varies with the actual hour of the day, *e.g.*, on the particular road tested the coefficient was highest at 2 a.m. and lowest at 2 p.m., the temperatures at all times being roughly inversely proportional to the coefficient.

The author points out that the construction of rough-surfaced roads, although excellent from the point of view of non-skid properties, is not always desirable in the interests of hygiene, and quotes an example of the use of pulverized rubber in the surface dressing whereby surface irregularities causing roughness were filled with rubber, giving a smooth surface without impairing cohesion. E. W. H.

522. Use of Bitumen for Road Construction in the United States. D. B. Miller. *Rev. Pétrolif.*, 1939 (828), 317–319.—The author gives a short summary of the history of the use of bitumen for road-making in America, and then briefly discusses liquid asphalts—the most common type—which are divided into three grades: road oils, kerosine cutbacks, and naphtha cutbacks. Equally important in the U.S.A. is the employment of bituminous emulsions.

A table is given showing the methods of road construction and dressing suitable for roads of traffic density varying from 0 to 300 vehicles per day to 500 to 5000 vehicles per day, together with the approximate cost per mile for widths of from 18 to 20 ft., and the expected durability in years of each type of construction.

E. W. H.

523. Employment of Asphaltic Materials for Road-surfacing. W. S. Housel. *Rev. Pétrolif.*, 1939 (828), 320–321. Attention is directed to the marked development in the use of bituminous materials for road-surfacing in the United States during the past few years. The most recent progress is in connection with improvements to secondary roads such as those serving rural communities, carrying a comparatively small amount of traffic, the treatment of which is justified by the resulting economy of maintenance. Mention is also made of the greatly increased use of bituminous materials for car parks, aerodrome runways, etc., by earth-mix and soil-stability methods, and of problems connected with the action of bituminous materials on mineral aggregates. E. W. H.

524. Uses of Emulsions. M. Duriez. *Rev. Pétrolif.*, 1939 (828), 322–329.—The uses and properties of emulsions for road-making together with standardized methods of testing, are described. Suitable types of emulsion for such purposes as surface-dressing, grouting, soil stabilization, etc., are given, together with descriptions of methods of application in each case. E. W. H.

525. Preparation and Properties of Bitumen Emulsions. G. Radulesco. *Rev. Pétrolif.*, 1939 (828), 330–336.—It is stated that the consumption of bituminous emulsions in France is of the order of 500,000 tons per year. Rapid-breaking surface-dressing types are the most important and most difficult to control, since they must be stable in storage, break rapidly on the road, and have a viscosity sufficiently high to prevent them draining away on application.

The author finds that the different properties of the emulsions depend directly on the pH of the aqueous phase, and in particular refers to the degree of dispersion, which has a considerable influence on the properties of bituminous emulsions. The degree of dispersion is claimed to be most conveniently and quickly examined by determining the coefficient of extinction of green light by the suitably diluted emulsion in a colorimeter. The large particles which are present to varying extent in all emulsions tend to coalesce on shaking the emulsion, and if these are removed the emulsion remains free from large particles unless again agitated.

The interfacial tension, which can only be measured between dilute benzene solutions of the bitumen and aqueous buffer solutions, decreases to a minimum as the pH increases. The interfacial tension is lowered by the different emulsifying agents added, and thus the emulsibility of the bitumen is increased. This, in turn, can be shown to be increased as the band of stability increases on the pH scale. This band is obtained by plotting the mean diameter of the particles against the pH, generally from pH 10·5 to 12·5, and is widened by the addition of emulsifiers.

The viscosity of emulsions can be increased by additions of substances as gelatine, bentonite, etc., but these increase the stability, and are thus unsuitable for surface-dressing-type emulsions. Stearic acid has been found suitable, however, since the stability is not increased, but emulsions containing this acid are found to be markedly thixotropic. Better results have been obtained with the use of certain sulphonic acids, in which the increase in viscosity is due to inversion. The author points out that this method may lead to unsatisfactory results in practice.

Stability on storage depends on a large number of factors (pH, degree of dispersion, etc.), as does the rate of sedimentation.

The "rate of breaking" of the emulsion depends on the surface area with which it is in contact, the nature of this surface, whether it is hydrophobic or hydrophilic, on the kind and amount of the emulsifying agent, on the presence of salts, and particularly on the atmospheric conditions.

The bitumen used has a considerable effect on the different properties of the emulsions, and the author attributes this difference to the presence of different active bodies. H. G. W.

526. Main Roads of Montana. D. L. Cheney. *Rev. Pétrolif.*, 1939 (828), 337–341.—Owing to transport expenses, roads in Montana are limited to the use of local aggregates and cutbacks. The main roads are treated with premixed aggregate either on the road or at works, whilst for the secondary roads cheaper cutbacks are used and thickness of the course is reduced. Details of the premixing operations are given, the aggregate being heated to 120° C. at the works and the calculated amounts of preheated cutback added. This type of road is laid only where conditions are severe, otherwise mixing is carried out on the site. Tentative specifications are given for the rapid, medium, and slow curing cutbacks used, these specifications being similar to those of the American Asphalt Institute; the rapid curing cutbacks are used for the best roads. A method of procedure in Road Mix construction is described, giving details of the procedure used for the main and secondary roads, and of the preliminary treatment before laying. All roads are seal-coated 10–21 days after laying, using rapid-curing cutback. It is claimed that Montana has thus obtained at reasonable cost over 10,000 kilometres of good-class level roads with long life and freedom from dust. H. G. W.

527. Effect of Addition of Bitumen on the Properties of Cement Mortar and Concrete. R. Grün and H. Schlegel. *Bitumen*, 1939, **9** (2), 25–31.—An investigation has been made of the effect of addition of up to 10% of bitumen, in emulsified form, on the ductility, beam test, shrinkage, and water resistance of mortar and concrete. Four brands of emulsion were used with Portland and blast-furnace cements, and in most cases tests were made on specimens stored in air for periods up to 28 days, and on specimens stored in water for 28 days; the shrinkage tests were made on specimens stored for 120–140 days. The results showed that the effect on the setting time differs with different cements and emulsions. The mortar strength was decreased to varying extents, but was still satisfactory. Water resistance was improved, whilst shrinkage increased with Portland cement and decreased with blast-furnace cement. In the case of concrete the strength was only slightly affected with a wet mix, and not at all with a plastic mix, whilst shrinkage was decreased in both cases. A. O.

528. Tar Chippings and Water. H. Mallinson and H. Schmidt. *Asph. u. Teer*, 1939, **4**, 51–54; **5**, 59–62; **6**, 75–79; **7**, 91–94.—The paper describes an investigation which was undertaken in an attempt to determine the factors affecting the resistance to stripping of tar coatings from chippings, on immersion in water.

100 gm. of warm chippings were mixed with 3·5 gm. of tar at 80° C. until completely coated, the chippings were stored in a closed box for a given time at room temperature and then covered with water; alternatively, the chippings were stored in the box for ½ hr. at 50° C. and then covered with warm water, the extent and time of stripping being noted.

No relation was found between content of phenols or bases and resistance to stripping, and although addition of these materials to tars resulted in increased stripping, it is pointed out that the amounts present in road tars are very small. The addition to tar of 0·5% of Montan wax or 2% of brown coal tar improved resistance to stripping, but oil or pitch from the latter, paraffin wax, soaps, stearic acid, stearine pitch, Montan wax pitch, rosin, and Irga chemicals had no effect. A tar containing 15% asphaltic bitumen also showed no improvement over a tar from the same source and of similar viscosity to the mixture. Emulsification of a tar with a small amount of water gave a slight improvement, and addition of 1% anthracene to a tar which was easily stripped gave complete resistance to stripping.

The effect of setting time of the tar on the resistance to stripping was examined, but no definite relationship found; similarly no relationship was found between resistance to stripping and micron content or benzole insoluble content of tar.

It is pointed out that the differences in properties of aggregates are far greater than between tars. Tests with a series of stones with tars of good, poor, and intermediate resistance to stripping showed no differences between the stones with either of the first two tars; the intermediate tar, however, showed marked differences. Siliceous and quartz aggregates had good resistance to stripping, basic and water-soluble stones poor resistance, and weathered stone, such as mica, orthoclase, and plagioclase, intermediate resistance. Tests with glass showed that resistance to stripping was improved by water extraction of alkaline constituents.

Differences were found in limestones from different sources, and this is attributed to porosity, nature and size of crystal formation and carbonate content.

Resistance to stripping increased with increasing time of storage; this is thought to be due to penetration of tar into pores in the stone, since viscosity increase was not possible in the closed box. The adverse effect of increased temperature of the water is believed to be due to reduction of viscosity and breakdown of structure in the tar film. Tests with distilled and tap water and various solutions indicated that resistance to stripping could be graded according to concentration of sodium carbonate, but it is pointed out that this classification has little practical value; calcium hydroxide and carbonate generally gave similar results to water.

The authors conclude that viscosity, setting properties, and the presence in the tar or on the stone surface of material which will result in the building up of a structure in the tar film all have an influence on the resistance to stripping of the tar by water; the presence in or on the stone of water-soluble materials or materials which swell in water has an adverse effect. It is pointed out that the behaviour of materials in the laboratory stripping test may not necessarily indicate the suitability of the materials for use in road construction, and results should be considered in conjunction with the practical experience with similar materials. A. O.

529. Patent on Asphalt. E. B. McConnell. U.S.P. 2,148,869, 28.2.39. Appl. 30.10.36. Production of asphalt by heating petroleum residuum to 400–550° F. and air-blowing, and introducing while air-blowing and, without substantial cooling, a small amount of catalyst—*e.g.*, oxides of nitrogen, chlorine, or a sulphur-containing substance. W. S. E. C.

See also Abstract No. 509.

Special Products.

530. Photo-oxidation of *iso*Propyl Ether. G. Radulesco. *Ann. Off. Combust. liq.*, 1938 (6), 1071–1082.—*iso*Propyl ether is oxidized in the presence of light, giving acetone, water, acids, peroxides, and resinous products. The proportion of these products formed varies with the volume of oxygen absorbed. Methods are given for estimating the percentage of acetone, water, and gum formed by oxidation, and the actual changes are brought about by immersing bulbs containing *iso*propyl ether and oxygen in a constant-temperature water-bath at 16° C. at a distance of 13 cm. from the filament of a 500-watt lamp. Absorption of oxygen is measured with a mercury manometer.

Under these conditions it was found that 0·1% of *p*-cresol, *p*-aminophenol, or *p*-phenylenediamine retards oxidation of *iso*propyl ether, and hence the formation of oxidation products, *p*-phenylenediamine being the most efficient. On the other hand, *a*-naphthol, which is a good oxidation inhibitor for cracked gasoline, actually assists oxidation of *iso*propyl ether under the conditions specified. E. W. H.

531. Insulating Oils. Shell Technical Service. *Olii Min.*, 1939, **1**, 1–6; **2**, 17–22.—It is stated that prior to the development of methods of refining mineral oils, rosin oil was used for transformers and switches, but these oils did not give satisfactory results owing to formation of polymerization products, appreciable acidity increase, high evaporation loss, and tendency to thicken at high temperatures.

With the progress made in mineral-oil refining, mineral oils were adopted, although they also suffer to some extent from the same disadvantages.

The factors most affecting the quality and life of a transformer oil are: high temperatures, oxidizing action of the air, and contact with a metallic surface; copper in particular has an adverse effect on the oil, the effect being more pronounced with a polished surface. In presence of acidic compounds insoluble soaps are formed with lead, and the acidity of the oil does not increase.

The injurious action of sludge in the oil is pointed out: sludge settles and collects on insulators, forming brittle oxycellulose with materials composed of cellulose.

The influence of light on the stability of the oil has been studied by observing the action of the individual solar spectrum rays; the red rays have the least effect.

The various refining processes are outlined, and the superiority of solvent extraction over the usual sulphuric acid treatment is pointed out.

The selection of the crude oil is also of great importance, since not all crudes yield distillates suitable for transformer-oil manufacture; naphthenic base crudes have been found especially suited for the purpose.

Concerning the methods of testing adopted in various countries, no definite agreement has been as yet attained, nor has the reproduction of the complex reactions occurring during use yet been achieved. The various procedures for estimation of the resistance of the oil to oxidation and high temperatures are substantially the same, and consist in subjecting, for a given time, a definite amount of oil to the action of heat and air either in presence or not of a catalyst. The alteration of the oil is shown by the increase in acidity and percentage of deposit. The data thus obtained by any one method have a purely comparative value. Other tests applied to this type of oil of particular importance are: flash point (P.M.), viscosity, dielectric strength. The latter property is not related to the physicochemical characteristics, but depends on the purity of the oil; traces of moisture or dust may impair dielectric strength appreciably.

Finally the switch oils are mentioned; although the conditions under which these are employed are different from those of transformer oils, the same characteristics are requested. P. G.

532. Agricultural Products as Insecticides. R. C. Roark. *Industr. Engng Chem.*, 1939, **31** (2), 168–171.—A review of insecticides and fungicides at present in use in the U.S.A. is presented. Although the materials used are mainly derived from the mineral kingdom, products from the vegetable kingdom are increasing in importance, in virtue of the fact that while many organic compounds are more toxic to insects, they are usually far less toxic to man than lead arsenate and other similar inorganic poisons.

The naturally occurring insecticides obtained from plants—*e.g.*, nicotine, pyrethrin, rotenone, etc.—are quoted, together with the pine-tar oils and similar materials obtained from trees of the coniferous type. Indications are, however, that the insecticides of the future will be organic compounds synthesized from products of plant origin. H. C. R.

533. Permeability of Neoprene to Gases. T. P. Sager and M. Sucher. *Bur. Stand. J. Res. Wash.*, 1939, **22**, 71–79.—The permeability of neoprene in the form of (*a*) unsupported films and (*b*) coated fabrics, to various gases has been examined and compared with that of rubber. It was shown that the rate of permeation is inversely proportional to the thickness of the film.

The specific permeability of unsupported films to hydrogen, helium, and carbon dioxide at 25° C. was shown to be about $\frac{1}{5}$–$\frac{1}{6}$ that of rubber. The effect of temperature was investigated in the case of hydrogen, and the increase in the rate of permeability with temperature found to be exponential.

In the case of coated fabrics, the cloth makes a definite contribution to the gas impedance. Moderate amounts of the usual compounding ingredients do not appreciably affect rate of permeation. However, the use of highly volatile solvents in spreading the compounded neoprene tends to produce pinholes.

Toluol or its equivalent appears to be the most satisfactory solvent. D. L. S.

534. Use of Paraffin Wax in Pyrotesting. F. Taradoire. *IIme Congrès Mond. Pétrole*, 1937, **2** (Sect. 2), 63–65.—Wax which is intended for use in conjunction with explosives must be free from acidity, fatty matter, and finely divided mineral matter. Inspection tests are described. In order to prevent autoxidation of wax, the addition of anti-oxidants (*e.g.*, hydroquinone) is recommended. P. G. H.

535. Patents on Special Products. E. I. Du Pont de Nemours and Co. E.P. 499,770, 27.1.39. Appl. 27.7.37. Production of boron fluoride by treating anhydrous HF and a compound from the group boric acid, boric anhydride and a borate, and treating the resultant product with calcium fluoride.

B. Collie, S. Ellingworth, A. Robertson, and Imperial Chemical Industries Ltd. E.P. 500,197, 30.1.39. Appl. 30.6.37.—Preparation of an insecticide comprising benzthioazyl-2-ethyl sulphide or 5-chlorobenzthiazyl-2-ethyl sulphide, etc., mixed with an inert pulverulent diluent or carrier—*e.g.*, chalk, kieselguhr, or bentonite—to which is added, if desired, a water-absorbent or dust-binding agent such as wool fat. The carrier may be dissolved, suspended, or emulsified in water or a suitable organic liquid which is immiscible with water—*e.g.*, mineral oil.

Standard Oil Development Co. E.P. 500,377, 8.2.39. Appl. 13.9.37. Production of a modified alkyd resin by reacting a polyhydric alcohol containing more than 2 OH groups with not more than 1 mol. of a naphthenic acid derived from petroleum until such partial esterification is substantially complete, and then reacting the resultant compound with a polybasic acid until the esterification is completed.

G. W. Johnson. E.P. 500,382, 8.2.39. Appl. 20.10.37. Production of olefine oxides by the catalytic oxidation of low-mol.-wt. olefines with O_2 or gases containing O_2 in the presence of Ag salts. The latter are prepared by the reduction of solutions or suspensions of Ag compounds in the presence of Cu or Au compounds.

G. W. Johnson. E.P. 500,745, 15.2.39. Appl. 13.9.37. Refining of synthetic methanol by means of chromic acid.

E. H. Strange and T. Kane. E.P. 500,880, 16.2.39. Appl. 16.8.37. Manufacture of alkyl chlorides by treating olefines with hydrogen chloride in the presence of prepared bauxite, at 150–300° C. at atm. pressure.

G. W. Johnson. E.P. 501,015, 16.2.39. Appl. 16.8.37. Conversion of compounds containing triple carbon linkages into those containing double carbon linkages by treating C_2H_2 or its non-metallic organic derivatives (containing triple carbon linkages) in an aqueous alkaline solution with metallic Zn.

G. W. Johnson. E.P. 501,071, 21.2.39. Appl. 1.9.37. Manufacture of butadiene from butylene using a solid catalyst.

W. H. Carmody. U.S.P. 2,149,275, 7.3.39. Appl. 23.9.37. Production of resins from acid sludge and pure still residues resultant respectively from the acid-washing and fractionation of light oils produced in the by-product coking of coal.

W. H. Carmody. U.S.P. 2,149,577, 7.3.39. Appl. 17.6.36. Production of an aromatic-solvent oil from distillate oil obtained from still residues. W. S. E. C.

Detonation and Engines.

536. Recent Aero-Engine Research Work. H. C. Mansell. *Aircr. Engng*, March 1939, **11** (121), 92–94.—A survey is made of the major phases of research which have led to the present position of the aero-engine as regards improved performance and reliability.

Increases of approximately 100% in the specific output of engines during the past ten years, due almost equally to increased piston speed and mean effective pressure, the latter secured largely by advanced anti-knock qualities of fuel, have imposed special demands on valve gear, piston, and bearing capacity. Reliability of valve gear has been vastly improved in the case of poppet-valve engines, mainly through metallurgic research in connection with valve steel, but the author considers that piston and bearing problems are still at the present time in large measure the focus of engine research. The tin-base white-metal, hardened with antimony, has given way to the general use of copper–lead mixtures, cadmium base alloys, and practically pure silver as bearing metals, whilst, as a result of intensive research still proceeding in the field of the lubricating medium, considerable advance has been made in corrosion inhibitors, film strength, and anti-ring gumming additives.

Study of the factors which control detonation has led to the evolution, in both liquid- and air-cooled engines, of greatly improved methods of cylinder cooling and promoted research into the improvement of supercharger efficiency with a view to reducing mixture temperature, which, apart from the fuel, is the most important feature governing detonation point. As an example of the combined effect of fuel anti-knock qualities and blower efficiency it is stated that, under economy conditions, one octane number is equivalent to about 3° C. mixture temperature change or 3 lb./sq. in. mean effective pressure alteration.

Reliability, durability, and freedom from servicing have been steadily improved due to research into fundamental engine problems and the design of certain items of the equipment. The ignition system, for example, has undergone considerable review to meet the demands of increased engine duty and prolongation of periods between attention; in this connection spark-plug life has been extended by the adoption of a fine wire, precious-metal electrode system, and vastly improved insulation material, together with series resistors or condensers which greatly decrease the spark-point erosion rate.

In a brief indication of possible developments and needs of the future, the author refers to the advantages of high altitude or "sub-stratospheric" operation and possible means of meeting the demands thereby imposed upon blower design and operation. The growing claims of the C.I. engine are also considered, as are too the advantages offered by the substitution of the direct-petrol-injection system for the carburettor. Complete immunity from engine freezing problems, reduced fire risk, increased reliability of control, and perfect distribution are said to be the chief claims for this system. E. F. C.

537. Development of Liquid Cooling. W. N. Twelvetrees. *Aircr. Engng*, March 1939, **11** (121), 107–110.—Following illustrations of early cooling systems in which inherent defects are shown, the paper describes a typical glycol-cooled installation for a 12-cylinder V engine incorporating thermostatic control and dual radiators. The important effect of coolant temperature on cylinder liner joints is discussed and the advantages gained by the use of thermostats in controlling this variable in actual flight conditions are shown. The paper concludes with a description of the method of operation of "pressure cooling" which represents the latest stage of development. In principle, the system consists of the normal installation layout, but, instead of glycol alone, the coolant is a mixture of water with 30% glycol, whilst the positive pressure relief is usually about 30 lb./sq. in. instead of 3 lb./sq. in. Advantage is taken of the high specific heat of water, whilst ebullition in flight is avoided. In addition, the superior specific heat of the coolant mixture over that of glycol alone permits of a reduction in radiator size of 20%. E. F. C.

538. Valve and Valve Seat Technique for Automobile and Aero Engines. F. R. Banks. *J. Instn Aut. Engrs*, 1938, **7** (3), 32–63.—This article reviews the causes of poor valve and valve-seat performance in automobile and aero engines, and gives examples of good and bad valve and port design. Specifications of the principal steels now being successfully employed, and details of many types of valve insert designs, are shown. Increasing interest is now being shown in the materials used for valve guides, and it is suggested that unalloyed cast iron, which is in general use in this country in automobile practice, may be superseded by nickel/chrome iron alloys. Experiments have shown that for every 0·001 in. increase in initial clearance between valve stem and guide, the wear in 10,000 miles running increased by 0·002 in. More serious attention is now being given to the finish of guides, valves, and seats. New types of silchrome steel are now being introduced which give much better results than the Silchrome No. 1, which has proved successful over a long period. Some details of results obtained with the new "Brightray" alloy of nickel and chromium for treatment of valves and inserts are given. This material is claimed to improve the resistance to wear, oxidation, and corrosion. Results now obtained in aero-engine practice show what can be achieved when cost is not of primary importance, and considerable data are given dealing with aero-engine valves and inserts. Regarding the use of leaded fuels, the author contends that many troubles attributed to lead have been due primarily to the increased power permitted by such fuel. It is true that leaded fuels are not so tolerant of poor design, inferior valve material, and poor seating. Engines do not now suffer as they used to do from these defects, and almost universal use of leaded fuels should provide adequate answer to queries regarding their value. C. H. S.

539. Supercharging of Compression–Ignition Engines. J. H. Pitchford. *J. Instn Aut. Engrs*, 1938, 7 (3), 64–94.—This paper reviews the behaviour of the smaller size of high-speed four-cycle engine under pressure-charged conditions. Under pressure-charged conditions the C.I. engine has one practical advantage over its petrol counterpart, as with the former air only is dealt with up to the moment of fuel injection, and the phenomena of pre-ignition and detonation do not exist. Unless the structure of the engine is very materially increased, injection timing must be adjusted to maintain substantially constant maximum pressures, which entails some sacrifice in the response to supercharge. It has been found in the case of a separately driven blower that the fuel consumption at loads below the smoke point is reduced by an amount corresponding to the work done by the supercharger on the engine piston during the suction stroke. The author contends that the reason for increased fuel consumption of road vehicles which are supercharged is mainly due to the fact that the greater power available is fully used in acceleration and in maintaining a higher road speed.

The alternatives to supercharging are enumerated. Objections to these alternatives lead the author to the conclusion that supercharging is the best solution to the increased power problem, since a relatively large increase in nett output may be realized without appreciably increasing the severity of the temperature conditions of the piston and rings, which must be regarded at present as the "bottle neck" in increasing specific engine output.

The influence of supercharging on general design is dealt with at length, and details of the popular types of supercharger are given, with their respective advantages and disadvantages. Experiments with induced intake rams lead to the conclusion that much more might be done by this means to increase power output. Data are given on the practical application of supercharging of C.I. engines dealing specifically with the use of a "Centric" supercharger, and details of cost are given relating to the production of engines of varying capacity. C. H. S.

540. Preliminary Chemical Reactions in a Gasoline Engine. L. A. Peletier, S. G. Van Hoogstraten, J. Smittenberg, and P. L. Kooyman. *Centre d'Etudes Thermiques, X^e Séance*, 16.12.38. *Chal. et Ind.*, Jan. 1939, **20** (225), 120.—During some research work on a C.F.R. engine into the effect of mixture strength on compression pressure, it was observed that measured values did not agree with those expected from calculation. This fact was confirmed by means of an optical indicator; a quartz window in the combustion chamber revealed a blue luminescence whilst running with the ignition switched off, thus establishing the existence of chemical reactions.

A C.F.R. engine was driven by an electric motor at 900 r.p.m., with an air-intake temperature of 150° C. and a compression ratio of 5·75 : 1, the ignition being switched off. As the mixture was progressively enriched, the expansion curve on the indicator diagram became flatter, and the torque required to motor the engine decreased. Minimum torque was recorded with a mixture 80% rich, under which conditions auto-ignition took place about 60° after top dead centre. The occurrence of these phenomena was suppressed by the addition of tetra-ethyl lead.

A small two-stroke motor-cycle engine was used for further tests, in which the exhaust gases were collected and analysed. The cylinder-head temperature was slowly raised whilst the engine was motored at 1500 r.p.m. At first the exhaust gas temperature rose in proportion to the head temperature, but when the latter reached 240° C. a sharp break occurred, accompanied by auto-ignition. Further heating of the head resulted in the formation of peroxides in the exhaust gas; a second zone of auto-ignition was manifest at 500° C. The results confirmed the conclusions of other observers, that considerable quantities of peroxides can be formed during the compression stroke, and that they have an important influence on the occurrence of detonation.

Similar effects were produced by means of a quartz tube in which hydrocarbon

vapours and air were allowed to meet at elevated temperatures, these being again accompanied by the occurrence of an exothermic oxidation process. It is believed that the phenomena studied in the two engines and the quartz tube are identical.
K. T. A.

See also Abstract No. 518.

Coal and Shale.

541. "Dust-proofing" of Coal. Anon. *Report of Fuel Res. Board for Year ending* 31.3.38, 89–96.—The effect of the porosity of coal on dust-proofing has been investigated, since it is considered probable that porosity largely determines the relative proportion of oil required for treating various coals.

To prevent penetration of the dust-proofing liquid some experiments in blocking the entrance to the pores have been tried out. The greatest success has been achieved with (*a*) 1–2% raw rubber or (*b*) an *iso*butylene polymer in a mineral oil. The equipment for spraying coal is described and two different types of nozzle have been used: (*a*) air operated—the fluid being atomized by air, (*b*) pressure operated—in which the oil at high pressure is forced through a fine orifice.

Dust-proofing appears to have little effect on the combustion properties of coal, but there is some slight evidence that size degradation is less with well-sprayed coals.
D. L. S.

542. Treatment of Tar and Oils. Anon. *Report of Fuel Res. Board for Year ending* 31.3.38, 147–186.—The study of the treatment of tar has been mainly confined to the investigation of the hydrogenation process. This in general takes place in two stages :—

(1) Liquid-phase treatment in presence of a finely dispersed catalyst to convert asphaltic material into oil.
(2) Hydrogenation in vapour phase of selected fractions from the first treatment over a fixed catalyst to yield the required product.

The liquid-phase hydrogenation of both high- and low-temperature tar takes place readily in the presence of hydriodic acid or a mixture of this acid with ammonium molybdate.

For the vapour phase treatment a fixed catalyst is used consisting of :—
(*a*) A supported material such as molybdenum sulphide on alumina gel, or
(*b*) A pelleted material such as pure molybdenum or tungsten disulphides.

(*a*) can be readily reactivated but (*b*) must be entirely re-made when its activity has deteriorated.

Results obtained by treatment of low-temperature Cannel tar and Kimmeridge shale tar are given.

Experiments have been carried out on the desulphurization of benzole by mild hydrogenation. Three catalysts were tried out :—

(1) Molybdenum sulphide on alumina gel.
(2) A mixture in equimolecular proportions of MgO, ZnO and MoO_3.
(3) Pelleted molybdenum disulphide.

Catalyst (1) showed the least loss in activity, but none of the catalysts effected a sufficient reduction in S. Catalyst (3) was found to be the most suitable substance for work at elevated pressures.

Diesel fuels have been prepared from low-temperature tars, Cannel tar, and shale tar by :—

(*a*) Direct distillation.
(*b*) Hydrogenation over suitable catalysts.

The two latter tars yield oils with good cetene numbers.

A number of pure substances have been treated by the hydrogenation-cracking process in order to study the nature of the reactions occurring during hydrogenation.
D. L. S.

543. Patents on Coal. A. Pott and H. Broche. U.S.P. 2,147,753, 21.2.39. Appl. 30.11.35. Production of extracts from solid carbonaceous substances by means of solvents—*e.g.*, tetraline and phenol—at 300–420° C. and at 10 to below 100 atm./sq. cm. pressure. The reaction is carried out in a closed vessel, and hydrogen is introduced during the extraction, and the extract slightly hydrogenated using a molybdenum dioxide catalyst.

E. Slatineanu. U.S.P. 2,151,165, 21.3.39. Appl. 18.4.36. Production of hydrocarbons from carbonaceous substances by treating them at 390° C. with a gas mixture containing substantial quantities of methane at at least 500 atm. pressure above normal, to cause polarization of the CH_4 present. W. S. E. C.

544. Patent on Shale. J. J. Crawford. E.P. 499,141, 18.1.39. Appl. 18.6.37. Treatment of kerogen-containing shale for the recovery of oil. W. S. E. C.

Economics and Statistics.

545. Economic Aspect of the World Asphalt and Bitumen Industries. W. Schmidt. *Rev. Pétrolif.*, 1939 (828), 350–354.—The author gives a statistical review of the production and consumption of natural asphalts and bitumens in the various countries of the world from 1909 to 1937 in the case of natural asphalts, and from 1924 to 1937 for bitumens. For purposes of discussion, the countries are divided into three groups : those treating their own crude petroleum for bitumen manufacture, those treating their own and imported crude, and those countries such as Great Britain which treat only imported crude. Two tables are given showing world production of natural asphalt and bitumen in thousands of tons over a period of years, and a third table shows exports, imports, and consumption of bitumen in thousands of tons for the year 1937, the world consumption for that year amounting to over 8 million tons. E. W. H.

546. Industrial Utilization of Fats and Oils. A. Guillaudeu. *Industr. Engng Chem.*, 1939, **31** (2), 158–162.—The principal uses of various fats and oils are outlined, and an attempt is made to forecast the trend of future developments in the oil-and-fat industry. H. E. T.

547. Increase of Tax on Petroleum in Ecuador. Anon. *Bol. Inform. Petroleras*, Sept. 1938, **15** (169), 119–120.—Decree constituting an increase of the taxes imposed on the 30.8.35 under concession to the Anglo-Ecuadorian Oilfields, Ltd. H. I. L.

548. Regulation of the Petroleum Industry in Portugal. Anon. Translated from *Diario de Governo*, 12.2.37. *Bol. Inform. Petroleras*, Sept. 1938, **15** (169), 106–118.—This decree (Act no. 1,947) comprises the Portuguese Government regulations controlling importation, storage, and use for industrial purposes of crude mineral oils, their derivatives and residues. It also covers the exploitation of mineral oil deposits in Portuguese Territory. H. I. L.

BOOK REVIEWS.

The Miocene Stratigraphy of California. By R. M. Kleinpell. Pp. 450, 22 plates, 5 folding charts (in pocket), 9 figs. and 17 tables in text. Tulsa, Okl.: Amer. Ass. Petrol. Geol., and London: Murby. 1938. $5.00.

This handsome volume claims to resolve the confusion hitherto surrounding the correlation of the Miocene formations of the several basins of California. As in so many other cases, what have been assumed to be formations of precise age-value, in simple sequence, are now explained as overlapping facies-formations of varying time-duration. The familiar names Vaqueros, Temblor, Monterey, and Santa Margarita must now fall into the same category as the English Greensand formation or the Upper Lias Sands. To determine their age-value in any area, recourse must be had to fossils of zonal value.

The clue to the sequence is found by the author in the Monterey Shales of the Reliz Canyon, Paso Robles Basin, where he distinguishes fourteen foraminiferal zones, for which he claims the same value as that of Jurassic ammonite-zones. Before arriving at this conclusion he discusses with great clarity the ecology of the foraminiferal faunules, and the discrimination between facies-marking and dating value. This long discussion (pp. 79–99), in which the views of Oppel, Arkell, and others on Jurassic zones are set forth, is of interest to other geologists than those concerned with the Miocene.

The fourteen zones (subdivided into zonules) he groups into six stages (or, rather, five and a half, the upper part of his highest stage having no foraminiferal fauna), to which he assigns entirely new names, with a seventh (Oligocene) below; These are, in ascending order: Refugian (Oligocene), Zemorrian and Saucesian ("Lower Miocene"), Relizian and Luisian ("Middle Miocene"), Mohnian and Delmontian ("Upper Miocene"). Correlation follows with six other Californian basins and others farther north. Correlation with mammalian faunas is attempted: the *Merychippus* faunas appear to be mainly Luisian, but ranging above and below; the *Desmostylus* fauna of Kern County, Relizian. European correlation is only suggested broadly, but it would seem that the Californian "Lower Miocene" would be called Oligocene here, and the highest "Upper Miocene" may be equivalent to Sarmatian.

Tabulations show how Vaqueros, Temblor, Salinas, Monterey, and Santa Margarita overlap one another in time and have no such precise age-value as is claimed for the new stages.

For those who are working at these Miocene formations in the field and laboratory, there is a series of range-tables of foraminifera, the most elaborate of which gives the range of some 450 species and varieties; whilst a folding table gives the much more detailed distribution of 132 of these in the type-section (Reliz Canyon), distinguishing over 150 horizons (at 10 or 15 ft. intervals) in 1635 ft. of Monterey Shale.

These questions of correlation constitute the first half of the book, which gives outline maps of the type-areas of the seven new stages. There is also a contoured map, with collecting localities, of the Reliz Canyon: this, unfortunately, has no scale, but from comparison with sections given elsewhere it would appear to be about 2·8 in. to the mile, or 1 : 22,630.

The second half of the book is a systematic catalogue of the foraminifera quoted in the first half, illustrated by 22 photographic plates. A tentative course for the evolution of the genus *Siphogenerina* is suggested. It is interesting to note that no addition has been made to the solitary record of *Lepidocyclina* by Taliaferro and Schenck, six years ago.

There is an admirable index, and extensive bibliographies.

A. Morley Davies.

Physical Constants of Hydrocarbons, Volume 1. Paraffins, Olefins, Acetylenes and other Aliphatic Hydrocarbons. By Gustav Egloff. Pp. 403. Reinhold Publishing Corp., New York, or Chapman & Hall, London. 45*s*. net.

When the Universal Oil Products Co. publish a work composed entirely of data, statistics, and bibliography, petroleum chemists will feel assured, without the recommendation of a reviewer, that no organization is better fitted to compile such a book, so high is the reputation in the petroleum world of the records and filing department of this company.

The developments of the petroleum industry are to-day proceeding along lines which concentrate attention less and less on the natural mixtures of uncertain composition, and more and more on the isolation, identification, and utilization of individual hydrocarbons, for these latter, obtainable from petroleum by distillation or by decomposition, now form the raw materials for the manufacture of a rapidly expanding range of commodities from aviation fuels and alcohols to rubber and resins. The primary necessity of the research chemist, in whose hands the future development of the petroleum and the synthetic chemical industry rests, is a precise knowledge firstly of his raw material and secondly of his derived products, and this knowledge depends *au fond* on the physical constants of the hydrocarbons he uses.

Dr. Egloff has therefore done a great service to petroleum chemists by preparing in a series of four volumes, of which this is the first, a very full series of tables of the physical properties of the hydrocarbons. These embody melting and boiling point at a range of pressures up to the critical point, expansion coefficient, specific gravity, and refractive index. The literature has been thoroughly searched, and every figure recorded bears its bibliographical reference. Those chemists who have had to seek for such information and have found a variety of inconsistent results will appreciate Dr. Egloff's action in printing in heavy type the figure he considers most reliable.

Not the least interesting part of the book is the introduction, in which Dr. Egloff gives an account of the sources of his information. He makes it evident that, in addition to the extensive publications from the laboratories of the oil companies, a vast amount of co-operative research is in progress in America, financed and assisted mainly by the big petroleum corporations working in concert with the Universities and collaborating with such organizations as the Bureau of Standards.

This volume, which is limited to the open-chain hydrocarbons, and those which will succeed it and deal with the closed-ring types of hydrocarbons, are reference books which no petroleum research laboratory can afford not to buy.

F. B. THOLE.

Histoire et Archéologie du Pétrole. Extrait du Tome IV. IIme Congrès Mondial du Pétrole, Paris. 1939. Pp. 95.

M. Maurice Mercier, President of the Economics Section of the 2nd World Petroleum Congress, records that it was with considerable doubt as to its ultimate success that it was decided to devote a section of the Congress to the history and archæology of petroleum, a section with no precedent at the London Congress of 1933. With the exception of scattered references in military history to the use of " Greek Fire," and certain well-known quotations from the Bible and Pliny, there appeared very little data to work upon. But in January 1936 M. André Seguin published a scholarly treatment of the history of petroleum in Greek and Roman times. A month or so later R. J. Forbes' monograph on " Bitumen and Petroleum in Antiquity " appeared (Leiden, May 1936). With these enthusiastic collaborators M. Mercier finally arranged an archæological section of the Congress. It is a proof not only of M. Mercier's own interest in the subject, but also of the real wealth of information available, that this section was so successful.

Nine papers covering the fifty centuries of petroleum in the Old World before the first well was drilled in the New were assembled for the Congress. These have now been reprinted as an excerpt from Volume IV of the *Proceedings*. The list of the papers is as follows :—

R. J. Forbes (Amsterdam).	"Sketch of the History of the Petroleum Industry."
Prof. E. Herzfeld (Princeton).	"The Aryan Myth of Naphtha."
André Seguin (Paris).	"Petroleum in Ancient Egypt."
,, ,,	"Petroleum in Western Asia in Ancient Times (Elam and Mesopotamia)."
,, ,,	"Petroleum in the Orient (Canaan, Carthage, and the Hittites)."
,, ,,	"Petroleum in Ancient Greece and Rome."
L. Lockhart (London).	"Persian Petroleum in Ancient and Mediæval Times."
T. Mikucki (Lwow).	"History of the Polish Petroleum Industry."
M. Mercier (Paris).	"Laboratory Verification of Certain Aspects of the History of Petroleum."

The excerpt is completed by a verbatim report of the Session of 14th June, 1937, presided over by M. R. Dussaud, Membre de l'Institut, at which the above papers were discussed. The General Summary prepared by M. Jules Toutain summarizes the nine papers.

The greater part of the material now collected together for the first time consists of literary references and interpretations. This is in itself an achievement, in that it provides the essential data on which a connected history of petroleum in antiquity can be based. Mr. R. J. Forbes has, indeed, attempted this task. He has displayed historical judgment in presenting the various epochs in the history of petroleum in their proper perspective, relating them to the appropriate stage in the development of civilization. The modern interpretation of the function of archæology is that of supplementing or correcting recorded history, and it is to be hoped that M. Mercier will continue his investigations in that spirit of scientific research exemplified in his own contribution to this valuable symposium of papers.

S. J. Astbury.

PUBLICATION RECEIVED.

British Standard Specification No. 829 for Mild Steel Drums for Inflammable Liquids. February 1939. Pp. 16. British Standards Institution, 28 Victoria Street, London, S.W.1. Price 2*s*.

This specification relates to welded mild steel drums intended to be used for the storage and conveyance of highly inflammable liquids not completely miscible with water, and of moderate vapour pressure and flashing below 75° F., when tested in accordance with the Petroleum (Consolidation) Act of 1928. It represents an advance in the technique of transporting petroleum products of an inflammable nature, inasmuch as it has been found possible to standardize a lighter drum than was previously in use. This has been achieved through the active co-operation of the Railway Companies and the Oil Companies, and the tests on lighter drums undertaken by the courtesy of the Railway Companies have demonstrated that it is possible to use a lighter drum without any material sacrifice in the safety requirements for the carriage of inflammable products.

INSTITUTE NOTES.

May, 1939.

STUDENTS' MEDAL AND PRIZE.

The Council has awarded the Students' Medal and Prize to V. G. Norris, Stud.Inst.Pet. (Birmingham University), for a thesis on "Porous Flow and its Application to Increased Recovery from Petroleum Reservoirs."

A Special Prize has also been awarded for the highly commended thesis of N. V. Munster, Stud.Inst.Pet. (Birmingham University) on "Addition Agents for Lubricating Oils."

Conditions of 1939–1940 *Award.*

The Council has decided that the Students' Medal and Prize in 1939 will be awarded for a thesis on a set subject, and not for theses on subjects chosen by the candidates themselves.

A short list of alternative subjects on which theses are invited will be issued by the Council to all Students of the Institute after 30th June, 1939.

TRANSFERS TO NEW CLASSES OF MEMBERSHIP.

Members who wish to apply for transfer to one of the new classes of membership are requested to submit their applications as early as possible on the forms provided for the purpose at the back of the leaflet convening the Special General Meeting in January, 1939.

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 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.

Bangert, Norman Roy, Student (*Shell-Mex & B.P., Ltd.*), 26, Harrington Square, London, N.W. 1. (*J. Corthesy ; W. Wardlaw.*)

Forrester, Donald Stewart Rose, Engineer, c/o Soc. Unirea, Casuta Postala No. 1, Ploesti, Roumania. (*O. A. Bell ; C. G. Hitt.*)

Fussteig, Rafael Simon, Consulting Engineer, Kraszewskiego 16, Jaroslaw, Poland.

Morgan, Leo Clark, Geologist (*Morgan Acid Inc.*), 207, Ellis-Singleton Building, Wichita, Kansas, U.S.A. (*I. Gardescu ; W. W. Connor.*)

Morley, Ronald Herbert Henry, Chemist (*Asiatic Petroleum Company*), 8, Cartwright Gardens, London, W.C.1. (*J. Kewley ; W. W. Goulston.*)

Pizanty, Mihail, Editor (*Moniteur du Petrole Roumain*), B-dul I.C. Bratianu, 26, Bucharest, Roumania. (*P. R. Clark ; L. Edeleanu.*)

RUTHRUFF, Robert Freeborn, Chemist, The M.W. Kellogg Co., 225 Broadway, New York, U.S.A. (*G. Egloff ; A. E. Dunstan.*)

SOPPET, Denis, Customs Officer, 118, Lansdowne Road, Worcester. (*A. R. Bowen.*)

WARD, John Thomas, Engineer (*M.W. Kellogg Co.*), 841, Cedar Terrace, Westfield, New Jersey, U.S.A. (*A. E. Dunstan ; F. B. Thole.*)

ARTHUR W. EASTLAKE,
Honorary Secretary.

ASPHALTIC BITUMEN GROUP.

A visit to the Road Research Station at Harmondsworth, Middlesex, has been arranged for Tuesday, 20th June, 1939. Members of the Asphaltic Bitumen Group and other members of the Institute who are desirous of participating in this visit should communicate as early as possible with the Honorary Secretary, Mr. C. E. Evans, c/o London and Thames Haven Oil Wharves, Ltd., Thames Haven, Essex.

Two meetings of the Group have been held since its inauguration in December 1938. Both meetings were held in the Institute's Library in The Adelphi. On 28th March, Mr. D. C. Broome gave a paper on "Measurement of the Flow Properties of Bitumen." Dr. A. R. Lee followed with an account of some of the work carried out at the Road Research Station on the same problem.

On 9th May, Mr. L. G. Gabriel gave a paper on "Bitumen Emulsions—Their Development and Present Sphere of Utility." Both these papers will be subsequently published in the Institute's *Journal*, probably in the August issue.

The following constitute the Committee of the Asphaltic Bitumen Group :

J. S. JACKSON, B.Sc., F.I.C. (*Chairman*).
C. E. EVANS, B.Sc., A.I.C. (*Hon. Secretary*).
D. C. BROOME, F.C.S., M.Am.Chem.Soc.
F. H. GARNER, Ph.D., M.Sc., F.I.C.
R. PRESTON, M.Sc., A.I.C.

Members of the Institute resident in Great Britain who are not yet registered for receipt of the notices relating to the Asphaltic Bitumen Group and who wish to be informed of its programme should communicate with the Honorary Secretary at the address given above.

WORLD AUTOMOTIVE CONGRESS.

Dr. A. E. Dunstan will represent the Institute at the World Automotive Congress in New York and Detroit from 22nd May to 2nd June, 1939. Dr. Dunstan will address a General Session of the Congress in New York on 22nd May on "To-day and To-morrow in Petroleum."

Mr. N. Mitchell, M.Inst.Pet., is the official delegate of the Institution of Automobile Engineers.

JOURNALS WANTED TO PURCHASE.

The Institute is prepared to purchase copies of the following issues of the Journal at the price of 10*s.* 0*d.* each :—

No. 1, June 1914
,, 19, April 1919
,, 31, April 1922

Journals should be forwarded to the Secretary, The Institute of Petroleum, The Adelphi, London, W.C. 2. Only copies in good condition will be considered for purchase.

PERSONAL NOTES.

Mr. R. Chandler has left for Bahrein Island.
Mr. F. E. J. Foxall-Smedley is home from Burma.
Mr. H. T. Lorne is returning to Iran.
Mr. C. V. Rutherford is returning home from Iran.
Mr. L. A. Wilshere has returned to Iran.

Correspondence or *Journals* forwarded to the following members have been returned, and the Secretary would be pleased to receive any information regarding their present address : G. E. Barber, E. C. Brown, K. Burton, E. B. Chapelle, O. C. Elvins, V. C. S. Georgescu, J. J. L. Hamilton, J. R. Horth, A. D. Jones, J. Lander, H. R. Lovely, I. Lusty, F. Mackley, A. MacLean, G. P. Melville, C. A. Moon, L. Mountford, S. Nicol, S. Papp, R. G. Reid, N. D. Rothon, R. W. Smith, H. G. Spearpoint, and P. F. Thurlow.

NOTICES.

The Institute as a body is not responsible for the statements of opinion expressed in any of its publications.

Copyright.—Publication of abstracts of Papers and articles appearing in the Journal is permitted, provided that acknowledgment is made to the Institute of Petroleum.

Papers and Articles.—The Council invites Papers and Articles both for reading at Ordinary Meetings of the Institution and for publication in the *Journal.* All Papers, whether for reading or publication, will be submitted to a referee appointed by the Publication Committee.

The Institute has published a brochure "Instructions for the Guidance of Authors" containing details of recommended practice in the preparation of Papers for publication. Copies of this brochure will be supplied on request.

Pre-Prints.—Advance proofs of Papers to be read at Ordinary Meetings are generally available about a week before the Meeting. Members wishing to be supplied with these pre-prints are requested to notify the Secretary.

Abstracts.—Members and Journal Subscribers desirous of receiving the Abstracts printed on one side of the paper only, can be supplied with these at a charge of 10*s.* per annum per copy, payable in advance.

Issue of Journal.—Members whose subscription is not in arrear receive the *Journal* free of cost. A member whose subscription is not paid by March 31st of the year for which it is due is considered to be in arrear.

Changes of Address.—Members are requested to notify any change of address to the Secretary.

Benevolent Fund.—The Benevolent Fund is intended to aid necessitous persons who are or have been members of the Institute, and their dependent relatives.

The Fund is raised by voluntary annual subscriptions, donations, and bequests, and all contributions should be sent to the Secretary of the Institute at The Adelphi, London, W.C. 2. The Fund is administered by the Council through the Benevolent Fund Committee, and all applications in connection therewith must be made on a special form which can be obtained from the Secretary of the Institute.

Appointments Register.—A register of members requiring appointments is kept at the offices of the Institute, and every effort is made to assist members of the Institute in search of employment.

Members who desire their names and qualifications to be included in this register are requested to apply to the Secretary for the Form of Application for Registration, if they have not already done so. Members residing in the London area are asked, if possible, to return this Form in person and make themselves known, together with their requirements, to the Secretary. It is also requested that members should notify the Secretary immediately they have obtained an appointment.

In submitting names of candidates to prospective employers it is understood that the Institute accepts no responsibility and gives no guarantee.

Library.—The Institute's Library may be consulted between the hours of 9.30 a.m. and 5 p.m. daily. (Saturdays, 9.30 a.m. to 12 noon.)

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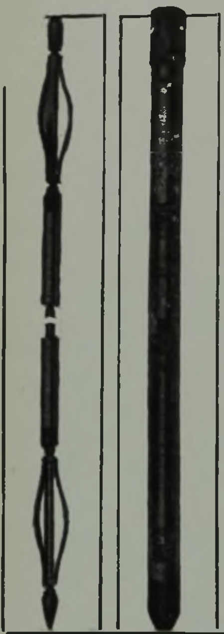

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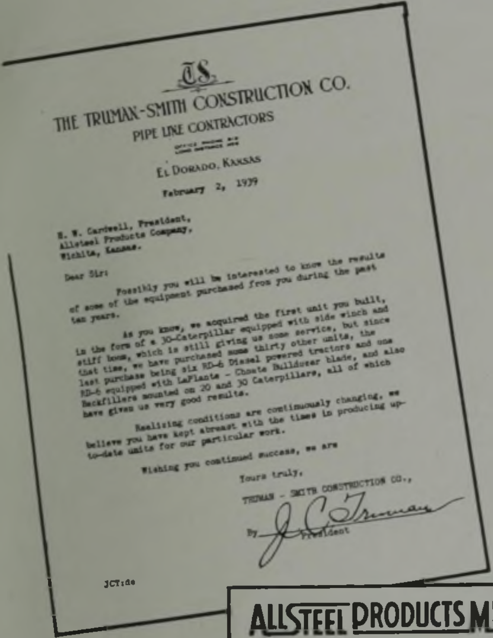

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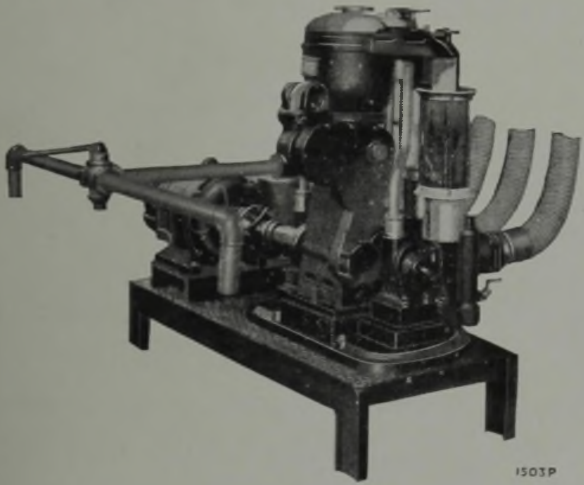
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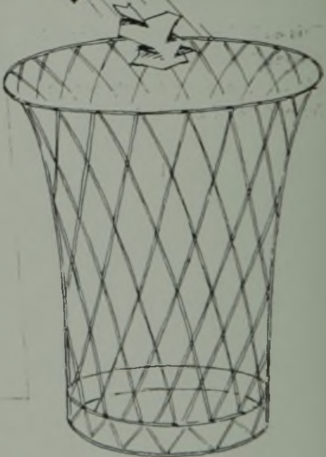

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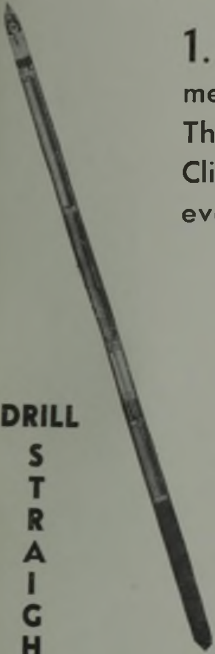

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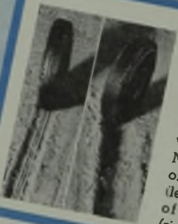

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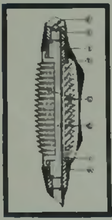

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